Development of a work pattern model to meet the changing service requirements with respect to patient and staff needs in Scottish radiology departments

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1. Abstract

Radiology departments across Scotland are currently challenged with increasing workload demands together with 24/7 service sustainability. Planned care must be aligned with unscheduled care to ensure equity of access for all patient groups. In addition to the workload, government and local policies have altered the pattern of healthcare provision and thus the spread of referrals throughout the 24 hour period. Nationally there is a move to redesign radiographic out of hours (OOH) duties to respond to government policies with consideration to the subsequent effect on core hours arrangements. This is hoped to aid recruitment and retention. There is, however, no structured model that defines the staff resource required in general radiography for an unscheduled workload. This is an essential component in determining the resource required to meet the needs of a 24/7 service. This study aimed to develop a model that encompassed a defined staff resource per workload and embedded this resource in an application that provides satisfactory 24/7 service cover.

A detailed workload analysis of a data extract from the radiology information system (RIS) was undertaken to comprehend workload patterns and trends in the principal study centre. A workpattern model was developed by deductive analysis and reasoning of the data derived from the above evaluation. This determined the staff resource required dependent on the workload. The workforce profile was determined by means of the principle of crew pairing to determine skill mix. Applications of this model over 24/7 were explored: the theory of adaptive planning was employed to describe the staff resource required for general radiography across the 24 hour period dependent on the non deterministic nature of the workload while responding to cost effective patient management. The findings were extrapolated in case studies of the principal study centre, a teaching centre and an urban general hospital.

An attitude survey was undertaken in the three case study centres, (rural, urban and teaching centres) with differing workload streams relevant to the characteristics of the different centres. Radiographer attitudes to this workpattern model and modular application were evaluated by likert scale responses. This investigated whether they considered that the model and application would be appropriate in centres of differing characteristics and also whether there are currently sufficient numbers and the appropriate grades of staff to support the model. Attitudes to the effect of the model on radiographers personal development plans and worklife balance was also evaluated.

The workpattern model developed allows a structure to be imposed on the staffing resource required dependent on local workload statistics. Thus this model could be applied to all hospitals regardless of characteristics. The modular application is flexible and therefore suits local adaptive planning, meeting the needs of the 24/7 service.

Contents

2. Introduction

Radiology Departments across the country are facing challenges in meeting workload demands and aligning unscheduled care and planned care. Workload demands have increased over the past few years (ISD, 2008-1). The structure and referral pattern of the workload has altered as a result of government polices and targets in addition to modern attitudes to healthcare provision. (Scottish Government, 2008-2, NHS 24.com, 2008). The policy that led to major change in the hospital culture is the Working Time Regulations (WTR) (HMSO, 1998). Doctors now work shift patterns in place of the previous on-call arrangement, to ensure that they do not breach the Working Time Regulations (Direct Gov, 2008). Thus diverse imaging is required across the 24 hour horizon to support the changing pattern of medical care (Department of Health, 2003- 2).

There has been some research already undertaken by the Scottish Government in analysing radiology workload as part of the Diagnostic Collaborative initiative (Scottish Government, 2006-2). This was not focused fully on workload and did not explore staff attitudes to work pattern changes, concentrating more on process change in relation to planned care. The Unscheduled Care Collaborative (Scottish Government, 2005) undertook data analysis of various aspects of the unscheduled care pathway but did not undertake specific investigation into radiographic processes, workload and workpattern.

The Unscheduled Care Collaborative, (2005) indicated that timely investigations allow clinicians to decide to admit patients for appropriate treatment rather than admit patients to decide on the investigative pathway (Hassan, 2003). This indicated that there should be appropriate resource management to support early investigations of unscheduled care patients, to facilitate their treatment and care pathway (Lane et al, 2000). However, this must be aligned with planned care (patients whose investigations can be scheduled supporting demand and capacity planning). Neither group should be detrimentally affected by inequities of access.

Locally, general radiographic OOH duties in the principal study centre are currently covered by a combination of lone working shift work and stand-by (residential on-call). Due to the perceived increase in OOH workload and dissatisfaction of staff, there is a move to redesign OOH duties. This redesign has to be considered in concurrence with planned care during core hours as any alteration of the staff resource and current workpatterns may impact on 24 hour service sustainability. Nationally there are moves to redesign OOH duties across Scotland to achieve a national stratified approach. This is partly driven by demand management and partly to align the OOH cover across health boards. A

consistent approach to OOH, rather than individual local arrangements that may have differing financial attraction will facilitate national recruitment and retention.

It is, therefore, important to explore general radiography workload in detail to determine the staff resource requirement as this has not previously been undertaken, locally or nationally, in sufficient detail to aid workforce planning. Planning the workforce that meets the changing service requirements requires this data analysis. A model to determine the workforce profile in relation to workload across 24 hours is an appropriate tool to support service sustainability and workforce deployment. It is also fundamental to explore the implicit risks in workforce models and systems of work. A statistically derived, data driven model that underpins a local application and implementation strategy will acknowledge cost effective service equity across NHS Scotland. This workpattern will therefore support recruitment, retention and skills mix in radiography in accordance with local demand, activity and capacity planning.

3. Aim of the study

The aim of this study is to develop a workpattern model for general radiography that will underpin skill mix and role development. This model will support 24/7 working in general radiography and will facilitate a re-design of general radiographic service provision to meet the changing service requirements with respect to service, patients and staff needs in Scottish radiology departments.

4. Objectives for the study

- To critically evaluate current literature surrounding workload, workforce planning, government policies and healthcare priorities to comprehend the subject of workpattern modelling in relation to the unscheduled nature of general radiography, thus supporting the scientific perspective of minimising misconceptions and pre-conceptions.
- To undertake empirical research of the local workload demands by quantitative (time series) data analysis of workload statistics representing the workload using the time period from the installation of a new radiology information system (RIS) to just prior to the commencement of this study (Oct 2007-Dec 2008). This will show evidence of the spread of the demand for general radiographic service in the scientific perspective.
- By deductive analysis, forecast the expected workload demand for the time period following December 2008, by time series forecasting using decomposition analysis. This is an essential component in developing a future proof workpattern model for general radiography in Scotland.
- By deductive analysis, explore the frequency distribution of patient episodes. This will inform the development of a workpattern model.
- To develop a workpattern model by means of deductive reasoning, that will be appropriate and applicable for general radiography in radiology departments across Scotland.
- To explore implementation of the workpattern model with respect to local application.

5. Literature review

5.1 Keywords

In order to explore the issues around this study, it was important to determine the diverse areas of literature to review. Most importantly the literature on developing models was studied. As developing a workpattern model is the main focus of the study, it was essential that current and historical literature on workload models and workpattern models for other work situations be thoroughly reviewed for possible transferable options or elements that would be appropriate for the profession of radiography.

Investigating both workforce planning and workforce profile are essential components of this study as this will identify strategies for determining staff resource. This will support the development of the workpattern model. Many influential works are established research and current applications have roots in these significant studies.

The effects of the application of different workpatterns in the workplace on both the service and on life outwith work were briefly explored. This is important background knowledge that will inform on the implementation of the workpattern model. Searches on the designated profession and professionals were appropriate in providing important background information in the related areas of the study.

Thus key words of workload, workpattern, workforce models, workforce modelling, workforce profile, radiology, radiography and radiographers, scheduling and rostering, shift work, on-call and work-life balance were explored.

Medline, Pubmed, Ovid and Google Scholar were searched for these key words.

In addition library archives of the Society of Radiographers and the Royal College of Radiologists were searched for publications related to workforce planning and related subject matter.

Scottish Government (Health) publications and Department of Health publications were also searched for related subject matter.

5.2 Workpattern Modelling

Literature on workpattern modelling was explored to identify methods of developing models that may have transferable elements in radiography. Workpattern modelling is based on some form of mathematical evaluation or solution to a mathematical equation or algorithm. Workpattern modelling must be differentiated from traditional staff scheduling. Staff scheduling is related to time management and administration of staff resource. Workpattern modelling is a more holistic approach incorporating forecasting workload, and the staffing resource required to meet the workload. Modelling also requires integration of the workforce into the scheduling process through interactivity, management of working times, financial aspects of staffing and staff work-life balance preferences.

Bach, (1999) wrote about workpattern modelling founded on risk based testing for a software testing and quality engineering journal. He clearly explained the purpose of his article and explained the theory of risk based testing as being a problem that might happen and the more likely it is to happen, the greater the impact on the project. The technique of risk based testing during development of a project, has only nominal transferability to the current research. In this study, the only relevant risk based testing generates the demand into the service and thus acts as a demand filter. There is, therefore, impact on the service at the point of entry but the research is based on the management of the demand within the service and so the workpattern model based on risk based testing will have little commonality or transferability to the current research. In contrast, many workpattern models use the linear programming approach to create the model. Linear methods are based on assumptions that demand is based on a series of independent events, all of which have a consistent predictable outcome (Alfares, 1998). Alfares, (1998) described a cost efficient cyclic system to schedule the minimum staff required for the demand, working a five day working roster, followed by two days off. This method is often employed to model the workpattern in planned activity, which can be scheduled and so has transferability to certain aspects of radiography but does not have straightforward application for general radiography. The demands of unscheduled care across the 24/7 horizon require a flexibly planned staff resource across the 24 hours. The model described by Alfares, (1998) would work well if a pre- determined and equal resource was required across the 24 hours but does not support flexible resource. The computational algorithm would be excessively complicated and therefore time inefficient. The results using this method are often incomplete or not totally efficient, as there is no margin for variability and thus this explains the difficulty in aligning planned care and unscheduled care. Linear models relating to unscheduled care are ineffective due to the variability of the workload and thus require an alternative modelling approach due to the unpredictability of the workflow (Alfares, 1998).

A review of the literature for workpattern modelling in all professions has identified five broad categories of modelling: A limit to the caseload in numerical terms; a restriction of the caseload by access criteria; a breakdown of the elements of the workload and a time component within these elements; a mechanism based in costing with a time component built in; structured data analysis of historical and current data to analyse resource requirements. These five categories will be explored in detail looking for elements of transferability to the radiography profession and to radiology departments.

5.2.1 Numerical caseload limit

The first category of limiting caseload by numerical terms would include proposals for social work. Social work literature often mentions caseload limits but a maximum case number and a weighting system would be difficult to determine. Mansuri, (2009) writing on a community care forum website, indicated that there should be broad rules in place but specifying a number would be meaningless due to the complex nature of certain cases. Unison, (2008) believes that childrens' social workers should have a national standard of a maximum caseload of 20 families with adjustments made for types and complexity of cases matched to experience and training of the worker. This standard should be audited regularly to ensure compliance with, and sanctions against, employers who breach this standard. This may be a response to press coverage of specific cases where devastating events have been blamed on social workers. Social work response is often couched in caseloads too excessive to monitor all cases satisfactorily. There is no stated structure or data to support the numerical count recommended by Unison, (2008) and no weighting to support the complexity of cases. In contrast Health, Social Services and Public Safety, (2008) has proposed a caseload management model that has a weighting and quantifiable method of structuring a caseload. However, the proposal states that the model is not an exact science only a guide, and that team leaders can exercise authority to assign cases as necessary. It is therefore difficult to justify and evidentially quantify this proposed workload which may be derived from experiential sources. There is no parallel for this in unscheduled care and no commonality within general radiography.

5.2.2 Restriction by access criteria

In contrast, the second category, restriction of caseload by entrance criteria, is a structured assessment process using a risk based strategy similar to Bach, (1999) and has examples in medical backgrounds. Croydon PCT has pioneered the combined predictive model as the criteria for admission to the community matron caseload (NHS Networks, 2009). Patients are predicted as being at high risk of re-hospitalisation using a risk model encompassing data from previous hospital admissions, outpatient department data, emergency department (ED) data and GP data. This identifies the high risk patients who are then added to

the community matron caseload (Department of Health, 2006). Again this is a risk stratification tool, similar to Bach, (1999) and is broadly similar in application. There are risks which are identified by the extensive data collection; the higher the risks, the more likely the outcome of re-admission. Therefore the intervention of addition to the community matron caseload for the high risk patients reduces and hopefully eliminates the risk of re-admission. The report is detailed and describes the criteria used to measure the risk and the strategies planned to reduce the risk, in order to restrict the patients added to the caseload. This restriction allows focused care on the appropriate client group. Though a detailed report, this has few transferrable elements to general radiography or to this study.

Similarly, mental health teams have identified caseload difficulties associated with inappropriate referrals (Mountford, 2004). Mountford, (2004) discussed the project structure of determining the efficacy of an assessment tool to assess patients' mental health needs. This was introduced to improve the management of referrals by allowing identification and triage of patients most in need of mental health care. The article was very detailed, explaining the tool which uses validated scores and also explaining the domains of mental health being assessed. This is once more similar in concept to Bach, (1999) in that the higher risk client group is identified and the solution to ameliorate the risk is to intervene with acceptance of referral to the mental health team. Again, this restriction allows the effective access to the relevant care pathway for the appropriate client group. However, this project is not fundamentally transferrable to this current study.

A resource use measure tool was approved by Scottish Government, (2002) to assess the resources needed within the remit of the government's commitment to free nursing and personal care. The aim of this tool at local level was to: promote effective use of resources across caseloads; allocate local resources to promote equity of access; manage unmet need within caseloads and so inform service planning and development. The tool is very structured, with simple tick box responses, which are aggregated to determine the needs of a particular patient allowing quantification of the support resource required. Thus this resource tool is utilised to identify relevant referrals and appropriately deploy resources. This is an evidence based model related to restriction criteria that can be justified in relation to outcomes, echoing the risk based strategies above that function by assessing the risk and intervening to reduce risk by imposing relevant resource.

This category has minimal commonality with general radiography. However, there is a risk based strategy that filters patients using risk based guidelines. This is applied by clinicians who assess patients at a clinical consultation. Referrals for general radiography come from many sources but must be justified under Ionising Radiation (Medical Exposures) Regulations (IR(ME)R), (2000, 2006), (Department of Health, 2007).

These restriction criteria are not intended to restrict the workload only to ensure that referrals for examinations using ionising radiation are clinically appropriate. On the other hand, the use of a risk assessment strategy employing clinical judgement to justify referral is a nominal application of restriction by access criteria in general radiography. Referral guidelines are detailed by the Royal College of Radiologists ((RCR), 2007) and these act as a baseline guidance for medical clinicians. These guidelines underpin IR(ME)R, (2000, 2006) referral guidelines developed as competence based referral protocols for non-medical referrers (RCR, 2008). These RCR, (2007) guidelines act as a risk based assessment tool for medical and non-medical clinicians to filter and refer only patients whose clinical management would be facilitated by imaging for general radiography. However, there is no mechanism to limit, delay or manage the appropriate referrals which generate the unscheduled demand. Thus, while these criteria of workload limitation impact on the demand for general radiography, they have little relevance to the management of the workload and therefore have little application to the study.

5.2.3 Elemental analysis with time component

An entirely contrasting third category was identified in industrial and educational settings. This is a breakdown of the elements of a job into individually timed tasks (or units), or notional timed tasks and then a calculation of the number of tasks that can be undertaken during the work period. Utilising this method of workload units there is an inbuilt assessment for staff development, thus building a quality workforce. Clinical Molecular Genetics Society (CMGS) (2004-2005) details a service specification for a "workload units" scheme. The specification clarifies that the relevant task is broken into elements which are accorded a workload unit score (WLUS). WLUS includes time taken in interpreting and checking raw data. This elemental analysis has similarities in workload modelling in planned care but no relevance in the current study. Similarly, Tsushima et al, (1989) filed a patent in the United States of America for a work scheduling method and system. This involves a scheduling system involving job allocation to resources within which each element of the job is allocated a time unit. A workload balancing is performed for each resource capacity to ensure that the workload does not exceed resource. A second workload balancing is then undertaken to balance the workload allocated within the resource capacity. The second balancing ensures that sufficient resource is available from the preceding section to balance the next stage of the job allocation. This paper was published as a schematic diagram demonstrating the elements and the balancing process. This was extremely clear and easy to follow and the paper was written as the service specification for the manufacturing process. The balancing process construct is dissimilar to CMGS, (2004-5) above and aims to ensure that each section of the elemental analysis is resourced from the previous section. All of the elements in this process are predictable and consistent. This model is suitable for a

project which needs to consider a number of restrictions of the job allocation and again would have application in planned care e.g. ensuring that patients are prepared for a procedure, by support staff, to ensure that the procedure can take place at the scheduled slot. This combinatorial mechanism of elements is not appropriate for general radiography, or this study, due to the demand led and unscheduled nature of the workload. A further application of elemental analysis is higher education institutions (HEI) which have a structured workload allocation model. Workload allocation software is used to implement the workload allocation model encompassing elements for teaching, research, commercial activities and administrative and managerial time. These elements attract a numerical count of a specific number of units (time related intervals) per activity. Lancaster University (Lancaster University, 2000) workload measurement scheme covers the same elements as Napier University (Napier University, 2007/8) and aims to quantify different duties and to allocate work in a way that is fair, equitable, transparent, appropriate and defends and enhances quality. Again, as with Napier University, there is a workload unit which is a time related interval (hours, minutes or other specific measurement). This application is similar in character to CMGS, (2004-5) above in that required tasks are allocated a weighting and the worktime is composed of tasks to the value of the specified workload units. Again, this criteria of modelling is appropriate for planned care but has little application to the unscheduled nature of general radiography.

A common characteristic of many jobs is the variability in the types of tasks that might be undertaken by a particular worker (Nolan, 2009). Nolan, (2009) discusses a theoretical model in higher education and the implications of task allocation using a mathematical model. The paper is clear in aim and works through the process of allocation of tasks using the model. The findings were demonstrated in clear tabular and graphic format. The implications were unexpected, but obvious when explained, regarding differences in time allocation of tasks, such as research allocation, dependent on the length of contract. This paper highlights that mathematical models are on occasion incomplete, as they do not have the ability to accommodate inconsistencies as mentioned above by Alfares, (1998). A further element of this workplace model is the variability of outputs. In the manufacturing industry the output is the product and the aim is a cost effective product with a profit margin. In education, it is the notional product of the teaching culture. The output from manufacturing is a defined product, the output from HEI is a more nebulous concept and there is greater potential for inconsistency in the tasks required. This inadequacy of structured modelling demonstrated the difficulty in developing a model for unscheduled care, such as general radiography, which exhibits an inconsistent workload.

These models are popular due to the need for transparent costing in of academic activity and in the manufacturing process. This category of workload modelling can be measured and accurately predicted. A

broadly related application of the third category is within a medical background. This is only applicable when the activity can be controlled on a sessional basis. Units for radiology involvement were based on time weighting. The Royal College of Radiologists (RCR) points system (RCR, 1999) was introduced to evaluate the time spent on examinations by radiologists, rather than a system based on a costing structure. The reporting time for a chest radiograph was allocated as 3 minutes. Thus 75 chest reports could be generated in a 3.5 hour session. Other examinations were allocated a time weighting dependent on the unit of chest radiograph time (3 minutes). This system assessed the work involved in radiological examinations and a series of weightings was created. A three minute activity was allocated 1 point and a complex activity (over 80 minutes) was allocated 25 points. This system does not relate to the complexity of the individual examination or the experience of the radiologist but only relates to the expected time spent on the activity. However, this allowed a workload allocation of a set number of points per session for radiologists. The system was not fully developed, as the nature of the medical role of radiologists evolved into consultation and advisory capacity. Unfortunately, this system was never validated, though the theory is still often used to assess individual doctor's reporting activity for local workload analysis. While this system has application within radiology departments, there is no application in this current study.

Workload allocation in endoscopy departments is also based on a points system, or in other words, a timed allocation (British Society of Gastroenterologists, 2001). Each endoscopic procedure is accorded a number of points (1, 2 or 3) dependent on the complexity and therefore the time taken, to undertake the procedure. This has similarities to the radiology points system and also the workload allocation in manufacturing and education demonstrating that this is a strategy that is transferrable across industries where the workload can be planned. An endoscopy list or session is planned around a specific number of points. The lists can be made up of a smaller number of high point procedures, a higher number of low point procedures, or a mixed list, responding to the demand. The maximum number should not be exceeded, to ensure that physical fatigue does not occur, as the procedures can be physically taxing. This supports patient safety and the effects of fatigue on duty pattern are discussed later in this review (5.6.7). The number of actual points per list may be lower if the time planned for the list is limited. This modelling category is used to control the activity to a safe level. This modelling is integral to the resource costings for the colorectal cancer screening programme (Weller and Alexander, 2003). This was a very detailed evaluation of the screening pilot. The data analysis was extensive and displayed in graphical, tabular and text. Of note for this study, the statistics supported quantitative analysis of the workload that the programme would generate for each health board. This in turn, using the endoscopy model, allowed calculation of the resource required to meet that extra workload. Neither of these clinical applications is

appropriate to general radiography, which is demand led and where activity has to match this demand in an immediate timescale. These are therefore rejected in terms of this study.

5.2.4 Activity costing with time component

The fourth category of modelling is a costing of activity with a time component in-built and is found in medical literature. England and Wales used Koerner codes to provide an analysis of workload related to casemix, though there is an inbuilt component of estates costing . These were designed to assess the complexity of examinations in financial terms and thus grouped examinations into six categories based on cost (RCR, 1999). This historical college document traces the history of the strategies of manpower planning in radiology departments. These Koerner codes are no longer in the NHS Data Dictionary but had their roots in a time interval measurement and the costs thus incurred (NHS, 2011). The Koerner system was not updated to accurately reflect the costs of, and the radiologists' time involvement in, modern radiology departments. There are no statistics available to show the relationship of Koerner units to the workload of individual radiologists. However, if the analysis of the Koerner data had been undertaken in a relevant manner, it may have aided understanding of clinical episodic workload to facilitate workload model building. However this was not the case and no current data is available to demonstrate workload modelling. Similarly there was a radiography workload estimation tool used in Scottish radiology departments in the late 1980s, early 1990s - the Foresterhill Unit scheme (RCR, 1999) (so called after Foresterhill area of Aberdeen which piloted this scheme). Each radiographic activity and activity with radiologist involvement was given a numerical code. This was a representation of the time period that the examination was expected to take. The daily radiographic workload was calculated over a one month period across all radiography departments in Scotland. This information, along with the staffing levels, was submitted for two agreed months of each year. This was the very early days of clinical workload benchmarking. This category of model had limitations in identifying and modelling individual workloads. Rather, the data retrospectively measured workload that had been undertaken and related this to staff complement for the department. Thus, this would have offered useful background data in the current study of developing a workpattern model. The data could have been usefully analysed to assess workload as a measure in predicting future workload and assess workforce but sadly this was not undertaken at the time. The opportunity was therefore lost and no data can be traced relating to this activity.

5.2.5 Data analysis

The fifth category involves thorough data analysis of demand, capacity and activity. Data was captured over a time period in two chemotherapy sites (Cancer Services Collaborative, 2005). The analysis showed

that there was spare capacity at certain times and a surfeit of demand at other times. An electronic booking and scheduling system was developed to accommodate the different regimen types (these equate to a treatment chair time). This allowed demand to be matched to capacity, allowing better time management of activity. The demand capacity match both enhanced patient care and staff roster management. Likewise, the Diagnostics Collaborative (Scottish Government, 2006-2) provided a toolkit designed to assess demand, activity, capacity and queue in planned care modalities. In the same way as above (Cancer Services Collaborative, 2005) in combination with process mapping allowed certain services to be re-designed to maximise capacity and reduce waste. Diagnostics Collaborative work indicated the necessity of collecting data for demand, capacity, activity and queue in order to maximise capacity and reduce waste (Scottish Government, 2006-2). This was effective but only in modalities that allow structured time slots i.e. planned care (e.g. ultrasound examinations (US), computerised tomography (CT) and magnetic resonance imaging (MRI) examinations are booked at set time intervals dependent on the complexity of the examination). In contrast general radiography may take differing amounts of time dependent on the complexity of the examination and the fitness of the patient which can only be assessed at the time of the patient presentation. These patients cannot be booked or scheduled as this area of the service is demand led and the concepts of capacity, activity and queue need to be assessed by an alternative method. Thus this application of modelling is inappropriate for general radiography though, it has clear application in other aspects of radiography and will therefore be useful when determining staff resource for the total department following development of the workpattern model for general radiography.

Jenkins-Clarke, (1992) discusses four approaches to workpattern modelling by utilising nursing workload management systems that assess activity and capacity in distinct arrangements. This is again a historical discussion paper that clarifies the approaches as mentioned above. Jenkins-Clarke is a research fellow who undertook this study and wrote the discussion paper as commissioned by the Department of Health. She indicates that the need to develop workload models was not new. However, the need to develop evidence based, accurate and cost effective models was now more important, due to the advent of resource modelling. This is still the case many years later and is the intention that this current study aims to address. Workload management systems are based around either a dependency level approach (the dependency of ward patients on nursing care to perform basic tasks of living), a task oriented approach (predicting nursing interventions for individual care), a care planning approach (workload planned via care plans) or a ward based approach (staffing requirements based on bed occupancy or throughput). All of the approaches have limitations and strengths debated in the discussion paper; however a common theme identified by Jenkins-Clarke, (1992) is the benefit of reliable demand and activity data in applying these

approaches. It is essential when applying any of these models to ensure that data is current and local. The recommendations that data be collected to assess the trends for workload, to allow prediction of a workable workload model holds for radiography as well as for nursing. The nursing workload is most similar to general radiography, in that interventions often cannot be booked. The workload may be variable dependent on the ward, department or the level of patient dependency. Frequency distribution of timed tasks and current staffing levels, in addition to mapping the activity over full working days, informs the modelling process. Assessment of local needs both historically and prediction of future needs inform the modelling process and are the essential building blocks of workload modelling. This category of modelling is most applicable to the unscheduled nature of general radiography and detailed assessment of workload and staffing resource will be undertaken in this current research to provide the building blocks for developing a workpattern model.

5.3 Scheduling and Rostering

Finally when developing a workpattern model and the effect on service sustainability, it is important to investigate mechanisms for assigning and deploying staff within the model. As mentioned above, workpattern modelling is related to understanding workload and workpatterns both past, present and future and determining the staff resource required, ensuring viability of the model. Scheduling and rostering is more related to time management and the practicality of mapping the staff resource into the model. Consequently, it is important to understand the mechanisms of scheduling and rostering to explore the utilisation of the staff resource, identified within the model developed, in the workplace. It is also important to comprehend the effects that these rosters have on the service and on individuals' work life balance. It has been difficult to find rostering parallels to radiography in literature. There are many papers relating to nurse scheduling and rostering; however, the majority of the papers adopt mathematical programming to enforce constraints regarding ratios of nurse grades. This involves limiting the staff resource by determining a minimum number of certain grades and a maximum number of other grades but there is little such specific guidance for radiography. However, there is also in literature, a less quantifiable technique that uses experiential knowledge known as heuristics. This is discussed below and is the implicit technique used in scheduling and rostering in most radiography departments.

Heuristics has been identified as a useful method for generating functional complex scheduling solutions and are "rules of thumb", educated guesses, intuitive judgments or simply common sense. This technique can identify models that are optimised to many different criteria at the same time. Heuristic is an adjective for experience-based techniques that help in problem solving, learning and discovery and is used to rapidly achieve a solution that is the best possible answer, or 'optimal solution'. Heuristics, though less

quantifiable than many methods, has a place in problem-solving and can be used where applicable and appropriate (Whitmore, 2008) A heuristic used in problem solving can be employed to reduce the number of options by systematic enquiry or experiential judgment and can help to eliminate unworkable solutions (Mind Tools, 1995-2009). Another heuristic is to look at a similar problem and consider whether the solution to the comparable problem can be adapted to the original problem (Open University, 2007). Scheduling, in practice, is often an educated guess, an intuitive judgment by experience or a measure of crisis management using common sense due to extenuating circumstances. Whitmore, (2008) identifies that heuristics should not be confused with algorithms, as algorithms are for problems that can be quantified in management. It is imperative to ensure that if a heuristic method is employed, it is capable of handling future data sets. This means that the designer must fully understand the rules and the data and develop a plan to meet those requirements and not just address the current data sets (Pearl, 1983). These recommendations are all appropriate in certain aspects of radiography when planning across the roster horizon and will be useful in supporting application of the workpattern model, when developed, into rostering. Heuristics or experiential judgments have historically been the basis of workforce planning in the radiography profession. Bach, (1999) agrees with the above application in rostering, indicating that heuristics is an iterative process of testing a solution against requirements, improving the project and bringing the direction nearer to the goal. This has many similarities to the current rostering and scheduling in radiology departments.

The majority of the documents on scheduling and rostering in nursing, utilise integer programming with the addition of metaheuristical approaches. Downsland, (1998) of similar era to Jenkins-Clarke, (1992) discusses the use of Tabu searching in relation to nurse scheduling. This is a mathematical optimisation heuristic using memory structures. The theory of this programming is that the algorithm does not revisit a previously identified possibility (Taboo). The programming would be useful in scheduling radiographers with multiple specialist interests, as they could not be double booked in error but does not accommodate any arrangement to ensure equity of tasks. Downsland and Thomson, (2000) discuss the natural models of integer linear programs and explain that the integration of a flexible heuristic approach, such as the knapsack approach, leads to a robust scheduling system. A knapsack problem is an issue of combinatorial optimisation. Broadly, all the elements of the problem are allocated a value and a weighting factor. The resultant algorithm identifies the combination of elements that weight less than a given limit and as high a value as possible to be cost effective. This was all discussed clearly in the paper allowing realisation of similarities to the points system in endoscopy workload allocation (British Society of Gastroenterologists, 2001) and could be transferred to radiology modalities based in planned care, where the patients are scheduled to an appropriate length time slot in the working day. This approach was initially considered for

implementation of the findings of this study, as the problem in general radiography is a combinatorial problem of elements that require being reconciled. However, due to the complex nature of flexible working patterns and skills mix, the computational complexity of the scheduling was deemed to be time inefficient to utilise for general radiography and was therefore rejected.

Within a workpattern model, staff assignment occurs at various points in rostering. Tasks are grouped or assigned to subsets of individuals with specific skills. This may involve grouping or pairing as in crew scheduling. Crew pairing within crew scheduling is often related to airline operations and train services (Day and Ryan, 1997). In these industries it is essential that crews of varying skills and covered by differing legislation (e.g. constraints on pilot duty periods without breaks), are buddied together to ensure appropriate staffing for differing duty periods. The underlying objective in the planning problem is to produce a schedule of feasible duties which cover all the timetabled journeys in the most efficient manner possible (Ryan, 1992). Ryan, (1992) authored a technical paper that discussed staff resource allocation in air crew scheduling. It was clearly highlighted that heuristical applications had been the historical method for rostering. However, as crew pairing was seen as a combinatorial problem of skills and legislations where the constraints and variables could be identified, computational optimisation was possible. This was stated as a cost effective and equitable method of task distribution. This theory has transferrable elements to radiography and aligns with the more modern NHS Education Scotland (NES) skills maximisation toolkit recommendations, regarding uniqueness of professional task scheduling (NES, 2007). Elements of this buddying process can be developed within radiography by buddying staff of different bands to cost effectively optimise the rostering.

The main similarity to general radiography with the nursing fraternity is the Emergency Department (ED). Kulatunga et al, (2009) researched a method of adaptive planning. This method, in essence, reviews demand at varying times in the ED and adaptively plans staffing to accommodate the activity. Kulatunga et al, (2009) described the aim of integrated health care delivery and the evolution of a staff model developed from flexible optimisation of a transient queuing system. The aims of a cost effective model that meets patient needs and waiting time targets is very similar to the aims of this study. The unscheduled nature of the workload in the ED is similar to the nature of the workload demand in general radiography. In addition, the 4 hour target in ED includes time spent in the queue awaiting general radiography. Thus the integrated nature of patient investigation and care is incorporated into the service level. Kulatunga et al, (2009) established the demand per hour and matched this with the staff resource using computational algorithms. There were several complex formulae in this paper but the text explanations were clear and easy to understand. This has similarities to the Unscheduled Care Collaborative (Scottish Government, 2007) who undertook analysis of the workload across the 24 hour

period, and thus supported allocation of staffing levels to meet demand. Likewise, the workload in general radiography follows an analogous pattern and the theory of adaptive planning discussed by Kulatunga et al, (2009) will be integrated into the implementation of the workpattern model developed in this study.

Efficient rostering involves maximum coverage at minimal cost. Under resourcing involves poor patient care and failing of service levels, in whatever way these are measured e.g. waiting time targets (Lane et al, 2000). Lane et al, (2000) authored the case orientated paper in response to patient concerns regarding delays in the ED department, with particular reference to the dynamics of the ED and associated facilities. This study was a very detailed study and their findings underpin Kulatunga et al, (2009). They agree that the application of relevant resource both within the ED and relating to the ED (this may be a reference to imaging in radiology for ED patients) is essential to smooth patient management. They also support the requirement of balancing planned and unscheduled care to ensure that no patient group is disadvantaged in order to advantage another. Over resourcing involves increased cost and surplus staffing levels, thus wasted resource. Balancing these factors is challenging when demand for a service is non-deterministic. This is a challenge to be considered during the workpattern model development in this study.

Methods used in call centres and audit scheduling (Dodin et al, 1998) were considered as both of these industries involve non homogenous workforces and unscheduled demand. Papers related to these industries mainly relate to integer programming with metaheuristic methods superimposed. Again, it is difficult to align the complexity of the computational requirements with the many flexible working patterns in radiography and was therefore rejected. In the call centre Industry, there are standards (Customer Grade of Service –CGOS) for clients to have calls answered in a specific time period, in a percentage of the time. Henderson et al, (1999) developed a staffing model for a call centre using integer programming with heuristical smoothing. The paper is extremely technical with several engineering formulae but the text is clear and logical. CGOS is expressed as a percentage with 100% meaning ideal service and 0% meaning that clients have abandoned the call. An example of a standard is that 95% of clients should receive a CGOS>80%. CGOS relates to a queuing system and is a measure of work requirement. Once the work requirements (demands) are identified over the course of the work hours, the work allocation problem is determining staff numbers and shift staff times to cover the work requirements over the course of the working day at minimal staffing cost. This is similar to the process of adaptive planning discussed by Kulatunga et al, (2009) and uses similar formulae. The adaptive planning technique within the theory of service standards, has some merit in radiography and in the application of the workpattern model. There are no national standards for a target time for patients to be seen for general radiography, unlike standards in industry. However, general radiography falls within unscheduled care targets of 95% of patients being discharged within four hours from the ED (Scottish Government,

2007-1). This involves patients being seen in the ED, referred for general radiographic imaging, have the imaging procedure undertaken then return to ED for assessment and subsequent treatment. Thus, the time component of this target time, spent within the radiology department, must be contained within the other activities required in the clinical episode, as discussed by Lane et al, (2000) and is therefore similar to the standards in call centres. In some radiology departments ED patients are imaged within the same area as other categories of patients for similar imaging (e.g. GP patients and patients from outpatient clinics). Likewise, in some centres, ward patients are examined within the same area as patients from outpatient clinics. It is important that ED patients are not delayed inappropriately as this may cause patients to breach the 4 hour target. However, the other categories of patients must not be adversely compromised by favouring ED patients as discussed by Lane et al, (2000). In essence, all patients groups are therefore examined on a first come, first seen basis, as each group is disposed to a risk or vulnerability of some nature. The only exception to this is the emergency situation e.g. a major road traffic accident. Thus, queue management is an important factor when considering workforce levels and workload, as in industry (Henderson et al, 1999). A queue is not merely an inconvenience in radiography but can impact on further aspects of the patients' management and will be discussed later in this study, in the data analysis.

A review of OOH cover in the West of Scotland was undertaken by the Radiography Out of Hours Working Group, (West of Scotland Regional Planning Group, 2009). This was an extensive piece of work undertaken across several health boards. This identified many differing working practices across several boards. In order to support recruitment and retention, it was planned to develop a cohesive OOH provision that would ensure movement across boards was not related to differences in conditions of service and remuneration for OOH provision. This group performed a general SWOT analysis that identified strengths of consistency, increased activity and response to targets, flexibility, working time regulation compliant (WTR, HMSO, 1998), fixed costs, facilitate extended working day, still have core staff 9-5 and allowing CPD. The weaknesses identified were potential financial disadvantages to staff, new staff paid at different rate from current staff (pay protection), no incentive to undertake extra duties due to pay protection, shifts beginning and ending at unsocial times, staff finding shift working tiring, unfavourable staff perception, concern over sustainability of service, both core hours and OOH, if radiographer numbers drop. Opportunities identified, indicated that similar systems across the West of Scotland should reduce staff poaching, examine overall costs in relation to AfC terms and conditions, facilitate the working day and increase activity, facilitate shorter duties making them more family friendly, no lone working, better scope for training, no compensatory rest required so potentially staff levels are easier to manage. Finally, the threats mentioned were that staff may move jobs if all health boards do not implement shift systems,

radiography will be considered a less attractive career without on-call, recruitment might be difficult if boards offer different remuneration and any reduction in radiographer numbers would mean a reduction in core staff as OOH shifts would have to be covered. Shift working is a complete culture change in OOH working and recruitment in some boards may be difficult. This would complicate staffing shift patterns. Several rota options were proposed in this paper. However, while a scoping exercise on role development and specialist skills was undertaken as part of the review, no reference to this was mentioned in the roster options. There was no presentation of workload or workpattern modelling in relation to the roster proposals, so it would be difficult to transfer the proposed options to fit local workload. Nevertheless, there is a consistent theme of shift options that can be considered in relation to the local workpattern model.

The proposed roster patterns from the West of Scotland review, (2009) are: 12 hour shifts, 8 hour shifts and 4 hour modules. These themes will be considered later in the study when discussing application of the workpattern model.

Following on from scheduling and rostering, allocation of staff to lines of work across the rostering horizon is a prerequisite of operational management. It is essential that the rules for shift allocation are clear i.e. the model for assignment has been developed (Ernst et al, 2004). Ernst et al, (2004) reviewed several rostering problems and the applied solutions. They explain that the model which underlies the rostering tool requires understanding and analysis of historical workload data to forecast future requirement and enables the conversion into staff resource. A scheduling tool must be developed that aligns constraints and provides a cost effective personal schedule (or roster). This entirely supports the purpose of the aim and objectives for this study. The review did not assess software packages but acknowledged that software packages, manual processes and mathematical algorithms are all used in different industries. Ernst et al, (2004) discussed the rostering problem for flexible demand, which is a similar application to general radiography. The proposed solution identified in the review is the link between the requests for service (demand) and the staffing levels (resource) and often takes the form of a service standard or target. This is applied to a queuing analysis of the incident arrival distributions. The outcome is usually a specification of the numbers of staff required at different times of the day, similar to the adaptive planning discussed by Kulatunga et al, (2009). This is similar to the proposed analysis and deductive reasoning planned for this study and echoes elements of the development of nursing models (Jenkins-Clarke, 1992).

The following methods of rota generation or lines of work were considered. Generation of sequential allocation methods could simplify rostering. Sequential allocation methods, or step down assignment methods, have roots in accounting resource allocation as discussed by Caplan, (2003). However, the

theory of sequential allocation methods might meet the requirements in radiography. Caplan, (2003) explains that lines of work require to be generated to assign staffing, not only to general radiography but to other modalities, in the individual centres whose staff allocation has been determined by scheduling related to demand, capacity, activity and queue (DCAQ) analysis (Scottish Government, 2008-1). The theory of step down allocation is achieved by a decision to allocate resource to one element initially (the key element) and then subsequent allocation or assignment follows on a preferential requirements basis. In general radiography, the OOH duty must be scheduled i.e. the key element, as there is no option to cancel this duty if there is no resource available. The staffing resource can then be allocated, on a step by step process to each modality developing the lines of work. This is a practical description of the current activity of roster generation for radiographers to meet service needs and may still be an appropriate deployment of staff resource identified by the workpattern model in some centres.

A comparison with staff scheduling in radiography is staff scheduling for a fast food department (Loucks and Jacobs, 2007). The staff in the fast food industry have to be treated individually as they are mainly part-time workers (flexible hours) they are qualified in different aspects of the industry (skills mix) and require to work with staff with certain qualifications in order to establish satisfactory skills mix. This paper references Ernst et al, (2004) as being influential work in the field. Comparing this industry with radiographers who may work part time or flexible work rosters and who have individual skills, there are certain similarities. Various methods such as goal programming and heuristics were rejected as being too complex to resolve the scheduling problem efficiently in the fast food industry. Again, similar to radiography, statistical analysis of demand was carried out and an initial workpattern schedule was produced. A computerised step by step approach was then undertaken, identifying who could undertake a given task at a given time (staff/task/hours). A draft assignment (lines of work) was thus identified that was followed by an improvement phase to reduce wastage and ensure cost effective resource management. The paper was clear in aim and though, again, had many mathematical formulae is very understandable and echoes the roster generation for radiographers in many centres, though this is often done manually and by experiential process. This could be considered as a method of staff deployment of the staff resource identified from the workpattern model.

An earlier method of resource allocation identified is database management for staff scheduling as described by Meyer and Markowitz, (1997). Meyer and Markowitz, (1997) described a relational database based on several related files containing data pertaining to annual leave, days worked, hours worked and rules relating to duplicate entries, such that staff cannot be double booked. The lines of work are built by entering staff in fields appropriate to the rules relevant to the individual. The Meyer and Markowitz, (1997) example relational database did not take account of skills mix and featured mainly the numbers

and duty hours of availability. It could be proposed that, if a master file was designed as the predetermined workpattern model for general radiography and files with staff matrix for other modalities, this could be applied in current radiology departments. This would require all of the rules and constraints of Agenda for Change (AfC) bands and specialist job requirements to be inserted. This would be a useful resource for staff deployment following the development of the workpattern model in this study but there is no commercially available software.

Elements of the above three methods of rostering i.e. sequential allocation, demand and skills analysis and a relational database for generating lines of work for staff, would be appropriate to radiography. The database method would not take account of equity of rostered tasks, nor would the sequential method. The staff/task/hours scheduling method may accommodate equity of rostered tasks but is unlikely to prevent duplication (staff double booking). Lines of work for the individual centre could be generated using useful elements of the above methods.

Methods of allocation of staff (rostering) are detailed but there is no commercially available allocation tool that can ensure equitable commitment for staff allocation. There are varied requirements such as holiday, flexible working patterns, sick leave, training, specialist skills and shift rotation. In certain centres not all of these criteria will apply to all staff. Thus scheduling and staff allocation is a local dilemma that requires a local solution whether this is an automated or manual plan.

Lowden et al, (1998) suggested that scepticism for any proposed roster developed from the proposed workpattern model should be expected and this needs to be factored into any consultation discussion. Operational change must be managed in a transparent manner. They undertook an evaluation of a change in shift pattern by administering an attitude questionnaire to staff prior to the change. Staff were tasked with either keeping diaries and activity loggers, both before and after the change. Reaction time tests were also undertaken before and after the change. They then administered the same questionnaire following the implementation of the change. Employee feedback, two way communication and education are the recommended tools for managing change. This was an extremely detailed study with the results displayed in textual and tabular format. This was challenging to follow but the conclusion was clear, that alertness increased when night work decreased. The concept of administering the attitude questionnaire is an interesting concept and one that would be useful in the current study. Resistance to change is likely to be related to anxiety, resistance to a potential loss of income, fear of the unknown or resentment (Evans, 1995). The repeat questionnaire following implementation of the change would allow staff to respond with experience of the change. Lowden et al (1998) recommends implementation of change through consultation and example must be considered. This allows staff to feedback their opinions and

inform operational change. Pilot studies of any roster alterations are a safe mechanism for managing change. This supports the objectives of this study as a staff attitude survey is planned. Undertaking a change of workpattern as a pilot, with the confidence of a full review and the assurance of addressing any outstanding drawbacks identified within the pilot study, before implementation of the substantive model is an important element of change management. A consideration here must be the staffing of the pilot study if this required any additional staffing. A plan for temporary staffing must be an integral component of the pilot. This is useful information to discuss with management regarding implementation of the workpattern model when developed.

5.4 Workforce Profile

Workpattern modelling must be appropriate for present workload but must also be future proofed to meet the demands of future workload with a relevant and appropriate workforce. This is essential for service sustainability, as has been stated in Jenkins-Clarke, (1992) and similarly more recently in Ernst et al, (2004). The following section reviews literature relating to development of the workforce profile and the effect that profile has on workload and workload planning. This will inform, in the scientific perspective of obtaining relevant facts, on issues of the workforce profile that will be required to sustain general radiographic service within the workpattern model being developed.

5.4.1 Workforce planning

Workforce planning, by its name, indicates a strategy for planning the workforce of the future. O'Brian - Pallas et al, (2001) in a report written for the World Health Organisation discusses integrated health human resource planning as an aggregate level resource planning process in the long term. They state that this requires a "needs based" approach, in which resource requirements are based on population needs rather than planning based on supply and utilisation. This approach requires vast data collection and forward thinking to consider the future needs of a service but echoes the emphasis of future proofing discussed by Jenkins-Clarke, (1992) and Ernst et al, (2004). The current research aligns with the above by developing a workpattern model to support service redesign, based on needs or demand and is also a long term project that requires future proofing. A current application of this population based strategy would be the colorectal cancer screening programme (Weller and Alexander, 2003). They discuss the original faecal occult blood test (FOB) trial in the UK, conducted in Nottingham in 1996. This resulted in the pilot screening programme being rolled out in both England and Scotland in 2000. The pilot sites chosen were of similar population size but differing demographics (ethnicity and rurality). The pilot sites sought to confirm the findings of the Nottingham trials in relation to uptake and incidence of disease. The pilot

studies did confirm the findings of the original study and on this basis; health boards calculated the resources required to roll out the bowel screening programme nationally. The expectation is a 60% uptake of the original FOB test with an approximate 6% positive finding. These 6% of patients all require further investigation. An expected 2% of the 6% will require surgery for sinister disease. This can be numerically quantified per health board, dependent on the population of the health board, and the resource implication costed. However, this quantification and costing is related to a mathematical model and can, on occasion, be much higher and on some occasions be much lower than the prediction as discussed by Alfares, (1998). Overall, the quantification smoothes out across the annual horizon (NHS Tayside, 2009). This approach has not been widely adopted for workforce planning initiatives in other fields due to huge data collection issues. The workforce planning initiative investigated the demographics in Scotland to facilitate planning for allied health profession (AHP) activity in the future (NHS Scotland, 2008). This initiative offers information resources regarding demand, capacity and models developed for planned care though this is not as detailed or as exhaustive in analysis. In contrast there is no equivalent modelling for general radiography or any form of unscheduled care. The initiative also offers access to a workforce calculator but again this is dependent on known workload or demand and patient episode times. The theory of forecasting demand and patient episode times are a component of the analytical deductive reasoning in this current research. However, the workforce calculator does not give information of grades of staff required for the cost of staff resource.

Bosanquet et al, (2006) reports on defects of centralised manpower planning within the NHS. This team was an independent think tank whose aim is to determine better ways to deliver public services. They agree with O'Brien- Pallas et al, (2001) above, reinforcing that human resource planning is not based on any encompassing strategy. Bosanquet et al ,(2006) rightly states that manpower planning has been based on quantity rather than quality and that employment is silo based rather than patient focused or team based. This defect is reflected in the current issues, regarding implementation of the 4 tier structure in radiography (NES, 2006). Bosanquet et al, (2006) refers to human resource planning within nursing which is analogous to radiography. The statement relates to lack of experience in the early career years in nursing and when experience has been gained, many experienced nurses move to specialist posts. This leads to a situation where there are decreased experienced staff hours in general nursing where nursing care has become more complex and clinically demanding. The analogy for radiography is that many radiographers (practitioners) gain experience in general radiography and then specialise as advanced practitioners or consultants in specialist fields. Thus the experienced staff hours in general radiography are reduced. The reduction in experienced staff hours impacts on the OOH service as specialised skills and therefore the specialist staff are required within core hours. Thus OOH is often staffed by radiographers

who are at an early career stage and therefore an early stage of experience also. The lack of experience may impact on the stress levels of the less experienced staff providing the OOH element of the service, as they may feel that the demands on them exceed their ability to provide that resource. This will be discussed below (Raymond, 2000).

Bloor and Maynard, (2003) undertook an extensive and detailed comparative review of healthcare systems across five countries. The objectives were to categorise systems of finance and delivery of health care, international human resource planning and to contribute to the development of indicators of effectiveness and efficiency. The interactions of service delivery and workforce planning were compared and contrasted. Interestingly, most countries have some central planning regarding medical clinicians with strategies, sometimes inadequate, in place for forecasting future demand for doctors. In contrast most countries have some central planning for nursing and Allied Health Profession (AHP) staffing but little or no strategy in place for forecasting future staffing demand. This supports Bosanquet et al, (2006) that planning is not patient focussed or team based. The current study will develop a workpattern model for radiography that will be generalisable, patient focussed and future proofed.

Bosanquet et al (2006) also reports that a smaller workforce with more effective support can be empowered to deliver high quality care. This aligns with the skills mix and task blurring of advanced practice but it is difficult to visualise how a smaller team of radiographers can support an increasing general radiographic workload over OOH, as the staffing level is often a lone working situation. Bloor and Maynard, (2003) similarly to Bosanquet et al, (2006) support the findings of Doyal and Cameron, (2000) and Audit Scotland report, (2002) that workforce planning ignores relationships between health care professionals. This has effects on workpattern implementation in relation to skill mix and task drift. Bloor and Maynard, (2003) state that supply and demand for human resource in health care is subject to two major weaknesses: narrow in focus, ignores relationship between professional groups (skill mix) and is supply driven rather than either demand or population based. This agrees with O'Brien- Pallas, (2001) and underpins the findings of Bosanquet et al, (2006) that resource planning is silo based and that in all health care systems there are substantial variations in practice that reflects inefficient use of resources. The above studies indicate that workforce planning systems ignore such practice variations and explore few comparisons of relative practices. There is little sharing of good practice and potential performance indicators are concerned with health outcomes but are more likely to be measured by activity. This literature indicates that healthcare workforce planning, across several countries has little cohesion and limited direction with regard to skill mix and task drift. However, in contrast, the Scottish radiology benchmarking project set within the national benchmarking project (Scottish Government, 2007-2), aimed to redress this balance by undertaking benchmarking across Scotland using the balanced scorecard

approach. This benchmarked radiology services using indicators of cost, efficiency, patient experience, supply and demand, staff resource and health improvement. The Audit Scotland report, (2008) drew on data from the Radiology Benchmarking Project and on experiences from the Diagnostics Collaborative (Scottish Government, 2008-1). Recommendations were made, within the report, in relation to service improvements and reflections of good practice, including skills mix, across Scotland. These proposals are in contrast to the findings in Bloor and Maynard, (2003) regarding lack of sharing of identified good practice. The radiology benchmarking report was published under the cover of the diagnostics steering group (Scottish Government, 2009). The work of the radiology benchmarking project and the recommendations regarding cohesive practice within the diagnostics steering group (Scottish Government, 2009), is being taken forward by Managed Diagnostic Imaging Clinical Network (MDICN) (NHS, 2011), who are also reviewing workpatterns across Scotland. An example of the good practice, task drift and integrated wider healthcare issues would be the Hospital at Night(H@N) team initiative(NHS Hospital at Night, 2008) which supports the modern training programme for training grade doctors (Modernising Medical Careers-(MMC)- Department of Health, 2003-2). This has altered the delivery of patient care OOH by a team approach that encompasses all the necessary skills required to care for patients OOH (NHS Hospital at Night, 2008). However, the effect of this team effort OOH is that the work pattern is altered for radiographers due to the disseminated team referral pattern. Radiographers are not perceived to be members of this team, echoing Bosanquet et al, (2006) comments on silo based resource planning. The H@N practitioners may all refer for general radiography, thus potentially altering the demand for radiographic service (multiple simultaneous referrals from the team members) and the human resource implications on radiography. The workpattern model developed in this study will address the staff resource required to manage the demand caused by this altered delivery.

Coombs et al, (2003) undertook a qualitative study by individual and group interview that assessed radiographers' perceptions of radiography. Recruitment for radiography is an issue that is not advanced by perceptions of working hours and inflexibility. Returners to the profession are also unlikely to be tempted to take up posts within the NHS for the same reasons. The population of current radiographers in post are increasing in age and this will swell the list of issues regarding the OOH cover. This group are very experienced and competent but find the long periods of duty, rather than whether the duties involve night hours or day hours, physically exhausting. Again this underpins that stress is evident when the demands on the individual exceed the ability to deliver that resource (Blaug et al, 2007). This effect must be considered when evaluating the effects of shift and on-call duties and is described below. When the issues regarding recruitment are combined with the career progression structure to advanced practitioner and consultant level, this identifies worrying trends of a decreasing workforce profile for general radiography.

These factors confirm the findings of Hutt and Buchan, (2005) who reviewed key trends in London's NHS labour market. They identified that recruitment to the radiography profession is unlikely to rise in the near future, due to financial constraints in the NHS. These factors also support the findings of Coombe et al, (2003) regarding recruitment. The overall population of radiographers may be decreasing due to many staff approaching retiral age with no complementary recruitment. There is no current workforce planning strategy that addresses this. The workpattern model developed in this study will address this balance by supporting implementation of the 4 tier structure (Society of Radiographers, 2005). Hutt and Buchan, (2005) also discuss recruitment and retention of staff as a key indicator of London NHS workforce. This can be a self fulfilling prophesy as the perceived workload (per radiographer) will increase if there is a chronic recruitment problem. The perceived increased workload is likely to deter other staff from application. The remaining staff may leave posts thus resulting in a spiralling decline in staffing levels. Coombs et al, (2003) suggests that radiographers are hesitant to return to radiography without some form of workpattern modelling, due to concerns of low staffing levels and high workload. Again the need for workpattern modelling supports undertaking the current study.

Stubbings and Scott, (2004) reviewed literature relevant to workforce planning to support alterations in patient care delivery following the introduction of the Working Time Regulations (HMSO, 1998) that applied to junior doctors from 2004. In relation to nursing, Stubbings and Scott, (2004) identified that, within the Audit Scotland report, (2002) there is little guidance on the appropriate levels of nurse staffing and that levels of staff have historically been determined on the basis of experience and professional judgment despite early workforce planning strategies (Jenkins-Clarke, 1992). This can therefore be extrapolated to other health care professions. There is little specific literature related to workforce planning in terms of workpattern modelling and relevant staffing for general radiography. The only cohesive workpattern modelling in radiography has been related to the Diagnostic Collaborative (Scottish Government, 2008-1) and was centred on CT, MR and US which are defined as planned care rather than general radiography which is unscheduled care. Effective cohesive workpattern modelling that supports modern healthcare pathways and with specific reference to skill mix is currently an omission in general radiography. Thus the current research will contribute to the radiography profession and to wider healthcare issues.

5.4.2 Skills mix

Diagnostic radiography has evolved into a service that supports the investigative pathway of the patient journey in ways quite diverse from the traditional role and must therefore be explored in relation to the workforce profile and service needs when developing the workpattern model. There has been little

guidance and direction in workforce planning of the development of skill mix, despite the encouragement of NES in implementation of the 4 tier structure (NES, 2006). Staffing levels in radiography are still determined on a historical and experiential, perhaps heuristic, basis. Early implementer sites are now planning workforce on the basis of the 4 tier structure but there is still no guidance on the skill mix issues and the workforce planning for the different tiers. The 4 tier structure involves a movement of professional responsibilities and a restructure of traditional roles within radiography (Society of Radiographers, 2005). This paper explains that consultant radiographer roles involve a new level of expertise, with autonomous working and responsibility for service delivery across disciplines and absorb some duties that were previously considered to be medical functions. Advanced practitioner roles require a high level of specialisation and subject specialist knowledge and expertise. In addition advanced practitioners must demonstrate a level of autonomous practice and responsibility for service delivery. Practitioner roles require a general expertise and good general knowledge base. Within the 4 tier structure there is an unregistered tier of assistant practitioner who is trained in the practical aspects of the role of radiography. An educational training, that supports a satisfactory knowledge base to allow tasks to be performed under protocol, is adequate for this function. It is the intention that this tier of staff takes up the day to day practical aspect of the traditional radiographers' role, allowing the upper three tiers to progress and develop their roles and expand expertise to support patient care. However as Richardson, (1999) identified in an evaluation of costs, skills, patient benefits, time and substitution of health care professionals in the early stages of nursing skill mix, there is little guidance on workforce planning in this implementation. In consequence, this 4 tier structure also has a powerful impact on OOH. As mentioned earlier, the upper tiers have an increasing specialist practice that may not be required OOH. These radiographers may continue to work OOH undertaking less specialised tasks (therefore effectively underperforming), which is therefore less financially efficient. The alternative is that the upper tiers of radiographers do not work OOH, in order to utilise their specialist skills during core hours and so addressing the needs of planned care. This would result in the pool of staff undertaking OOH being reduced by the loss of the specialist staff. A further complication is that the assistant practitioner, as this is an unregistered role, must always be supervised by a radiographer. Therefore, dependent on the workforce staffing structure, the OOH pool of radiographers might be reduced still further by the employment of the assistant practitioner grade in place of radiographers. Assistant practitioners cannot cover any aspect of service as lone workers, either during core hours or OOH. The practitioner grade is likely to bear the major burden of the OOH service, thus opportunities for experiencing and developing as a specialist will be reduced. This has huge career implications for the practitioner grade, as they will not be able to progress to a specialised advanced grade as they may be required to undertake a greater proportion of the OOH duties. This will then have further implications in succession planning, in the broad

aspect of service delivery and in planned care within targets such as the 18 week target (Scottish Government, 2008-2). The workforce model developed in this study will support implementation of the 4 tier model meshing with workload demand and thus aim to address the skills mix issues.

Wanless, (2002) wrote the first ever evidence based assessment of the long term resource required in the NHS. This assessment was population based and meshed neatly with the literature above, that discussed workforce planning by population base (O'Brian- Pallas et al, 2001) Wanless, (2002) stated that the potential shortfall in doctors would be overcome if 20% of their work could be undertaken by specially trained nurse practitioners. He stated that this can only happen if 12.5% of nursing duties can be performed by health care assistants (HCA). This has the secondary effect of requiring an increase in the population of HCA's to undertake the duties vacated by the task drift. This has parallels in radiography. Skill mix can be extremely effective and efficient with consultant and advanced practice grades absorbing some medical tasks. However, the basic practitioner work, no longer undertaken by the radiographers who have upskilled to advanced practitioners and consultant staff, must be absorbed. Doyle and Cameron, (2000) also discuss the task drift philosophy where advanced practitioners undertake new roles in the complex mosaic of healthcare delivery. They identify that, though the workforce profiles of interdisciplinary working have expanded together, the workforce planning is developed entirely in isolation agreeing with the silo theory from Bosanquet et al, (2006). A notable exception in the Hospital at Night (H@N) initiative (NHS Hospital at Night, 2008). The WTR, (HMSO,1998) affected the hours that junior doctors were legally allowed to work and thus affecting service sustainability. The Hospital at Night initiative was developed to upskill experienced nurses with skills of clinical decision making. The aim of the initiative was by the ethos of task drift, for nurses (H@N practitioners) to undertake certain elements of junior doctors duties and thus by a team effect, ensure service sustainability. This initiative was carefully orchestrated in terms of workforce planning and workforce profile with the nursing roles being developed in a cohesive manner with the medical members of the team. The traditional nursing roles were removed from the H@N practitioner profile and were undertaken by replacement staff. It is not clear in any of the initiative documents whether this replacement was by registered staff or by HCA staff as discussed in Wanless, (2002). There is no evidence of any similar national initiative in radiography to support task drift from medical clinicians to radiographers, though the early implementer sites, mentioned above, may be the precursors . Further, Doyal and Cameron, (2000) underpin Wanless, (2002) in that they recommend that particular care be paid to the emerging new categories of healthcare worker, such as the healthcare assistant and assistant practitioner, to fill the gaps left as the task drift alters patterns of work among traditional professionals. Rightly, they state that necessary changes for healthcare delivery are constrained by professional structures from the past. The roles assigned to the emerging staff group must be carefully

considered within the local service delivery, as they do not replace the traditional radiographer role on a like for like but less expensive basis. Rather they work as a crew pairing model of skill mix. Again this emerging role will be assessed in the current research. A radiography skills mix project (Department of Health, 2003) identified workforce issues such as career progression, recruitment and retention as being critical to service sustainability. The drive for continuous improvement in the delivery of the diagnosis of cancer and the continuing expansion of cancer services to meet public expectations, challenges the current workforce. There is also a move towards efficiency and effectiveness within general diagnostic processes. The skills mix project (Department of Health, 2003) was established to introduce and evaluate the new tiered service delivery model designed to help address these needs. However, there is no guidance on workforce planning for the 4 tier system within the report. Radiographers have upskilled in many fields, not only in practical aspects of the role but in characteristics of service delivery. This has required post graduate academic underpinning to ensure the relevant level of expertise is in place to support these developments (Society of Radiographers, 2010). There is, however, no clear guidance as to how this can be implemented with particular reference to OOH. Thus sustainability of service across the 24/7 horizon has many wider challenges, not only related to workforce planning and worklife balance such as alignment of the workforce profile across 24/7 horizon. Implementation of the workpattern model developed in this study will accommodate skills mix within workforce planning to sustain the broader aspects of patient care across the service horizon.

5.4.3 Unscheduled care v planned care

It is essential in understanding the configuration of the workforce profile that the nature of the workload distribution and the profile related to that workload is fully explored in relation to skills mix. Unscheduled care, which is a demand led operation that occurs both in and out of core hours, is mainly managed within the hospital environment (Scottish Government, 2005). Accidents, acute admissions (medical and surgical), minor illness and injury are often assessed within the ED. ED is a core component of delivering appropriate care while optimising in-patient beds base and acts as a virtual clinical decision units (CDU) (Hassan, 2003). The efficacy of the virtual CDU is dependent on the availability of relevant investigations, including imaging, in a realistic timescale. This agrees with Lane et al, (2000), that the timely availability of facilities outwith the ED impact on the effectiveness of the treatment offered in the ED. This CDU assessment supports the ethos of the unscheduled care collaborative (Scottish Government, 2005) that timely investigations allow clinicians to decide to admit patients for appropriate treatment, rather than admit patients to decide on and await the investigative pathway (Hassan, 2003). Advanced practice radiographers undertake an extensive role in ensuring this availability of imaging for unscheduled care but

must ensure that this aspect meshes with the planned care workload. As unscheduled care is demand led it is more difficult to quantify in a meaningful way to inform the development of workpattern modelling. However, good local data collection and deductive analysis of data allows trends and frequency distribution of caseload to be assessed (Ernst et al, 2004). Robust projections of future workload can be forecast (Scottish Government, 2005) from the extrapolation of local data collection. Deductive data analysis is essential in development of the workpattern model. As an illustrative example, recent initiatives such as H@N team (NHS, 2008) encompass the ethos of task drift with staffing in place within this initiative to support the team structure OOH in accordance with workload planning. However there is little support outwith the radiography profession for aligning planned care and unscheduled care. This omission was identified earlier in a review by Bloor and Maynard, (2003) reviewing international workforce planning strategies for the research foundation of Canada. They identified, as one of the main messages, that resource management does not often consider the relationship between professional groups and this reduces the efficiency of the professional groups and the effect of the strategies.

Skills mix addresses the need to have an appropriate clinician performing the pertinent intervention at the expected time and thus is a component of radiology's response to the Scottish Government "18 week" referral to treatment (RTT) policy (Scottish Government, 2008-2). This target focuses on the entire patient journey through the hospital process, rather than a specific section of the journey such as diagnostics. The concept is of "whole system approach", where the patient is co-ordinated through the referral, consultation and diagnostic phase and on to treatment in a maximum of 18 weeks. The 18 week RTT is rooted in planned care and requires that sufficient staffing and skills are available to deliver this planned care. At the same time targets such as the 4 hour ED target (unscheduled care) still run in parallel. The importance of aligning unscheduled care with planned care depends on ensuring that the staff resource is suitably skilled and appropriately deployed. Relevant skilled staff, for the specific roles, are the most important resource in delivering health care (Scottish Government, 2008-2). There has been some research already undertaken by the Scottish Government in analysing radiology workload as part of the collaborative initiatives (Scottish Government, 2006-1, 2006-2, 2007-1, 2008-1). However the alignment of planned care with unscheduled care has not yet been reconciled by any of the government initiatives. Planned care is affected by unscheduled care, in that currently, patients are often admitted to decide on and to arrange investigations that are not immediately available. This has the effect of blocking beds, thus preventing scheduled admissions for planned care. Equally, unscheduled care is affected by planned care as skills mix may impact on the staff resources available to deliver the unscheduled care. The current research aims to deduce and identify an effective, efficient staff resource within the workpattern model and a workplace application that aligns the staff resource to support the service requirements.

5.5 Summary of Workpattern Modelling and Workforce Profile Literature

The literature above will inform the main section of the current research and will enlighten the deductive reasoning in development of the workpattern model. The literature on workpattern modelling, in all industries, identifies five broad categories. The first category of limiting demand by setting an arbitrary numerical value of cases and not accepting any further caseload, is not appropriate in radiology departments and in particular in general radiography. The second category of limiting the demand by applying strict referral or entry criteria, is a risk based strategy and is evident as the gatekeeper process of assessment and referral to radiology by appropriately trained clinicians. It is not particularly useful in smoothing the configuration of referrals to radiology which is an unscheduled pattern. The third category of workpattern modelling is rooted in timing of tasks and balancing of resources in accordance with timings for the tasks and the available staff resource. To an extent this category of workpattern modelling is already utilised in planned cases in health care and certain planned aspects of radiography but is not directly applicable to unscheduled nature of general radiography. The fourth category is similar to the third category and involved allocation of numerical values to tasks. These values involved a time component but rather than limit the workload to a defined maximum number, these values gave a structured method of establishing workload undertaken with a mixed caseload. Again, as general radiography (unscheduled care) cannot limit demand in a session this category of modelling is not appropriate but is relevant to modalities that undertake planned sessions. The fifth category has roots in healthcare provision and is mainly related to staffing nursing workload. The main recommendation from this category is that local workload must be studied to comprehend trends to meticulously analyse patterns, thus supporting deductive reasoning when developing a workpattern model. This fifth category is most transferrable to general radiography.

The common theme from all of the workpattern models above is the analysis of local data. Unless this local data is clearly understood and the foundation of trends identified, then deduction of future workload cannot be predicted. Workload must be forecast to future proof workpattern modelling and resource management. An implementation of a workpattern model that can be locally appropriate and facilitates the function of the workpattern model over 24/7 duty horizon is an essential component of any model. Scheduling, rostering and allocation are all components of the implementation of the model in the workplace. The Diagnostics Collaborative (Scottish Government, 2006-2) did not attempt to analyse workload in general radiography but previously analysed workload in planned care within CT, MR, US and Fluoroscopy. This supported radiographer allocation across these modalities. The collaborative analysis, in

combination with workpattern modelling in general radiography, underpins scheduling and staff allocation across the roster horizon.

Elements of different scheduling strategies such as crewpairing (Ryan, 1992) will be assessed in allocation and rostering of staff resource. This strategy is supported by the more recent skills maximisation toolkit (NES, 2007) that evaluates the uniqueness of each task and seeks to assign the relevant qualification of staff resource to the particular task. The tasks are defined allowing the expertise required for each task to be described and the combination of skilled resource to be determined. In this way the most cost effective permutation of staff resource required to execute the workload can be assigned. The workload, and thus the staff resource required for the workpattern model, will be deduced by adaptive planning analysis of the workload statistics.

Literature is clear that workforce planning is often not data driven nor population or requirement based, though NHS workforce planning attempts to address this (NHS, 2008). Rather, workforce planning is often historical in nature and does not accommodate the alteration of health care delivery such as skill mix, task drift and backfill. Heuristics is a method of accommodating service delivery by applying rules of basic common sense but is often not data driven or statistically structured, though an understanding of past and current data is essential to apply heuristics. There are currently no guidelines on the major impact of skills mix and the 4 tier structure on workforce planning in radiography. As staff specialise in specific areas of expertise and by task drift absorb duties delegated by medical staff, the overarching plan is that duties vacated by the specialist staff will be backfilled by the assistant practitioner tier of staff. In practice this is slow to happen as the workforce planning and workforce profile is not determined across professions. In particular there has been no guidance on how the implementation of the 4-tier system can be managed over the 24hour period. This lack of direction can have two effects; the first of which is reduced daytime staffing levels and experience in General radiography as specialist staff are undertaking advanced practice. This effect can be adequately resolved by the employment of assistant practitioners. The second effect is that specialist staff may not cover the OOH period as their skills are required to manage demands of planned care during core hours. OOH duties are often lone working situations in many centres across Scotland. These situations must be staffed by a registered member of the Health Professions Council (HPC) i.e. a radiographer. This effect cannot, therefore, be ameliorated by assistant practitioners, as this grade is an unregistered grade and cannot work unsupervised. Advanced practice, skill mix or task drift, however the upskilling is described, is likely to reduce the pool of radiographers available to undertake OOH duties.

Unscheduled care is required within normal working hours as well as OOH (e.g. ED cases and urgent admissions to wards). Through the work of the unscheduled care collaborative in Scotland, unscheduled

care (Scottish Government, 2007-1) tools are available to analyse the unscheduled care workload and can be transferred to analyse radiographic data. A normal working day across a radiology department is a finely balanced mix of planned care superimposed with unscheduled care. It is important to investigate workload carefully, to ensure that patterns and trends in radiology departments are explored and understood. Deductive analysis, such as frequency distribution and workforce analysis, allows workpattern modelling decisions to be data driven. The workforce profile must be appropriate for service sustainability in the broadest sense and must be a component in workpattern modelling. In addition, the potential impact of workpatterns should be considered on the individual, as there is the possibility of inequality in the deployment of duties dependent on individual skills.

These theories are all appropriate in determining a workpattern model appropriate for the non deterministic workload in general radiography. It is possible to identify workload and consider trends both OOH and within core hours. Frequency distribution analysis allows evaluation of the time elements of workload (complicated cases with a higher time weighting). Using combinations of the above theories, deductive analysis explores workload time elements (patient episode times) from frequency distribution investigation and evaluates the logic and approach of crew pairing, to maximise skills resource assignment in general radiography, will be undertaken to develop a model that aligns staff resource with patterns of workload. It is also fundamental to evaluate the opinions of radiographers to the proposed workpattern model. This will identify mis-perceptions and pre-conceptions and, in accordance with the scientific perspective, will allow these issues to be addressed to aid the smooth implementation of the workpattern model in the workplace. Therefore this will support organisational development.

5.6 Workpattern Effects

The effects of different workpatterns on the service, the individual and the work-life balance were appraised. This is in order to inform the data gathering exercise in the scientific perspective. This will facilitate the workplace implementation of the workpattern model. This supporting literature will describe the possible effects on the implementation of the workpattern model and will inform on exploring the staff attitudes to the proposed model. Any proposed alteration in workpattern must be assessed, in the light of understanding of issues surrounding the proposals, to ensure the management of change. Many of these effects have historical roots and several influential papers are elderly but still have current application. The effects of different workpatterns are described below.

5.6.1 Shift working

Wedderburn and Smith, (1998) undertook a case study review of flexible working patterns including long shifts. They state that shiftwork is primarily associated with two occupational stressors: working unsocial hours and fatigue. These two factors are associated with family and social life disruption and also result in increased sickness, absence and lower job satisfaction. Nightwork presents particular fatigue hazards because it involves disruption of the normal circadian rhythm. The circadian rhythm is a powerful force that cannot be overcome by bright lights and caffeine alone. Humans are naturally programmed to sleep at night and to be awake and most alert during the day, as explained in Healthlink, (1999). Therefore, it follows that a full-shift working pattern does not counteract fatigue, as stated by the BMA, (2006) in their joint position statement the Junior Doctors Committee and Training Grade Committee. This statement has drawn on studies into medical errors and sleep deprivation in addition to research into shift rotation patterns. These findings are therefore transferrable to other health care professionals who work night shifts and who have a similar duty of care to patients. Staff can be sleep-deprived during periods of night duty as it is more difficult to sleep during the days between shifts and the quality of sleep is different. As the number of night shifts mount, there is an accumulation of daily sleep deficits and increasing fatigue. Murray et al, (2005) studies reports and research into doctors experiences of newly devised shift patterns designed to align with the WTR, (HMSO, 1998). A week of night shifts is the pattern most associated with poor performance and accidents. This statement supports the finding from Wedderburn and Smith, (1998) that fatigue is a major consideration with long shifts and flexible working. Thus the risk associated with accidents and health care professionals must be carefully tempered in relation to effective shift cover, due to the nature of the duty of care. The British Medical Association (BMA) joint position statement indicates that the research considered in relation to the statement points to the risk increasing exponentially over the course of the night and increasing further still over consecutive nights (BMA, 2006). This agrees with Murray et al, (2005) above and the Rail Safety and Standards Board (RSSB), (2004) who discussed several studies that reported increases in accident risk over four successive night shifts. These studies are not described and, therefore, cannot be assessed for design or validity but support the suggestions of cumulative risk. Knauth and Hornberger, (2003) conducted a review of options of shiftpatterns considering aspects such as health, commuting, family and social interaction, shift patterns and artificial light, manager and worker education and the ability to sleep at home during daytime hours. They recommended a set of ergonomics that reduce the accepted risks of shift work such as cumulative sleep deficits, disruption of circadian rhythm, accidents and also improve social contact time. Their recommendations involve the number of early, evening and night duties in a row (maximum 3) and forward rotation of duties with adequate recovery time of a minimum of two days recovery time between shift changes. These

ergonomics facilitate social contact and thus improve worklife balance. They concluded that there were few studies that considered the use of ergonomic guidelines for implementation of shift patterns and those that had been done did little to affect the shift pattern issues. Nevertheless they recommended that use of the guidelines would reduce health and psychological problems with shift workers. These findings underpin Kecklund et al, (2008) who undertook a questionnaire survey on police officers' attitudes to different shift systems in addition to a section in the questionnaire on attributes relating to age, family circumstances and career stage. The study sample of 2000 included representation across all of the shift patterns currently undertaken, all age groups and career grades. The results were well displayed in tables in addition to text. The inferential statistical analysis by "paired t tests" was appropriate to identify significant differences between the different shift patterns. Validated health and sleep scores were employed. The study indicated a few limitations such as respondents' inexperience of different shift systems earlier in their career and the difficulty in understanding a shiftpattern that differed from the pattern currently in place. The results concluded that a majority of officers preferred a rotation with shorter hours and more time off between duties, though with fewer days off, as this supported family and social interaction and was also less physically tiring. However, Kecklund et al, (2008) state that they are unsure if the findings are transferrable to other professions and work categories, though the findings support, in theory, the recommendations of Knauth and Hornberger, (2003). This agrees with Lowden et al, (1998) whose study applied an attitude questionnaire prior to and after experience of a new duty roster. This is a significant proposal in any alteration to workpattern. Radiographers are hesitant to agree to alter workpatterns without experience or proof of any positive outcomes, though the current system causes substantial stress and distress. As recommended by Lowden et al, (1998) a change with a thorough evaluation structure is a valuable tool in proposing an alteration of a workpattern. There must be a reliable system in place for review of change to encourage confidence in change management. Realistically, there must also be an implementation strategy related to staffing complement to support a change such as a pilot study, otherwise confidence in change will not be authentic. There are also associations within this study with the attitude surveys of the medical profession. Mather, (2001) undertook a survey of training grade doctors to obtain detailed attitude to shifts. The introduction of shift working patterns for all junior medical staff was, at that time, considered inevitable in order to comply with the Working Time Regulations, (HMSO, 1998). The evaluation identified a huge majority in favour of remaining with on-call, rather than a move to shifts, on the basis that shifts would adversely affect training and career progression. However, the free text feedback identified that the on-call in the format of the time period of that study was unworkable due to workload and frequent disturbance. This has parallels in radiography. Radiographers are welded to the notion of on-call rather than shifts, perhaps for the financial uplift but perhaps also for the maintenance of the structure of Monday to Friday core hours, with occasional

additional on-call duties. However, radiographers in the main study centre have indicated in local empirical research that the current format of OOH duties is unworkable and requires review (Appendix 1). This is an attitude that is fluid dependent on individual agendas of the local radiographers. The attitude study of medical clinicians used likert questions with a section for free text comments (Maher, 2001). This quantitative approach is similar to the attitude survey in the current research. Free text within the attitude survey often indicates the difficulties of duty rosters at particular training grades of doctors. This is mentioned as being the likely child rearing years. Maher, (2001) also indicated doctors concern regarding career progression as training in specialist roles was less sustainable if a rota was planned specifically with the emphasis on OOH cover. This free text section was not analysed thematically but was reported verbatim.

This finding regarding career progression is also echoed by some radiographers in the principal study centre. However, especially in smaller hospitals, the OOH commitment does not alter through the years and is still evident through career progression. Thus, personal agendas change but there is little scope for accommodating these agendas in the OOH commitment. Similarly to Maher, (2001) there is concern from both management and staff regarding the maintenance of service and skills in role development and training when the emphasis for rostering is rooted in ensuring OOH cover (Appendix 1).

In addition Ericksen and Kecklund, (2007) stated that satisfaction with the work schedule is strongly correlated with greater likelihood of influencing one's work hours. Thus, if workers are allowed to participate in the design of the duty model, the attitude to work hours and work time control improves. This can improve the negative reactions and is an important consideration when planning alterations to any schedule. Consultation is an essential factor in designing work schedules. In the statistical interrogation of the workload and the research into workpattern models for this current study, the attitude survey is a vehicle for analysing the attitudes and reactions of the staff to the workpattern model. However, negative attitudes are still to be expected and can be useful in identifying misconceptions that can be addressed. Though 24/7 working is unavoidable in certain professions and in particular healthcare, there are many factors that must be considered before introduction or change of working pattern. Concern for staff health and safety, while undertaking shift work, must be mirrored with concern for the safety of the patients being cared for by these health care professionals. In addition, the sustainability of the service must also be considered, as the risk of staff health issues may compromise duty cover.

5.6.2 On-call

Additionally, in considering whether a change to shift patterns would be appropriate to support service sustainability in radiography, it is important to explore issues around the current working pattern. This allows a balanced assessment of the advantages and disadvantages of current practice in comparison with proposed alterations. This was highlighted above, by Kecklund et al, (2008). Many of the recommendations above are also applicable to on-call (or residential on-call known as standby). There is limited literature on the subject of on-call, however, Nicol and Botterill, (2004) conducted an extensive review of studies into on-call work schedules over several professions. They considered sixteen studies divided into areas of stress, sleep, mental health and personal safety. These studies were mostly more than five years old at that time (more than ten years old now) but contain factors that are still current issues.

The effects of on-call work where workers are called to work, either between regular hours or during set on-call periods, has not merited much attention. This form of work scheduling occurs in a variety of diverse occupations, for example health care professionals, utility workers, electrical technicians, information technologists and media personnel. In many of these professions, being on-call is not an option but rather a component of the job, as in radiography. Nicol and Botterill, (2004) identify that on-call, can in some circumstances be considered as a combination of a night duty and an overtime shift when calls to duty are frequent and substantially disturb sleep. This form of scheduling is often used to provide 24/7 coverage for facilities such as hospitals and laboratories where emergencies require personnel to immediately deal with critical situations but where the volume of evening and weekend work does not necessitate full shift coverage. In these circumstances, an on-call system is often seen as a cost effective system for employers. Other forms of on-call include work done by health care professionals. These health care professionals spend periods of time "on-call" at a hospital where space is provided for them to sleep. This form of on-call work is distinct because workers remain at work to undertake their call to duty. During these periods, staff often work sixteen hour periods of duty with little or no sleep resulting in a combination that is both a night shift and an overtime shift (Nicol and Botterill, 2004). This describes the residential on-call (stand-by) arrangement for radiographers in many centres and is embedded in the radiographic profession. As on-call is technically overtime, it is not contractually compulsory, though it is an expectation in certain jobs and a commitment to OOH is contained within the job descriptions of most radiographers. The non compulsory nature of overtime raises issues of service sustainability.

In relation to on-call and stress it is interesting that the element of stress identified in the review conducted by Nicol and Botterill, (2004) was associated with GP's on-call. This stress was noted to have

reduced during the period of the study. The reason identified from the review is that GP workpatterns have changed to include co-operative working. Whether this reduced the amount of time on-call, the frequency of on-call duties, or reduced the time lone working when on-call, is not clear. It is therefore difficult to transfer any findings to inform potential changes in the profession of radiography. In contrast, a study was undertaken on a population of GP's to establish if there was an improvement in stress levels and mental health following the introduction of a co-operative OOH arrangement (McLaughlin et al, 2005). The study expected that there would be lower stress levels and better mental health following the introduction of the co-operatives. The results however did not demonstrate these expectations. The results stated reflect that, while the frequency of on-call is decreased, the associated levels of stress whilst on-call remain as high. This phenomenon may be mirrored in radiography and is a significant factor to consider when reflecting on attitudes regarding on-call and may be perceived as having a parallel in radiography as indicated by the local empirical research (Appendix 1). The frequency of the OOH duties is a stated issue but the stressors that affect each individual duty, in terms of lone working and fatigue, should also be explored in detail.

The relationship of sleep was also explored in the review by the above authors. There was a similarity across different professions that sleep was very difficult during the periods of on-call duty as the expectation of an emergency call prevented falling asleep and staying asleep. The impact of sleep deprivation on performance was not clear in the review of literature. While the review by Nicol and Botterill, (2004) demonstrates limited research, they suggest that being on-call can have negative impacts on workers' sleep patterns. Individual perceptions of the tiring nature of the work is important when considering the tiring nature of the workload. The work pattern involves a shift period followed by an on-call period. A further factor that should be mentioned here is that the radiographer may be a lone worker OOH, dependent on the centre. Nicol and Botterill, (2004) also identify a lack of research into the impact of age on the ability to cope with on-call. This aspect is very important for the profession of radiography, as discussed earlier by Hutt and Buchan, (2005).

While on-call work scheduling can be less expensive in some circumstances than a full shift system, it is not without human costs. On-call employees must plan their lives and the lives of their families around a call schedule. This commitment is usually in addition to the full complement of working hours. The review of studies (Nicol and Botterill, 2004) has found that on-call work patterns can have a major influence on employees' lifestyles and their interactions with family members and friends.

Mark et al, (2006) reviewed published data related shift patterns and pathological conditions. Though there appeared to be many conditions that have been related to workpatterns, there are many non

occupational factors that predispose the population to the same risks. However, they suggest that work place errors have been associated with sleep disturbance. This agrees with the findings of the BMA, (2006) that errors increase when sleep is disturbed. Mark et al, (2006) reported an increase in fatigue related errors and car accidents following on-call but the response rates in the studies were low (less than 25%). These were stated as restricted to respondents who had experienced or observed fatigue related errors. Nicol and Botterill, (2004) identified that the range of health effects studied in relation to on-call work has, to date, been inadequate. They state that health conditions and overall mortality need to be explored, as has been done in conjunction with work patterns, such as overtime and shift work. Factors such as personal safety and car accidents ,in relation to on- call, have only briefly been touched upon and merit more attention. Nicol and Botterill, (2004) recommended that further research in this area is required to provide a clear picture of the risks of this form of work scheduling.

On-call is currently still accepted by radiographers as a way of topping-up salary. The payment for on-call is paid in addition to the payment for the standard working week. This encourages a vast proportion of staff, with the backing of their professional body, to remain with this arrangement (Society of Radiographers, 2008). Agenda for Change (AfC) (Department of Health, 2004) altered the way that OOH payment schemes are remunerated. Hutt and Buchan, (2005) also indicated that AfC must address the payment for OOH. This has not yet happened effectively for radiographers. As diagnostic radiography is unique within allied health professionals (AHP) as being the only purely diagnostic profession (ISD, 2006), it is unique as an AHP profession in the cover provided OOH. The only profession that offers a similar diagnostic service in the NHS is the laboratory service and this profession too is currently in negotiations regarding cost effective OOH service sustainability. As mentioned above on-call is in addition to the core working hours and is therefore overtime and not contractually compulsory.

Baldwin et al, (1997) undertook an extensive survey, pre WTR, (HMSO, 1998), regarding junior doctors' attitudes to various aspects of workload. One of the sections related to on-call. The sample was representative of the population of all ages and career grade of doctors. The sample was asked to score measures during on-call. The doctors in the acute medicine specialty reported the highest number of clinical calls, highest number of admissions and fewest hours of uninterrupted sleep. As most of the patients admitted to this specialist area require immediate imaging investigations, some of these measures would be mirrored in radiography. The radiographer will experience a high number of calls and few hours of uninterrupted sleep. This will not affect recruitment but may compromise retention in centres that mirror this workpattern (Hutt and Buchan, 2005).

Bignardi, (1996) undertook a survey of laboratory staff that had many parallels with the current research, such as perceived job stress and workload management. Unfortunately, the questionnaire was not published, only aggregated results. However, the study identified many issues that are similar to general radiography such as: changes in skill mix and career opportunities; changes in on-call arrangements and extended routine working hours; continuous education schemes: new NHS "culture" and ethos. These changes have all been discussed in the literature in relation to radiography. Sadly, the proposed solutions identified in Bignardi (1996) did not address skill mix and role development with relation to the issue of OOH duties.

The Society of Radiographers, (2008) has issued a negotiators guide to the working time regulations. Sadly this does not reflect on the detrimental effects of the on-call system, that they rightly state, is the main provision for radiographers OOH work. They state that the detrimental effects of shift work should be used as evidence that a move away from on-call should be resisted. Without the balance of the effects of on-call, this point of view is skewed. The unstated, but likely, reason for this omission is the financial uplift that on-call offers radiographers. This factor is briefly mentioned in the document. As this document is written by the professional body, it is appropriate that there is support for maintenance of income but there is no support for the lifestyle deficits and detrimental health effects that on-call causes.

5.6.3 Lone working

As mentioned above, on-call is a cost effective system utilised when the workload does not require a full complement of staff. In consequence, it follows that the on-call system may involve lone working. Lone working as a component of a workpattern has significant implications for the service, the individual and worklife balance. Staff working in a team can support one another during periods of tiredness. The H@N concept is based on team working and on ensuring that patients' needs are met from within this supportive team structure (NHS, 2008). However, radiographers often work in isolation rather than as part of this H@N team, due to the on-call arrangement, and therefore are more susceptible to the effects of extreme tiredness (BMA, 2006). This supports the findings of Mark et al, (2006), above, that the error rate increases with fatigue, as there is no team support that might identify these errors. Even when radiographers are not technically alone during a period of duty, by the nature of the work, radiographers are often lone radiographers with no peer support, working within wider teams (e.g. theatre examinations and resuscitation situations).

In addition, there is the issue of personal safety that has been touched on, above, in relation to on-call (BMA, 2006). Risk assessments must be undertaken, when lone working is a component of the role to identify risks and put in place control measures (Health and Safety Executive, 2009).

Lone working accentuates all of the pressures of shift working and related issues of on-call, as there is no peer support. Thus, risks are not ameliorated by other members of a wider team, due to the unique nature of the skills required.

5.6.4 Flexibility

Finally, flexible workpatterns are explored in relation to the effects on the individual, the service and worklife balance. Taylor, (2001) raised a controversial point that had not been posed in any other paper. He suggested that, though employees may be pressured by workload and workplace stressors, few staff would wish to accept a reduction in pay in order to cut working hours. Taylor's paper summarised key points from topical social science research into worklife balance. A key point made by Taylor questioned the constraints of flexibility in the workplace. He discussed the issue of cover for flexible duties during holidays or sickness and how the duties are apportioned following the resignation of the flexible duty incumbent. This is a very relevant point, as service sustainability is essential. In relation to the above discussions regarding shift work and on-call, having to add duties not usually covered by rota will add to the burdens of OOH. Taylor further highlighted that flexibility is often seated in Government policy as part of the drive to move parents back into the workplace. Little consideration has been given to the lifecycle of parenthood and how the flexibility will grow and change with the family circumstances. This strategy works very well in practice, for both individual and service while the arrangement is appropriate for both but becomes unsustainable when the arrangement is outgrown by either party.

Jones et al, (2007) authored a working paper which provided a channel for recent research in equal opportunities. In this working paper, Jones et al, (2007) echoed similar factors and further mentioned that staff who do not wish, or are not able, to consider flexible working must not be detrimentally affected by having to cover work or duties on an unfair basis due to those staff undertaking flexible working. Within the constraints of care requirements and working time regulations (HMSO, 1998) there is space for creative alternatives that maximise the opportunity to achieve organisational and individual goals. The compressed working week (CWW) is often seen as a compromise on a rotating shift system. The compressed working week is a flexible mechanism for working the appropriate number of hours in a pattern mutually acceptable to staff and management. This is often longer hours worked over fewer days or perhaps the correct number of hours worked flexibly over a two week period. Wedderburn and Smith,

(1998) recommend that positives and negatives are considered before moving to the CWW alternatives. They suggest that sample rosters should be considered prior to any agreement and these should take account of annual leave commitments. This is often a factor not appreciated, that reduces the time off between duties and therefore increases the stressors of workpattern. This sample rostering supports Lowden et al, (1998) who advocates that all rota and scheduling changes should be trialled in a safe environment. Lowden et al, (1998) studied the attitudes of workers whose shift rotation involved forward rotation of 8 hour duties and who were changing to rotation of 12 hour duties. The study involved a questionnaire applied before the change of rota and a similar questionnaire applied 10 months after the rota. The questionnaire covered topics such as attitudes to work and workhours, health, sleep, sleep deficit problems, lifestyle and social factors. The second questionnaire also included comparing the experience of the 8 hour shift and the 12 hour shift. The evaluation showed a significant improvement for items that had demonstrated staff concern with the proposed schedule. However, concerns regarding fatigue and stress did not change significantly. Again, there are significant reflection points within this study. It is a useful tool in change management to evaluate a change by applying an attitude questionnaire prior to any proposed alteration to a workpattern and then re-apply the questionnaire following a pilot of the changed pattern. Kecklund et al, (2008) also indicate the difficulty that staff experience in comprehending the effects that new schedules inflict on work life balance. Jones et al, (2007) illustrates some models of flexible working, a large number of which are not suitable to the 24/7 caring environment (such as home working or term time working). They reinforce the fact that flexible working does not necessarily solve operational problems. There are still unpopular duties that flexible working may not resolve. Jones et al, (2007) agrees with Taylor, (2001) and warns against these duties being allocated entirely to staff who are not advantaged by the choice of flexible working. Coombs et al, (2003) undertook a qualitative study with thematic analysis on various populations of radiographers, exploring their perceptions of radiography and the NHS. The population group of non working or independent radiographers indicated that the lack of flexibility over hours and the need to work weekends and on-call made returning to the NHS an unpopular choice as the hours required are not convenient for family life. This agrees with Taylor, (2001) that flexible policies are often rooted in government initiatives to support parents returning to the workplace but is unsustainable when the arrangement is outgrown by either party. Employees have personal agendas for preferring particular work patterns. This often relates to care issues, interests outside paid work or working while studying .Taylor (2001) also claimed that employers are preoccupied with how the supposed requirements for higher performance and productivity can be reconciled with the demands and needs of employees. Taylor, (2001) further questioned whether the arbitrary division of work and life makes theoretical or practical sense. A fundamental factor of the NHS is that service requires 24/7 cover. This cannot be changed. As Jones et al, (2007) indicated, undue flexibility

for certain staff groups must have a detrimental effect on other staff groups, as duty cover cannot be compromised.

5.7 Workplace Tensions

The next section reviews workplace tensions that are related to workpatterns and the effect that these tensions have on the individual, worklife balance, workpattern and service. This background knowledge will support comprehension of preconceptions and misconceptions in accordance with the scientific perspective and explore the cognitive processes behind these thought processes. The factors gleaned from this exploration will facilitate the implementation of the workpattern model in the workplace.

5.7.1 Psychological contract

The psychological contract is the understanding of the mutual obligations between employee and employer (Conway and Briner, 2005). The psychological contract differs from the legal contract of employment in that the psychological contract provides an informal but robust representation of the reality between employee and employer of what is expected as part of the working association between the two parties. This can be more influential than the legal contract in affecting how staff behave on a day to day basis. The importance of the psychological contract is based on whether the employee considers that the employer has honoured perceptions of the contract e.g. delivery on training, concern over workload or support for staff in relation to workplace stressors. Coyle-Shapiro and Kessler, (2000) undertook longitudinal research in local authorities. They state that the public sector has been subject to a range of pressures over the last decade. This will include the NHS as well as local authorities. Issues of organisational survival and affordability are considered as the driving force behind the treatment of employees. The study was extensive with a two cohort study approach of attitude survey administered to managers and to employees in a local authority. The samples were large (administered to over 1000 managers – response rate 62% and administered to 23,000 employees - response rate 30%). The method employed was likert questions, administered anonymously but coded in order to track employee transition for future correlation. This was an extensive study, with very detailed findings displayed in tabular and text format, though it was difficult to comprehend the specifics of the findings but possible to see transferability to the current research. The findings were explained as a breach of the psychological contract though the perception of the contract differed between the two cohorts of the study. The managers considered that the employer was the local authority and that the constraints of budget caused the breach. The employees considered that the managers were the employers and held the managers accountable for breaches of expected work conditions and training. Coyle-Shapiro and Kessler, (2000)

suggest that the consequence of these breaches is detrimental effects of reduced organisational support, organisational commitment and organisational citizenship behaviour.

Employees will be more inclined to support the workplace with flexible attitude if they consider there is a positive contract. A positive psychological contract strengthens the employee work ethic while being associated with a positive work life balance. An accommodating management is likely to experience less conflict and confrontation in relation to duties and the process of change is more likely to be achieved by negotiation. This meshes with staff who perceive less conflict and therefore fewer workplace tensions and are more likely to gain positive benefit from worklife balance. In terms of the effect on workpatterns relevant to radiography and in particular on-call, a positive psychological contract is essential for service sustainability. Comparing this with the study undertaken by Coyle-Shapiro and Kessler, (2000) it is clear that if there is a perceived breach of psychological contract in radiography due to budgetary constraints in the NHS, the staff flexibility required to sustain the OOH service, by the voluntary nature of on-call, will be reduced. On-call, being “overtime” is therefore not contractually compulsory. However, a positive contract will support negotiations in relation to the change management of redesigning the radiography service to accommodate the changing needs of staff, service and patient needs within this current study.

5.7.2 Fatigue

Tensions related to fatigue, when considering workpatterns are rooted more in relation to the workpattern itself, rather than the tiredness caused by the workload of the job. Circadian rhythms are regular changes in mental and physical characteristics that occur in the course of a day (*circadian* is Latin for "around a day"). Symptoms similar to jet lag are common in people who work nights or who perform shift work. Staff whose workpatterns that are at odds with powerful sleep-regulating cues like sunlight, often become uncontrollably drowsy during work. They may suffer insomnia when they try to sleep at times at variance to the regular clock time (Smith, 2008). These are relevant issues for staff who undertake on-call in addition to core hours in relation to work-life balance and also performance and safety in the workplace. Thus the concern of duty of care and the risk of errors is a workplace tension that is strongly associated with fatigue and workpatterns (Murray et al, 2005). An understanding management would be expected to support a positive psychological contract to ensure a flexible attitude to sustain service throughout 24/7.

5.7.3 Stress

Workplace stress is a workplace tension frequently related to workload and worklife balance. The word stress forms a large part of most peoples' vocabulary. In the workplace the term is often employed by both management and workforce to describe individual and collective experiences of fatigue, distress and an inability to cope with the demands of work (Blaug et al, 2007). Perhaps this lack of definitive classification may lend weight to the issue of workplace stress and stressors that appear to differ for individuals. Blaug et al considered it important to define stress to facilitate the understanding of stress and stressors in the individual when considering stress in relation to workpatterns and work-life balance. Some definitions of stress are listed by Blaug et al (2007). These definitions arise from several sources ranging from 1978-2000. However, they all recognise that stress is a personal experience caused by pressure and demands and the individuals' perception of their ability to cope with the stressors. The timespan of the literature demonstrates that stress is not a recent phenomenon. However, the word stress has moved into commonplace vocabulary.

In order to measure stress in the workplace, several definitions were compared from literature. As early as 1989, Palmer, quoted in Blaug et al (2007) indicates that stress is the response, by an individual, when they cannot balance demands and their ability to meet these demands. It also then indicates that, when this stress is perceived over a period of time, it can lead to ill health. More recently Raymond, (2000) quoted in Blaug et al, (2007) considers that stress is a reaction that individuals feel when excessive demands are placed on them. The reaction occurs when they feel that they cannot cope. These two definitions represent deliberations from two time periods quite different in terms of work pressures and yet they reflect similar underlying sentiments.

In trying to understand stress in relation to workpatterns and work-life balance, it is important to understand that this balance may differ, depending on the life stressors relevant to the person, at the particular point in life. This aligns with Taylor, (2001) in that flexible working must reflect the changing needs of the life cycle of the employee to have any beneficial effect. The ability to cope may alter in relation to the lifecycle of the individual and may reflect the changing needs for flexible working. Stress may also be a contributory factor in lone working. Excessive workload demands, when staff are working alone and consider that they are unable to meet the demand, increases the pressures of tiredness (Mark et al, 2006). This also impacts on workplace safety as discussed by the BMA, (2006) and on life outside of work.

Stress will therefore be experienced by individuals when on-call. Demands for duty while on-call and when physically tired will stress individuals by testing their ability to respond to and cope with these demands. Health and Safety Executive, (2009) indicated that risk assessments must be undertaken and appropriate control measures implemented, to reduce risks identified. Thus, stress is a workplace tension that differs from individual to individual. This both influences, and is affected by, workpatterns. In particular in relation to this study, radiographers working OOH may experience stress due to several factors such as fatigue caused by long working hours, excessive work demands and possibly the lack of peer support if the duties are lone working.

5.7.4 Burnout

An American measure of workplace stress is burnout (Ackroyd et al, 2002). Gillespie, (1991) believes burnout is a reaction to continual work related stress, characterised by physical and emotional distress and defensive coping strategies. This would essentially underpin the discussion above, that stress is an individual response to perceived pressures. However, the study considers burnout using Maslach's, (1982) Concept of Burnout; that is measuring three sequential components that result from chronic stress. These three components are: emotional exhaustion, depersonalisation and lack of personal accomplishment. This has not been mentioned in other stress related papers. Of note, the Ackroyd et al, (2002) study identifies that as workload increases, burnout also increases. Burnout should be considered when assessing the effects of workpatterns that staff perceive as stressful. In addition the measures of burnout raise consideration of staff morale and how staff view the workplace and workpatterns. This aligns with the psychological contract above (Conway and Briner, 2005) that a positive contract supports a flexible attitude to the workplace and workpatterns. Consistent stress, if this leads to burnout, may cause staff to consider leaving the profession to preserve emotional well being in other areas of life. This may also have a bearing on retention within the profession as discussed by Coombs et al, (2003).

5.7.5 Dispositional optimism/pessimism

Further study by Hayes and Weathington, (2007) into the service industry, identified many similarities to healthcare situations. Individuals in service industries face stressful work situations on a regular basis, such as staff shortages and interacting with unhappy clients, in addition to meeting imposed targets within e.g. hospitality services. These are all situations that radiographers can face. Hayes and Weatherington, (2007) indicate that staff who approach these issues with optimism and expect a positive result experience a lower level of stress. They define psychological stress as the negative cognitive state that occurs when individuals believe that the demands placed on them surpass their ability to cope. This is a similar

definition of stress to those detailed above (Blaug et al, 2007). Dependent on the job or tasks, stress may be related to being overloaded with work, rather than not being in control of the job. However, there are two distinct stressors or workplace tensions in radiography: the perceived excessive workload demands in the OOH period and the frequency of the rostering of the OOH duties. Hayes and Weathington, (2007) findings suggest that individuals who have a higher level of optimism are better able to adjust to and overcome stressful situations. A further finding from the study suggested that stress impacted directly on life satisfaction without involving job burnout. Working through the findings from Hayes and Weathington, (2007) there is support for Judge et al, (1998) whose international study contended that the manner in which individuals view and interpret their environment, partly depends on their evaluation of themselves. This supports definitions of stress from across the decades, that indicate stress is an individual perception of coping. This is echoed in Taylor, (2001) above, in that staff have different agendas and coping strategies that relate to each period of duty and the workload demands. These then relate to the stress of workplace tensions within workpatterns. This background understanding will facilitate negotiations regarding the workpattern model.

5.8 Summary of workplace effects and tensions

Traditional workpatterns such as shifts or on-call are unfortunately essential to manage patient care over a 24 hour period. There are many disadvantages of both these traditional work patterns, not least health effects on staff and risks of mistakes in care due to tiredness. Most importantly the risks of fatigue to both patients and staff must be considered very carefully in selecting any workpattern. There is a service sustainability risk in OOH being covered by on-call, as on-call is undertaken in addition to contracted hours and is thus not contractually compulsory. In addition, the risks of lone working in increasing the risks of fatigue must be explored and assessed with control measures put in place to reduce risks as far as possible. There are a few perceived advantages in the provision of 24 hour care such as financial uplift and flexible working incentives. There is no doubt that there is no optimal solution for 24/7 cover in any job. Historically, on-call or residential on-call (stand-by) has been considered as the cost effective method of ensuring cover for general radiography. There has been a gradual move to combinations of shift patterns blended with on-call to accommodate increasing work pressures and to combat fatigue. These measures have avoided major disruption of care, while attempting to protect the ethos of the psychological contract. Radiographers have until now resisted more structured moves to shift patterns, as remuneration for an on-call commitment acts as a financial uplift (or in effect an overtime payment) or a mechanism for flexible working patterns. This must be explored as, for some staff, these are factors that are inbuilt to work-life balance and withdrawal of these elements would disrupt the balance. Flexible working is

excellent in theory but rarely takes account of the changing needs of staff over a lifecycle, or of the difficulties encountered in service sustainability and operational management, when the duty holders are on leave. There is also the risk that staff who have no family related requirements for flexible working are often disadvantaged by having to undertake the remainder of the duties that do not fit with flexible needs. Fatigue is an integral component of 24 hour working due to disruptions of the circadian rhythm no matter which workpattern is employed to cover the 24/7 period. Stress can be related to fatigue if staff consider that the workload overstretches their capabilities at that time. Staff expectations and capabilities are individual and therefore the staff attitude to the workpattern and workplace tensions and the workplace ethic and co-operation with management, is also dependent on individual agendas and whether staff perceive this relationship to be a positive psychological contract. This is an individual experience and is therefore difficult to measure qualitatively. However staff attitudes will be measured quantitatively in the attitude survey by likert scoring. Excessive tensions can exacerbate stress and can lead to burnout which can have detrimental effects on service sustainability. Burnout is again individual and staff who demonstrate dispositional optimism have been found to be less affected by stress and therefore less prone to burnout than those who demonstrate traits of dispositional pessimism.

Thus, workplace tensions are frequently related to workpatterns, in addition to workload throughput but are experienced at different levels on an individual basis. Tensions can often be ameliorated by good working relationships with management and this has the effect of underpinning flexible attitudes of staff. These good relations support a positive cognitive state and therefore sustain constructive negotiation towards a satisfactory sustainable service.

5.9 Impact of literature on the study aim

As stated in Section 3, the aim of this study is to develop a workpattern model for general radiography that will underpin skill mix and role development. This model will support 24/7 working in general radiography and will facilitate a redesign of general radiographic service provision, to meet the changing service requirements with respect to service, patients and staff needs in Scottish radiology departments. Following critical evaluation of the literature, no custom built or commercially available solution to workpattern modelling has been identified. Thus, the aim of the study remains to develop a work pattern model as above to facilitate redesign of service to meet the changing requirements.

5.10 Review of objectives

Critical evaluation of current literature surrounding workload, workforce planning, government policies and healthcare priorities was undertaken to comprehend the subject. This allowed the generation of more specific objectives

- To critically evaluate current literature surrounding workload, workforce planning, government policies and healthcare priorities, to comprehend the subject of workpattern modelling, in relation to the unscheduled nature of general radiography thus supporting the scientific perspective of minimising misconceptions and pre-conceptions.
- To undertake empirical research of the local workload demands, by quantitative (time series) data analysis of workload statistics representing the workload using the time period from the installation of a new radiology information system (RIS) to just prior to the commencement of this study (Oct 2007-Dec 2008). This will evidence the spread of the demand for general radiographic service in the scientific perspective.
- By deductive analysis, forecast the expected workload demand, following the time period above by time series forecasting, using decomposition analysis. This is an essential component in developing a future proof workpattern model for general radiography in Scotland.
- By deductive analysis, explore the frequency distribution of patient episodes. This will inform the development of a workpattern model.
- To develop a workpattern model by means of deductive reasoning, that will be appropriate and applicable in general radiography in radiology departments across Scotland.
- To explore implementation of the workpattern mode, with respect to local application.
- To plot a working day that applies the workpattern model, as developed.
- To determine a satisfactory skills base to support the working day, within the workpattern model.
- To develop an application of the workpattern model that can be flexible, to suit local service arrangements but that facilitates implementation of the workpattern model across 24/7 duty periods.
- To explore staff attitudes to the proposed workpattern model, to validate the generalisability of the model.
- To explore staff attitudes to the application of the workpattern model across 24/7.

6. Methodology

Methodology refers to a range of approaches that can be used to achieve the stated aims of the study; the theoretical perspective and philosophical views of the principal investigator direct the research and the plan of the method adopted. This methodology must align with the research aims and must be suitable for the contribution of the research i.e. appropriate and valuable new knowledge in the topic area.

6.1 Research Strategies

Higgs et al, (2009) highlights the approach of the paradigm and ontological stance. The paradigm is composed of beliefs, assumptions and structures and the perceptions of concepts that define the mechanism of enquiry. The ontological stance is the philosophy within the paradigm. This approach is analogous to Stanford Encyclopaedia of Philosophy, (2005) where the description of epistemology and theoretical perspective, is broadly equivalent to Higgs et al, (2009) paradigm and ontological stance. Epistemology is the study of knowledge and justified belief (Stanford Encyclopaedia of Philosophy, 2005). Both of these approaches adopt the structure that the different aspects of research layer upon each other from perception through to the methods employed in the study. Similarly, Saunders et al, (2006) also describes research layers that lead from broad philosophies through strategies to methods and data collection. The layers of research decisions for this study are detailed in the following sections.

6.2 Philosophy and Theoretical Perspective

The philosophical views and theoretical perspective of the principal investigator will influence the theoretical perspective and subsequent methodology and method employed for this study, in addition to the expected output and contribution of the outcome of the study.

The principal investigator usually acquires knowledge from direct observation or substruction rather than abstract thinking and discussion. As the objectives of the study are to undertake statistical analysis of current and forecasted workload as recommended by Jenkins-Clarke, (1992), a philosophy that embraces an evidence based theoretical perspective must be identified. Crotty, (1998) discusses the following theoretical perspective with regard to identifying a relevant theoretical framework. Realism, based on detailed observation of actual events, might be an appropriate perspective but does not favour contemplation and exploration of the subject and thus was rejected. Pragmatism and Interpretivism were also considered as they deal with facts, actual occurrences, judgements and consequences of events. However, as neither of these perspectives favour substruction and scientific analysis, they were both rejected. Subjectivism and Objectivism were both considered. Subjectivism was rejected on the basis that,

as the aim of the study is to develop a workpattern model that will meet changing service requirements in radiology departments; individual subjective experience would not support a scientifically derived formula, in the application of a developed model, throughout radiology departments in Scotland. Objectivism was also rejected as, even though the facts exist, they have to be interpreted for the situation using experiential judgment and scientific relevance of deductive reasoning. Thus, the principal investigator favours Positivism as a theoretical perspective. Within Positivism, Evidentialism (a traditional view) considers that a belief is justified by the possession of evidence. This would be a reasonable perspective, however, also within Positivism, there is a non traditional view of Reliabilism. Reliabilism considers that a belief is only justified if that belief originates in a reliable cognitive process or faculty. This encompasses information processing, both in factual and sensory form. As the principal investigator processes information in both evidential form and also requires cognitive reasoning to comprehend the evidence in a situational analysis, Reliabilism is considered to be the most appropriate theoretical perspective for the principal investigator to assess the study data.

6.3 Approach

Given that the aim of the study is to develop a workpattern model to meet the changing service requirements in radiology departments, health boards will require a data driven and data derived rationalisation of the model. Staffing resource is the main cost for health boards (Bosanquet et al 2006). Proven, effective workpattern modelling will therefore be an essential component of workforce planning. In order to demonstrate the effectiveness and to facilitate the costing of the proposed workpattern model, statistical evidence of the derivation of the model will be required by the health boards and other workforce planning initiatives (Audit Scotland Report, 2002). Thus, an analytical approach of deductive reasoning is necessary to produce an appropriate output contribution. The research goals of the empirico-analytical paradigm and the Reliabilist perspective of measuring, controlling, analysing, explaining, prediction and finding cause/effect would all be achieved by the choice of the deductive approach. Reliabilism supports the scientific perspective, as this encompasses an experimental, empirical or direct observation substruction and analysis methodology. The scientific perspective aims to minimise pre-conceptions and misconceptions. This is essential when developing a model for general use throughout Scotland. Deduction is the direct application of knowledge in the production of new knowledge. This analytical deductive approach sits within the framework of Reliabilism.

6.4 Strategies

The project has been split into three sections.

Section 1	Workload data collection and analysis
Section 2	Developing the workpattern model
Section 3	Staff attitude survey

Table 1: Study sections

6.4.1 Section 1 - Workload data collection and analysis

The first section is an empirical analysis that explores and measures the local workload data in the principal study centre and analyses the raw data in order to describe further characteristics of that data. This analysis is extrapolated to two further centres using workload data from those centres. This is a mini case study of the three centres. The case study method of research tests whether theories or models work in the real world and support the Reliabilist perspective of explaining, measuring and direct observation (Jenkins-Clarke, 1992).

The radiology information system (RIS) is the database that contains all data relating to examinations, patient details and time indicators for all radiology activity. However, due to a change in the RIS in late 2007, the data from prior to this time (legacy data) and after this time (new RIS) are not directly compatible. The data used for the main analysis in section 1 of the study is from the new RIS. Legacy data is used to determine trends only. It was considered important for the reliability of the study to use the data from the new RIS. This RIS is a component of a Scotland wide initiative allowing replication of data analysis in any Scottish health board. Thus statistical reports from the new RIS will allow commonality of statistics across Scottish radiology departments.

The three centres in this study have been selected due to the differing characteristics from each other and also the representative nature of the characteristics across the wider radiographic world. In this study the categories of the hospitals selected were a rural centre (the principal study centre), an urban district general and a large city teaching centre. All hospitals in Scotland would fit into one or other of these three categories of hospital. Thus by selecting these centres as the mini case studies, the research can be related to every hospital in Scotland.

6.4.2 Section 2 - Developing the workpattern model

The second section of the study is a deductive exercise that develops the workpattern model from the data analysis derived from Section 1. In addition to the workpattern model, options for the workplace application of the model are explored to facilitate the implementation of the model in the workplace, again utilising statistics from Section 1 and data from the review of the literature (Ernst et al, 2004). Forecasting will be undertaken. In order to address the aims of the study and to future proof the workpattern model, it is essential to predict future trends and therefore the probability of future service needs, thus methods of forecasting are considered below.

6.4.2.1 Trend analysis

Trend analysis is related to identifying trends and therefore forecasting anticipated developments and tendencies. Trend analysis involves comparison of the same data item such as treatment or examination over a significantly long period to detect the pattern or relationship between associated factors or variables and project the future pattern of these variables. Within the healthcare setting, trend analysis is used by healthcare resource groups, which are standardised grouping of broadly similar healthcare treatments, using similar levels of resource. Trend analysis facilitates benchmarking and comparison of treatment between organisations. These groups support healthcare commissioning across healthcare organisations (NHS, 2009). This method, though it would allow comparison across health boards, would not be suitable for the projection of workload for this study, as this workload is seasonally affected. Trend analysis, does not smooth the seasonal variances and would not take account of these variances in forecasting. In addition the data available for the principal study centre covers a time span of only fourteen months. This may not be a substantially long interval to demonstrate visual trends that are cyclic rather than seasonal.

6.4.2.2 Multiple regression analysis

This analysis is related to circumstances when two or more variables may interact or influence an outcome leading to the development of alternate models with different outcomes. A healthcare example of the use of multiple regression analysis, might be an anaesthetist who wished to study the effects of a new drug on patients' blood pressure and the effects of both the consequence of the drug on lowering the blood pressure and the resultant lowered blood pressure, on the patients recovery time. The dose of the drug affects the drop in blood pressure but the drug itself has an effect on the patients' recovery. However, the lower the blood pressure, the greater the effect on the patients recovery. The same dose of the drug has a different effect on the blood pressure of individual patients. Both of these variables have an effect on the

outcome and must be studied in relation to each other to forecast alternate models (Oxford Journals, 2009). This method of analysis would not be appropriate for the projection of workload as there are no multiple independent variables to be considered in developing the forecast.

6.4.2.3 Non Linear regression

This method of forecasting does not assume a linear relationship between variables. This means that dependent variables do not alter in a linear manner in relation to the independent variables. Non linear regression is a general technique to fit a curve through the data. It fits data to any equation that defines Y as a function of X and one or more parameters (Curve fit.com, 1999). An example of this method of analysis involves predicting survival in women with breast cancer. An increase in circulating tumour cells indicates an increased risk in both progression free survival and overall survival. A non linear increase in risk of both progression and death with increasing number of circulating tumour cells was observed (Botteri et al, 2009).This method of forecasting would not have been appropriate for the study, though non linear regression is often used when time is the independent variable as in this study, it does not consider the effect of seasonal variation. The workload can be mapped on a linear scale with trend lines.

6.4.2.4 Moving Average Analysis

The definition of moving average analysis is the mean**,** calculated at any time over a past period of fixed length. This action smoothes the time series and gives a trend estimate against a specified timescale. This analysis is used extensively in financial forecasting, as in the stock market. Within the healthcare setting, circumstances utilising moving average analysis, are often related to financial aspects of alterations in practice. An example of this might be the cost containment exercise required to ensure funding of the implementation of public provision of healthcare in Spain (Lopez-Casasnovas, 1998). Moving average analysis was employed to make recommendations on the financial burden of implementing the public provision programme. However, this method does not deseasonalise data thus would not be the most appropriate in the current study

6.4.2.5 Exponential smoothing

Time series data may be an essentially random process, or it may be an orderly, but noisy, process. Whereas in the simple moving averages, the past observations are weighted equally, exponential smoothing assigns exponentially decreasing weights as the observations get older. More recent observations are thought to be a better indicator of the future (and accordingly ought to be given greater weight). A healthcare application of this method of forecasting is discussed by Xue et al, (2001) in

forecasting the numbers of patients with end stage renal disease and the healthcare insurance implications of the burden of suffering. These projections are based on smoothed historical data with recent data given heavier weighting. This may have been a relevant method to have used in the study if there had been equivalent data from several years. With the alterations in healthcare provision, recent data would have given a more accurate current picture. However there is limited timespan of data available in the current format and therefore insufficient data to weight recent data, thus the method would not be appropriate for this study.

6.4.2.6 Adaptive filtering

An adaptive filter adjusts its response in relation to a fluctuating input factor. This allows for a more accurate output factor for forecasting. In healthcare circumstances an electrocardiogram (ECG) is corrupted by noise from the power supply (e.g. 50Hz). This corruption could be filtered out by a static filter. However, due to slight variations in the power supply to the hospital, the exact frequency of the power supply might wander between 47 Hz and 53 Hz. A static filter would need to remove all the frequencies between 47 and 53 Hz, which could excessively degrade the quality of the ECG since the heart beat would also likely have frequency components in the rejected range. To circumvent this potential loss of information, an adaptive filter could be used. The adaptive filter would take input data both from the patient and from the power supply directly and would thus be able to track the actual frequency of the noise as it fluctuates. This adaptive technique allows for a filter with a smaller rejection range, which means, that the quality of the output signal is more accurate for medical diagnoses. This is not appropriate for the study as there is no output related to the input. However a filter was used in some aspects of data cleansing. Examination times below a stated range and above a stated range were deleted as they were too short or too great to be realistic and were presumed to be administrative errors. This assumption was validated by relating the data to specific patient records and confirming the administrative error. This facilitated accurate forecasting.

6.4.2.7 Decomposition

Decomposition is a detailed decomposition of the data that observes trends and deseasonalises data to smooth the time series. This will produce a forecast of future demand with a measure of accuracy. This method uses some of the above elements of forecasting such as trend analysis and moving average analysis but further deseasonalises the data to smooth peaks and troughs in the data. This is extremely important in this study as workload and workpatterns must be matched by resource. This method of

forecasting will facilitate future proofing of resource management and is therefore the most appropriate method for this study.

Future values have a probability distribution based on past data and time series analysis and time series forecasting by decomposition, recommended by Chatfield, (2004) as an appropriate method of forecasting future data, will be undertaken in this study. This will be undertaken using Minitab statistical package. The remainder of the data collection and analysis will be undertaken using Excel spreadsheet package. This analysis aligns with the theoretical perspective of Reliabilism as the data is observed, substructed and further analysed by deductive reasoning. Frequency distribution of patient episodes will be analysed to determine the percentage ratio of patient episodes. This is important in determining staff resource in relation to activity. This application draws on the theory of adaptive planning (Kulatunga et al, 2009).

Local negotiations will be guided by this research and will include analysis of the strengths, weaknesses, opportunities and threats (SWOT) of potential workplace applications of the workpattern model. This research will guide the implementation of the workpattern model in all centres. Deductive reasoning was employed in the synthesis of this workpattern model from the base data.

6.4.3 Section 3 - Staff attitude survey

The third section of the study is the assessment of the workpattern model via a survey of staff attitudes. The workpattern model is a tool that can be implemented in all centres determining staffing levels and skills mix dependent on workload. It is important to sample staff attitudes in centres of differing characteristics as mentioned above. This workpattern model will underpin discussion on OOH working, aligning OOH and core hours working. It will impact on skills mix and role development across the wide radiographic population and will inform local and national policymakers in relation to guidance on OOH duties in relation to core hours. Thus, it is essential, as mentioned in literature, to obtain representative staff attitudes prior to any implementation strategy (Kecklund et al, 2008). This workpattern model must be tested against staff attitude, to support change management by reducing preconceptions and misconception in accordance with the scientific perspective. Thus survey methodology was judged to be the most appropriate methodology for Section 3 to gain information from radiographers in a selection of centres with different demographics. Surveys are aimed at a particular group of people and have a purpose that is related to that group (Barnes, 2001). In this case the group is “radiographers who undertake general radiography” and the purpose is “to obtain the group’s attitudes to the workpattern model”. Survey questionnaires are typically used to determine the current position or to estimate the distribution of characteristics or opinions in a population. They can be used to describe, compare or

explain behaviour, knowledge, attitude or preferences (Boynton and Greenhalgh, 2004). This sits within the Reliabilist theoretical perspective of measuring.

Surveys can be undertaken by several methods. At one end of the scale there are face to face, in-depth, interviews when the researcher asks the individuals questions from a questionnaire script and the respondents answer verbally with the responses recorded. This method could employ qualitative study and may identify individual agendas. This would involve interviews with a small sample of radiographers from the different study centres followed by thematic analysis of the interview text. However, it would be difficult to relate these agendas to the wider radiographic population due to the small sample size. This qualitative approach would not support generalisation of the findings. A further consideration for both the principal investigator and for staff in each study centre would be the time constraints which would reduce compliance. At the other end of the survey scale is the electronic questionnaire where both questions and responses are managed on-line and responses are usually required in a structured format. The on-line questionnaire is a data collection tool, whose function is to facilitate measurement of specific factors. This tool can target a large population (Boynton and Greenhalgh, 2004). This application of survey methodology would be considered to be quantitative, as the responses would be numerically assessed or assessed by code that could be demonstrated statistically. The advantage would be the potential wide population reached by this method and therefore the ability to generalise the findings. In the middle is survey by telephone questionnaires and postal questionnaires (Barnes, 2001). These can be either qualitative or quantitative dependent on the structure of the questionnaire but both have restrictions associated with data collection. The questionnaire method has disadvantages and advantages. Self administered questionnaire method was considered. The strengths of this method are numerous. This would target a large population and reach respondents in distant locations. Standard questions indicate there is low pressure on respondents and quantitative analysis can be straightforward with coded responses. This eliminates the possibility of interviewer bias where the interviewer asks leading questions (Thomas and Slater, 2009). Limitations of this method are also significant as questions cannot be further explained or background expanded as in interview. ESurveys.com, (2008) recommended avoiding loaded or leading words or questions to avoid biased results. In this situation, as the study requires focussed detail on a specific agenda to inform future operational management, it is reasonable to restrict responses to the study based agenda. A further advantage of the questionnaire method is the ethical consideration of confidentiality and anonymity as questionnaires can be administered and returned anonymously.

The format of a questionnaire can be used to assess factors within a framework of objectives by standard and structured questions (Thomas and Slater, 2009). Responses can be tick boxes or free text responses. Closed questions can be too prescriptive and may not capture valid data if insufficient choices are offered.

However, the responses can be analysed quantitatively and described in graph or tabular format. Open questions can be difficult and time consuming to analyse in a cohesive format when there is no face to face dialogue to explain the responses. Thus the responses can be analysed by qualitative format but this may be less rigorous due to the suboptimal nature of the data collection. Attitude questions require respondents to be reflective and usually to quantify their attitude on a likert scale. Attribute questions elicit information on personal or demographic material. The usual purpose for this information is to explore how other kinds of information (attitudes beliefs and behaviours) vary for people with differing attributes (Barnes, 2001). The combination of attitudes and attributes is valuable information for the radiography profession, both in terms of change management and for purposes of recruitment and retention. This was considered to be the most appropriate choice for section 3, the staff attitude survey. An attitude and attribute survey can be analysed quantitatively and with inferential statistics. This would inform the radiography profession on the generalisability of the responses across the profession, as the characteristics of the selected study centres are representative of the hospital across Scotland. The responses can be described in graphic and tabular format, thus aligning with deductive approach and quantitative methodology. This format is very appropriate when reporting to health boards as an attitude survey can supply key information to inform decision making and planning process planning. Action plans related to opinions elicited from an attitude survey, can identify ways in which employee support and commitment can be improved. This would be an advantage in managing change and implementing the workpattern model, as agreed by the Human Resource Development Group, (2005). They state that a well constructed attitude survey is considered an excellent starting point, when organisations need to effect any organisational change. In organisational development, carefully constructed survey instruments are often used as the basis for data gathering, organisational diagnosis and subsequent action planning. These seminal works still have relevance in current times. Data informs organisational management and professional bodies, (local and national policy makers) on issues related to OOH duties. The data also informs on service impact, that undertaking OOH duties may potentially cause, in relation to role development and core hours duties. Organisational development has been developed formally since the 1940s and is described as a planned, organisation wide effort to increase an organisation's effectiveness and viability. Bennis, (1961) has referred to organisational development as a response to change, a complex educational strategy intended to change the beliefs, attitudes, values, and structure of organisation so that they can better adapt to new technologies, policies and challenges. Lewin, (1948) developed the process of group dynamics and action research which underpins the basic organisational development process. This attitude survey will therefore allow decisions on organisational development to proceed in an enlightened manner with the benefit of identifying staff attitudes which will facilitate the

reduction of misconceptions in accordance with the scientific perspective. The data obtained will inform local and national policy on recruitment and retention.

Attitude questions using likert scales (Mogey, 1999) were considered. Construction of questions using likert scales is relatively simple and they are straightforward for respondents to complete, as they support a range of options, rather than a prescriptive binary decision (Mogey, 1999). The response rate for these types of questions is higher than open-ended questions. This format of question usually presents a statement and respondents are asked to express agreement or disagreement on a scale. These scales usually consist of five points, a bipolar scale meaning from strongly negative to strongly positive with a neutral point (NHS, 2006). This allows respondents to select the option closest to their personal attitude. If a neutral option is not offered this is known as a "forced choice" method and is only employed if there must be an affirmative or negative decision and to avoid the central tendency bias (where respondents may avoid using extreme response categories, i.e. points 1 and 5 on the scale). Respondents may consistently agree with statements in likert scale questions. This is known as acquiescence response bias. Finally respondents may try to present themselves or their opinions in a more favourable light (known as social desirability bias) by selecting the perceived socially or politically correct response. Attitude questions with responses on likert scale questions with a neutral option are the most appropriate choice to identify the attitudes of a large population (Trochim, 2006). This option also supports explanation, measurement and analysis and is therefore appropriate for the Reliabilist theoretical perspective. As the analysis of the data can be demonstrated in statistical form, this option is appropriate for a quantitative choice. Closed questions were rejected as being too prescriptive with a dichotomous choice. Open questions were rejected as being too difficult to analyse accurately and being time ineffective both for investigator and respondent.

There are several methods of administering a questionnaire (Human Resource Development Group, 2005): the traditional paper based survey which is the most robust and flexible approach. The disadvantages are costs of printing and postage. An alternative to this is to fax out and fax back but this may compromise confidentiality and anonymity. This has the advantage of speed but may have the disadvantage of faxes being difficult to read after transmission. A web based link within an e-mail is a cost effective way to administer the survey, as there are no printing or postage costs. This is particularly cost effective if the sample population is large (Trochim, 2006). The disadvantage might be availability of internet access and computer literacy. A further combination of the above is paper out and paper or web based reply. The questionnaire can be sent out by post, with a coded instruction to access a weblink. The response can be returned by the weblink, or posted back to the administrator, if there is difficulty with internet access. Finally, the questionnaire can be e-mailed directly to the respondent but this, though it can be accessed by

the majority of people, has the disadvantage of poor format transfer and more importantly, is not anonymous by reply. Postal delivery and return of the questionnaire was considered to the most robust delivery mechanism. The weblink return was considered but many radiographers do not have automatic computer access during working hours. It would also have been more difficult to enforce inclusion and exclusion criteria using electronic application thus requiring the use of filter questions (Trochim, 2006). Filter questions advise respondents to omit certain questions in the questionnaire if they do not meet specific inclusion criteria. The number of questionnaires over the three study centres was not excessive therefore postage costs were not prohibitive. The questionnaires were packed and posted to each department manager with a request to distribute these to all radiographers who undertake general radiography. The manager in each participating centre was asked to facilitate collection and return of the completed questionnaire (contained in the anonymised envelope provided). The department managers all agreed to support the study, in a non threatening manner, in order that staff in the study centres would not be intimidated.

6.5 Choices and time horizons

As the research is undertaken in three sections, the choices for each section will be considered individually. Sections one and two of the study align with the literature on local data analysis in workpattern modelling (Jenkins-Clarke, 1992). Due to the analytical nature of the study, the strategies selected for these sections were quantitative methods of observation, measuring, explaining, prediction and analysis. The deductive approach used in this section sits within the framework of Reliabilism. The second section is the development of the workpattern model. This development process will employ deductive analytical reasoning based on the data identified and generated in section one of the study. Deduction is the direct application of knowledge in the production of new knowledge and sits within the theoretical perspective of Reliabilism, by substructing the data pathways. Section three of the study, the survey of radiographer attitudes, is analysed quantitatively to facilitate generalisations of the attitudes across the wider radiography population. Accordingly the study was undertaken entirely by quantitative methodology. This meshes appropriately not only with the principal researcher's theoretical perspective but supports financial and statistical interrogation of the contribution of the study within health boards

The first section of the study observes workload data (the dependent variables of demand and activity) and generates and measures further data of examination duration and frequency distribution over a prolonged period of a year. As the same variables were measured and analysed over a prolonged defined time period, the study is a longitudinal study.

6.6 Method

6.6.1 Section 1 - Workload data collection and analysis

A data trawl of workload data from the RIS in the principal study centre from October 2007-December 2008 will be obtained. The data will be extracted from the RIS using the following fields; examination date, unique identifier, arrive time, start time, finish time and examination code. A time series is a chronological sequence of observations on a particular variable (Lindsay, 2004). Time series will be undertaken to demonstrate the descriptive statistics on a local data extract from the RIS. This will involve plotting workload activity against a timeline to allow for observation of trends. This timeline is appropriate to allow observation of cyclic trends (e.g. school holiday periods), seasonal variations (e.g., weekly or monthly variations due to repetitive patterns) and events (e.g. process changes initiated in response to local and national policies). This will inform on historical and current (at time of the study) service activity. The constraint is the upgrade to the new RIS. This limits the time of data collection to fourteen months (October 2007-December2008).

In addition to the descriptive statistics above, the data extract will support analysis of the number of patient episodes per hour, day etc and the time interval for the examination procedures. These parameters facilitate calculation of the numbers of patients seen in defined duty periods over the course of the study. In addition the parameters allow calculation and analysis of the time intervals of the episodes and the frequency distribution of these episodes together with relevant ratios and averages. The data will also permit forecasting of future data sets using decomposition by Minitab statistical package. This data trawl must initially be checked and cleansed of administrative error. Analysis of local data is an essential process in evidencing workload, workflow and workpattern and supporting development of the workpattern model.

Analysis will be undertaken, in the two additional study centres with differing characteristics as mentioned above, as mini case studies. The analysis will be extrapolated using the workload data obtained from the two study centres.

6.6.2 Section 2 – Developing the workpattern model

As recommended in literature, understanding of local workload is essential to developing a workpattern model (Jenkins-Clarke, 1992). The workpattern model will be developed using the analysis as described above for section 1. Analysis of frequency distribution of patient episodes as generated in the section 1 analysis (Ernst et al, 2004) in combination with crew pairing as described by Day and Ryan, (1997) mapped

against workload in general radiography across 24/7 will facilitate development of the workpattern model. Application and schedules will be constructed using the theory of adaptive planning (Kulatunga et al, 2009) to support implementation of the workpattern model in the workplace.

6.6.3 Section 3 – Staff attitude survey

The specific objectives of section 3 are

- to explore radiographer attitudes across the profession to the workpattern model and application in practice.
- to investigate how this would impact on options of OOH workpatterns.
- to determine the impact of the workpattern model on role development and skills mix.
- to assess the alignment with lifestyle balance.

The attitudes of staff will be sought in relation to the workpattern model and the application of the workpattern model in practice. The survey will be administered to staff in three hospitals across Scotland with differing characteristics. The case study strategy will explore whether staff attitudes are related to the characteristics of the centres or whether the attitudes are generalisable across the radiographic population.

A self administered attitude questionnaire using likert scale questions was decided as the method for this section of the study. These attitudes identified by questionnaire will be analysed by quantitative analysis of responses in a systematic statistical method using a lIkert scale analysis. Data collected from a likert scale are ordinal in that there is a logical ordering of the categories. The responses were presented as options on a likert scale from strongly disagree to strongly agree. The questions covered topics such as whether radiographers considered whether the workpattern model would be appropriate in each centre; that the current staffing would support the model; whether the practical application of the model would support personal circumstances and whether the practical application would affect personal development plans. The survey also sought information on attributes of the respondents (such as age range, stage of career and domestic circumstances) that are correlated with attitude responses. The descriptors were coded to facilitate analysis. Descriptive statistics were summarised using the mode. The attitude responses will be displayed in a barchart as percentages of respondents in each study centre (Mogey, 1999). Inferential statistical analysis will be undertaken, again using Minitab statistical package. Investigation of any association between two different sets of observations was undertaken by chi-squared test of association. Chi-square indicates where there was evidence of a relationship between the variables but it

does not indicate the strength of the relationship. Cramer's V is a post-test to give this additional information. Cramer's V varies between 0 and 1. Close to 0 it shows little association between variables. Close to 1, it indicates a strong association. This analysis is again in keeping with the Reliabilist theoretical perspective.

7. The Study

7.1 Section 1 – Workload data

7.1.1 Background

The RIS is an information system that records patient data in terms of patients examined, examinations performed, and various event times. This is also the database that provides the workload statistics. The RIS was updated in the main study centre in late October 2007 as part of a Scotland wide initiative to align systems to provide comparable data across health boards. The data extraction statistics vary between the old database (legacy RIS) and the new RIS. The legacy RIS (up till late October 2007) extracted the workload statistics by examinations i.e. data for a patient being examined for three procedures e.g. imaging of chest, abdomen and pelvis, is available on the Legacy RIS as a count of three examinations with one patient identified. The new RIS (from late October 2007) extracts the data in manufacturer defined reports, none of which are exactly comparable to the Legacy RIS. The new RIS allows an ad-hoc extraction of the workload statistics by patient episode, thus the patient having the chest, abdomen and pelvis examinations would count as one episode with a unique episode identifier. This would have an impact if the statistics from both databases are directly compared. Statistics for general radiography only will be analysed in this study. Workload statistics for US, CT, and MR and other planned care modalities were not evaluated in this study.

The zero datum points relate to duty periods where there is no data available. This was when the RIS was not operational due to malfunction. This was a frequent occurrence in the early post installation period of the new RIS. These occasions are validated by review of the statistics, when it was identified following these occasions, that there was a catch-up period where all the patient data was entered retrospectively on the morning following these events.

7.1.2 Spread of workload

The spread of throughput of patients throughout the day is important. There may be a preponderance of cases during a section of the duty period. It is important to establish this effect, as this will inform workforce planning and resource management. If this preponderance is focused in the on-call period, then this has significant implications for workforce planning. It is essential to comprehend the workpattern across the 24 hour working day when developing a workpattern model. The core hours of the principal

study centre radiology department are 9am to 5pm. Outwith core hours general radiography is staffed by an arrangement of shifts and stand-by (resident on-call).

As one of the objectives of this study is to balance the requirements of planned and unscheduled care, it is also important to establish the balance of workload and staffing throughout the 24 hour period. As an illustration of the spread of the workload in the principal study centre over 24 hours, two randomly selected examples of a weekly workload data over twenty four hours of each day (Monday to Friday) were extracted from the RIS. These data points demonstrate the number of patients examined (activity) per hour of the day. As this activity is demand led in unscheduled care this is also an expression of demand.

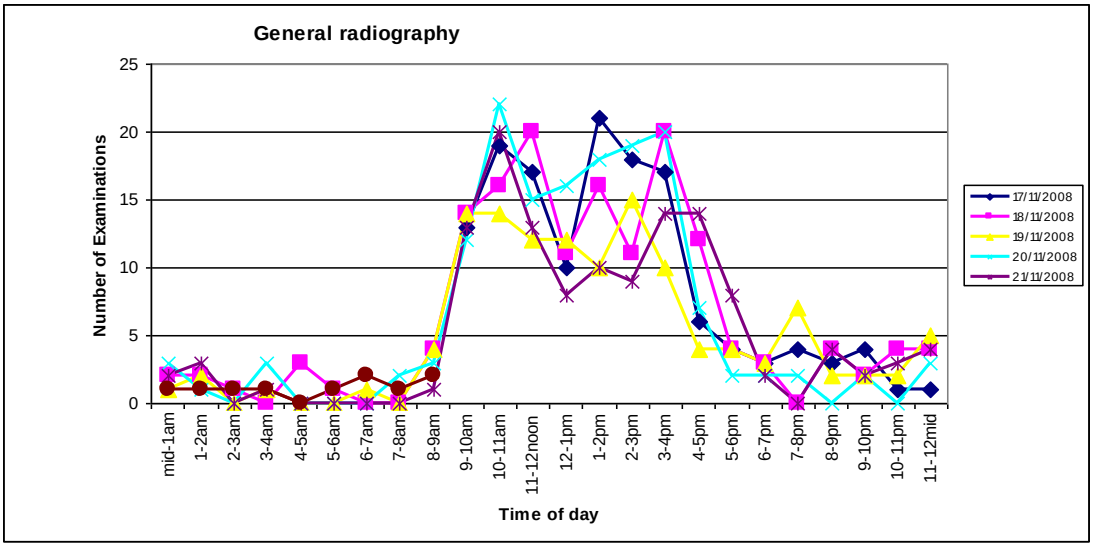


Figure 1: General Radiography Activity week beginning 17/11/08

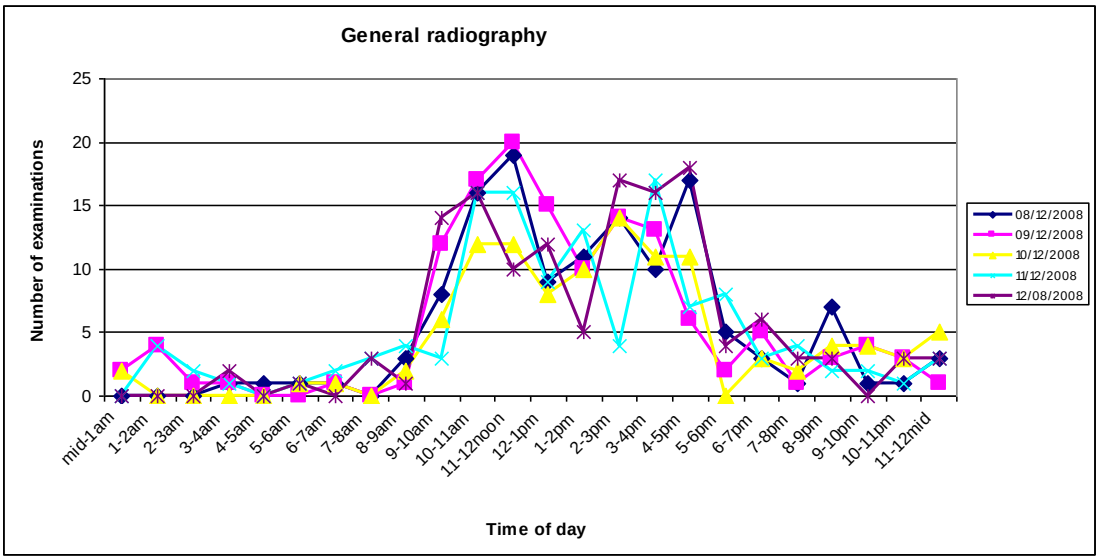
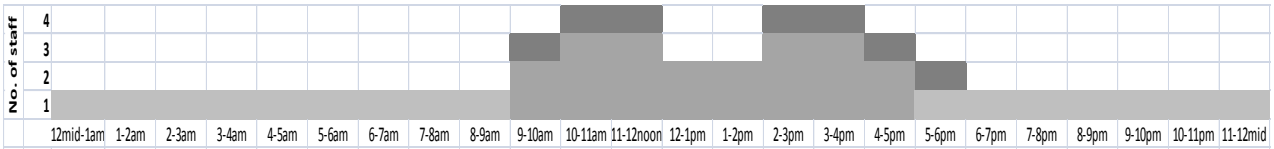


Figure 2: General Radiography Activity week beginning 8/12/08

Figures 1 and 2 show the number of patients examined during a 24 hour period over two separate weeks. These are arbitrary weeks but have been chosen as illustrations of typical weeks early in the study. These weeks have also been selected as they do not reflect any of the festive season variation of workload that is noted in later December. Further detailed study of the spread of the workload over representative timescales is undertaken later in the study.



	12mid-1am	1-2am	2-3am	3-4am	4-5am	5-6am	6-7am	7-8am	8-9am	9-10am	10-11am	11-12noon	12-1pm	1-2pm	2-3pm	3-4pm	4-5pm	5-6pm	6-7pm	7-8pm	8-9pm	9-10pm	10-11pm	11-12mid
Number of patients	0	0	0	1	1	1	1	0	3	8	16	19	9	11	14	10	17	5	3	1	7	1	1	3
	2	4	1	1	0	0	1	0	1	12	17	20	15	10	14	13	6	2	5	1	3	4	3	1
	2	0	0	0	0	1	1	0	2	6	12	12	8	10	14	11	11	0	3	2	4	4	3	5
	0	4	2	1	0	1	2	3	4	3	16	16	9	13	4	17	7	6	3	4	2	2	1	3
	0	0	0	2	0	1	0	3	1	14	16	10	12	5	17	16	18	4	6	3	3	0	3	3

Figure 3: Estimate of staffing levels

Figure 3 gives a graphic snapshot of the staffing resource that was available to manage the workload for week beginning 8/12/08. The table of values identifies the number of examinations performed during each hour of each day Monday to Friday. This demonstrates in tabular form that the workload peaks mid to late morning and again early afternoon. Figure 3 demonstrates that the available workload also peaks at times approximate to the increased demand/activity.

The lightly shaded cells from midnight to 9am and 6pm to midnight indicate that this period of duty in the main study centre is covered by a radiographer who is a lone worker with no administrative or peer support to deal with the workload. This period is a combination of a shift duty and an on-call period. The duty period is a shift from 5pm till midnight and is paid as a shift, the member of staff is then resident on-call (termed as stand-by). This stand-by period attracts supplementary recompense in addition to the payment for the shift.

The mid shaded cells between 9am to 5pm indicate that this is the approximate staff resource managing the workload. This may be the same person or may be different people, depending on staff breaks and alternate rotational duties.

The dark shaded cells between 9am and 6pm are notional staff resource. These staff may be available to assist with general radiography or may be performing examinations in remote locations such as ward and theatre locations.

Notably between 9am and 5pm there is peer support and administrative support.

7.1.3 Workload OOH

The workload OOH must be analysed in detail in order to understand the distribution of local workload data. Currently, as stated above, OOH has been staffed by a combination of shift and residential on-call. It is essential to understand the distribution of workload across the array of the OOH period to support development of a workpattern model. The OOH period is divided into five sections in order to fully describe the workload. There are five identifiable sections, some of which are subsections of each other, of the total duty period. 5pm-8pm; 8pm-12 midnight; 5pm-12 Midnight: Midnight – 9am and the total duty period 5pm till 9am. The importance of substructing the workload data into these sections is to support workplace implementation of the workpattern model such as adaptive planning (Kulatunga et al, 2009).

The first section reviewed is 5pm-8pm. The core hours of duty in radiology departments finish at 5pm in the majority of hospitals. The staff resource reduces in all radiology departments after core hours, with a reduced staff resource remaining on duty, to examine patients requiring general radiography, in the OOH period. In the main study centre the remaining staff resource is a lone radiographer. In contrast to this staff resource, the wards and the ED remain on full shift with full shift staffing and an expectation that routine general radiography will be undertaken in a timely manner. At 8pm in most hospitals throughout Scotland, the hospital moves onto a night duty "essential care" mode. The Hospital @Night team then comes on duty. This team delivers clinical care across the hospital overnight with the expectation that routine decision making should reduce from 8pm as the team cares only for the patients requiring the highest level of support. Other patients are monitored during the sleeping hours by nursing staff, only alerting the Hospital @Night Team if the patients clinical condition demands. This regime should reduce referrals for radiography from the wards after 8pm. New admissions requiring imaging to assist with the patient diagnostics and patients whose condition has deteriorated will still be referred for general radiography. The workload from the ED does not alter due to this changeover period; ED is staffed by a full medical and nursing team across 24/7. The period from 8pm-12 midnight is the remainder of the shift section of the duty. The workload for this section is described separately for clarity, in addition to the workload over the full duty period from 5pm-midnight.. The workload over the residential on-call section of the duty from 12 midnight -9am is also described.

This is all undertaken by time series to demonstrate the spread of the workload over the longitudinal study.

There is a consistent slight incremental trend identified from the Legacy RIS as demonstrated by the trend line superimposed on the graph (figure 4). Remembering that the legacy RIS statistics described the number of examinations, this incremental trend means that there was a gradual increase in the number of examinations performed in the OOH duty period in the timescale from January 2006-October 2007.

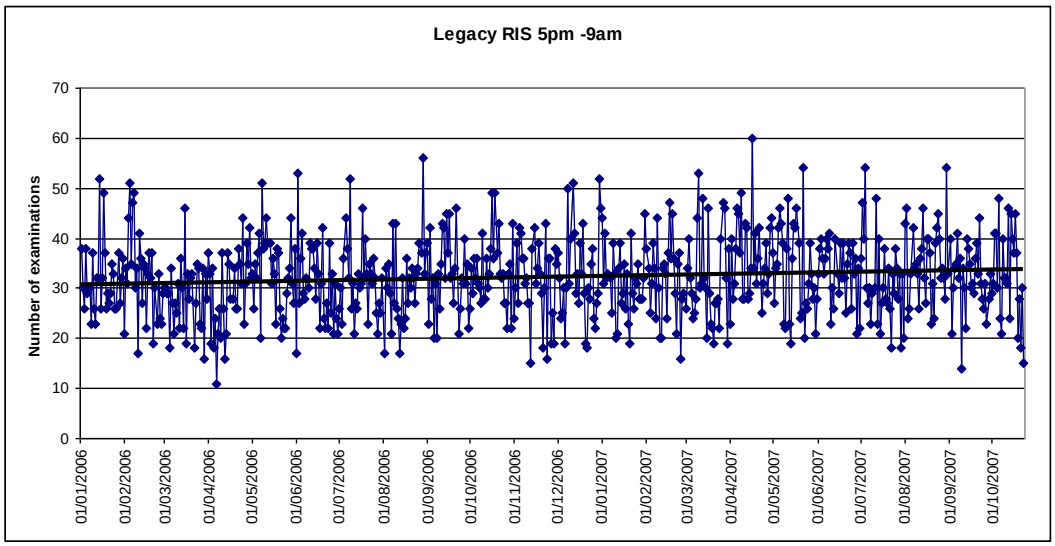


Figure 4: Legacy RIS OOH data

However, this is not matched by an incremental trend, as demonstrated by the trend line on the graph below (figure 5). This means there was no notable increase in the trend of patient throughput in the period October 2007-December 2008 (the time period of data extract in this current study). A possible deduction from these data is that similar numbers of patients are being seen but some of these patients are having multiple examinations thus promoting staff perception that the workload is increasing.

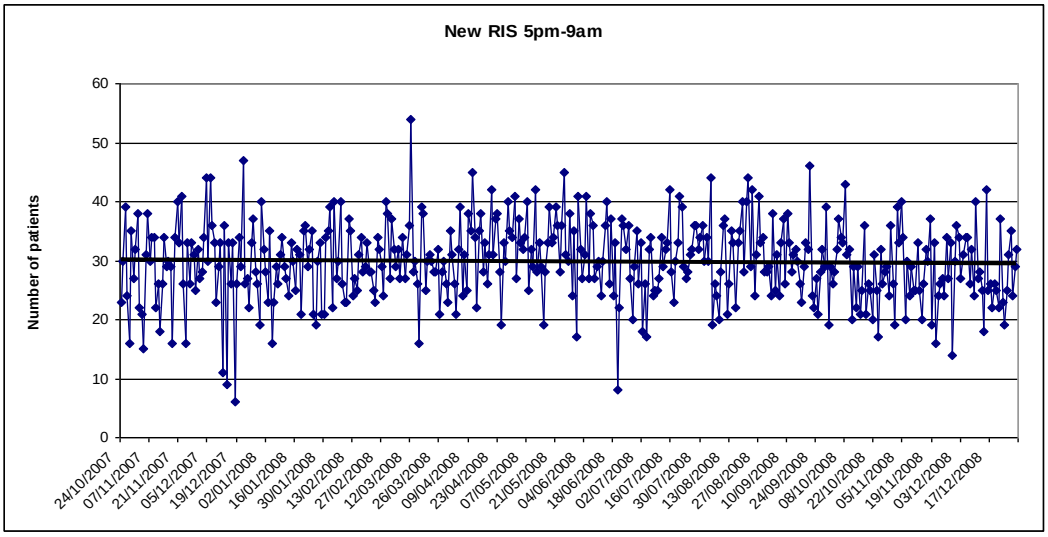


Figure 5: New RIS data OOH data

It is essential that, in keeping with the scientific perspective, data is described and clearly understood. Data analysis will be performed on the statistics extracted from the new RIS (in patient episodes, rather than examinations performed). This will allow transferability of analysis to all Scottish health boards as the new RIS is a Scotland wide initiative.

The first section to be examined is the period between 5pm-8pm. This is the period when radiography resource reduces but the main body of the hospital (wards and ED) is still on full shift cover. Figure 6 indicates that there is a small decrease in the number of patients examined between 5pm and 8pm. This is demonstrated by the trend line generated by Excel. This small decrimental trend may simply be a function of the activity throughout the hospital and is so tiny it is not considered sufficiently significant to explore further.

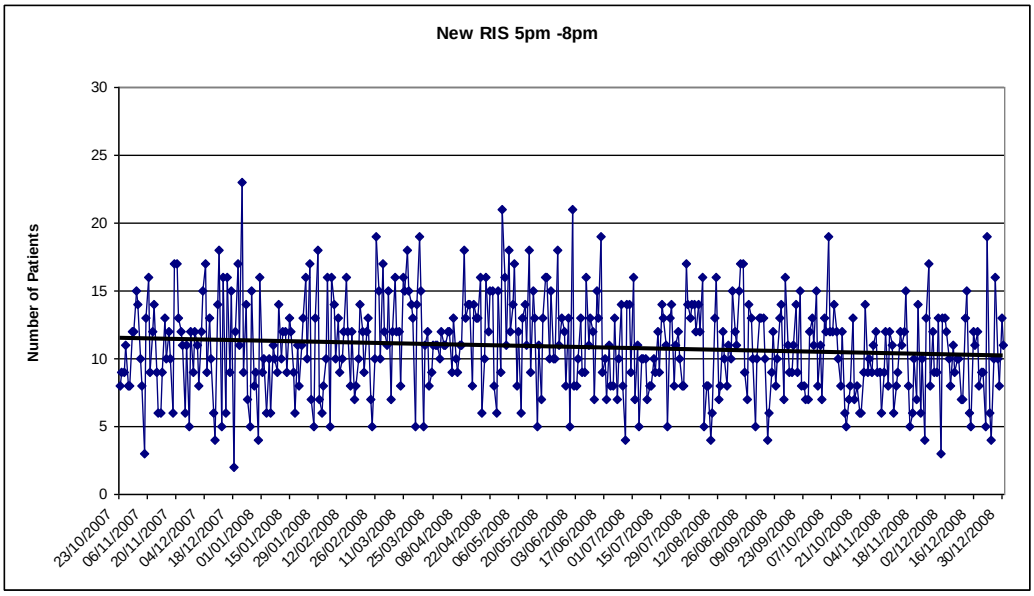


Figure 6: New RIS Workload 5pm-8pm

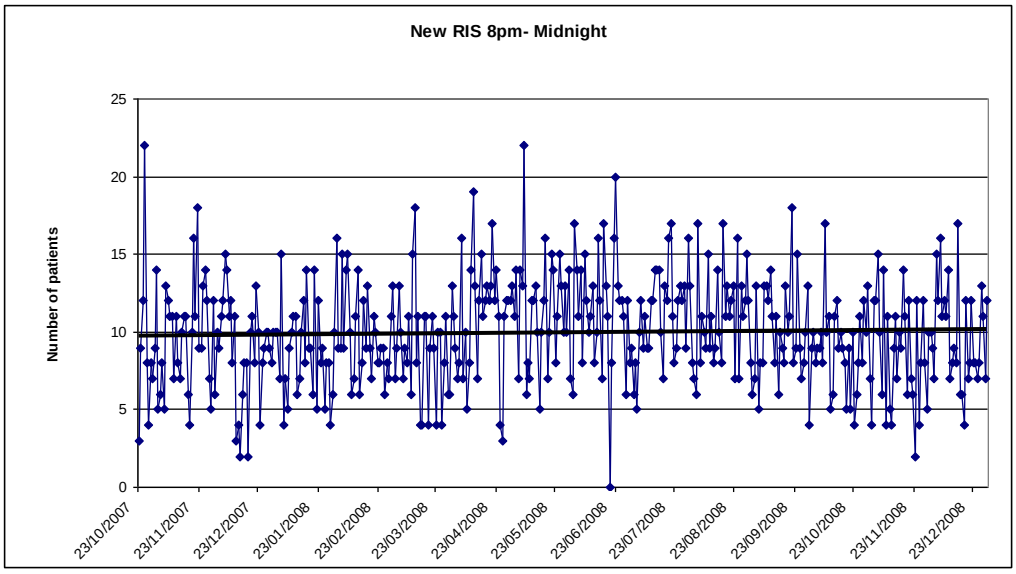


Figure 7: New RIS Workload 8pm-Midnight

The second section to be inspected is the time period between 8pm-12 midnight. This time period is important, as the hospital moves into the night shift period for other staff groups on duty. There is a very small increasing trend in the number of patients examined during this time period from October 2007-December 2008, as demonstrated by the trend line (Figure 7). Again, this is such a small variation that it is not considered significant and is thus not explored further.

The third section explored is the combination of the previous two sections i.e. 5pm- 12 Midnight. In the main study centre this is the "shift" section of the duty period. Unsurprisingly, as this is the combination of the two duty periods above, Figure 8 shows a minor decrimental trend, described by the trend line, in the number of patients.

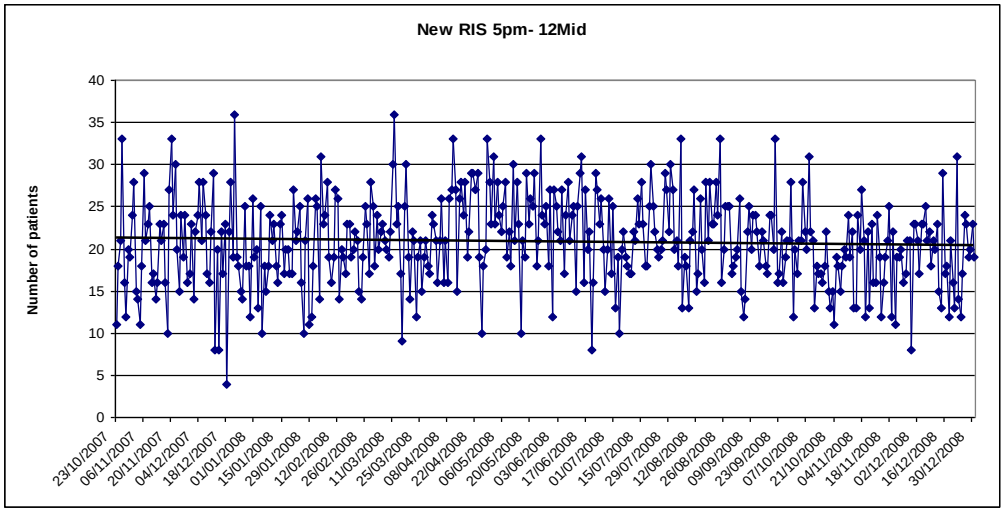


Figure 8: New RIS Workload 5pm-Midnight

The duty period from midnight to 9am is covered by residential on-call in the main study centre. As discussed above, implementation of the workpattern model will require complete understanding of the workpattern and workload across all sections of the duty period. Thus, the patient throughput for this section is also described. It is important to explore this section separately from the total OOH duty period, as the workpattern model will require revision of current working practices. It is essential to understand the workload throughout the duty periods. This section also demonstrates a very minimal incremental trend as demonstrated by the trend line on the graph (Figure 9).

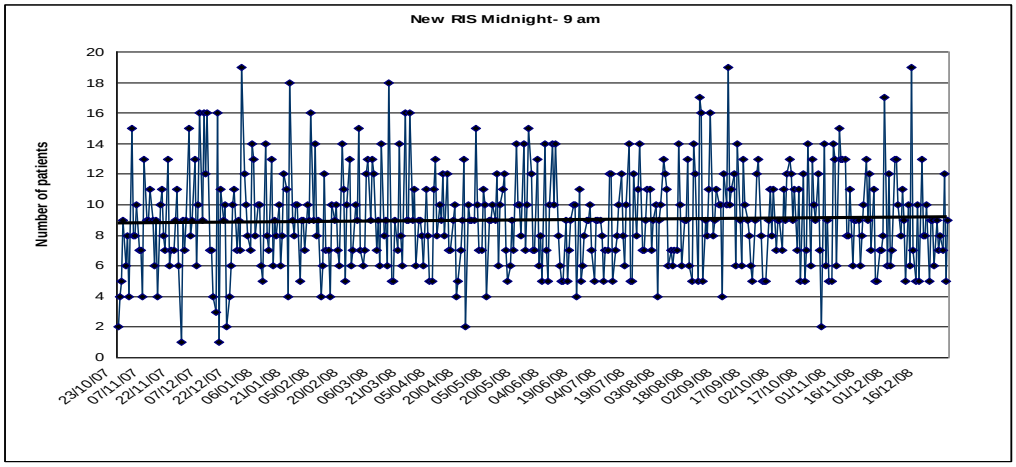


Figure 9: New RIS workload Midnight-9am

Unsurprisingly, the complete OOH duty period of 5pm-9am (Figure 10) the data identifies no incremental or decrimental trend, as described by the trend line, in the number of patients seen during October 2007-December 2008. It has been demonstrated above that this steady trend of patient throughput is consistent through the discrete sections of the duty period.

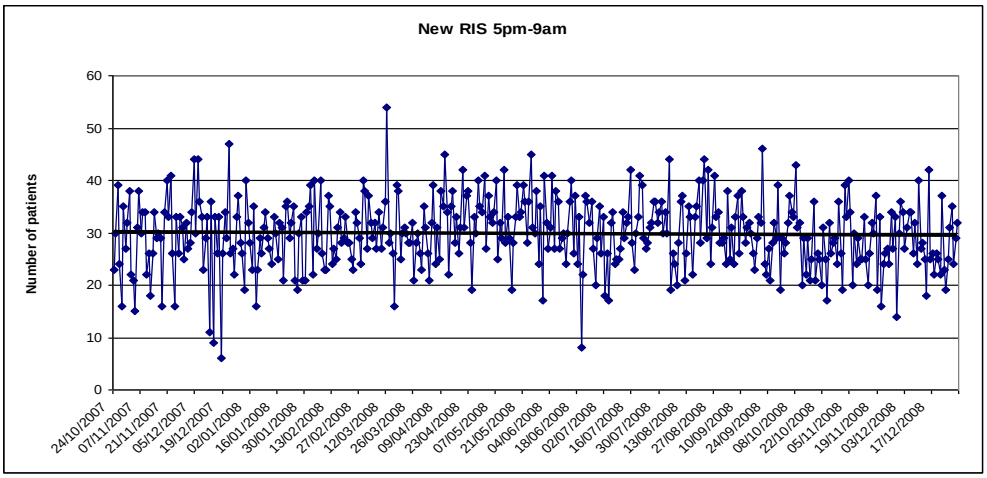


Figure 10: New RIS Workload 5pm-9am

The above demonstration and description of data throughout the OOH period would indicate that the patient throughput has changed little during the study period. However, maximum information on the spread of the workpattern is essential to facilitate implementation of the workpattern model.

The workload is not measured simply by patient numbers and further analysis must be undertaken. The statistical interrogation of the RIS is a definitive science but this does not describe the complete picture. In addition to the numerical evaluation of the workload statistics in terms of patient throughput, a patient may present for a number of examinations and be co-operative. These examinations will then be completed in a timely fashion. Comparing this with a badly injured or uncooperative patient presenting for a single examination that is difficult in terms of time and complexity is problematic.

In accordance with the scientific perspective of reducing pre-conceptions and misconception, the above data will inform the radiographers on patient throughput and will support comprehension of the issues and agendas, regarding the need for redesign of the radiographic service. Further deductive analysis will be undertaken to explore the patient episode time and the frequency distribution of these episode times, in accordance with the necessity to entirely understand the subject matter (Ernst et al, 2004). This understanding and analysis of the subject, by review of all of the available evidence with deduction of new knowledge and comprehension, is entirely consistent with the Reliabilist scientific perspective employed in this study. The data will support the scrutiny of health boards across Scotland, by demonstrating the development of the workpattern model in statistical and quantitative terms. This will, in turn, support the implementation of the workpattern model in the workplace.

7.1.4 Patient episode time – frequency distribution

The chart below (Figure 11) describes examination times from the new RIS per patient, during 2008. The times shown are the times taken to examine each patient (patient episode) rather than the time taken to perform a single examination of a body part (e.g. chest or hand etc).

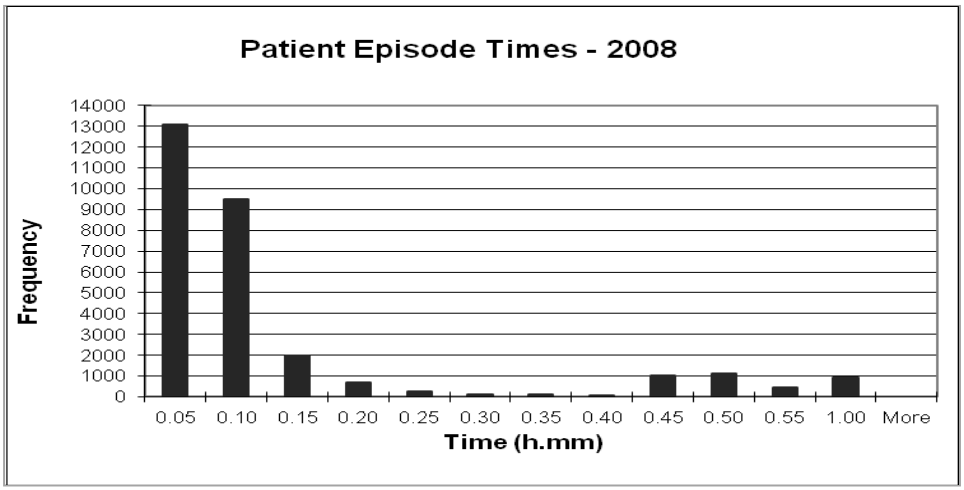


Figure 11: Patient Episode Examination Times: 2008

Figure 11 shows the frequency of the differing examination times over 24 hours during the year 2008. To cleanse data of administrative errors, episode times of below one minute have been omitted.These few data entries were validated as administrative anomaly. Figure 11 demonstrates that 86% of patient episodes were completed in 15 minutes or less.

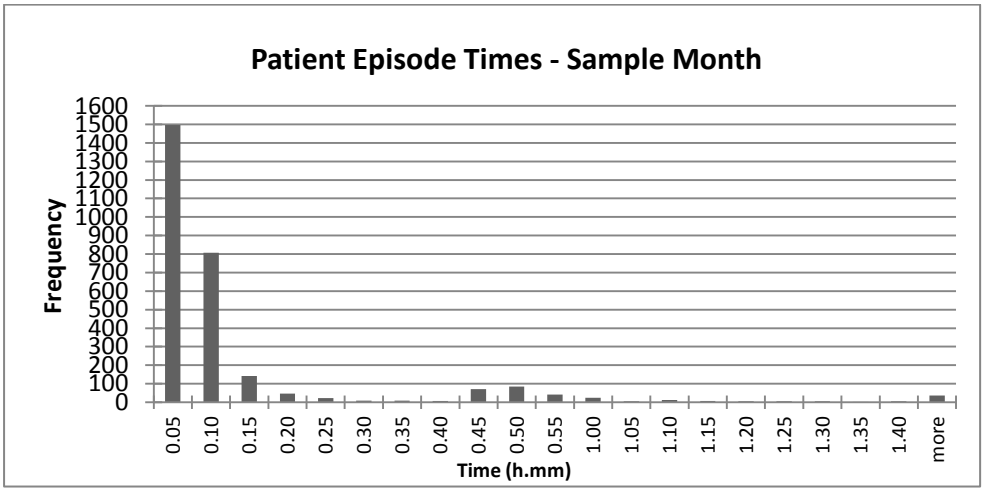


Figure 12: Patient Episode Times (Sample month) 2008

Figure 12 demonstrates the frequency distribution of patient episode times, in one sample month of 2008. There are no “good or bad” months throughout the year. All months have pressures, whether this is potential sporting injuries or holidays - either school holidays, referral clinicians holidays or radiology staff holidays. The only exception to this is the festive season when all routine work is disrupted. Thus the sample month avoids the festive season. This shows a very similar frequency distribution to figure 11 above, describing that 86% of the patient episodes are completed in 15 minutes or under. Episode times of less than one minute have again been omitted as these few datum points are due to administrative anomaly.

Theatre data is unvalidated data as the theatre workload cannot be extracted from the RIS due to the method of data recording. However it is essential to have a flavour of the frequency distribution of theatre examination to identify the effect that this may have on the patient episode distribution. A small data collection exercise was undertaken by the radiographers. During the sample month, radiographers recorded, on a data collection sheet, the accurate time interval for each theatre episode and the total time spent in theatre on each day of the sample month. Theatre is remote from the radiology department, thus a member of staff is removed from the pool of staff for this period. This can be during OOH as well as during core hours. This is a consideration when developing the workpattern model as allowance for this effect must be explored and is a particular issue when the radiographer is a lone worker. This understanding of the issues behind the workload data is in keeping with the Relibilist perspective of understanding the processes pertinent to the evidence. The theatre workload does not make a great difference to the frequency distribution (Figure 13). 84% of the total examinations in the sample month were still completed in 15 minutes or less with the average time interval for the remaining examinations of 1hour 15 minutes. This is due to the time penalty of examinations performed in theatre (lengthy procedures). Measuring the workload data, including unvalidated data to identify evidence pertinent to the development of the workpattern model, is in keeping with the Reliabilist perspective within the broader scientific perspective.

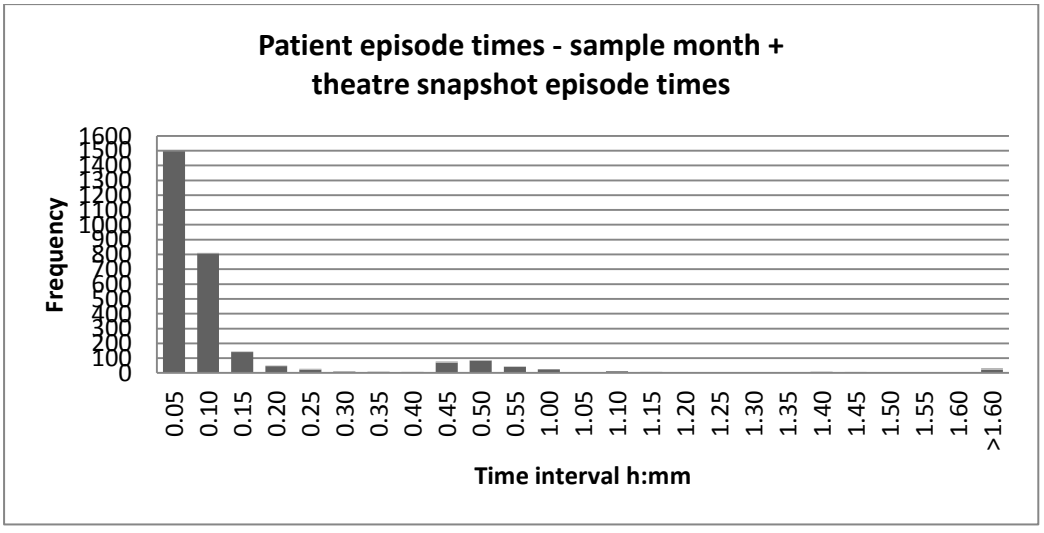


Figure 13: Patient episode time (sample month) + theatre snapshot episode times

In the following graph (figure 14), time intervals of less than 25mins have been deleted, to allow a more detailed view of the remaining workload. Although this represents a small percentage of the patient episodes, the time involved for each episode is substantial.

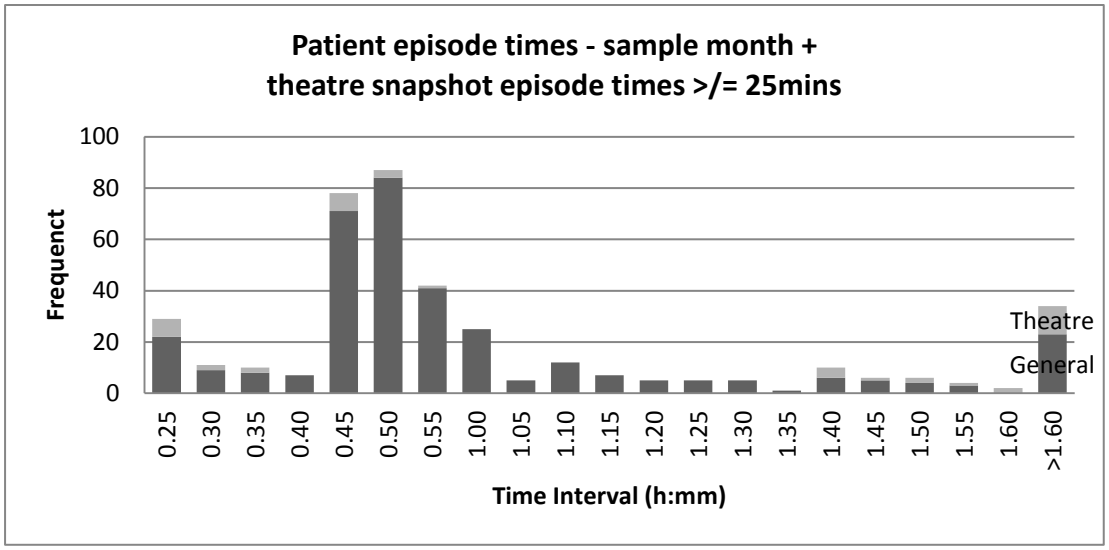


Figure 14: Patient episode time (sample month) + theatre snapshot episode times>/= 25mins

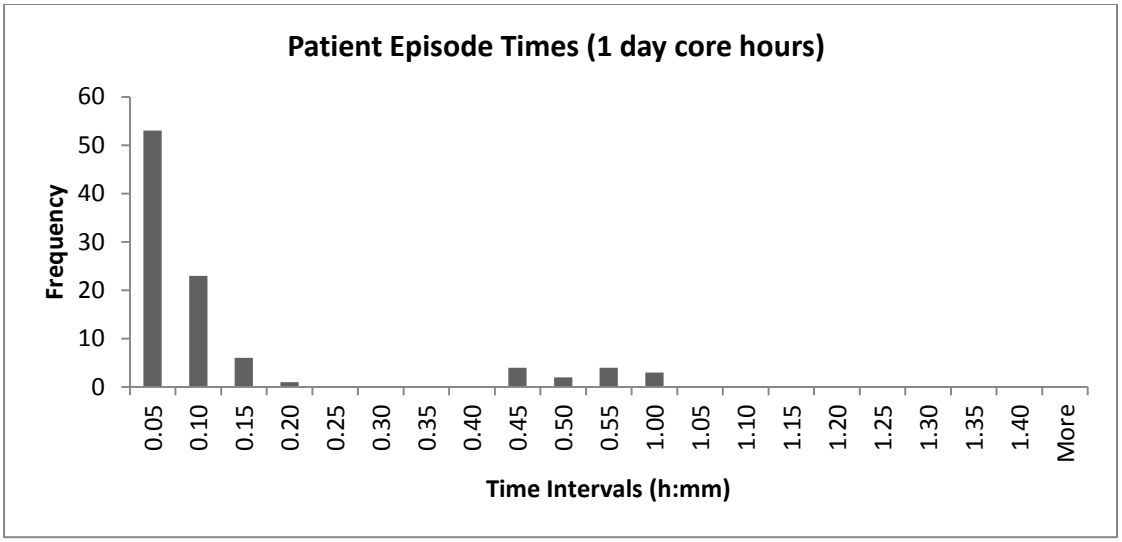


Figure 15: Patient Episode Times-sample core hours

Figure 15 shows the distibution during an example of 1 day core hours (9am-5pm). All weekdays have similar pressures from planned clinics in addition to unscheduled care as well as staffing issues. The day selected at random was not unduly different in terms of greater or lesser demand. The distribution curve is very similar to figure 11 (year) and figure 12 (month) . The core hours frequency distribution was further evaluated (not including the theatre data as this cannot be validated). On the example day 55% of examinations were completed in 5 minutes or less, 79% of the examinations were completed in 10 minutes or less, 85% of the examinations were completed in 15 minutes or less. The remaining 21% (>/= 10minutes) were completed as per the frequency distribution chart. The average examination time for the category >/= 10minutes, on this example day, is 37 minutes.

The distribution for all the time periods explored demonstrates the Pareto principle (80/20 rule), the natural observation of imbalance or the observation of typical distribution in nature (Azad, 2009). A radiographer with full administrative and peer support should be able to complete 6 examinations per hour, 79% of the time. However, the more time consuming examinations (extended element) have to be managed by the same pool of staff and flexibility must be built into the workload percentage. To accommodate this extended element it may be reasonable to assume that if an individual radiographer is assumed to have the capacity to complete 5 examinations per hour, 79% of the time, this should provide satisfactory aggregated time for the pool of staff to accommodate the extended element (average of 37minutes per examination) in 21% of the time. Decisions require to be made on resource allocation and management, based on the distribution percentages. There is no doubt that all of the examinations require to be resourced. The decision is effective resource deployment both in cost and clinical governance terms. Deductive reasoning and analysis of this data was undertaken in keeping with the development of new knowledge from known data. Jenkins-Clarke, (1992) indicated that it is essential that local data is explored and underlying issues clearly understood, when developing a workpattern model to avoid misconceptions in accordance with the scientific perspective.

Core Hour (Daytime) Distribution of Patient examinations

Time interval	% Patient Examinations completed
5 minutes or less	55%
10 minutes or less	79%
Average 37 minutes	21% (>10 minutes)

Table 2: % Distribution of time intervals per patient examination- Core hours

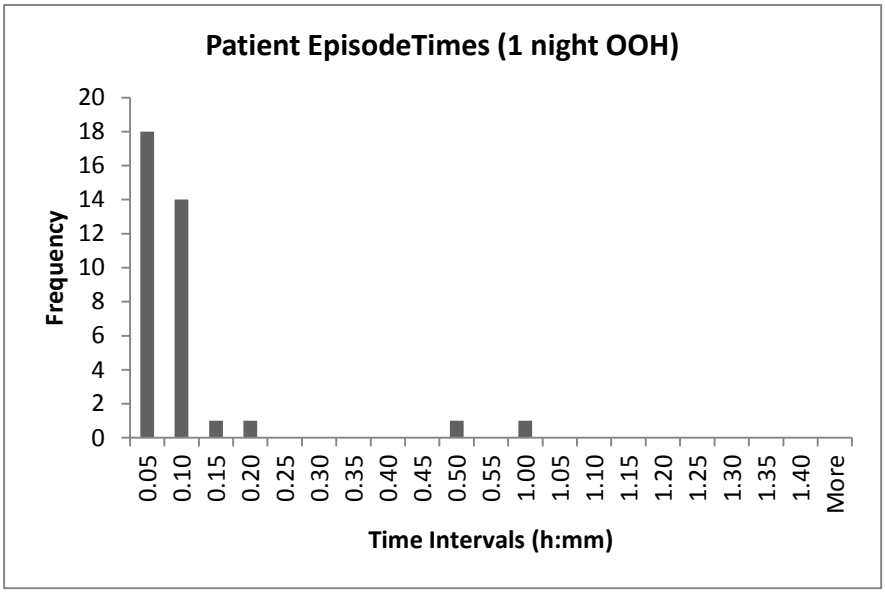


Figure 16: Patient Episode Examination Times- sample night OOH

Figure 16 shows the distribution curves for a single sample night duty period. Most night duty periods are challenging. Several night duties were considered for the purposes of this study, nights when there had been no calls to duty in the post midnight on-call period were excluded as being abnormal. The frequency distribution was very similar for all of the night duties selected. An exemplar was chosen from the selection. The curve for Figure 16 above broadly follows the curves on the previous charts (figures 11, 12 and 15). However, it must be noted that there is a difference in the relative proportion of the patient episode times of 5 minutes and 10 minutes, than during core hours (Table 2 and Table 3). This will be attributed to a function of OOH in that the radiographer(s) must complete all administrative duties in addition to clinical duties during the examination which will clearly extend the patient episode time. The night duty statistics were evaluated, again excluding theatre statistics. 50% of examinations can be completed in 5 minutes or less. 89% of the examinations can be completed in 10 minutes or less. 92% of the examinations can be completed in 15 minutes or less. The remaining 11% (>/=10 minutes) of examinations are completed as per the frequency distribution chart. The average time for examinations, in the category of >/=10minutes, is 34 minutes. Deductive reasoning and analysis of this data was undertaken in keeping with the development of new knowledge from known data. The data indicates that a radiographer with no back-up administrative support can still complete 6 examinations per hour, 89% of the time, though a smaller percentage can be completed in 5 minutes (50%) than in core hours, due to completing administrative processes in addition to clinical duties. This 89% completion rate in under 10 minutes is higher than the percentage during core hours and is likely to reflect the nature of the work undertaken in an OOH situation. There is a higher proportion of shorter patient episodes rather than the more complex procedures that are undertaken during core hours with full peer support. However, the

more time consuming examinations (extended element) have to be managed in the principal study centre by a lone working radiographer OOH. This reduces the flexibility of the workload percentage as the extended element is the responsibility of this single member of staff. In other study centres where OOH is not undertaken by lone working, there will still be a smaller radiographer base OOH than during core hours. The extended element may require to be delivered remotely e.g. theatre or wards. It may then be reasonable to set the realistic parameter for an individual radiographer, responsible for both clinical and administrative workload, to a lower level than during the day. Thus it is reasonable to assume an individual lone working radiographer to have the capacity to complete 4 examinations per hour, 89% of the time. This would then provide satisfactory aggregated time to accommodate the extended element (average of 34minutes per examination), 11% of the time. This is summarised in Table 3 below. It must be remembered that in reviewing the frequency distribution during both core hours and OOH that theatre data is not included in the data. Whilst the extended time element will be absorbed within the matrix suggested from the frequency distribution this may be difficult in practice when considering remote theatre duties. Particularly in the OOH situation this can alter the staff resource required to deal with patient throughput. This understanding of the issues underlying OOH duties is in keeping with the Reliabilist perspective.

OOH (Night time) Distribution of Patient examinations

Time interval	% Patient Examinations completed
5 minutes or less	50%
10 minutes or less	89%
Average 34 minutes	11% (> 10minutes)

Table 3: % Distribution of time intervals per patient examination- OOH

Summary Table Distribution of Patient episodes

	% patient episodes <5 mins	% patient episodes < 10 mins	% patient episodes < 15 mins	Average time interval extended element	% patient episodes extended element
Core Hours (Daytime)	55%	79%	85%	37 mins	21% (>/= 10mins)
OOH (Nights)	50%	89%	92%	34 mins	11% (>/=10mins)

Table 4: Summary % Patient episodes

7.1.5 Average patient episode time

An average patient episode time can be calculated from the new RIS data across the 24 hour period. The average patient episode time in January 2008 was just under four minutes per patient, with a minimum of one minute and a maximum of approximately two hours. In June 2008, the average patient episode time was four minutes, with a minimum time of one minute and a maximum time of over three hours for a trauma theatre case. The average patient episode time in December 2008 was five minutes, again with a minimum time of one minute and a maximum time of just under two hours. The average time per patient episode has increased only very slightly between June 2008 and December 2008. This is such a small increase that there is little significance, though it may suggest that there is an increase in the number of more time consuming examinations.

7.1.6 Patient episode: number of examinations ratio

The ratio of patient episodes to number of examination in 2006 was 59115:72335 (1:1.224) (legacy RIS data). The same ratio in 2008 is 64047:78630(1.228)(new RIS data and patient examination numbers identified by patient archive communication system (PACS)). This demonstrates a slight increase in the number of examinations per patient but is unlikely to impact on queue.

7.1.7 Demand, activity and queue

In the OOH period the radiographer enters the patient details on the arrival of the patient in the department (arrive time). This is also the "start time" in the OOH period as the radiographer undertakes the examination immediately the patient details are logged onto the RIS.

Thus the activity in the OOH period may not reflect the genuine demand in the time period. The genuine demand may exceed that which a lone worker can undertake in the time period. This may then generate a queue of pending work that will be undertaken in sequential order but is delayed demand/activity.

This queue (delayed demand/activity) will appear in the following time period as activity. However a flavour of the difference in "arrive time" and "start time" can be shown from statistics available from daytime hours. The "arrive" time is recorded in the RIS by the administrative staff on the arrival of the patient. This time is not recorded in the OOH period, as patients are held either in ED or wards and arrive in radiology only when the radiographer is free to perform the examination. This is one of the safety measures in place to support lone workers, protecting the radiographer and the patients from adverse events that may occur, if patients in the radiology department are unsupervised, while a radiographer is working alone.

During core hours, the arrival time is the time that the patients arrive in the radiology department and their referral is processed on the RIS. The patient then waits in the waiting area until a radiographer is ready to perform the examination. The "start time" represents the time when the radiographer collects the patient from the waiting area to begin the examination. Figure 17 demonstrates an example of the disparity in arrival time and start time between the patient presenting in the radiology department and the patient being seen for examination over a period of a sample day. On a few of the measured data points, more patients arrived in the department, than could be seen by radiographers during that time. There is then a delay from patient arrival to start time, this therefore forms a queue. (Figure 18). The queue is cleared when the influx of patients slows and there are fewer patients arriving in the department than are being seen for examination. This queue effect is likely to be magnified when the member of staff is a lone worker. As mentioned previously, most days have challenges such as staff shortages due to sickness and annual leave. There are usually external pressures from busy clinics and referral demands. Thus, though days are never the same, they are all typical of unscheduled care and thus the sample day is typical of the pressures, variations and challenges.

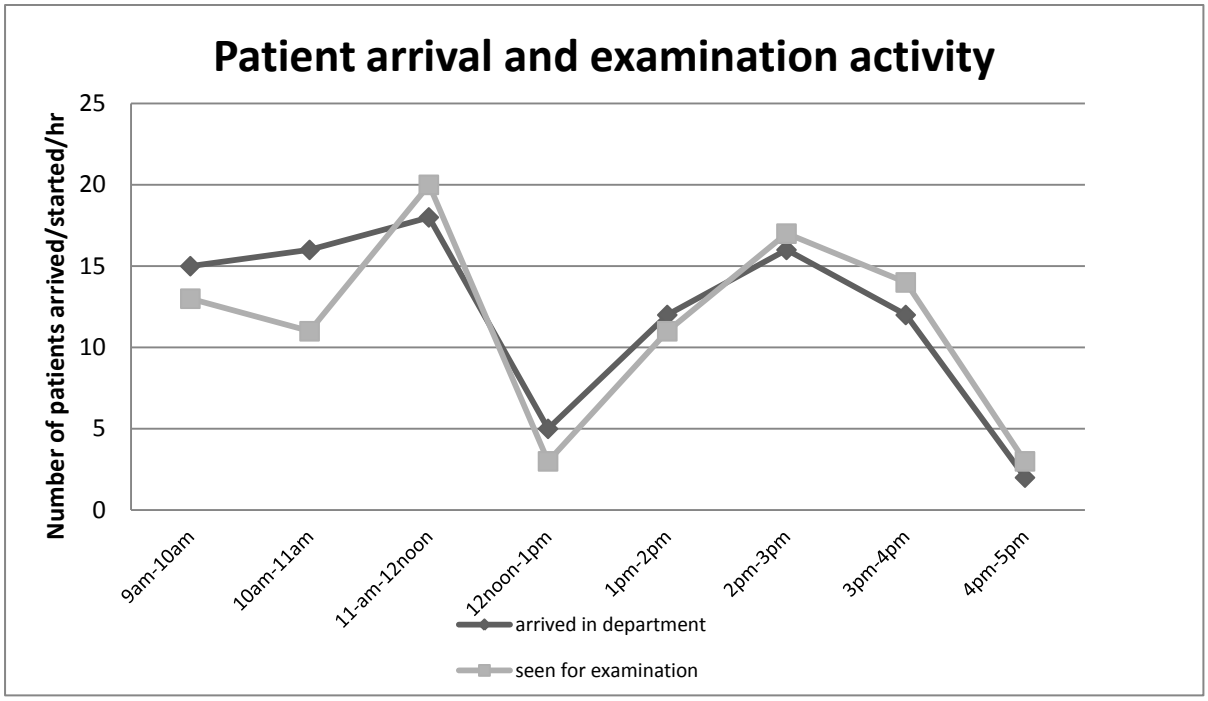


Figure 17: Number of Patients Arrived: Number of Patients seen

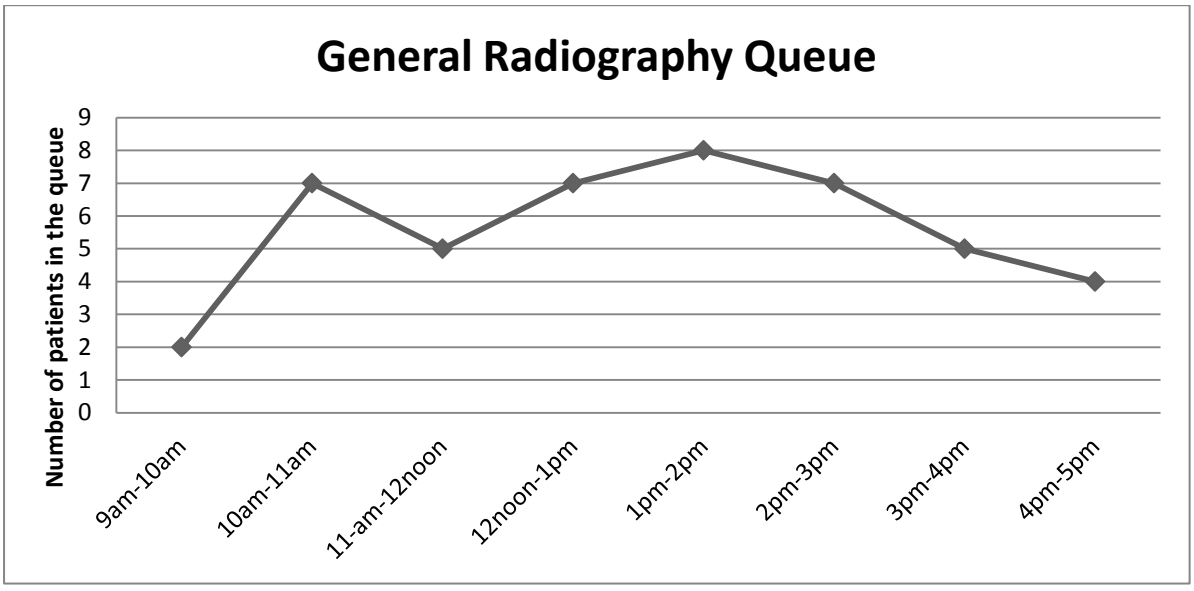


Figure 18: Number of patients in the queue for general radiography

Demand Activity Summary OOH

	mean	mode	St dev	min	max
5pm-8pm	11	12	3.5	2	41
8pm-12 mid	10	8	3.4	2	26
5pm-12 mid	21	21	5.3	4	51
12 mid-9am	9	9	3.2	1	26
5pm-9am	30	33	6.7	6	53

Table 5: Patient Episode Statistics

The table of statistics of patient episodes OOH (Table 5) for the data period of October 2007 till December 2008 shows the demand activity. As seen from the table, the mode between 5pm-8pm is 12. The mode between 8pm – 12 Midnight is 8. The mode number of patient episodes between 5pm-Midnight is 21. Contrasting with this, the mode number of patient episodes in the on-call period (12Mid-9am) is 9. This is 30% of the average workload (30) of the complete duty period (5pm - 9am)

As previously mentioned, this data analysis is not an exact science as there are no statistics (model) for the number of patient contacts, appropriate for lone workers, in a specific period of duty. However, 30% of the workload of the duty period is regularly being performed during the on-call period when the radiographer would be called from sleep to perform these examinations. This disruption of sleep pattern may have health and welfare implications and may impact on work-life balance. The long term sustainability of this workpattern must be considered. The Department of Health, (1991) has indicated, in the case of junior doctors, that on-call arrangements are only appropriate where the doctor is not required to work for a substantial proportion of their contracted hours above the standard working week for full-time posts. This recommendation should surely also apply to any health care professional undertaking on-call duties. This is reinforced by the Working Time Regulations (HMSO, 1998) which states that an individual must not work more than an average of 48 hours per week. (This average is calculated over a 17 week period). A snapshot of the current average working hours indicates that some radiographers are regularly working close to the maximum average.

7.1.8 Workload guidelines

Similarly to the social work workpattern model (Mansuri, 2009) it is difficult to determine what a proper and correct workload is for radiographers. There are no guidelines regarding case load and, as discussed above, the workload is not necessarily determined by a numerical count i.e. the difficult nature of a patients' condition is a factor that is not easily quantifiable. Therefore there is no standard time for examinations. Foresterhill units (RCR, 1999) attempted to benchmark time per examination by identifying the likely timescale for undertaking the examinations in the majority of circumstances. It also attempted to benchmark workload and workforce. Unfortunately, Foresterhill was never further developed and data from that study is no longer available.

Information Statistics Division (ISD) (2008-2) details the number of radiographers in post, in Scotland, as of September 2008. This data has been extracted from Scottish, Workforce Information Standard System (SWISS). The number of radiographers in post at that point in time was 1929 WTE (whole time equivalents).

The other statistic that ISD offer is the number of conventional general radiography examinations performed. In the year 2007-2008, 2,030,489 examinations were performed. This cannot be related to the number of staff in post, as radiographers may work in any modality in addition to, or instead of, general radiography. There is no breakdown of staff per modality that would allow an approximation of a staff to workload ratio. Scottish radiology benchmarking statistics offer statistics in a different format (NHS e-lib, 2009). The statistic offered by Scottish radiology benchmarking, is the number of radiographers per 100,000 population as at 30th September 2007: for Scotland as a whole this is 22.5. This relates to the workforce planning recommendations of O'Brian- Pallas et al (2001) that workforce should be related to the population. A further statistic that is offered by Scottish radiology benchmarking is the number of patient attendances per radiographer. This, for Scotland, is stated as an average of 2266 per year in 2007. This statistic involves the workload for all modalities and so cannot be related to the general radiography workload. This may be a realistic average figure, as this will contain the lower turnaround of the more complex procedures, as well as the rapid turnaround for the faster general radiography examinations. The statistic is measured in patient episodes, rather than examinations and is therefore a comparable measure to the data from the principal study centre. However, as the Scottish radiology benchmarking statistic mentioned above (22.5) is measured across all modalities, it cannot be used for direct comparison with the general radiographic workload for the principal study centre.

There is no current ISD statistic that offers any calculation of the percentage workload undertaken OOH. However, there is an archive ISD document that indicates that from 1990-1995 the percentage workload undertaken in core hours is between 81% to 85.2 % (ISD, 2000). This period in the 1990s was before many of the policy and logistical changes in the NHS. There is no indication if these statistics included weekend day duties as normal working hours or as OOH. Statistics for the principal study centre have been explored for 2008 to establish the percentage workload currently undertaken OOH. The statistics are available from the new RIS as patient episodes rather than examinations performed. This, however, gives a good indication of the workload undertaken in normal working hours and OOH (Tables 6 and 7).

Workload statistics 2008	**OOH**	**Core Hours**
Patient episodes undertaken during core hours (1)		**26396 (65.75%)**
Patient episodes undertaken during weekend day duties (a)	**2835 (7.06%)**	
Patient episodes undertaken during evening/standby (b)	**10917 (27.19%)**	
Patient episodes undertaken OOH (a+b) (2)	**13752 (34.25%)**	
Total number of patient episodes for plain film examinations (2008) (1+2)	**40148**	

Table 6: Workload Statistics 2008

These statistics indicate a shift in the spread of timing in work practice from approximately 15-20% of the workload performed OOH in 1990-1995 (ISD, 2000) to 27-34% of the workload undertaken OOH in 2008 (Table 6). This data, though not directly comparable with the data collection of the archive ISD document, demonstrates a significant shift in the workload undertaken OOH. The staffing system has not altered significantly since the time period explored in the archive document. The on-call duties in the principal study centre are still covered by one person undertaking the equivalent combination of an overtime and night duty (Mark et al, 2006).

In an attempt to consider the comparative workload in the different duty periods a descriptive analysis was performed on the department workload during 2008 (Table 7).

Duty period	Ave Number of patients	Approx no of Staff	Ave number of patients per radiographer per session	Ave number of patients per radiographer per hour	Session length	Support (admin and peer)
Daytime- Core hours	102	3	34	5	7.5 hours	Full
Weekend and Public Holiday (Daytime -OOH)	26	2	13	2	9 hours	nil
Evening/Standby (OOH)	30	1	30	2	16 hours	nil

Table 7: Comparative Workload - Core hours, OOH

26,396 patients were examined during 256 weekday daytime duties. This is an average of 102 patients per duty. During these periods there is an approximate staffing level of three radiographers (workforce determined by experiential measures and often not balanced against the workload demands) and full administrative support. This means that the radiographers have peer support to assist with difficult or complicated cases (and with moving and handling) thus the duty is physically less taxing. In addition the administrative support ensures that radiographers have only to deal with the clinical aspects of the examination. Taking a staffing level of three radiographers as a guide, the average number of patients examined per radiographer on a weekday day duty is 34. The average number of patients examined per radiographer per hour in this duty period is approximately 5.

2,835 patients were examined during 108 weekend and public holiday daytime duties. This is an average of 26 patients per duty. During these periods there is a staffing level of two radiographers with no administrative support. This means that radiographers have peer support to deal with difficult or complicated cases (and with moving and handling) thus the duty is physically less taxing. There is no administrative support therefore radiographers have to deal with both the clinical and administrative aspects of the examination. The average number of patients examined per radiographer on a weekend day duty is 13. The average number of patients examined per radiographer per hour, in this duty period is approximately 2.

11,154 patients were examined during 366 evening/standby duties. This is an average of 30 patients per duty. During these periods there is a staffing level of one radiographer with no peer or administrative

support. This means that the radiographer has no peer support to deal with difficult or complicated cases which have the potential to be physically and emotionally taxing. There is no administrative support therefore the lone radiographer has to deal with both the clinical and administrative aspects of the examinations. The average number of patients examined by a lone radiographer on an evening/standby duty is 30. The average number of patients examined per hour in this duty period is approximately 2, however, this workload is spread throughout the evening and throughout the night therefore disturbing the radiographer from sleep.

There is, however, no standard unit time to examine a patient, as all patients have differing requirements for assistance. In general radiography there is always a mixed workload of examinations and each examination requires a diverse time period as noted above.

It is apparent from this analysis that the balance of the workload undertaken during normal hours and the workload undertaken OOH, has changed markedly over the years with no marked change in the workpattern model.

The daytime workload is monitored by the waiting times groups across health boards and shows a gradual increase in the overall workload for modalities other than plain film. This is understandable given the government policies to rationalise working practices, in order to reduce waiting times, by eliminating waste and optimising capacity. General radiography is not monitored by this group.

The analysis above supports the aim of this study to develop a work pattern model to meet the current needs of staff and patients in Scottish radiology departments across 24/7.

7.1.9 Time series forecasting

It is essential, when designing a workpattern model, to ensure that any proposed model will encompass future workload, not merely address the current workload issues. Forecasting of the workload data was undertaken using the data from 2008. The method of choice for this study was decomposition in order to deseasonalise the data. Forecasting can be done using various purpose designed software packages and in this study this was undertaken using Minitab Statistical Package. Minitab computes three measures of accuracy to the fitted model.

Mean absolute percentage error (MAPE) measures the accuracy of fitted time series values. It expresses accuracy as a percentage of the error. For example, if the MAPE is 5, on average the forecast is off by 5% and so future predictions would also be off by 5%. (A mean percentage error near zero can be produced by

large positive and negative percentage errors that cancel each other out. Thus MAPE is a better measure of relative overall fit as this is the mean *absolute* percentage error).

Median absolute deviation (MAD) is a simple way to quantify variation. Half the values are closer to the median than the MAD, and half are further away. MAD is similar to MAPE though MAD expresses accuracy in the same units as the data, which helps conceptualize the amount of error. Thus if the MAPE is 5% of the forecasts, approximately 5% of the number of the forecast points will equal MAD.

Mean squared deviation (MSD) is always computed using the same denominator, n, regardless of the model, so that MSD values can be compared across models. MSD is a more sensitive measure of an unusually large forecast error than MAD. Thus outliers have less of an effect on MAD than on MSD.

Smaller values for all three measures generally indicate a better fit.

Core Hours

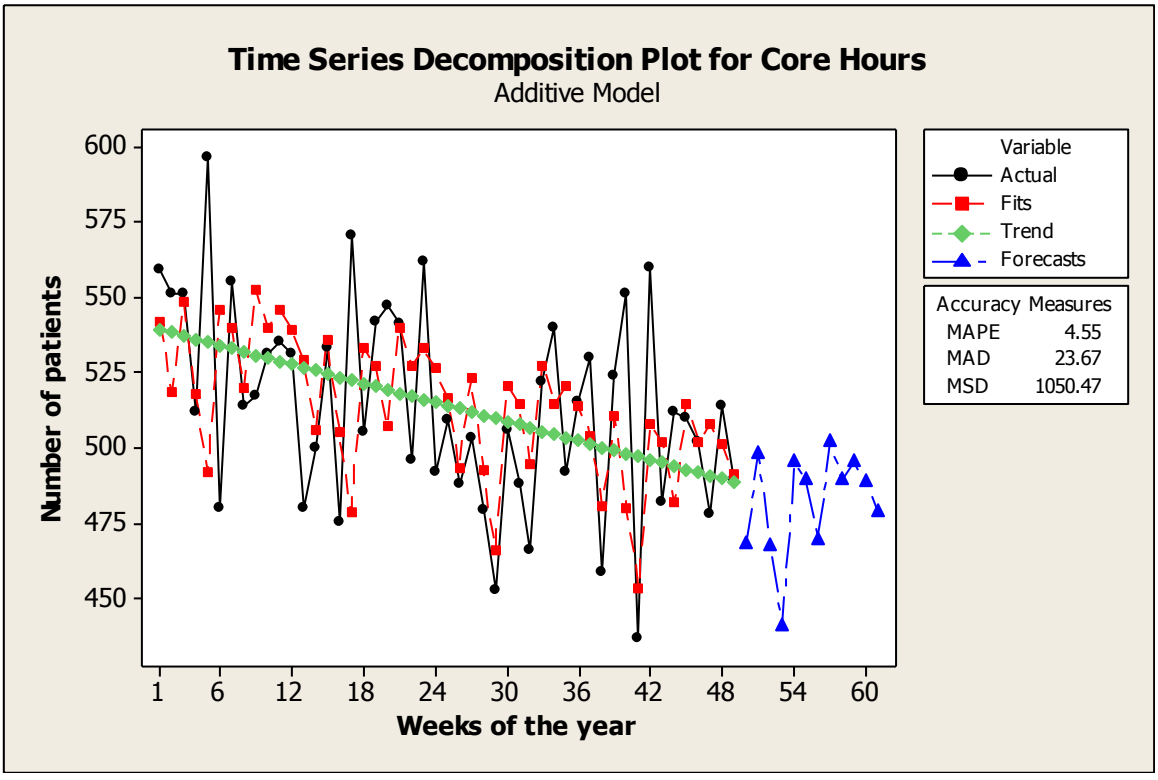


Figure 19: Minitab Forecast - Core hours

The graph of time series decomposition forecast for core hours in early 2009 based on 2008 data, is shown in Figure19.

The statistics for the final two weeks of 2008 have been excluded from the forecasting statistics. There is an abnormal reduction in the workflow during these two weeks due to the festive season. These

abnormal statistics skewed the calculations. The range of the remaining statistics is 488-539. This is a range of 98 - 107 per day.

The accuracy measures above indicate that the mean absolute percentage error (MAPE) is 4.55 and thus any future forecasts would also have an error of approximately 4.5%. The median absolute deviation (MAD) is stated as 23.67, thus the number of patients identified in each future forecast is likely to have an error of approximately 24. The mean squared deviation (MSD) squares the deviation so to compare it to MAD, the square root of MSD requires to be calculated. The square root of 1050 = 32.4. This is a little larger than MAD = 24 suggesting a point or few points with "unusually large" forecast error. As MSD is a more sensitive measure of an unusually large forecast error than MAD, the outliers had less of an effect on MAD than on MSD.

Weekend working

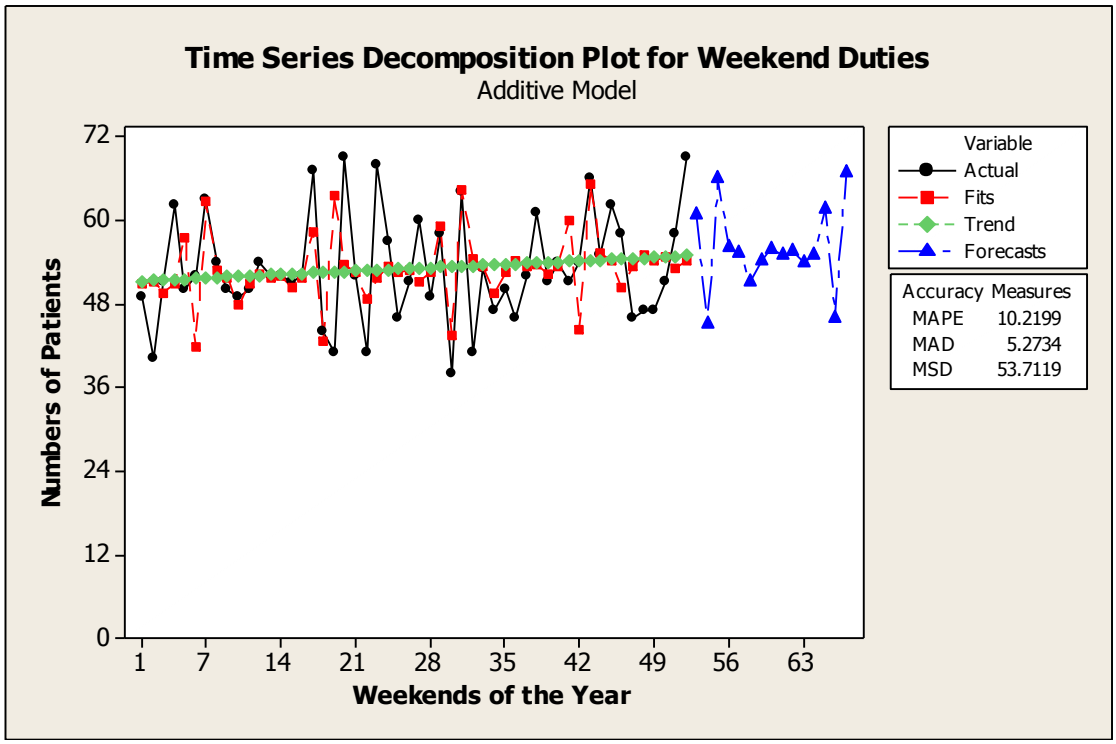


Figure 20: Minitab Forecast - Weekend duties

The graph of time series decomposition forecast for weekend duties in early 2009, based on 2008 data, is shown in Figure 20.

The accuracy measures above indicate that the mean absolute percentage error (MAPE) is 10.2% and thus any future forecasts would also have an error of approximately 10%. The median absolute deviation (MAD) is stated as 5.2, thus the number of patients identified in each future forecast is likely to have an

error of approximately 5. The mean squared deviation (MSD) squares the deviation so to compare it to MAD, the square root of MSD requires to be calculated. The square root of 53.7 = 7.3. This is similar to MAD = 5.2 suggesting that there are no points with unusually large forecast errors.

Night duties

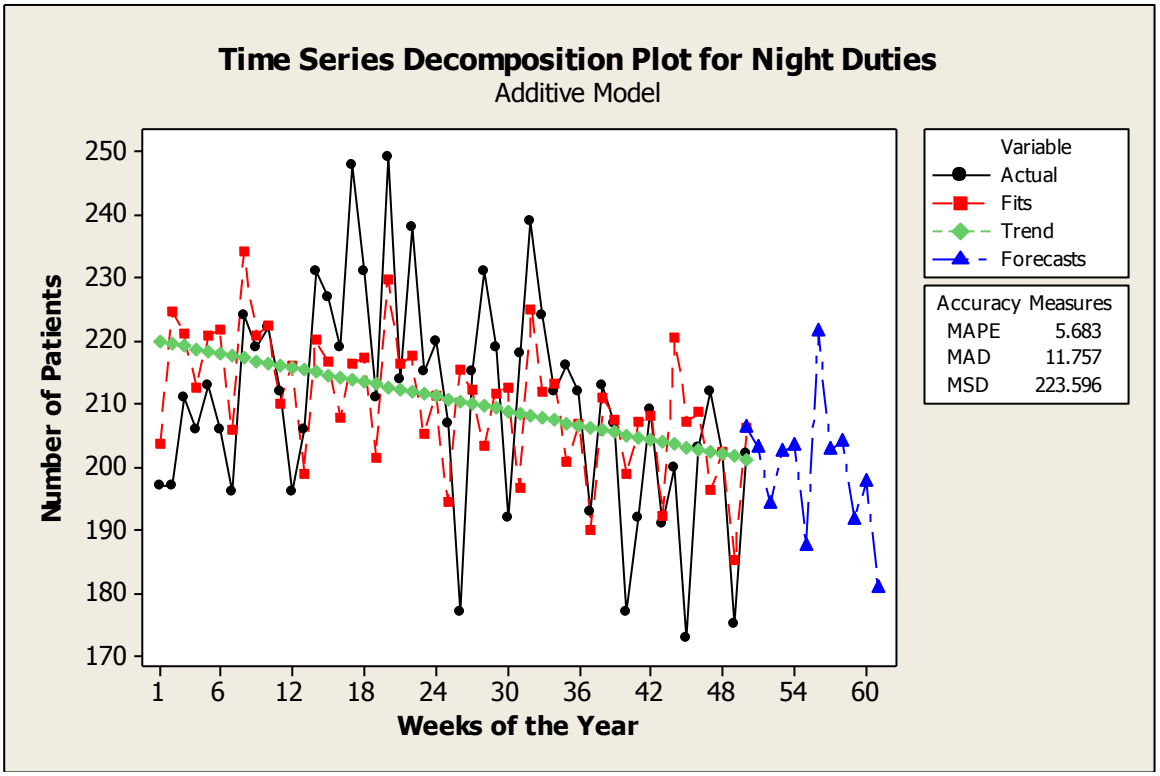


Figure 21: Minitab Forecast - Night duties

The graph for time series decomposition forecasting for night duties in early 2009 based on 2008 data is shown in Figure 21. An unusual outlier corresponding to the festive period skewed the calculations and was therefore excluded.

The accuracy measures above indicate that the mean absolute percentage error (MAPE) is 5.68 and thus any future forecasts would also have an error of approximately 6%. The median absolute deviation (MAD) is stated as 11.75 thus the number of patients identified in each future forecast is likely to have an error of approximately 12. The mean squared deviation (MSD) squares the deviation, so to compare it to MAD the square root of MSD requires to be calculated. The square root of the MSD - 223 = 14.9. This is only a little larger than MAD = 12, suggesting only a few outliers.

The Minitab forecasts all demonstrate trends both incremental and decremental. The core hours chart demonstrates a decremental trend with several outlying datum points. This is realistic as many days are

excessively quiet or excessively busy. The night duty chart demonstrates a decrimental trend but consistent numbers of patient episodes with few outliers. The weekend forecast indicates a small but steady incremental trend again with few outliers suggesting constancy in patient numbers.

Forecast Validation

Workload analysis is essential including forecasting, when undertaking workforce planning. The timescale used as data extract to perform the forecast, was the maximum possible at the outset of this study. The analysis of workload statistics in a relevant and appropriate timescale is an essential component of workforce planning and in the implementation of a workpattern model. However, this requires to be validated to confirm the forecast.

To validate the forecast, data from the first six months of 2009 were obtained (figure 22). Perhaps surprisingly the trend of the workload is similar to the trend in 2008. This may be demonstrating a cyclic trend where the workload is particularly high at the beginning of the year perhaps due to "winter vomiting", increased respiratory infections and increased numbers of ice related injuries. However, rather than a continuous decrimental trend from 2008, the data range of the 2009 statistics is 551-577 which is a little higher than 2008. This is a range of 110-115 per day in comparison with the core hour range for 2008 (98 - 107). These ranges are not markedly different, with a difference of 8-12 patients per day. This is well within the forecast error of 24 for core hours in 2008. Figure 22 demonstrates the actual workload during core hours in January - June 2009. MAPE is 4.2 which indicates that future forecasts have a percentage error of 4%. The MAD is 23.7 meaning that each forecast had a potential error of 24. The square root MSD of 856 at 29 is only a little greater than the MAD thus indicating only a few outliers. The statistics for the OOH duties show similar comparison to 2008. The results of these measures of accuracy indicate that the forecast for 2009 statistics is very similar to 2008 statistics and therefore further confirms the forecasting analysis. The weekend and night duty forecast for 2008 indicated constancy and were therefore not subjected to validation.

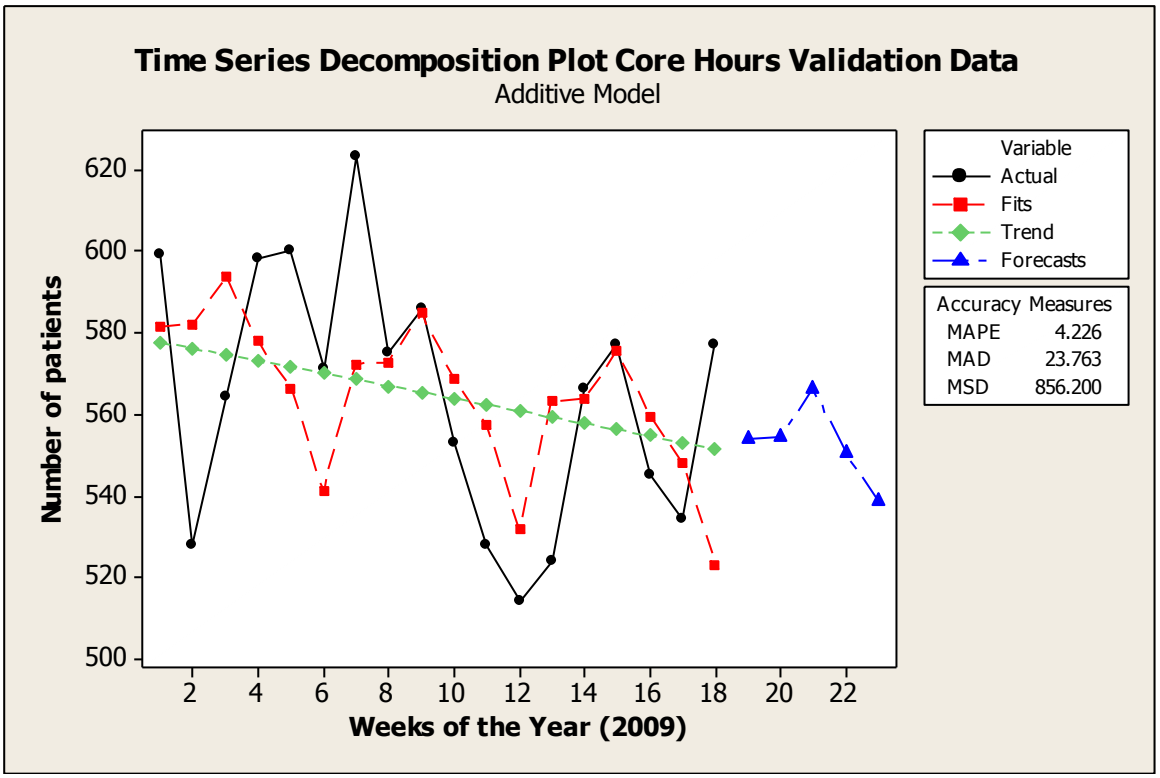


Figure 22: Forecast January - June 2009

Forecasting Synopsis

The forecast for daytime duties indicates a downward trend with a maximum value of 539 and minimum value of 488. The downward trend confirms the earlier discussion that indicates a reducing number of patient episodes with an increasing trend in the time taken, per patient episode, due to increasing complexity of many examinations. RCR, (2007) guidelines have dramatically reduced general radiography of spine and facial bones. Cross sectional imaging is considered more appropriate to facilitate patient management. All of these examinations were often requested by the ED. This decrease in referrals has contributed to a significant reduction in the overall patient episodes. Alterations in orthopaedic working practices have increased the average time per patient episode due to more complex imaging required for many patients. The significant downward trend of the daytime forecast is perhaps exaggerated. The limitation of this study was only one year of data was available as the basis of the forecast. In order to identify events such as the implementations of new work practices, it would be necessary to observe data from several years before this study. This was not possible in this study due to the change in the RIS. It is anecdotally understood that the workload has settled into a pattern, with the reduction from altered work practices embedded in practice and that an increased time per patient episode is also embedded in

practice. The median absolute deviation for core hours 2008 is stated as approximately 24, thus each duty period measured has an error of approximately 24. (Duty periods measured are weeks of the year therefore there is a forecast error of +/- 24 patients for each week).

The weekend forecast identifies a slightly incremental trend. This reflects the perception of current weekend duties. The median absolute deviation is stated as approximately 5.2, thus each duty period measured has an error of approximately 5. (Duty periods measured are weekends of the year therefore there is a forecast error of +/- 5 patients for each weekend).

The night-time duties forecast demonstrated a slightly decrimental trend. The median absolute deviation is stated as approximately 12.5, thus each duty period measured has an error of approximately 12. (Duty periods measured are weeks of night duties through the year, therefore, there is a forecast error of +/- 12 patients for each week of nights.

These errors seem reasonable and anecdotally accurate, considering the overall numbers of patients involved in each duty period. The total workload statistics indicate that the year begins with a high volume of work, the volume gradually decreasing as the year progresses. This is a similar distribution to 2008 and therefore suggests a cyclic trend. The forecasting validation data for the core hours duty period 2009 indicates very similar accuracy measures, therefore further validating the forecast and verifying a cyclic trend. The forecasting of future workload is a crucial element of this study. Workforce planning requires solutions that are future proofed. Potential workforce planning decisions must therefore take cognisance of workload projections in a timescale appropriate to the plan. Thus, planning a satisfactory workforce to implement the workpattern model is inextricably linked to the workload forecasting. Implementing any workpattern model can only proceed on the basis of the workload analysis and forecasting.

7.2 Section 2 - Developing the Workpattern Model

The aim of this study is to develop a workpattern model, or algorithm, by deductive analysis and reasoning. The purpose of deduction is to develop new knowledge from known data. In this study, the workpattern model will be developed from analysis of quantitative data and from data obtained from the literature review. Ernst et al (2004) indicated that the problem must be clearly classified. The classification entails determination of the specification of the workload, over a relevant time period, and the workforce and workforce profile required in relation to the workload.

Initially activity data, as a proxy form of demand data, for general radiography was obtained for the principal study centre and analysis and forecasting of workload carried out. The demand relates directly to

the activity as general radiography is demand led and immediate in nature. Demand modelling is the process of translating a predicted pattern of incidents into associated duties and using this data to facilitate the demand for staff requirement. In this study, the demand is unscheduled i.e. the demands have random arrival times. However, by structured analysis of past data and forecasting of future demand by seasonal decomposition, a future demand was predicted.

This permits the determination of workforce required to meet the demand at the various time intervals. This demand, when fed into later rostering phases acts as a constraint on the staff complement. This may require penalties related to over or under cover to be identified and managed cost effectively.

Lines of work, related to the work schedules, and spanning the roster horizon must then be developed for each modality. These lines of work relate to building blocks of the total workforce complement associated with specific skills. This involves task scheduling and each individual's skills or seniority is attached to a specific line of work. The procedure above as described by Ernst et al (2004) and if modified to relate to the wide radiography profession, provides a framework within which workpattern modelling and algorithms may be placed. The lines of work construction are challenging for all radiology departments as radiographers have many specialist skills. These have to be structured to best manage demand for these skills over the roster horizon of all modalities in the individual centres.

7.2.1 Demand and activity data – principal study centre

Demand modelling was by far the most significant factor identified in integrated work scheduling (Buffa et al, 2007). In general radiography the demand is difficult to measure. Activity is a proxy measure for demand but does not give an accurate estimation of queue. Thus the frequency distribution gives an accurate measure of the actual patient episode times, allowing the staff resource required per number of patients to be identified.

It is essential at this stage to revisit the elements of local demand and activity data. Radiography modalities other than general radiography, e.g. CT, MR and Ultrasound, have been subject to demand, capacity, activity and queue analysis recently as part of the work for the diagnostic collaborative (Scottish Government, 2006-2). These modalities involve activity that is mainly planned and can therefore be scheduled. This analysis has identified the staff levels required to maintain service levels in these modalities (lines of work). No analysis of this nature has previously been undertaken within general radiography (unscheduled) and so both workpattern models and staff rosters have been based on experiential and historical algorithms, rather than evidence based algorithms. General radiography,

including ED, mobile and theatre radiography, is mainly demand led. In order to investigate demand statistics, it was essential to obtain representative data.

Thus it was decided to review activity data from throughout the year 2008 as proxy data for demand statistics. A weeks detailed data was obtained from each quarter of the year. The middle month of each quarter was selected to reduce festive variations. Different weeks within the months were reviewed to reduce seasonal variations related to clinic activity that may be associated with specific weeks of the month. Thus data was reviewed for the first week in February 2008, second week of May 2008, third week of August 2008 and fourth week of November 2008. These data were analysed and substructed to review the workload per hour for seven days in each week (four weeks). Maximum and minimum values were identified and average workload per hour throughout each week and across the four week period was calculated.

The minimum, maximum and average number of patients per hour (weekdays) is demonstrated in Figure 23.

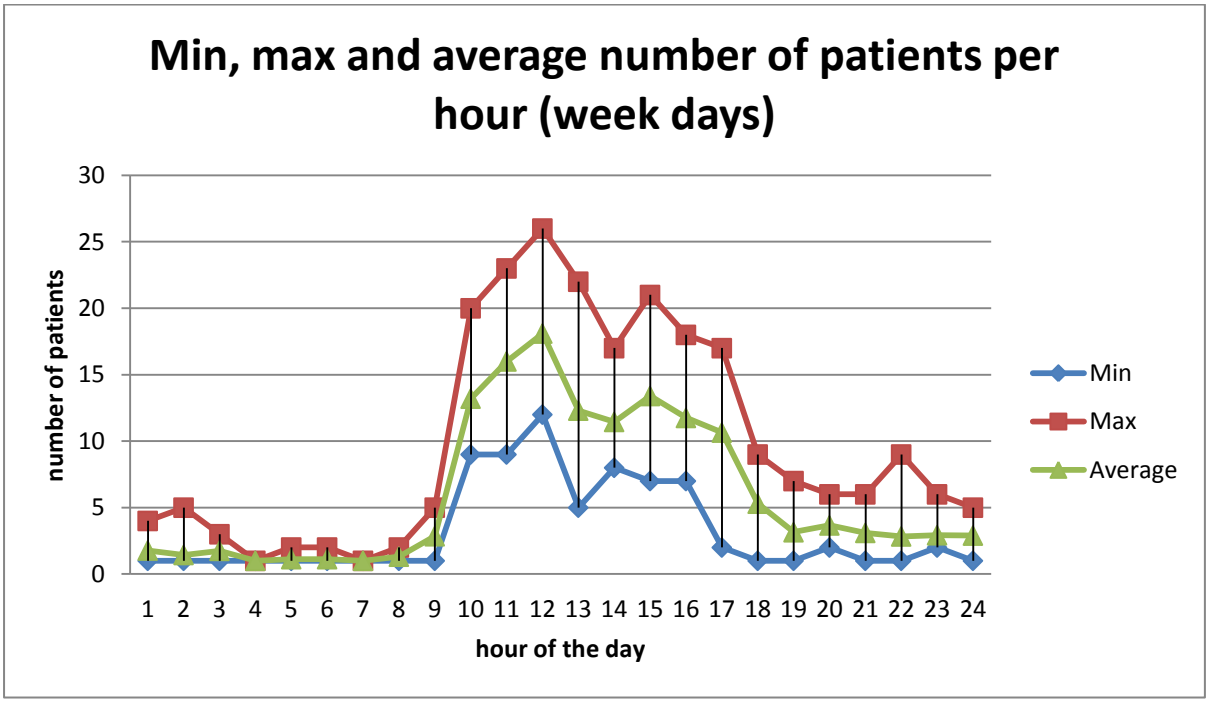


Figure 23: Minimum, Maximum and Average number of patients - weekdays

The minimum, maximum and average number of patients per hour (weekends) is demonstrated in Figure 24.

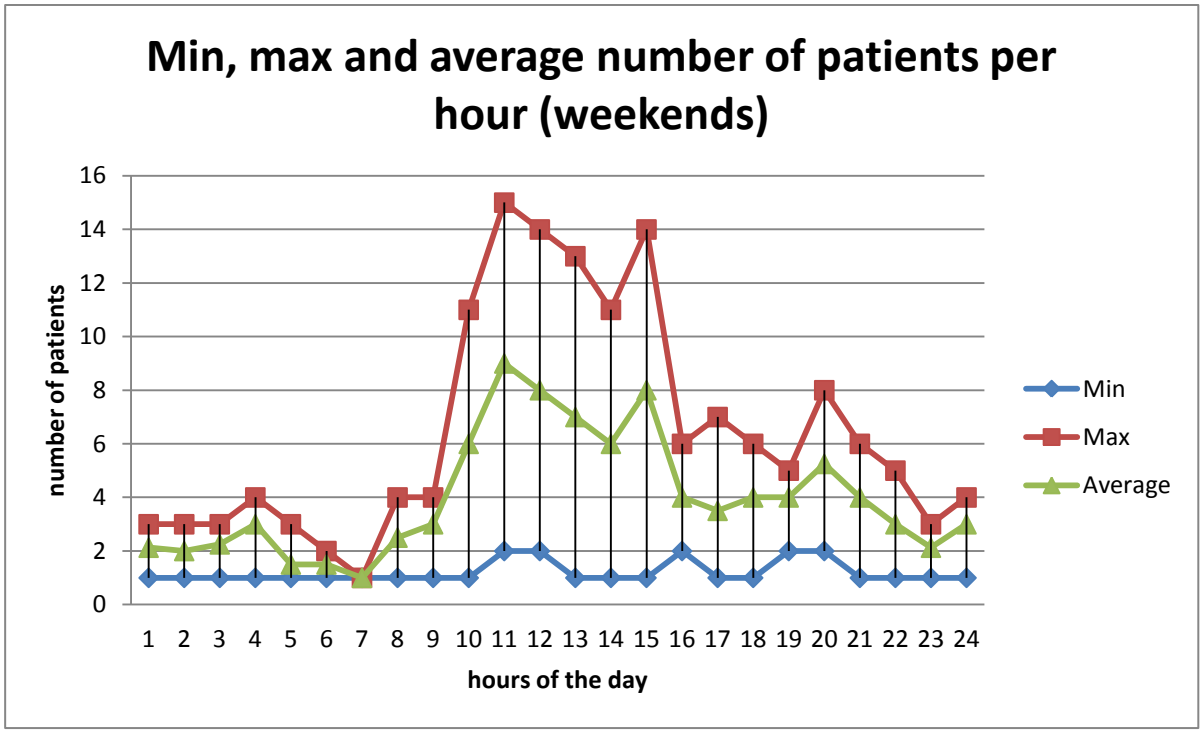


Figure 24: Minimum, Maximum and Average number of patients – weekends

7.2.2 Developing the model

Similarly to Kulatunga et al, (2009) data from the frequency distribution charts was analysed. The daytime statistics for the principal study centre were evaluated initially, though not including the theatre data, as this cannot be validated. Table 4 is repeated below as Table 8

Summary Table Distribution of Patient episodes

	% patient episodes<5mins	% patient episodes<10mins	% patient episodes <15mins	Average time interval extended element	% patient episodes extended element
Core Hours (Daytime)	55%	79%	85%	37 mins	21% (> 10 mins)
OOH (Nights)	50%	89%	92%	34 mins	11% (>10 mins)

Table 8: Summary % Patient episodes

As discussed previously, 55% of examinations were completed in 5 minutes or less, 79% of the examinations were completed in 10 minutes or less, 85% of the examinations were completed in 15 minutes or less during core hours. The remaining 21% (> 10 minutes) were completed as per the frequency distribution charts (figure 15), with an average time of 37 minutes per examination, plus the theatre workload. The logical synthesis of this data is that an individual radiographer, with full administrative and peer support, should be able to complete at least 6 examinations per hour 79% of the time. However, as mentioned earlier the more time consuming examinations have to be managed by the same pool of staff. It may be reasonable to suppose, that if an individual radiographer is assumed to have the capacity to complete 5 examinations per hour, this should provide satisfactory aggregated time to accommodate the extended times of the element of patient episodes taking >10 minutes in 21% of the time without undue wasted resource.

For example, using the local data from the preceding chart, Figure 23, the average number of patients examined between 9am and 10am on weekdays is approximately 13 patients. According to the data an individual radiographer, with full administration and peer support, can examine 5 patients in one hour; therefore to examine 13 patients, 3 radiographers would be required. Between 11am and 12 noon using the same chart, Figure 23, the average number of patents examined would be approximately 18 patients. Thus 4 radiographers would be required. This would allow for aggregated time to accommodate the extended times of the element of patient episodes taking >10 minutes from within this pool of staff.

The night duty statistics for the principal study centre were then evaluated, again not including theatre statistics as this data cannot be validated. 50% of examinations were completed in 5 minutes or less, 89% of the examinations were completed in 10 minutes or less. The remaining 11% (> 10 minutes) of examination were completed as per the frequency distribution chart (figure 16), with an average examination time of 34 minutes per examination. The logical synthesis of this data indicates that an individual radiographer, with no back-up administrative support, can still complete 6 examinations per hour 89% of the time. However, the more time consuming examinations have to be managed by the same individual radiographer or small pool of radiographers with no administrative support. It may be reasonable to set the realistic parameter for an individual radiographer to a lower level than during core hours. Thus, it may be reasonable to assume an individual radiographer to have the capacity to complete 4 examinations per hour, in order to provide satisfactory aggregated time to accommodate the extended times of the element of patient episodes taking >10 minutes (including theatre radiography) 11% of the time without undue wasted resource. However, as theatre radiography is remote from the main department, this may have a consequence of generating a queue of general radiographic requests when theatre is being serviced.

For example, using the local data from the chart, figure 24 above, the average number of patients examined between 7pm and 8pm is approximately 4 patients. According to the data a lone radiographer, with no peer or administrative support, can examine 4 patients per hour. Thus one radiographer can manage the average workload during this time. The extended element of work can, in theory, be covered during this period by the same radiographer. The caveat to this, of course, is that if the radiographer is called to theatre, the requests for general radiography during that time will form a queue.

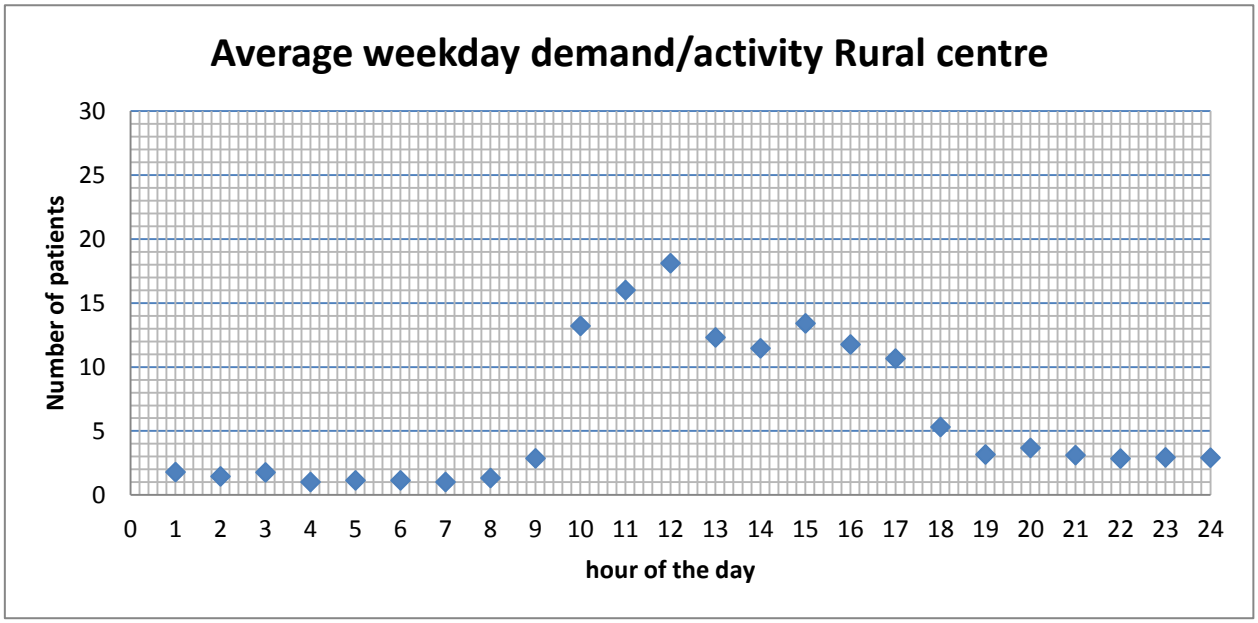


Figure 25- Average demand activity (Weekdays) Rural centre

	12mid-1am	1am-2am	2am-3am	3am-4am	4am-5am	5am-6am	6am-7am	7am-8am	8am-9am	9am-10am	10am-11am	11am-12noon	12noon-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm-7pm	7pm-8pm	8pm-9pm	9pm-10pm	10pm-11pm	11pm-12mid
										3	4	4	3	3	3	3	3							
Staff	1	1	1	1	1	1	1	1	1									1	1	1	1	1	1	1
Ave no patients	2	1	2	1	1	1	1	1	3	13	16	18	12	11	13	12	11	5	3	4	3	3	3	3

Figure 26: Workforce calculation

Applying this deduction on the average demand/activity weekday data (Figure 25) allows a calculation of the staff required across the full working day including OOH (Figure 26). However, managing the patient throughput is only part of the issue. However to obtain maximum skills benefit and cost effective service to effectively deploy skills mix to maximise use of specialist skills.

Figure 26, shows the staffing level required for average weekday activity/demand in the principal study centre. The feasibility of the staffing levels identified, this time against the maximum activity/demand, is

investigated below (Fig 27 and Fig 28) again for the principal study centre. To deal with the maximum activity/demand using the model that has been developed, the number of staff required is also identified. As mentioned above, staffing to the average may incur penalties either financial or service related on occasions of under or over demand. In the situation below, during core working hours the assignment of the band 7/8 as a specialist and/or management resource (see Table 9), in the principal study centre, may absorb or buffer the majority of the activity. However, the evening duties cannot be buffered by the assignment of a band 7/8 in the principal study centre, as there is no specific role for deploying this expensive expertise. This could incur a service penalty that may not be acceptable if ED targets are related to this workload. Even if no targets are related to this workload, this workload will relate to reduced patient outcome by delay in examining the patients (Lane et al, 2000). An illustration of this potential queue effect is demonstrated below (figure 29).

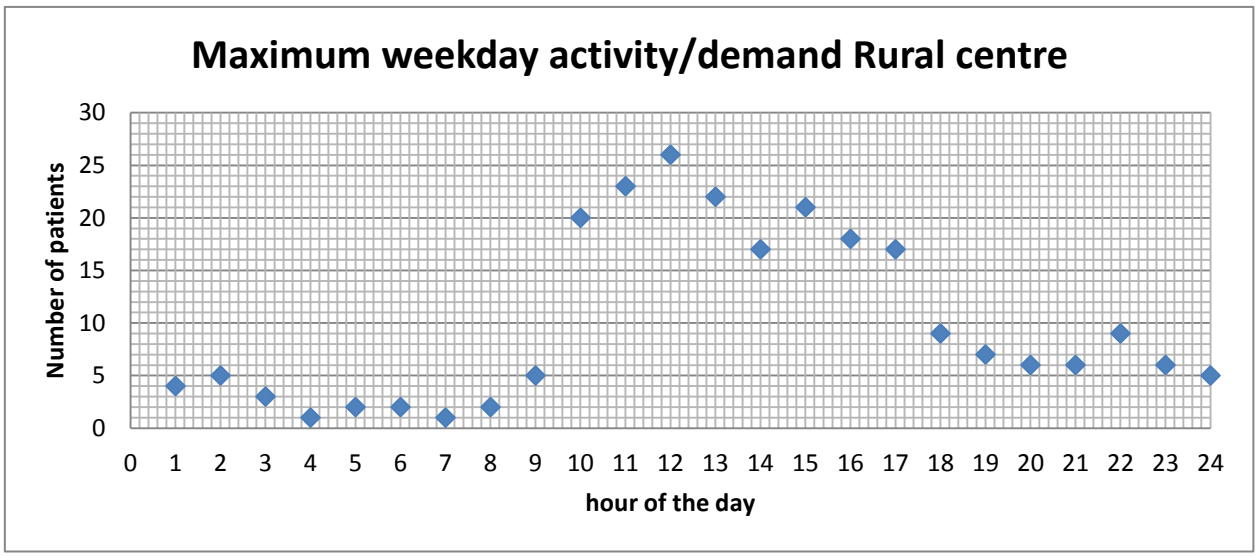


Figure 27: Maximum demand/activity

Time	12mid-1	1am-2	2am-3	3am-4	4am-5	5am-6	6am-7	7am-8	8am-9	9am-10	10am-11	11am-12	12non-1	1pm-2	2pm-3	3pm-4	4pm-5	5pm-6	6pm-7	7pm-8	8pm-9	9pm-10	10pm-11	11pm-12
staff	1	2	1	1	1	1	1	1	2	4	5	6	5	4	5	4	4	2	2	2	2	2	2	1
max demand/activity	4	5	3	1	2	2	1	2	5	20	23	26	22	17	21	18	17	9	7	6	6	9	6	5

Figure 28: Workforce calculation - maximum demand

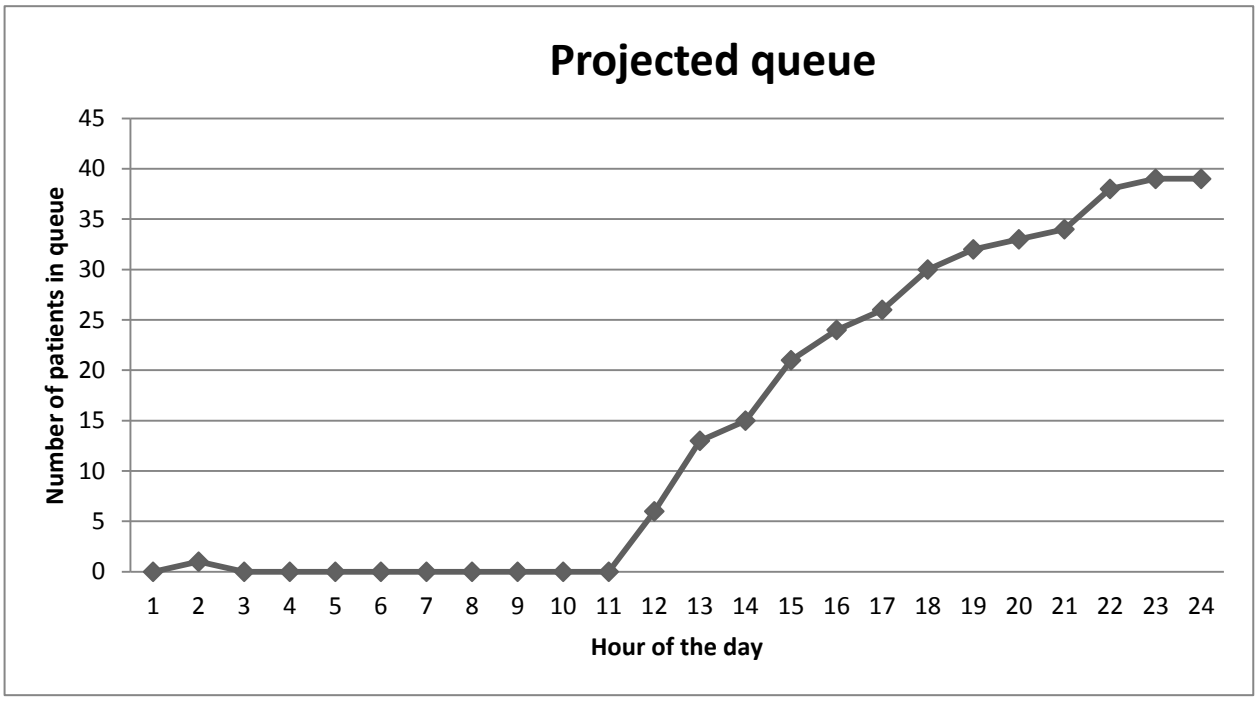


Figure 29: Theoretical cumulative queue

Figure 29, is an illustration of a notional cumulative queue that could hypothetically build on a day of maximum demand, with staffing resource only applicable to the average demand/activity. This illustrates a the resulting crisis in patient throughput. On an isolated occasion, such as a major incident, this could be ameliorated by staff resource being diverted from other modalities to support an exceptional demand in general radiography. If this level of demand was to occur more regularly, review of resource management would be required. Local risk analysis would be required to judge whether reduced patient centred outcome by cumulative queue is acceptably balanced against the financial penalty of over resource.

Figures 30 and 31, illustrate a notional situation where additional resource, has been applied according to the model to facilitate the hypothetical queue management. A fourth member of staff is added between 12 noon to 5pm and a second member of staff between 5pm and 6pm. This demonstrates the impact of resource deployment to partly meet the maximum hypothetical demand and to address and manage the queue. This does not deploy maximum staffing from the workforce model, but demonstrates the benefit of this targeted additional resource in reducing the exponential trend of the queue in Figure 31. This staff deployment would have a financial implication and would require to be planned in advance, unless the staffing resource is flexible in terms of start and finish of duty times. The cumulative queues with and without the staff upgrade shown in Figure 30 are demonstrated in Figure 31.

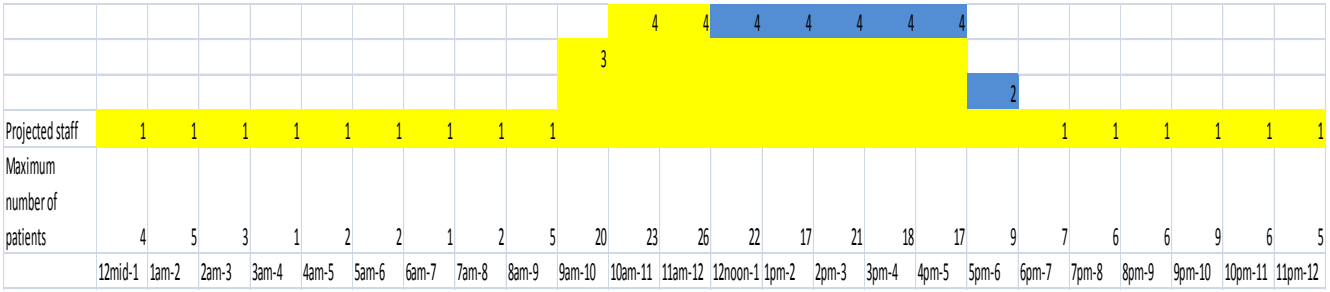


Figure 30: Potential staff upgrade

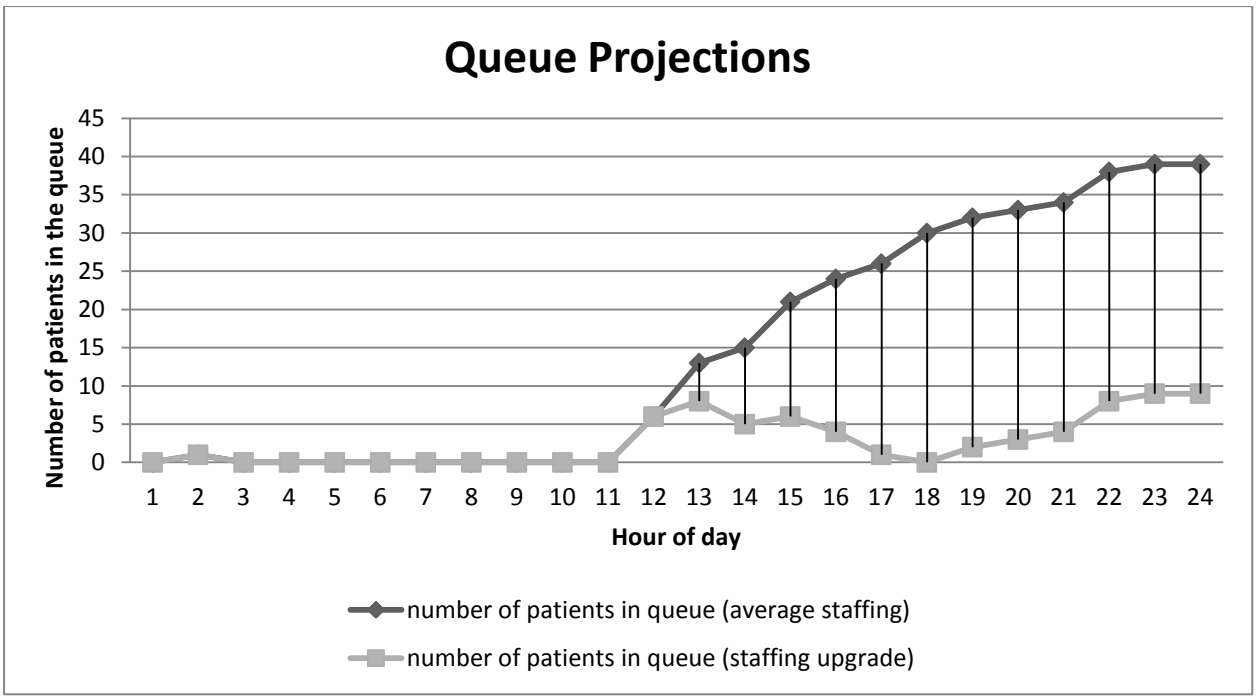


Figure 31: Projected queue with staff upgrade

7.2.3 Demand and activity data – urban general hospital

Workload figures supplied from the RIS by the radiology manager in an urban general hospital indicate that the workload in that centre is 1.9 times that of the principal study centre. The unscheduled care collaborative (Scottish Government, 2007-1) measurement tools identified that the spread of unscheduled workload followed a predictable pattern from hospital to hospital. The reasoning behind this is likely to be the nature of clinic schedules: there is a Scotland wide patient administration system and the characteristics of human domestic schedules and domestic pressures (e.g. school runs, sporting fixtures etc).Thus, assuming the frequency distribution and spread of workload to be similar to the principal study centre, the weekday workload distribution and total staffing requirement, would be demonstrated by the charts below, Figures 32, 33 and 34.

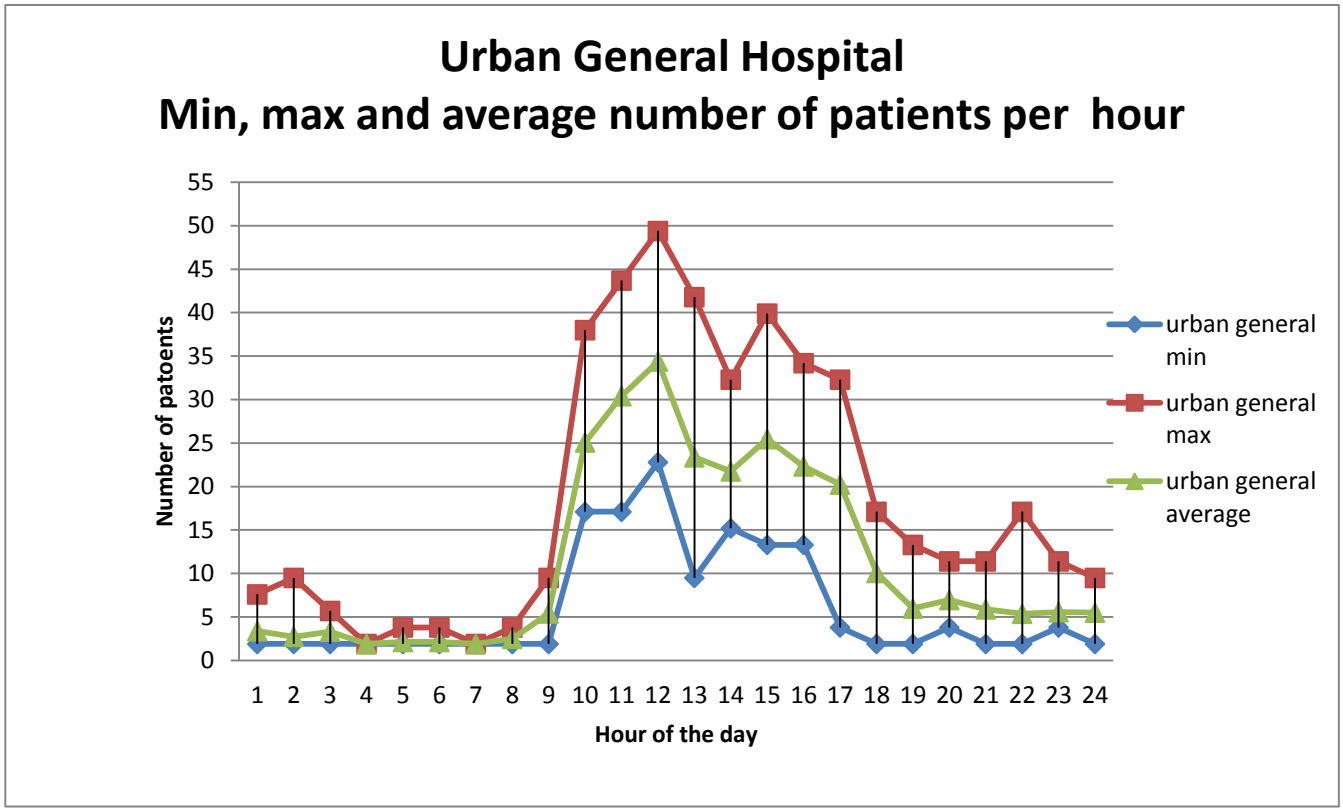


Figure 32: Urban General Hospital - Maximum/minimum patients

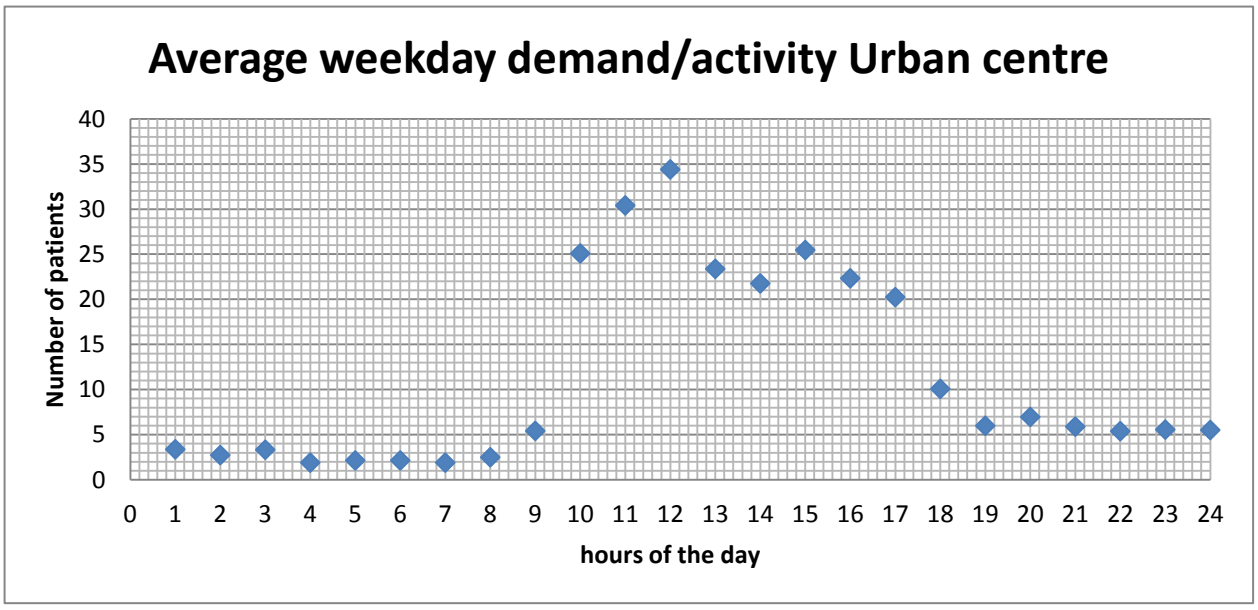


Figure 33: Urban General Hospital - Average patients

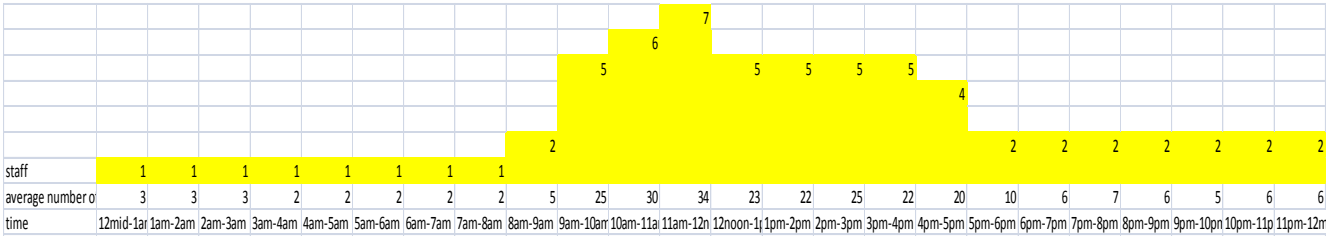


Figure 34: Workforce calculation

However, the urban centre differs from the principal study centre, as it has a second remote site of the radiology department where emergency patients are examined. The total workload is demonstrated in figure 32 and figure 33 above. The total workload figures for each separate site are very similar to each other; however, only one of the sites operates out of hours. Thus, the total staffing levels and resource allocation would have to be considered in relation the two separate sites. Allocation of staff to each site, on an hour by hour basis would require workload analysis per site, per hour, as in the principal study centre. Figure 34 above demonstrates the total number of staff required for the average 24 hour period. The allocation per site would be determined using adaptive planning (Kulatunga et al, 2009). This "staff per site, per hour" detail was not calculated within this study, as the data available was in total numerical terms but not in a format that could be broken into an hour by hour analysis per site for the urban centre. This would be a local requirement prior to application of the model.

Figure 34 above shows the staffing level required for average weekday activity/demand in the urban study centre. The feasibility of the staffing levels, identified against the maximum activity/demand, is investigated below (figure 35) for the urban study centre. To deal with the maximum activity/demand using the model that has been developed, the number of staff required is also identified (Figure 36). As mentioned above, staffing to the average may incur penalties either financial or service related on occasions of under or over demand. This could incur a service penalty that may not be acceptable if ED targets are related to this workload (Lane et al, 2000). Even if no targets are related to this workload, this workload will relate to reduced patient outcome by delay in examining the patients (demonstrated by the projected queue in figure 37).

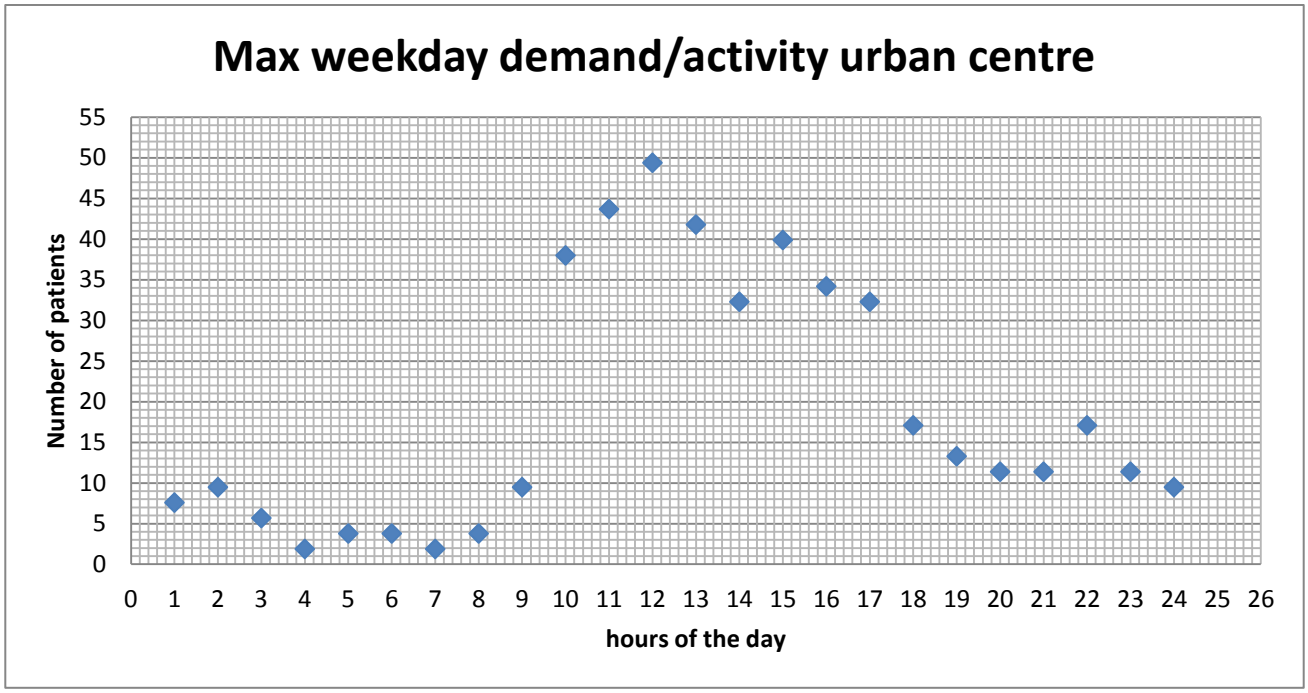


Figure 35: Urban General Hospital - maximum demand/activity

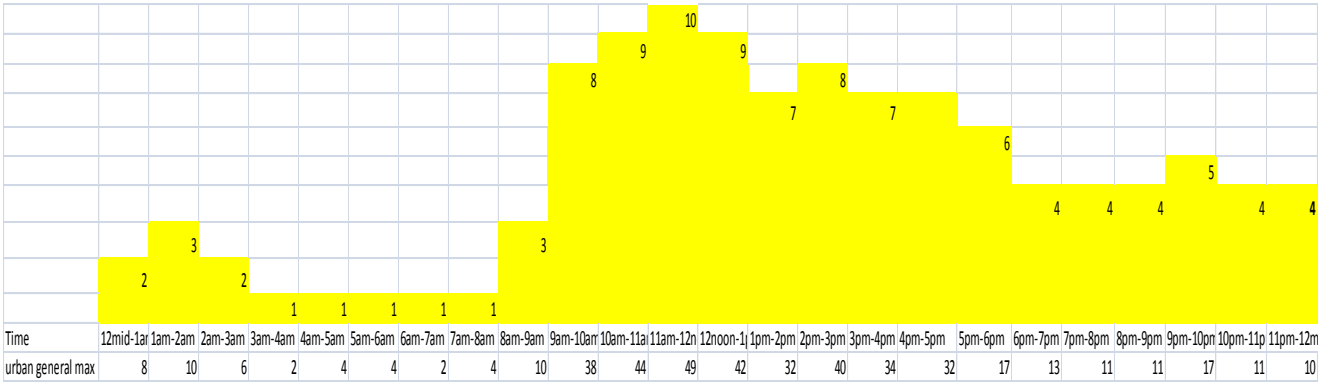


Figure 36: Urban General Hospital- workforce calculation maximum activity

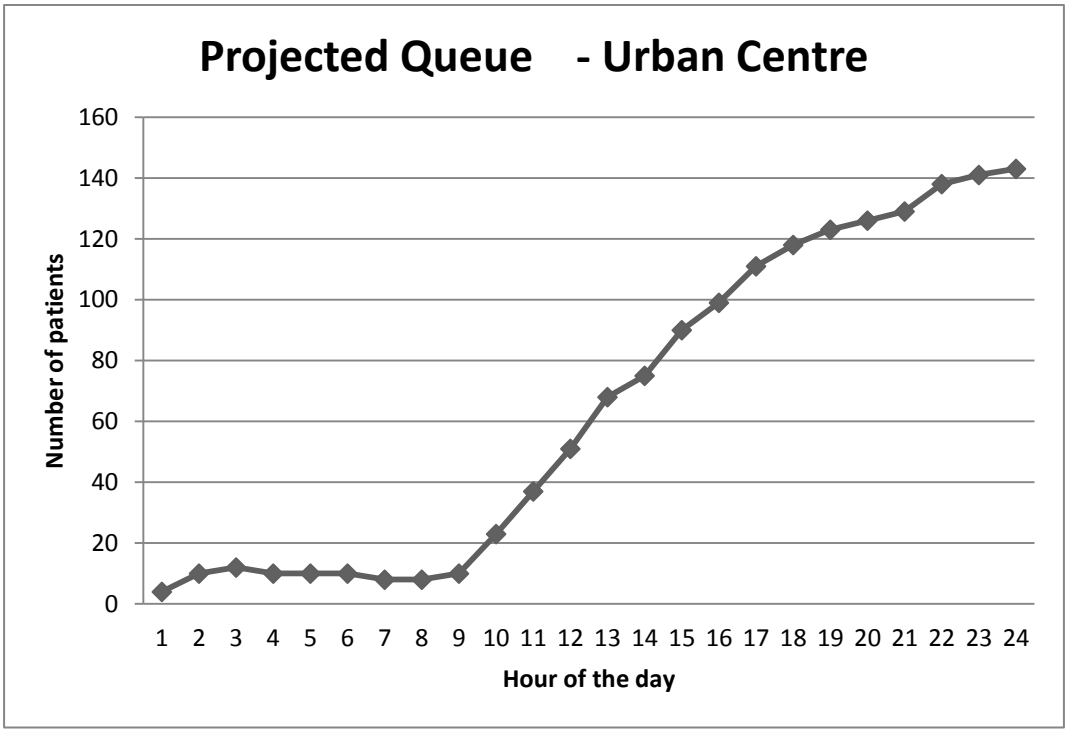
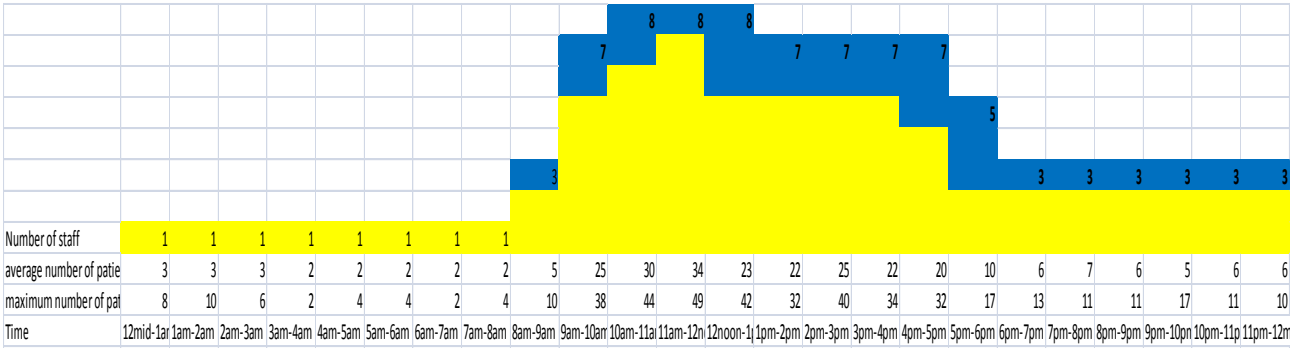


Figure 37: Theoretical cumulative queue

Figure 37 is an illustration of a notional cumulative queue, that could build on a day of maximum demand with staffing resource only applicable to the average demand/activity in the urban centre. As mentioned previously this would effect a crisis in patient throughput. Again as mentioned previously, on an isolated occasion, this could be ameliorated by staff resource being diverted from other modalities to support an exceptional demand in general radiography. However local risk analysis would be required to judge whether reduced patient centred outcome, by cumulative queue, is acceptably balanced against the financial penalty of over resource. This is determined by the frequency of this risk.

Figure 38 demonstrates a staffing resource calculation that does not fully accommodate the maximum demand for the urban centre, but does reduce the queue to a more reasonable and realistic level. The additional resource is highlighted on Figure 38. This would still have a financial penalty for the employer on the days when the workload is either average or minimum level. The decision to balance the financial implications of resource against patient throughput is again for local discussion.



Time	12mid-1ar	1am-2am	2am-3am	3am-4am	4am-5am	5am-6am	6am-7am	7am-8am	8am-9am	9am-10am	10am-11ai	11am-12n	12noon-1	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm-7pm	7pm-8pm	8pm-9pm	9pm-10pn	10pm-11p	11pm-12m
Number of staff	1	1	1	1	1	1	1	1	3	7	8	8	8	7	7	7	7	5	3	3	3	3	3	3
average number of patie	3	3	3	2	2	2	2	2	5	25	30	34	23	22	25	22	20	10	6	7	6	5	6	6
maximum number of pat	8	10	6	2	4	4	2	4	10	38	44	49	42	32	40	34	32	17	13	11	11	17	11	10

Figure 38: Staffing resource – Urban centre with staff upgrade

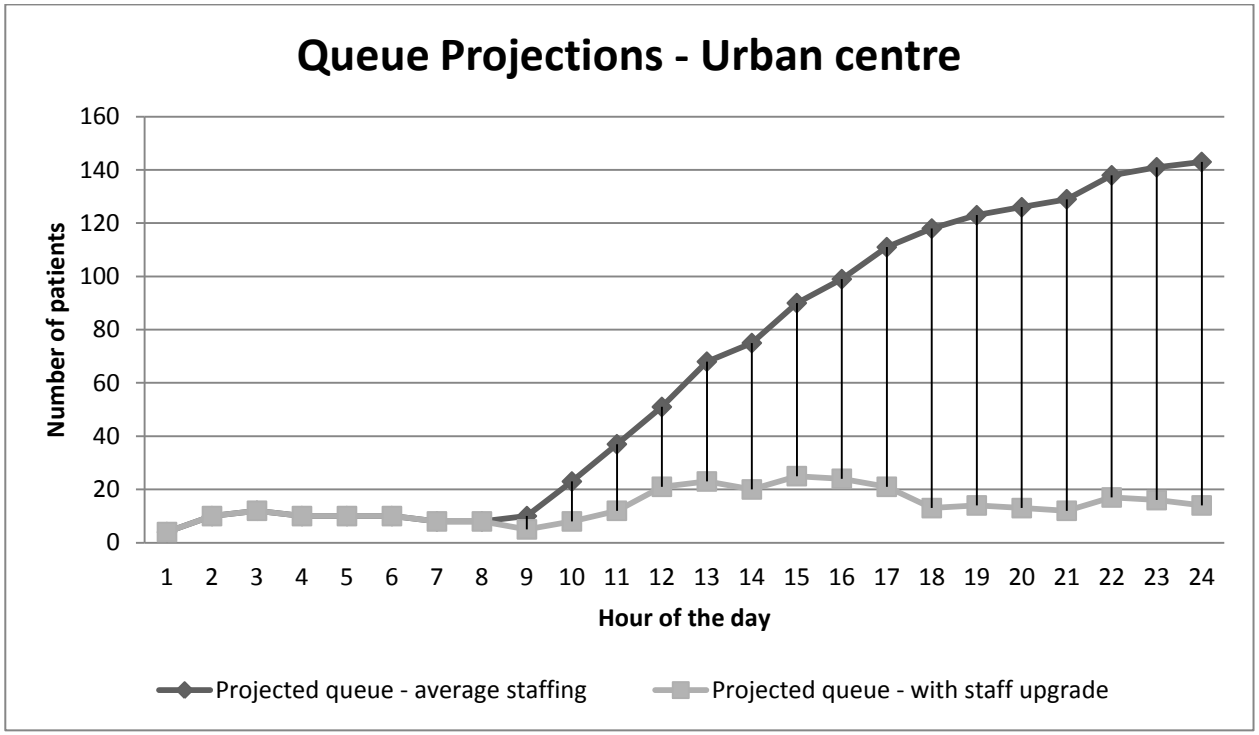


Figure 39: Urban centre queue projections

The comparison of the queues for the urban centre, with and without the staffing upgrade as described in Figure 38 is demonstrated in Figure 39.

7.2.4 Demand and activity data – teaching hospital

Workload figures provided from the RIS in a teaching centre, by the radiology manager, indicate that the total workload is 2.7 times that of the principal study centre. As mentioned above, the toolkit measurements from the unscheduled care collaborative indicate that the spread of workload in unscheduled care is very similar from centre to centre, though the patient throughput is obviously

different (greater or less dependent on the characteristics of the hospital) from centre to centre (Scottish Government, 2007-1 and 2007-2). Thus, the frequency distribution and spread of workload is similar to the principal study centre the workload distribution and total staffing requirement would be demonstrated by the charts below Figures 40, 41 and 42.

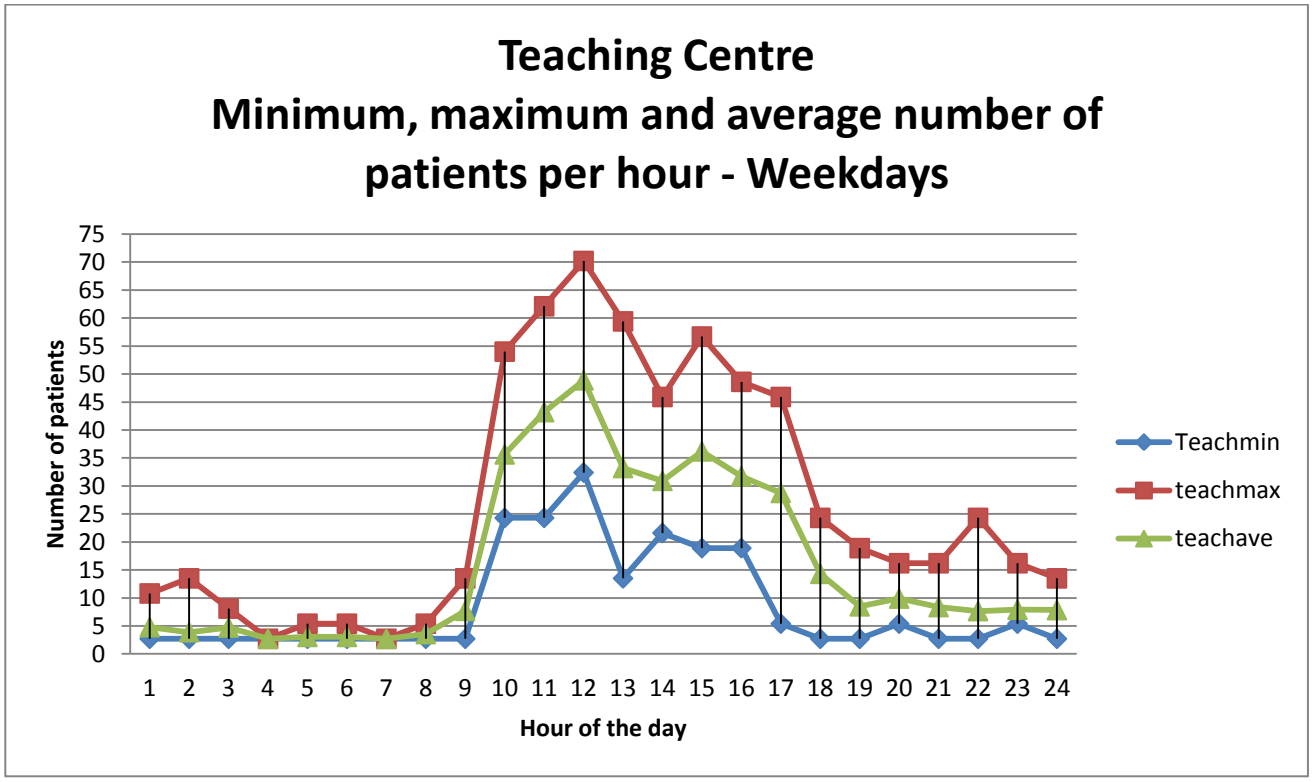


Figure 40: Teaching Hospital- Minimum/Maximum patients

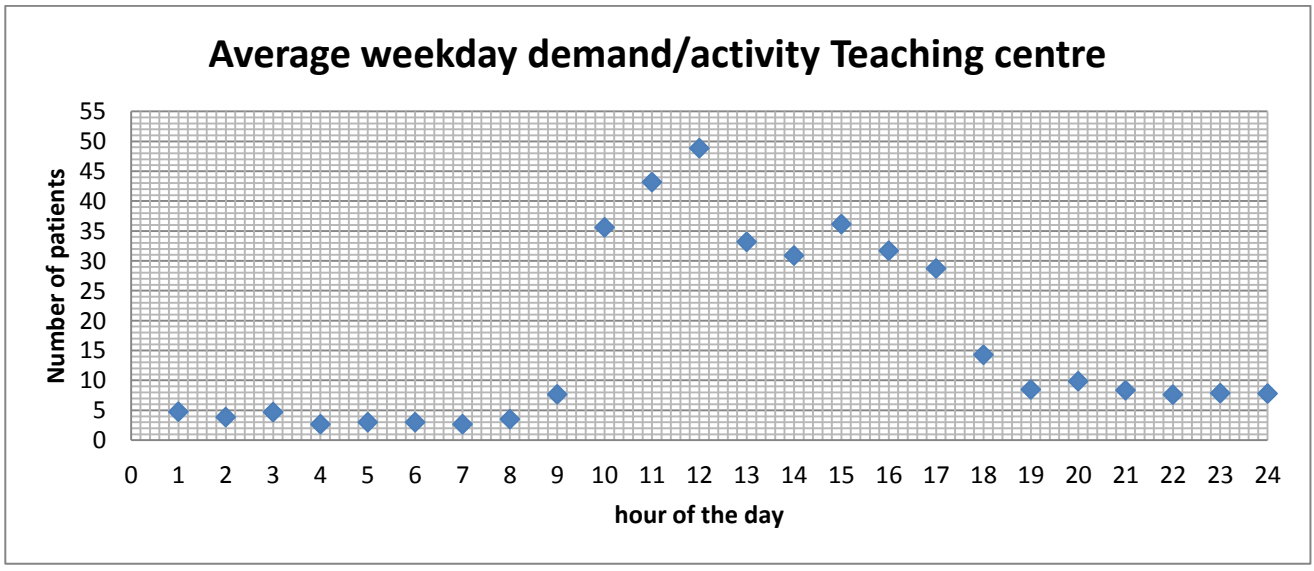
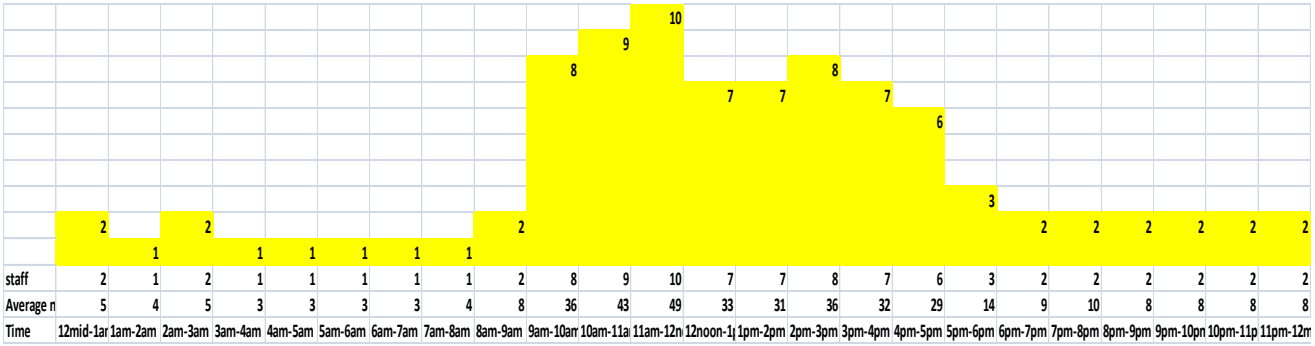


Figure 41: Teaching Hospital - Average patients



Time	12mid-1ar	1am-2am	2am-3am	3am-4am	4am-5am	5am-6am	6am-7am	7am-8am	8am-9am	9am-10am	10am-11a	11am-12n	12noon-1	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm-7pm	7pm-8pm	8pm-9pm	9pm-10pn	10pm-11p	11pm-12m
Average n	5	4	5	3	3	3	3	4	8	36	43	49	33	31	36	32	29	14	9	10	8	8	8	8
staff	2	1	2	1	1	1	1	1	2	8	9	10	7	7	8	7	6	3	2	2	2	2	2	2

Figure 42: Teaching Hospital - Workforce calculation for average workload

The teaching centre differs from both the urban centre and the principal study centre, as general radiography is delivered on several separate sites where emergency patients, out patients and in-patients are examined for general radiography but in different geographical locations, for each patient group. The workload figure for the emergency department is 120% of the total workload for the principal study centre total workload, the outpatient department is 91% of the principal study centre total workload and the in-patient department is 51% of the principal study centre total workload. However, only one of the sites (the emergency department) operates out of hours. Figure 40 and Figure 41, above, indicate the total workload for the teaching centre. The staffing level for the total average workload is demonstrated in Figure 42. The staffing levels for each site would have to be calculated by application of the model, following workload analysis of each site. This would identify the staff resource allocation for the separate sites, on an hour by hour basis, as in the principal study centre. Figure 42 demonstrates the total number of staff required for the average 24 hour period in the teaching centre. The allocation, per site, would be determined using adaptive planning (Kulatunga et al, 2009). This “staff per site, per hour” detail was not calculated within this study, as the data available was in total numerical terms but not in a format that could be broken into an hour by hour analysis per site.

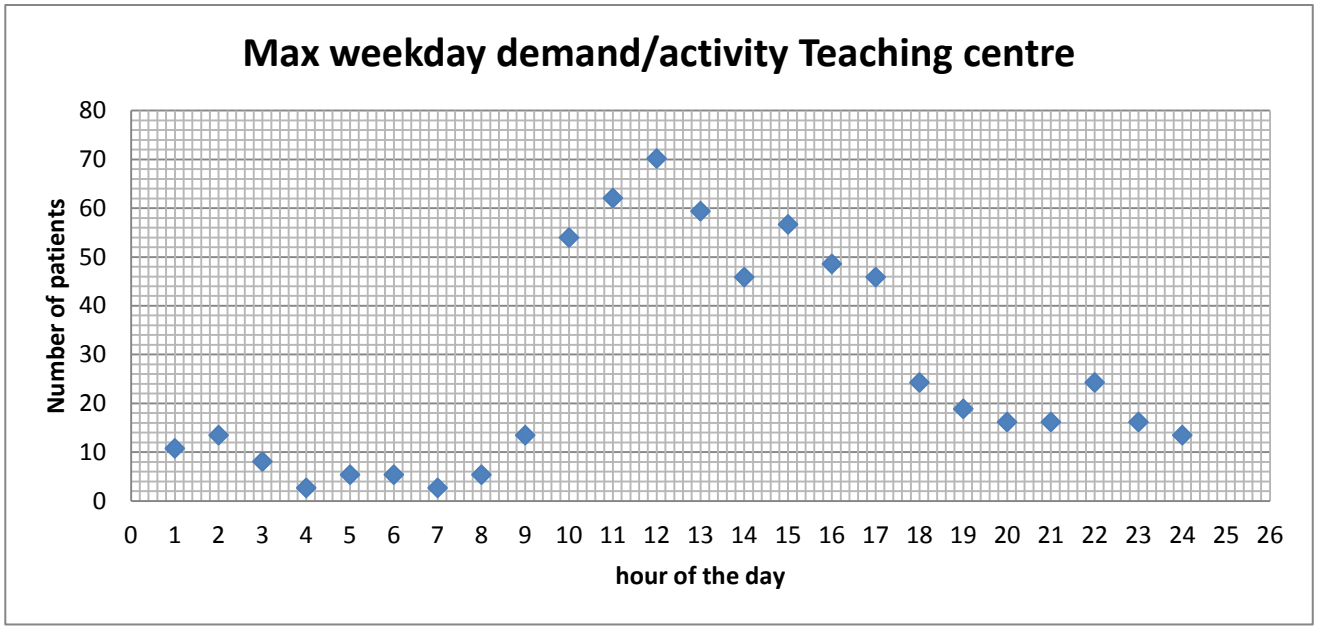
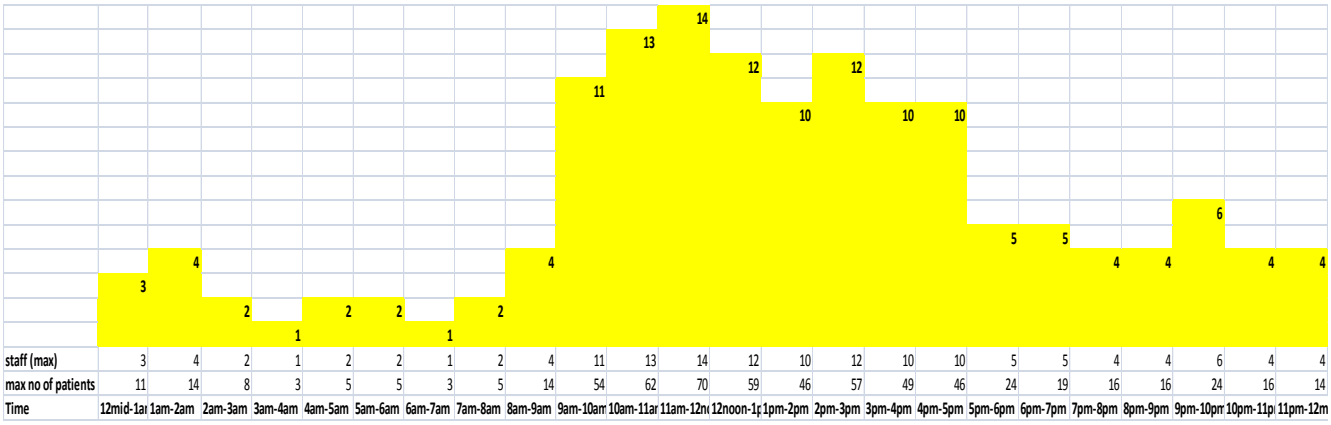


Figure 43: Maximum demand/activity Teaching Centre

Figure 43 demonstrates the maximum demand/activity for the teaching centre. The staffing resource required to accommodate this activity is demonstrated below, Figure 44.



	12mid-1a	1am-2am	2am-3am	3am-4am	4am-5am	5am-6am	6am-7am	7am-8am	8am-9am	9am-10am	10am-11a	11am-12n	12noon-1	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm-7pm	7pm-8pm	8pm-9pm	9pm-10pm	10pm-11p	11pm-12m
staff (max)	3	4	2	1	2	2	1	2	4	11	13	14	12	10	12	10	10	5	5	4	4	6	4	4
max no of patients	11	14	8	3	5	5	3	5	14	54	62	70	59	46	57	49	46	24	19	16	16	24	16	14
Time																								

Figure 44: Workforce calculation- Maximum demand Teaching Centre

Resourcing the teaching centre, to accommodate the maximum demand, has a financial penalty during days when the workload is below the maximum. Figure 45 illustrates a hypothetical cumulative queue that might build in the teaching centre on a day of maximum demand with staffing resource only applicable to the average demand/activity. This illustrates a potential crisis in patient throughput as in the principal (rural) study centre and the urban centre. As in previous discussion, in an exceptional circumstance, staff resource may be diverted from other modalities to support this exceptional demand in general radiography, though this could not sustain service if this level of workload was more the norm. The penalty of financial resource over patient delay would again be a local decision. This staff deployment

would have a financial implication and would require to be planned in advance, unless the staffing resource is flexible in terms of start and finish of duty times.

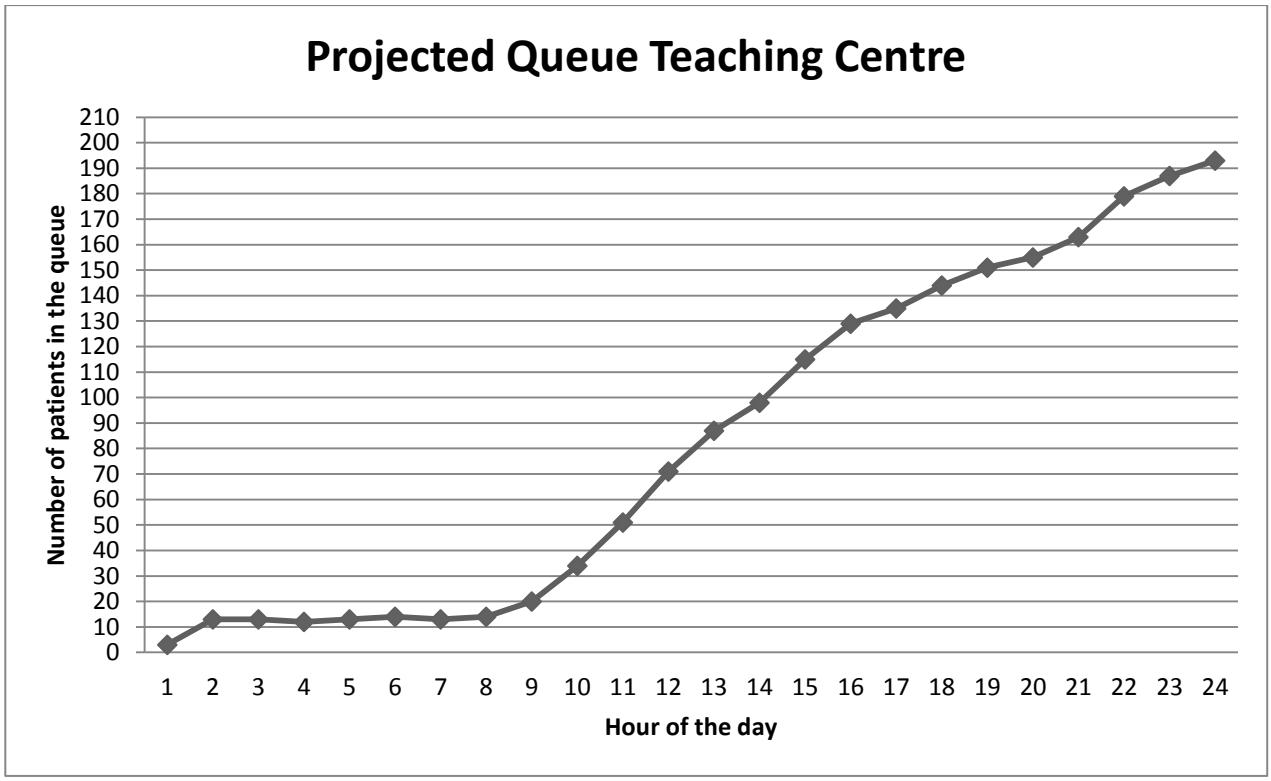
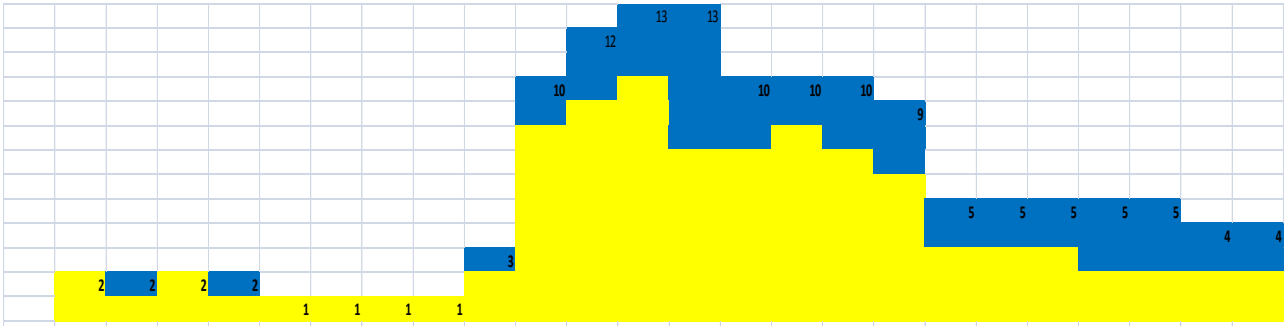


Figure 45: Projected queue- Teaching Centre. Average staffing- Maximum demand

Like the rural and urban setting, the queue will develop exponentially where staffing to the average demand is employed and the demand exceeds the average. Figures 46, illustrates the notional situation where additional resource has been invested to facilitate the queue management. Again adaption of the logic is required to keep this queue effect to a minimum. This would still have a financial penalty for the employer on the days when the workload is either average or minimum level. Risk analysis of the frequency of these occurrence would be required to determine the financial benefit of additional resource deployment.



Time	12mid-1ar	1am-2am	2am-3am	3am-4am	4am-5am	5am-6am	6am-7am	7am-8am	8am-9am	9am-10ar	10am-11a	11am-12n	12noon-1	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm-7pm	7pm-8pm	8pm-9pm	9pm-10pn	10pm-11p	11pm-12m
projected	3	13	13	12	13	14	13	14	20	34	51	71	87	98	115	129	135	144	151	155	163	179	187	193
projected	3	9	9	5	6	7	6	7	6	10	12	17	11	7	14	13	14	18	17	13	9	13	13	11
max	11	14	8	3	5	5	3	5	14	54	62	70	59	46	57	49	46	24	19	16	16	24	16	14

Figure 46: Staffing resource- Teaching Centre with staff upgrade.

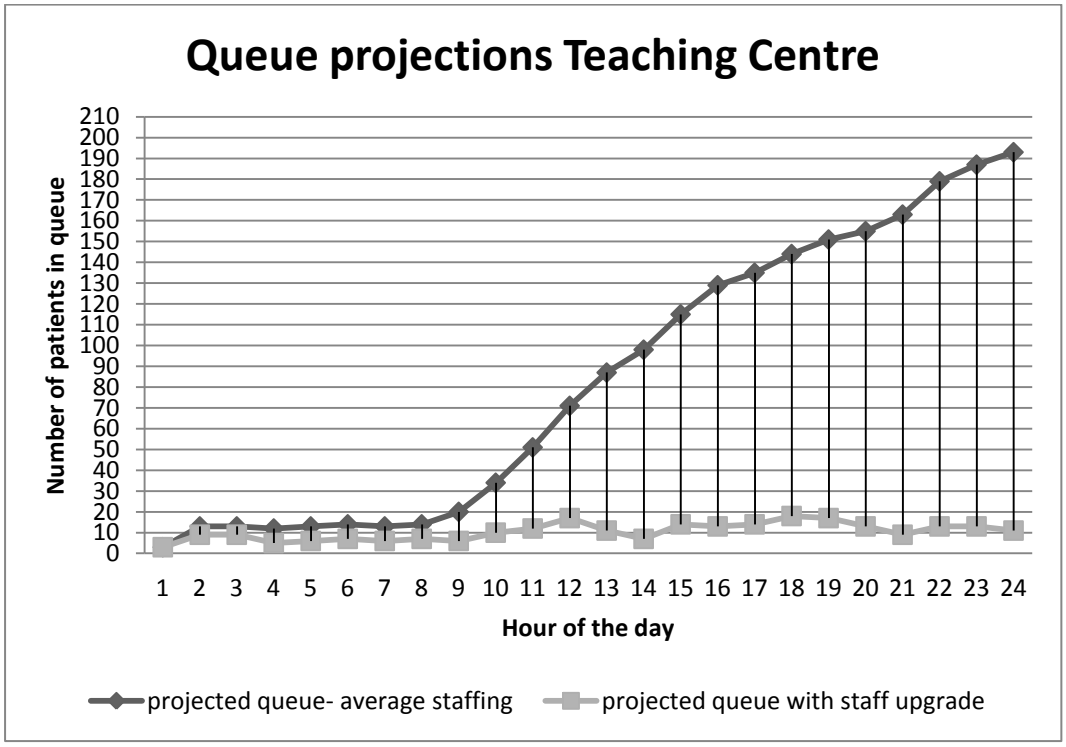


Figure 47: Projected queue comparison with staff upgrade - Teaching Centre

The comparison of the queues for the teaching centre, with and without the staffing upgrade as described in Figure 46, is demonstrated in Figure 47.

7.2.5 Workforce profile for the workpattern model

Agenda for Change (AfC) bands 1-4 are support bands and AfC bands 5-8 are HPC registered radiography staff. The skills maximisation toolkit (NHS Education Scotland (NES), 2007) suggests identification of uniqueness of tasks for both support bands and for Health Professions Council (HPC) registered staff and recommends improving team performance on the basis of the most appropriate person for the task

elements. Staff on bands 1-3 can provide support in preparation of the patient but cannot image patients. Band 4 staff can image patients under protocol in addition to patient preparation but require to be supervised by an HPC registered radiographer. Band 5 radiographers can work autonomously but have no managerial responsibility. Band 6 radiographers can work autonomously and may have a specialist interest and/or some managerial responsibility. Band 7-8 radiographers will have specialist interest and/or managerial responsibilities that are likely to require the majority of their time (Table 9).

Band	Supervision	Role
1-3 Support staff- helpers, porters, orderlies, HCAs, ATOs Work under supervision- Non HPC registered	Supervised by bands 5-8	Support role. Administrative support (registering and booking patients) Patient preparation
4 Assistant Practitioners- Works under supervision- Non HPC registered	Supervised by bands 5-8	Support role Patient preparation Administrative support Imaging under protocol
5 Radiographers HPC registered	Autonomous role- often linked by experiential learning to Band 6 Responsible to bands 7/8	Patient preparation Imaging Administration
6 Radiographers HPC registered	Autonomous role Responsible to bands 7/8	Patient preparation Imaging Administration Specialist interest ?Managerial role
7 Radiographers HPC registered	Autonomous role Responsible to band 8	Patient preparation Imaging Administration Specialist interest and/or Managerial role
8 Radiographers HPC registered	Autonomous role Responsible to hospital management	Autonomous role Patient preparation Imaging Administration Specialist interest and /or Managerial role

Table 9: Workforce descriptor (developed from NES, 2007)

7.2.6 The model

A model has been developed by deductive analysis and reasoning that assigns a staff resource matched to activity in general radiography. This was developed from the frequency distribution charts and local activity data. This workpattern model, equivalent to an algorithm or matrix, can thus be applied to all centres, providing data acquisition of general radiographic activity has been undertaken. As discussed above in Jenkins-Clarke, (1992) understanding the local data is essential in workpattern modelling. In

accordance with the Reliabilist perspective it is essential not only to obtain the evidence but to understand the process behind the evidence in order to comprehend the effect of applying change.

The Workpattern Model – (Core Working Hours)

Patient Activity per hour	Clinical Support staff Band 1-3	Administrative support staff Band 2-4	Radiographer/ assistant practitioner assignment
1-5 patients	Yes	Yes	1x band 5/6
6-10 patients	Yes	Yes	2x band 5/6
11-15 patients	Yes	Yes	2x band 5/6 1x band 4
16-20 patients	Yes	Yes	3x band 5/6 1x band 4
21-25 patients	Yes	Yes	4x band 5/6 1x band 4
26-30 patients	Yes	Yes	4x band 5/6 2x band 4
Managerial, supervision and education			Band 7/8

Table 10: Workpattern model- Core hours

Table 10 above demonstrates the workpattern model, within core working hours, in a general radiography department with full administrative support:

- If the average activity, in a specified hour, is less than 5 patients, assign a band 5/6
- When the activity increases, by multiples of 5 patients, assign a further band 5/6 followed by a band 4
- Ratio of 2:1 band 5/6: band 4 to ensure adequate supervision. This ensures that there is always supervision for the unregistered band 4 staff, when one of the registered member of staff is required to absent themselves from the workplace (e.g. provide imaging in theatre, undertake an IRMER practitioner duty or have a meal break).

A band 7/8 (the most expensive resource) should be assigned within core hours for supervision, managerial and specialist guidance and to buffer excesses in demand. This band should be deployed even when the activity does not require this practical support as the management, education and advisory aspects of the role are essential support for radiographers.

This matrix should be applied to local activity data derived from activity, on an hour by hour basis, over at least a 4 week period, to measure workforce requirement.

The Workpattern Model – (Out of Hours)

Patient Activity per hour	Clinical support Staff Band 1-3	Administrative support Staff Band 2-4	Radiographer/ assistant practitioner assignment
1-4 patients	No	No	1x band 5/6
5-8 patients	No	No	2x band 5/6
9-12 patients	No	No	2x band 5/6 1x band 4
13-16 patients	No	No	3x band 5/6 1x band 4
17-20 patients	No	No	4x band 5/6 1x band 4
21-24 patients	No	No	4x band 5/6 2x band 4
			Band 7/8 (only if specific skills required)

Table 11: Workpattern Model- OOH

Table 11, above, demonstrates the workpattern model within the OOH period, in a general radiography department with no administrative support:

- If the average activity, in a specified hour, is less than 4 patients, assign a band 5/6
- When the activity increases, by multiples of 4 patients, assign a further band 5/6 followed by a band 4
- Ratio of 2:1 band 5/6: band 4 to ensure adequate supervision, as explained above.

A band 7/8, as the most expensive resource, should only be assigned if the particular centre requires managerial or specialist support in the OOH period.

The workpattern model for general radiography generates the workforce resource requirement (both numerical and expertise) for general radiography when mapped to workload data. When combined with the workforce requirement for other modalities identified by demand, capacity, activity and queue analysis (DCAQ) this generates the total staff resource requirement (lines of work) for the individual centre (Scottish Government, 2006-2). This resource must be allocated to modalities and sites on an appropriate basis dependent on local data analysis. Using the data from the model, numbers and bands of staff can be calculated to cover the workload demands in general radiography. A matrix for each centre should be generated, related to lines of work using DCAQ data from modalities undertaking planned workloads such as CT and MR in addition to the lines of work from general radiography. Thus the workforce requirements

for a typical week in any centre, can be planned mathematically. This facilitates financial planning for workforce resource.

Following the development of the workpattern model, it is essential for the purpose of the study to investigate the elements of implementation of the model in the practical situation. Thus, the evidence relating to implementation strategies and constraints to the implementation process, is discussed below. This investigation is within the scientific perspective of reducing misconception and avoiding preconceptions by supporting and explaining the practical application in the workplace. This, therefore, remains within the deductive approach as the findings are being analysed and interpreted in a practical setting, using deductive reasoning to implement the model in an operational conceptual framework. This evidence is discussed below.

7.2.7 Workforce contracts

Radiographers employed on a full time contract historically worked 35 hours per week. However, since AfC, all allied health professionals on full time contracts are required to work 37.5 hours. Thus, radiographers employed since October 2004, when AfC terms and conditions came into force, on full time contracts work 37.5 hours. Radiographers employed prior to October 2004 have been increasing their weekly hours incrementally on an annual up to 37.5 hours per week, achieved by 2011. The 35 hour per week contract equate to 5 x 7 hour days, the 37.5 hour contract equates to 5 x 7.5 hour days.

Radiographers on part time contracts were mostly employed on contracts of multiples (or divisions) of 7 hours (e.g., 3.5, 14, 17.5, 21 etc). These were mostly worked in full days, unless local conditions supported more flexible contracts for either child care reasons, or where local service requirements required specified periods or utilising specific skills. Under AfC terms and conditions, part-time staff may retain the hours worked but have these hours recalculated as a percentage of the current full time contract hours. However, part -time staff may also choose to work additional time, thus maintain the original percentage of a full time contract. Thus, in most departments, there are a mixed set of staff availabilities due to staff working full time, staff working part-time but full days and staff working part-time but not full days.

7.2.8 Roster options

In similar timescale to this study, the principal study centre was undertaking an evaluation of the local service requirements. The research undertaken in this study, in particular the workload statistics and the forecasting, has enlightened the review allowing deductive reasoning and evaluation of local service requirements. The workpattern model developed above has supported a quantification of the required

staff resource and expertise in relation to general radiography. This, when meshed with an understanding of the skill mix issues also identified in this study and the lines of work determined by DCAQ analysis (Scottish Government, 2006-2) has facilitated the framework of the total staff resource required in this centre.

However, this application of the workpattern model requires a roster outline to be in place to facilitate implementation of the workpattern model in the principal study centre. The roster options below were deduced from the recurrent themes from the West of Scotland Review (West of Scotland Regional Planning Group, 2009) and assuming a future employment strategy of full time staff on 37.5 hours per week and part- time staff working a multiple of 7.5 hours. This will future proof roster options based on the 37.5 week. OOH staff allocation impacts on core hours of duty, thus the impact of radiographer allocation for OOH must be developed in relation to skills required during core hours. The staff resource during core hours will always be greater than staff resource during OOH in every centre, due to the nature of imaging required during OOH. The proposed OOH rotations below, would therefore be staffed by a small proportion of the total staff complement. The greater proportion of staff will cover the core hour duties. Undertaking local data analysis from each centre in combination with the workpattern model (Tables 10 and 11) would facilitate the required radiographer resource both for core hours and for OOH in all centres. The data analysis related to adaptive planning as discussed by Kulatunga et al,(2009) will also demonstrate the most appropriate starting and finishing times for duties in all centres to accommodate the workload fluctuations throughout 24 hours. This had been undertaken in the principal study centre as part of this research. This information informs on staffing resource. Thus option appraisal, on OOH arrangements that support core hours radiographic skills, must be undertaken to facilitate implementation of the workpattern model. A SWOT analysis of the options developed are described below.

Option 1: A weekly shift rotation of 3 x 12.5 hour night shifts

An option to support the 37.5 hour week, of 12 hour shifts suggested by the West of Scotland Review (West of Scotland Regional Planning Group ,2009) has been increased to 12.5 hour shifts (3 x 12.5 hour night duties). As mentioned above, an individual radiographer would be on this rotation infrequently depending on staffing levels. The remainder of the radiographers would be required during core hours. Sufficient radiographers would be required to cover the core hour duties as determined by the workpattern model. The staff resource of radiographers required to support functionality for this shift pattern, in each centre, must be calculated according to the workpattern model identified above.

Swot analysis.

STRENGTHS: There is anecdotal evidence that some staff consider that one “night” duty is difficult to reconcile with lifestyle and that a run of night duties would be easier to manage. This is dependent on personal agendas. The shift element would allow more integration with current wider healthcare delivery. This system may allow extra leisure time within the week as it is only 3 duties over 7 days. This option is just within the criteria of WTR (HMSO, 1998).

WEAKNESSES: A master rota may indicate a reduction in the number of occasions that night duty would be required than the current on-call rota. This must be tested, in relation to annual leave and potential sick leave requirements (Ernst et al, 2004). There would be a requirement to alter the daytime work schedule to integrate with the night duty roster. This option would require radiographers to cover between the end of core hours and the beginning of the night shift. This would be essential to ensure that there would be radiographic cover following core hours until the night duty period commences. This would have further implications on the skills for radiographic cover during core hours. This system would have repercussions for part time staff (and for centres) who do not work multiples of 12.5 hours. This will have an impact on availability of specialist skills. This system details longer night duties than recommended by the West of Scotland Review (West of Scotland Regional Planning Group, 2009). The working time regulations require a 20 min break after 6 hours. This is the only regulatory break that would be required during this shift period. However a 12.5 hour shift, though within the WTR, (HMSO, 1998) would be exhausting with only a 20 minute break.

OPPORTUNITIES: A three shift system may allow for more leisure time, as the duty period would be contained within a shorter working week. This system may predispose an extended working day.

THREATS: This system removed the current structure of perceived Monday to Friday core hours for the radiographers undertaking this rotation. There is anecdotal evidence that staff are keen to maintain this traditional structure, both for lifestyle reasons and for reasons related to the broader NHS structure relating to provision of service to support clinics. A three shift system would impact on skills mix dramatically. The staff would be removed from the skillsmix pool for a complete week. This would lead to a skills maintenance issue. There may be a financial penalty due to an on-call system being converted to a shift system. This would have to be quantified and pay protection discussed. In order to comply with WTR, (HMSO, 1998) of an unpaid break after 6 hours, the period of duty would extend to just under 13 hours. This would make this shift system only just compliant, under the working time regulations, with an 11 hour break between duties. Should staff wish to take more reasonable timed breaks, this might result in this

system being non- compliant with insufficient rest break between duties. Complete weekends may be involved in working this shift system. Additional radiographers would require to be employed to implement this system. There is still the requirement to include weekends in the shift system. This is a culture change for radiographers.

Option 2: A weekly three shift rotation of 12.5 hour duties- mixed day and night option

This option is very similar to Option 1 above and the SWOT analysis is entirely similar. Again this option is based on the 12 hour duty roster option suggested by West of Scotland Review ((West of Scotland Regional Planning Group, 2009)) increased to 12.5 hours due to AfC. However, instead of three night duties as option 1, this option suggests a mixture of day and night shifts rather than e.g. one day duty followed by two night duties or two day duties followed by a night duty. There is anecdotal evidence that some staff like only one "night" duty as, dependent on individual agenda, this is easier to reconcile with lifestyle. This is dependent on personal agendas and also dependent on the requirements of individual centres. This option would support radiographic cover between the end of core hours and the beginning of the night shift.

Option 3: duty roster built on a modular system

This is a flexible roster option that can accommodate flexible working as, dependent on the needs of the particular centre, individual radiographer rosters can be constructed using modules while still being reconciled within a master roster. Table 12 describes the construction of the working week by modules.

Weekly contract	Module duration	Total duty time	Modules Per week
Full time (37.5hrs) + breaks	4 hours (3hrs 45mins + 15 min break)	40 hours	10 modules
30 hrs + breaks	"	32 hours	8 modules
22.5 hrs + breaks	"	24hours	6 modules
15 hrs +breaks	"	16hours	4 modules
7.5 hrs + break	"	8 hours	2 modules

Table 12: Modules per contracted hours

Option 3a: 8 hour shifts

The day can be conveniently divided into 3 x 8 hour segments. This reconciles with radiographers working a 7.5 hour day, plus a ½ hour meal break, that equates to 2 modules (Table 12 above). A forward or backward rotation of 8 hour shifts (SoR, 2008) undertaken by an element of the radiographic staff (number dependent on local data analysis and adaptive planning related to the workpattern model developed above) would meet the needs of the service. E.g. 8am-4pm, 4pm- 12midnight, 12midnight-8am. The remainder of the radiographers would cover core hours with staggered starts and finishes where necessary to ensure service coverage over the horizon of the day (Kulatunga et al, 2009).

Swot analysis 3a

STRENGTHS**:** This rotation may be easier to administer as it involves the usual number of hours in a standard working day. It may be more appropriate for part-time staff due to the length of the shifts. As shown in Table 12 above, radiographers who work part-time can work an appropriate number of modules to complete their working hours. Contracted set days of work may be more easily accommodated, assisting with childcare plans. The length of the night duties is that recommended by the Society of Radiographers (SoR, 2008). It might be possible locally to undertake a rostering arrangement where a mutually acceptable number of night duties per week, would be factored into the working week. This system involves the shortest shift which is an advantage for radiographers who feel physically compromised by the length of duties.

WEAKNESSES**:** The radiographic staff undertaking this rotation would be removed from standard core hours and would be a greater number than the other options, as there needs to be cover for a link shift to cover between the core hours and also the night shift. This could have even more of an impact, as the radiographers working the previous link and night shifts are lost from the core hour staff resource in addition to the radiographers working the link and night shifts on the current day. The fewer night duties worked together in the roster, the more interfaces between staff completing runs of link shifts or night shifts and new cohorts of staff about to undertake link shifts or night shifts. At these interfaces, as mentioned above, the staff resource for core hours is depleted by both cohorts of radiographers. Skills mix during core hours would be substantially affected by this rota as a greater participation by individual radiographers would be required for this roster. The number of radiographers required to undertake OOH duties would have a profound effect on the radiographic service cover for core hours. Where there is a greater number of part-time staff, the administration of this roster would be very complex, but possible.

There would be a requirement for radiographers undertaking the night duty to commence duty very late in the evening or very early in the morning. This may be difficult in relation to transport to the hospital.

OPPORTUNITIES**:** This system may allow for more free daytime hours. This may suit personal agendas. The length of duty would be the shortest duty of any of the options. There is the opportunity to factor link shift and night shift into the working week reducing the loss for skills mix. The shorter shifts should ensure that radiographers, who have opted out of the current OOH duty system due to the length of the duties, are able to participate in this system.

THREATS**:** There may be a financial penalty due to a shift system replacing an on-call system. This would have to be quantified and pay protection discussed. The number of staff removed from the core daytime duties would denude staffing and experience. Additional radiographers will require to be employed to support implementation of this system dependent on the staffing complement in place in the individual centre. Due to the nature and shorter duties in this system, the number of additional radiographers required is higher than any of the other options. There is still the requirement to include weekends in the shift system. This is a culture change for radiographers.

As mentioned above, an individual radiographer would be on this rotation more frequently than in Options 1 and 2, due to the additional link shifts depending on staffing levels. The remainder of the radiographers would be required during core hours. Sufficient radiographers would be required to cover the core hour duties as determined by the workpattern model. The staff complement of radiographers required to support functionality for this shift pattern in each centre must be calculated according to the workpattern model identified above.

Option 3b: mixed modules

Weekly contract	**2 module duties**	**3 module duties**	**Total Modules per week as per contract**
Full time (37.5 hours)	2	2	10 modules
4 days (30 hrs)	1	2	8 modules
3 days (22.5 hours)	0	2	6 modules

Table 13: Mixed module assignment- option 3b

This rota is created from the 4 hour module option in a compressed working week. The week is composed of some 3 module duties and 2 module duties to add up to the total number of contracted modules as Table 13 above. There is the flexibility for the 3 module duties to be worked as day shifts or night shifts, dependent on needs of the individual centres and the personal agendas of the radiographers. Night duties and day duties could match each other to cover the time gap between the end of core hours and the start of the night shift therefore there would be no need for link shifts. The remainder of the compressed working week is worked as 2 module days. The length of the night duty is, however, longer than that recommended by the Society of Radiographers (SoR, 2008).

Swot analysis 3b

STRENGTHS: There is anecdotal evidence that some staff consider that one "night" duty is easier to reconcile with lifestyle but this is dependent on personal agendas. The shift element would allow more integration with current healthcare delivery. The 3 module night duties in the week would be matched by 3 module day duties that would ensure continuity of service cover through the early evening. This system would have fewer repercussions for part time staff (and for the centre) as most radiographers work multiples of the module time. This would be a reasonable rota to administer. Staff who work fewer than 6 modules for personal reasons may be amenable to aggregate duties. This system would support the broader NHS structure relating to provision of service to support clinics. The impact on skills mix of option 3b would be less than options 1, 2 and 3a.

WEAKNESSES: A rota may indicate a reduction in the number of occasions that duty would be required; this must be tested in relation to annual leave and potential sick leave requirements. There would be few opportunities to swap duties as is the current custom. The part time staff may have to alter the contracted days worked. The part time staff currently working set days, might find difficulty in rearranging child care for rostered days. There are 3 module day duties in this system. These may be more tiring than the current 8 hour (2 module) duties. Weekends, under this option, are covered by shifts as part of the rota rather than the current arrangement of core Monday to Friday duties with occasional weekends as extra duties.

OPPORTUNITIES: This system may allow for more leisure time due to compressed weeks. There is the probability that the combination of duties, being contained within a week, would allow for easier management of duties within the social timetable.

THREATS: There may be a financial penalty due to an on-call system being converted to a shift system. This would have to be quantified with discussions related to pay protection. The lack of opportunity to swap duties would be an issue in managing personal agendas. The loss of the Monday to Friday core week is a

threat to the structure of life for some radiographers. Additional radiographers may require to be recruited to implement this system dependent on the staff complement in the individual centre. There is still the requirement to include weekends in the shift system. This is a culture change for radiographers.

Option 3c: mixed modules

This option was created from the 4 hour module system in an aggregated monthly rota. The night duty is a 12 hour (3 module) duty with an 8 hour (2 module) day duty and an 8 hour (2 module) link shift. The hours of duty are aggregated over a monthly period rather than a weekly total.

Swot analysis 3c

STRENGTHS: This is a half-way house in relation to implementation of the workpattern model as the night duties are integrated into the shift system but the weekend day duties remain as overtime. Thus, staff who have concerns over the financial deficit of moving from on-call to shifts have potential to achieve a financial uplift. There is anecdotal evidence that some staff consider that one "night" duty is easier to reconcile with lifestyle but this is dependent on personal agendas. The shift element would allow more integration with current healthcare delivery. The 3 module night duties in the week would be matched by 2 module day duties and 2 module link shifts, that would ensure continuity of service cover through the early evening. This system would have fewer repercussions for part-time staff (and for the centre), as most radiographers work multiples of the module time. Staff who work fewer than 6 modules for personal reasons may be amenable to aggregate duties. This system would support the broader NHS structure relating to provision of service to support clinics. The impact on skills mix would be less than options 1, 2, 3a and similar to 3b. Part-time staff would not be required to alter the contracted days worked. These may be less tiring than the current overnight duty, as the duty is shorter. This is less of a culture change for radiographers.

WEAKNESSES: This rota may indicate a reduction in the number of occasions that an individual would require to undertake OOH duty; this must be tested in relation to annual leave and potential sick leave requirements. There would be few opportunities to swap duties as is the current custom. Weekend night duties under this option are covered by shifts as part of the rota. Weekend daytime duties are still covered by overtime and thus are subject to risks related to service sustainability. This would a complex rota to administer.

OPPORTUNITIES: This option retains the current structure of Monday to Friday duties. There is still an opportunity for staff who wish overtime to work additional day duties at weekends, for additional

remuneration. There is also an option for these weekend duties to be covered by “bank staff”. This has the benefit of allowing this flexible staff resource, the opportunity to both support service when required and to support flexible working for radiographers’ personal agendas.

THREATS: There may be a financial penalty due to an on-call system being converted to a shift system. This would have to be quantified with discussions related to pay protection. The lack of opportunity to swap duties would be an issue in managing personal agendas. Additional radiographers may require to be recruited to implement this system dependent on the staff complement in the individual centre. With the weekend day duties still covered by an overtime arrangement there is still a risk that an essential service is covered by a voluntary arrangement as overtime is not contractually compulsory.

7.2.9 Local evaluation

The deduction of the options above was informed by the research undertaken in this study, however conversely, the local evaluation informs the study by supporting an understanding of the process whereby options are appraised, selected and implemented. This is in keeping with the Reliabilst perspective, in understanding the cognitive processes behind the evidence. The development of the rosters from the recurrent themes identified in the West of Scotland review (West of Scotland Regional Planning Group, 2009) also identifies options which will not be appropriate for the individual centres. Thus, the rosters can be “tested to destruction” in local conditions (Hedges, 1997). Research can help with understanding strengths and weaknesses of a particular option and to understand the background against which the option would function (Meyer and Markowitz, 1997) e.g. a centre with a large proportion of part-time staff may find difficulty in rostering the 12.5 hour shift rotations. This is the situation in the principal study centre, where the staff complement is heavily populated with part-time staff employed on a historical basis of multiples of “days”. Both the roster options of 12.5 hour duties were “destroyed” at an early stage in the local appraisal process.

Various applications of the 8 hour duty version of the modular system were also “tested to destruction” at an early phase. Link shifts and night shifts should be matched to ease administration. This is difficult with staff who work differing numbers of hours. Most importantly, at each interface of staff change, 4 radiographers are lost from core hours (the two radiographers who have been on link shift and night shift the previous day and the two radiographers who will be going onto link shift and night shift on the current day). This option was not therefore totally destroyed but was less popular initially. In addition there was concern regarding the number of additional radiographers that would be necessary to sustain this option.

The option of variations of the modular system remained viable. Three variations of the modular system were developed for steering group appraisal including an application of the 8 hour duties.

Validating the roster for individual radiographers, to ensure equity of access to the rostered duties, was undertaken at this point. This required mapping each radiographer against duties over a time period appropriate to the roster, to ensure that over the roster horizon the distribution of duties is equal (SoR, 2008). The OOH roster was then cross-referenced against the model for detailed staffing requirements, ensuring that there are sufficient radiographers, of the appropriate skill mix, to ensure service continuity across the days and weeks of the sample roster. It was essential that the OOH rota is not considered in isolation. These steps were undertaken locally, in the principal study centre, as the major steps in the scoping exercise or review of the OOH system and prior to the local option appraisal process.

7.2.10 Option appraisal

Roster generation also demonstrates the roster horizon on an individual basis. It is important when testing proposed systems of work, that staff are able to appreciate the new system on a personal basis (SoR, 2008). The financial impact on individuals is also a critical issue. Provision of an individual roster facilitates the process of developing an individual financial statement.

Prior to any alterations in work practices in the NHS, a process of option appraisal must be undertaken prior to the final decision being made. This was undertaken in the principal study centre as part of a national review into OOH. A local radiology OOH steering group was set up to embark on this process. This group has representation from the human resources, financial directorate, employee director, relevant strategic and operational managers and staff side representatives including the principal investigator. This mix is essential to the appraisal process to obtain information from all relevant stakeholders. The principal investigator brought the research related to workload statistics and workpattern modelling. The five possible options identified, were first discussed with the staff or staff representatives. Engaging with staff consolidates the appraisal process as the suggested options may identify specific and personal issues and agendas that add to or decrease the perceived value of the options; this in accordance with the scientific perspective of reducing misconception and avoiding preconceptions. This engagement involves appreciating others agendas and their world view and may affect development of further options that evolve in relation to the consultation (Emerald Group Publishing, 1997). Prior to taking a final decision it is appropriate that these options are scored on a cost/benefit analysis as the NHS is a public service and is thus accountable for providing cost effective services. As mentioned above, the analytical nature of this study produces data in a quantifiable format and thus, supports a cost analysis for presentation to the

health board. This is a technique for deciding quantitatively which course of action is most cost effective while considering the impact on the service across 24 hours (Mind tools, 1995-2010). This technique again informs the study as a critical step in implementation of the workpattern model.

Service needs and resource utilisation also needs to be assessed using sub categories relating to sustainable 24 hour cover and effective use of scarce resources. The proposed rosters must be easy to administer and must also support productivity and targets requiring skills mix and advanced practice, as these skills underpin current service (Scottish Government, 2006-2). The options must meet all legislative requirements such as Health and Safety at Work Act (1974), WTR, (HMSO, 1998) and national guidance such as AfC.

All of the above options were assessed by the OOH steering group against the service based criteria. These are weighted in relation to the importance placed on the criteria. The steering group was joined by additional radiographer representatives to score the five options. The most important criteria are related to patient safety. A comparison of the options is essential to determine whether the patients are put at increased risk by any of the proposals. This relates, to whether patients are exposed to the probability of staff being more tired during periods of duty, or whether lone working puts patients at more risk than at present. The safety and sustainability of the service is also considered, and weighted; this aspect considers service elements such as sustainability of service during staff shortages from annual leave, sickness or recruitment problems. The main objective of this aspect of the assessment is to ensure that a safe service, that achieves the standards identified in national and local strategies, is acknowledged. Finally, proposals must be assessed for acceptability by staff. Assessment, in relation to remuneration, is arguably the most important factor. The effects of work-life balance of any proposal must also be considered.

Each option is scored against all of the above criteria. This score generates a total score per option. These scores are then ranked with the highest scoring option being the preferred option. Each option is then costed. The score for each option is divided by the cost, giving the cost benefit score per option. This score is again ranked. This highest ranking option should theoretically give the most effective and efficient option (Mind Tools, 2010).

The steering group decision was that Option 3c (the modular system created from 3 module night duties mixed with 2 module day duties and link shifts) was the preferred option for the principal study centre (Table 14) . This option, is considered to be the most cost effective of all of the options, requiring fewest additional radiographers to implement. This is partly due to the weekend day duties still remaining as overtime and

not being staffed from within the shift pattern; this retains the risk of service sustainability but is perceived as a half way measure in the culture change to shift patterns. This option is considered to increase patient safety by reducing staff fatigue. The composition of the roster echoes the current roster in many respects, thus reducing the change of culture shock.

	Patient Safety	**Service sustainability**	**Financially detrimental**	**Effect on Skill mix**	**Effect on worklife balance**	**Total score**
Option 1 (3x 12.5 hr night duties)	1	5	1	2	1	**10**
Option 2 (3x 12.5 hr mixed duties)	1	5	1	2	1	**10**
Option 3a (8 hr modules)	5	5	1	1	2	**14**
Option 3b (Mixed modules- b)	2	5	1	3	2	**13**
Option 3c (Mixed modules c)	4	5	1	4	4	**18**

Table 14: Option appraisal scores

The local evaluation process and option appraisal informs the current research by identifying the processes required to effect implementation of an organisational change (Evans, 1995). This enlightened the process of change management from the organisational perspective.

7.3 Section 3 - Radiographers' attitudes to the workpattern model

The final step in the scoping exercise was to seek radiographer attitudes to the model, that underpins the options (Baldwin et al, 1997). This strategy would be appropriate for any centre. In addition, it is important when considering recruitment and retention of radiographers, that radiographer's attitudes to the model and to the effect on skill mix of the modular application of the model should be tested to ensure generalisability in the wider radiographic population. The workpattern model is an important

strategy in determining appropriate staffing and skill mix, in relation to the distribution of skills, and demand across the workload horizon. The workpattern model will be used as a tool, in determining staffing levels and skills mix and so it is important to sample staff attitudes in centres of differing characteristics, to ensure that the model functions effectively in a generalisable fashion. This model, if generalisable, will underpin discussion on OOH working and the impact on skills mix and role development across the wider radiographic population. The model, if generalisable, will inform local and national policymakers in relation to guidance on OOH duties.

7.3.1 Aim

The specific aim of this section of the study was to research radiographer attitudes from different centres with different demographics to the workpattern model and modular application.

7.3.2 Objectives

The objectives were

- To explore radiographer attitudes across the profession to the workpattern model and modular application.
- To investigate how this would impact on options of OOH workpatterns.
- To determine the impact of the workpattern model on role development and skills mix.
- To assess the alignment with lifestyle balance.

7.3.3 Inclusion criteria

Radiographers who undertake general radiography, at the three case study sites, were invited to participate in the study. This may involve some radiographers who do not undertake general radiography OOH. However, as OOH (unscheduled care) must be aligned with core hours (planned care) it was important to elicit attitudes of radiographers, who have to sustain the service during core hours, when the workforce is reduced by the number of radiographers required to cover OOH.

7.3.4 Exclusion criteria

Radiographers who do not undertake general radiography were excluded from the study. It was considered that the attitudes of radiographers who work within general radiography would be more valuable, valid and reliable than those of radiographers whose agenda is either an observational capacity

(those who do not undertake general radiography but who observe the issues from a specialist modality) or service sustainability capacity (those who have managerial responsibility to sustain the radiographic service in general radiography).

7.3.5 Questionnaire design

Questionnaires were standardised to ensure reliability, generalisability, and validity. Every respondent is presented with the same questions and in the same order as other respondents (Smith, 2005). It is important to be clear about the aim of the questionnaire and how the responses will facilitate these aims to obtain useful responses in a cost-effective way. Each question must relate directly to the survey questionnaire objectives and be phrased such that all respondents interpret it in the same way (Smith, 2005). Mudvalley Marketing Company, (2009) recommended the "ladder" approach to designing questions. This involved studying why the question was being asked and why there was a need to know that particular fact. This agreed with Smith, (2005). Broad and general questions, such as the characteristics of the study centre and the nature of the respondents' role in the study centre, were situated at the beginning of the questionnaire as recommended by Mudvalley, (2009). The specific data questions were sited in the body of the questionnaire, to allow data collection related to the survey objectives, even if the later demographics were incomplete (Mudvalley, 2009). These questions included testing agreement with the descriptors of the model, when applied in the individual study centre. This section was followed by more general questions such as demographics. Respondents were not asked to provide information of a confidential nature and the questionnaire was anonymous. Privacy is an important issue to most people and questions regarding income, finances, family life, can be intrusive and may be rejected by the respondent. However, it was important for this study to establish whether there was any correlation between responses and domestic circumstances and age. Thus, questions regarding these attributes and stage of career, were included in the questionnaire. Respondents can refuse to respond to any questions that they do not wish to answer simply by non-completion. North Bristol Trust (2009) help sheet on questionnaire design, supported the design above. General advice on questionnaire design indicates that respondents may answer superficially if the questionnaire takes a long time to complete (Barnes, 2001). Thus, the mistake of asking too many questions was avoided. Two options were not covered in one question; short succinct statements were expressed which were focussed and as short as the subject matter allowed. The questionnaires were single sided ; these strategies increase the likelihood of receiving a completed response as recommended by Barnes, (2001) and Puffer et al, (2004). North Bristol Trust, (2009) advised that it is important to consider the outline of the questionnaire, to

ensure that questions are not split over a page. The design of the study questionnaire adhered to the strategies above.

7.3.6 Questionnaire validity

Where there is an existing validated and published instrument, this should be used, as it may then be possible to compare the current study results, with previous studies. However, where there is no appropriate valid instrument, where possible, questions may be taken from validated instruments and entered into the current study. This ensures that questions and/or sections are already validated (Boynton and Greenhalgh, 2004).

7.3.7 Data response reliability

The responses from questionnaires are gathered in a standardised way, so the questionnaires were more objective than interviews. Potentially, information can be collected from a large sample of a population. If returns from questionnaires are low, this potential is not realised. It is, therefore, important to reduce the non response rate to postal questionnaire. Response rates are quoted as low as 30-35% (Barnes, 2001) to 40-48% (Iglesias and Torgerson, 2000). Inglesias and Torgerson, (2000) identified that an improvement in response rate could be achieved by the use of shorter questionnaires and by a user friendly format. The questionnaire in the current study, is as short as the subject matter allows, in accordance with the strategies identified above.

As the questionnaires are standardised, it is not possible to explain any points in the questions that participants might misinterpret. This can be partially solved, by piloting the questions on a small group of volunteer respondents; the pilot study phase can identify options that have not been offered (Thomas and Slater, 2009). The questions must then be revised, to ensure that the majority of responses are covered. In order to address misunderstandings, or issues from loaded or ambiguous questions, in this study, in accordance with the scientific perspective, the questionnaire was piloted in the principal study centre. Questions that caused confusion and required further information, or explanation, to the respondent, were revised prior to issuing the final version. Brainstorming of possible answers was also undertaken as part of the pilot study; questions considered ambiguous were modified and retested.

The reliability of the likert scale (Mogey, 1999) tends to increase with the number of points on the scale. However, as the number increases, so does the time taken to complete the question. This may demotivate respondents and so between 5 and 7 points on a scale is optimal. The response options can be coded with a numerical response from 1-5. However, there is evidence that more reliable and valid data is yielded, if

all the points on the scale are labelled with data descriptors rather than the numerical code. When analysing the responses from likert scales, the data can be treated as quantitative data, as the data descriptors are coded and thus easy to analyse statistically (Mogey, 1999).

7.3.8 Sample and population

For the purposes of this research, it was decided to conduct the survey on the population of radiographers from the rural principal study centre, a general hospital in an urban location and a teaching centre who undertake general radiography. This is to ensure a relevant representative population of radiographers and would identify the attitudes of radiographers, from a wide range of differing working environments to the model and to the application of the model both in core hours and OOH. It also identifies the attitudes of the population, to the effect of the model on role development. The characteristics of hospitals in Scotland would all fit into at least one of the categories of centres above, thus ensuring a representative sample from the population of radiographers, who undertake general radiography.

7.3.9 Survey structure

Self administered questionnaire method was selected as the most appropriate method to obtain information from the widest population of respondents. This eliminated the possibility of interviewer bias and sought to reach the widest population in distant locations. Literacy of the respondents, was not considered to be a limitation to this survey, as the population was qualified radiographers. The context of the questions was explained in the participant information letter (Appendix 2). The questions were developed on a likert scale for quantitative analysis. In order to obtain unbiased responses, the options were placed on a continuum from very positive, to very negative, with a neutral option. The questions were structured and standardised and were intended to reduce bias. e.g., questions were ordered in such a way that a question does not influence the response to subsequent questions. Agreement bias was avoided by framing both negative and positive questions. This requires respondents to evaluate all questions, rather than uniformly agreeing or disagreeing to all responses. A negative response is as relevant as a more positive opinion and very valuable in this study. Social desirability bias (wishing to be seen in a good or compliant rather than controversial perspective) was unlikely, as the topic is current and emotive. Radiographers across Scotland are presently in detailed discussion regarding workforce planning and OOH arrangements, thus genuine, even if negative, attitudes are more likely to be recorded.

In Section 1 of the questionnaire, the questions were geared to identifying the characteristics of respondents' workplace, the duties related to general radiography and whether the respondent has an

identified specialist interest or role development. These questions aid later exploration of respondents' attitude to the model, in relation to these characteristics.

Section 2 of the questionnaire explores respondents' attitudes to the workpattern model, as identified in the participant information sheet (Appendix 2). This model details the workforce profile in relation to workload and also explores the modular application in the implementation of the workforce profile and the relevance to role development.

Section 3 of the questionnaire, seeks the personal attributes of the respondents. This information may allow exploration of the relationship between attributes and attitudes. There was no validated questionnaire available on the subject matter, so certain questions were identified from validated questionnaires and used in the attribute sections (NHS, 2009-1).

Section 4 of the questionnaire, seeks any further input into this study that respondents may wish to offer, or any statement that they may wish to make. The comments are reproduced verbatim at the end of Appendix 2.

7.3.10 Invitation to participate

Respondents are more likely to co-operate if the researcher is clear about the purpose of the survey and the possible advantages of participation. The invitation section of the survey identified the study, the selection of the respondents (the radiographer respondents in the selected study centres who all undertook general radiography duties), the duration of the involvement in the study (one episode of approximately 15 minutes) and the potential benefits. Identifying a benefit to the respondent is known to encourage participants to respond to the study (Barnes, 2001). In this study it was not possible to identify a tangible benefit, such as a gift but intangible benefits, such as an opportunity to voice an opinion, both at local and national level, is valuable. The invitation explained that the responses would be useful to local and national policy makers and that anonymised versions of the results would be made available to the participating study centres. These factors fit well with the requirements for the participant information sheet that is required under the Integrated Research Application System (IRAS).

7.3.11 Data security

The confidentiality aspect of the responses (eSurveyPro, 2009) was respected by the responses being anonymous and only identifiable by the characteristics of the study centre. The data was held on a password protected computer in the principal investigators study centre, and no paper copy contained

any code or other identifiable data. Respondents were advised that they did not have to respond to any questions if they did not wish to give the information.

7.3.12 Permissions

Ethical permission was sought via an IRAS application and agreed by letter, with a requirement to approach the governance committees in each centre. Permission from the ethics committee at the academic centre supporting the study was also sought and agreed. An explanation of the study and a courtesy request for permission, was sought from the manager of each department that was included in the survey. There was agreement from all centres and distribution of the questionnaire was supported by management. Research and development permission for each centre was also sought, with additional application to governance committees in each centre. Permission was granted at all levels.

7.3.13 Analysis of the questionnaire

The total number of questionnaires administered was 129. A total of 61 questionnaires were returned. This is a total response rate of 47.2% or just under half of the population. This response rate sits close to the upper level of the range (40%-48%) stated by Iglesias and Torgerson, (2000) and is therefore considered to be a very reasonable response rate for a postal questionnaire.

Section 1: characteristics of the study centre

The initial section of the questionnaire was related to the centre in which the participant currently works.

Question 1, asked whether the participant worked in a rural district general hospital, an urban general hospital or a teaching centre. The distribution of the respondents is displayed with the percentage response rates shown below.

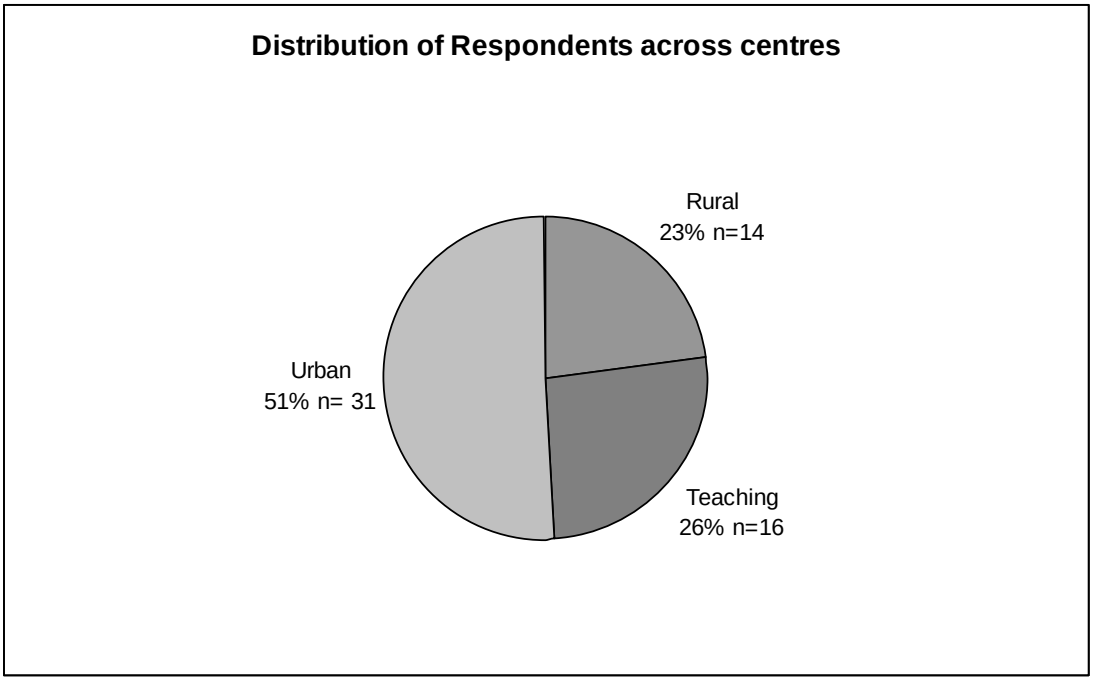


Figure 48: Distribution of respondents

51% of the total responses returned originated from the urban DGH, the percentage returned from the teaching centre (26%), was just over a quarter of the total responses returned, with the remaining 23% of the responses derived from responses from the rural centre (Figure 48).

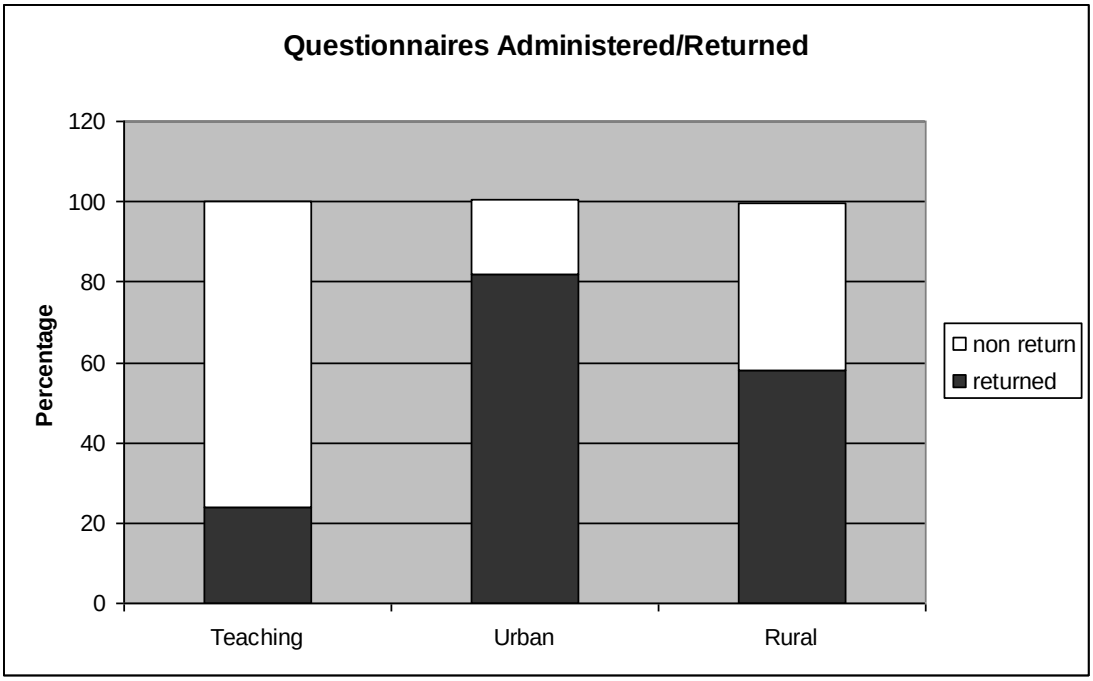


Figure 49: Questionnaires administered/returned

In contrast, the percentage of responses returned from each study centre, suggests a different distribution (figure 49). A response rate of 81.5% from the urban centre (a high percentage) was, therefore, very representative of the attitudes of the radiographers in this centre. The response rate of 58.3% from the rural DGH (just over half the radiographer population in the rural centre) may represent the majority of radiographer attitudes in this centre. The response rate of 23.6% from the teaching centre (less than a quarter of the population), may not represent the majority of radiographer attitudes in this centre. The response rate from the teaching centre is below the lower margin of the identified range of response rates of 30-35% quoted by Barnes (2001).

Question 2 enquired whether the respondent undertook general radiography within core hours. The target population was radiographers who undertake general radiography, whether within core hours or OOH. As the balance of staffing between the core hours and OOH is crucial to the overall service, it was important to identify the proportion of the population and therefore the attitudes of the categories of the population of radiographers, who undertake duties both in core hours and OOH. Of the respondents who answered this question (1 respondent did not answer) 100% of radiographers undertook general radiography within core hours. Due to the method of questionnaire distribution, this non-respondent was not excluded on this basis. The questionnaires were only distributed to radiographers who performed general radiography. The data missed by this non response, is only whether the non-respondent undertook general radiography within core hours and/or OOH. As the model ascertains staffing resource required over the 24 hour period, it is essential that the respondents have current experience of general radiography, during core hours, to have an understanding of the staff resource deployment.

Question 3 enquired whether the respondent undertook general radiography OOH.

80% of the respondents undertake general radiography OOH (figure 50). Of the respondents who undertake OOH, 36% are aged between 20-30 years, 29% are aged between 31-40 years, 25% are aged between 41-50years, 10% are aged over 50 years (figure 51). It is difficult to know if this is representative of the age profile of radiographers, as there are no current published statistics across Scotland.

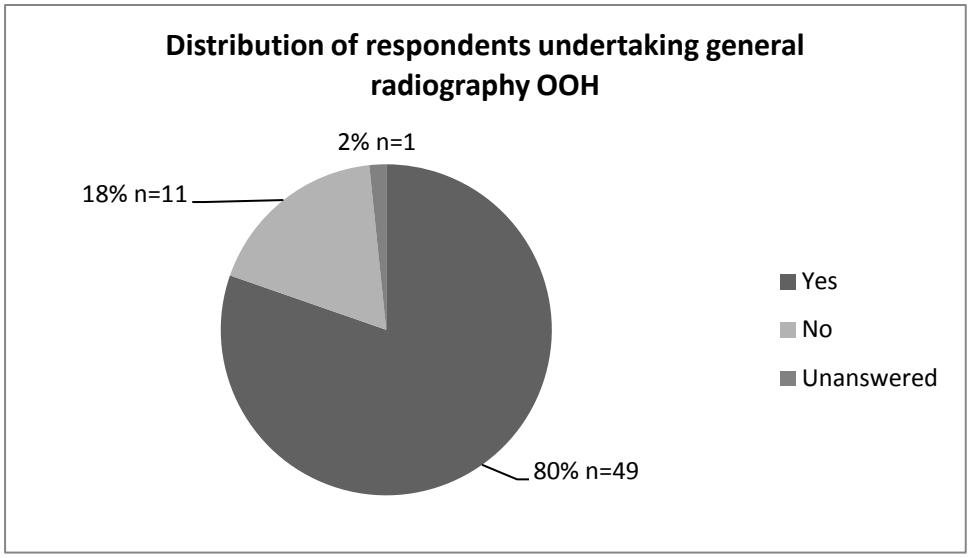


Figure 50: Distribution of respondents undertaking general radiography OOH

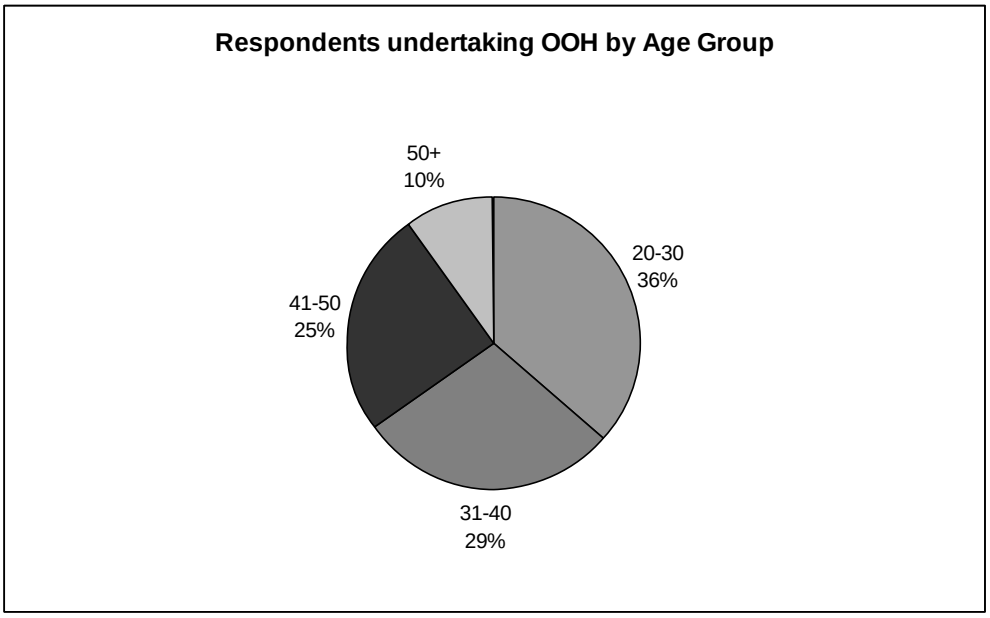


Figure 51: Respondents undertaking OOH by age group:

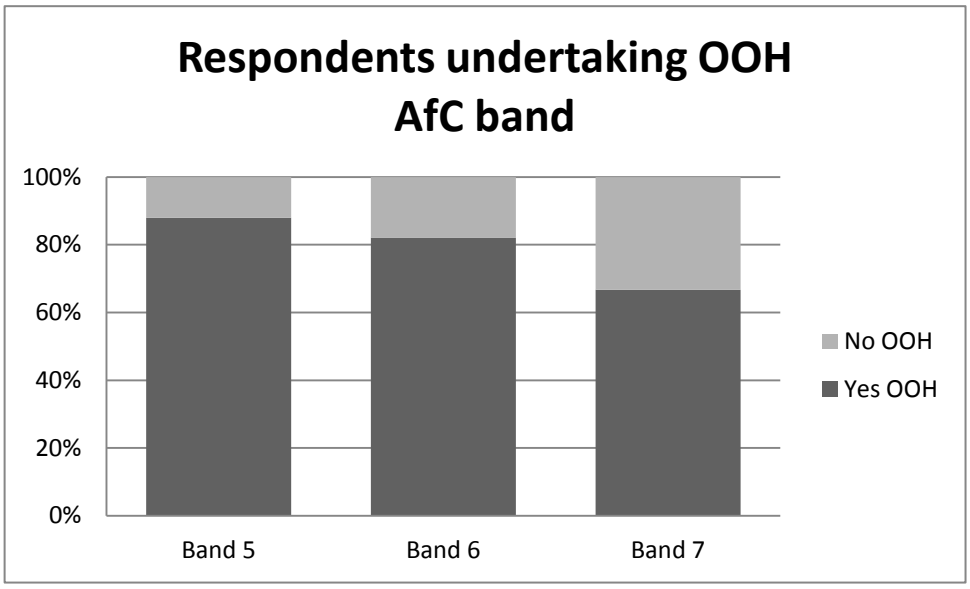


Figure 52: Respondents undertaking OOH by AfC band

88%, 82% and 66% of AfC band 5, 5 and 7 respondents, respectively, undertook general radiography in OOH. (figure 52).

Of the respondents who answered in the negative, there was a single respondent from the teaching centre who was an AfC band 5 radiographer. The remaining respondents who answered in the negative were from the urban centre and were from the population of AfC bands 5, 6 and 7. There appears to be little indication that AfC band differentiates whether radiographers undertake general radiography OOH.

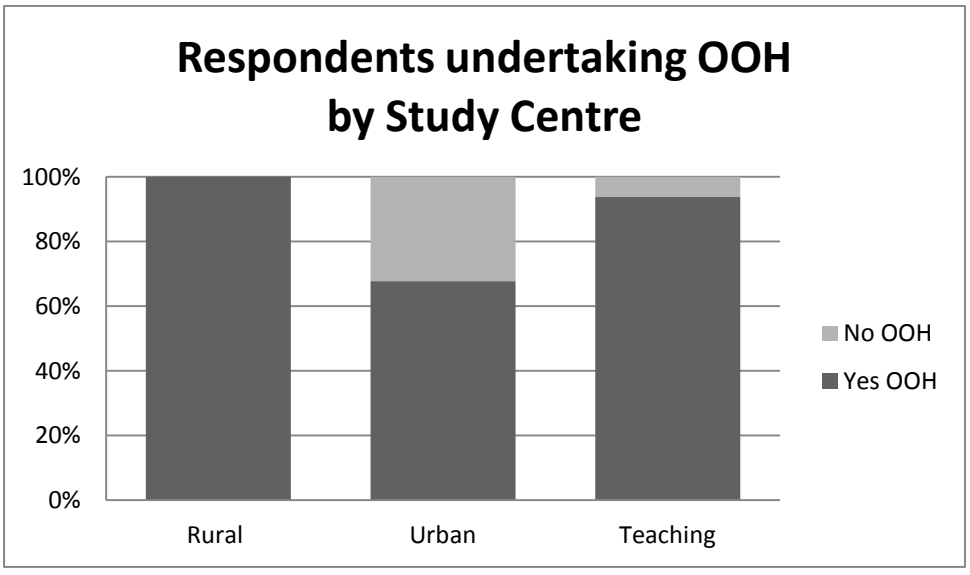


Figure 53: Respondents undertaking OOH by study centre

Figure 53 demonstrates that 100% of respondents in the rural DGH, (7% of respondents did not answer this question), 94% from the teaching centre and 68% from the urban centre undertake general radiography OOH.

A substantial majority of respondents, from all study centres, have experience of general radiography OOH. This is important, as respondents should have either personal or management experience of workload OOH, to appreciate the staffing deployment, indicated in the model in the OOH situation.

Question 4 enquired whether the participants' PDP identified a role development or a specialist radiographic interest or skill

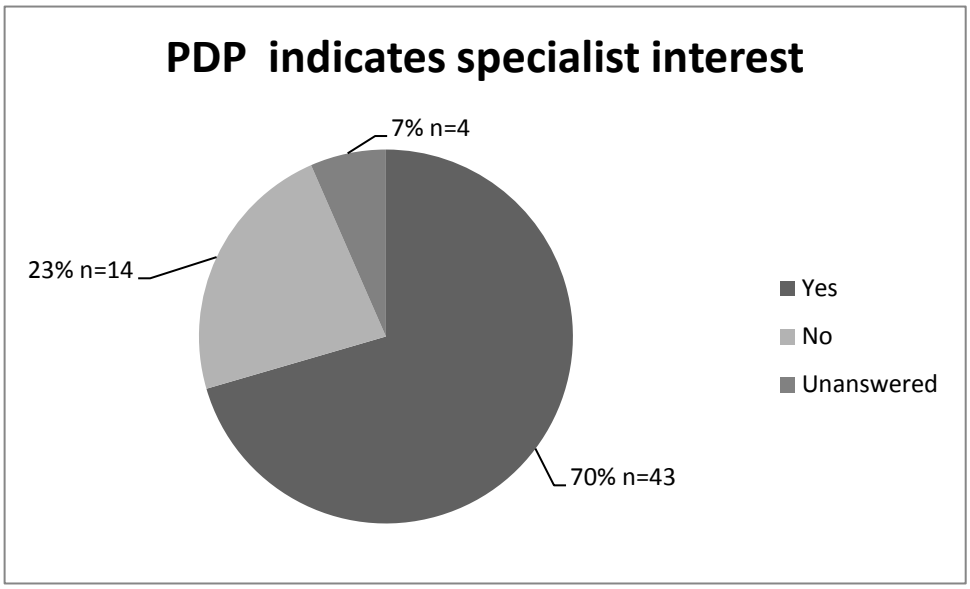


Figure 54: PDP indicates specialist interest

70% of respondents indicated, that they undertook a specialist interest or role development. 23% did not and 7% did not respond to this question (figure 54).

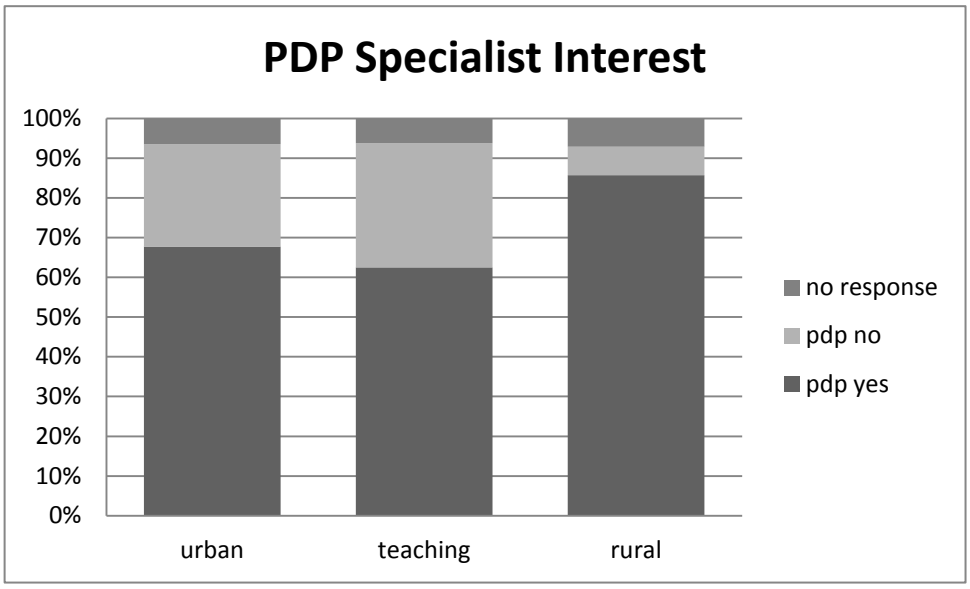


Figure 55: PDP Specialist Interest by study centre

86% of radiographers, within the rural study centre (primary study centre,) indicated that their PDP did identify a role development or a specialist interest or skill. 7% of radiographers did not respond to the question and 7% of radiographers, within the rural centre, indicated no specialist interest (figure 55).

The percentage of non responses was similar in the other two case study centres but the percentages indicating “no specialist interest” rose to 31% and 26% for the teaching and urban centres respectively.

A further factor to explore is, if the probability of a radiographer with a specialist interest undertaking general radiography, is more likely to occur in a specific centre or not. A substantial majority of the respondents, from all centres, have a developed role or a specialist interest. However, it is noticeable that the rural study centre identifies a higher percentage of respondents undertaking a specialist interest or role development. This may be due to the smaller staff resource and, therefore, the requirement for more staff to diversify, to meet workplace and patient focussed requirements.

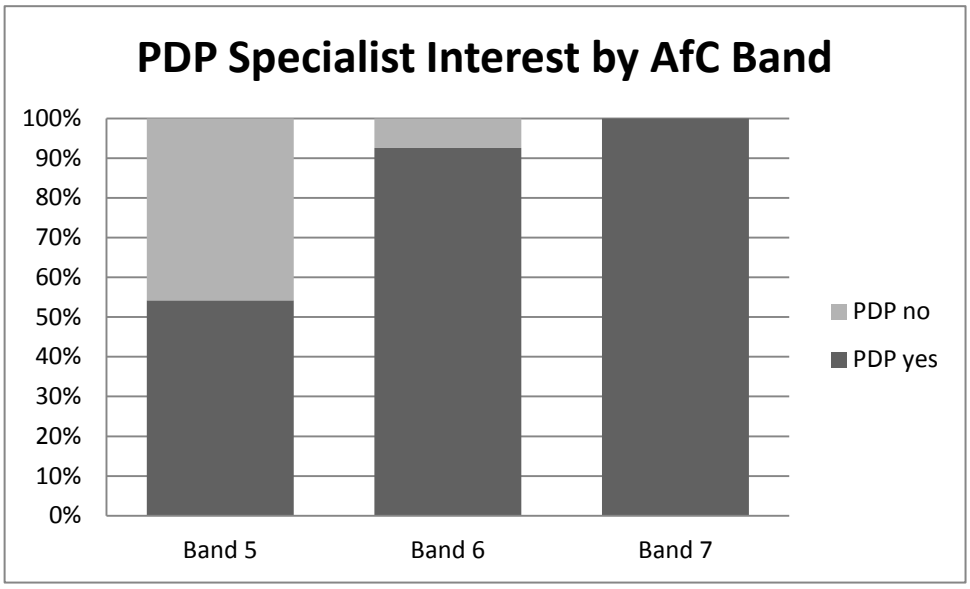


Figure 56: PDP Specialist interest by AfC Band

Identification of a specialist radiographic interest, or role development, within the personal development plan (PDP), is an important factor in exploring radiographer attitudes to the model. Specialist interest or role development is often undertaken, only within core hours, and is associated mainly with planned care. Thus, radiographers whose PDP involves activity within planned care, are often required to be available to deliver this activity within core hours. This can have an effect on radiographers' availability to undertake general radiography OOH. Considering specialist interest by AfC Bands, it is unsurprising that all AfC Band 7, most (91%) AfC Band 6 and a little over 50% of AfC Band 5 radiographers have a specialist interest (figure 56). This specialist interest may assist Band 5 staff, to present themselves as appropriate candidates for promoted posts.

The descriptive statistics indicate no apparent relationship of age, AfC band or specialist interest that suggest incompatibility with undertaking general radiography OOH.

Section 2 – Radiographer attitudes to the model

The likert scale, for this section, was coded as 1 for strongly disagree and 5 for strongly agree.

There are both positive and negative statements in this section. The response rates are displayed as percentages of respondents in each study centre.

Chi – Square test of association was undertaken using Minitab statistical package. A 'statistically significant relationship' is taken as being a probability no greater than 0.05 (5% chance). The probability is that a more extreme difference in attitude (larger Chi-Squared value), could have arisen fortuitously and

therefore, would not reflect a real relationship in the attitudes, being associated with the different hospitals. Chi-Square can indicate, that there is an association between variables but it does not indicate how strong this association is. Cramer's V is a post-test that gives this additional information. Cramer's V test is therefore also undertaken. Cramer's V varies between 0 and 1. Close to 0 it shows little association between variables. Close to 1, it indicates a strong association. The number of degrees of freedom is the number of values, in the final calculation of a statistic, that are free to vary.

H_0- The difference in attitudes is not affected by the different characteristics of the hospitals

H_1- The difference in attitude is affected by the different characteristics of the hospitals

Question 5 enquires of the respondent whether the staffing numbers in their centre would currently provide satisfactory radiographic cover for the model across 24 hours

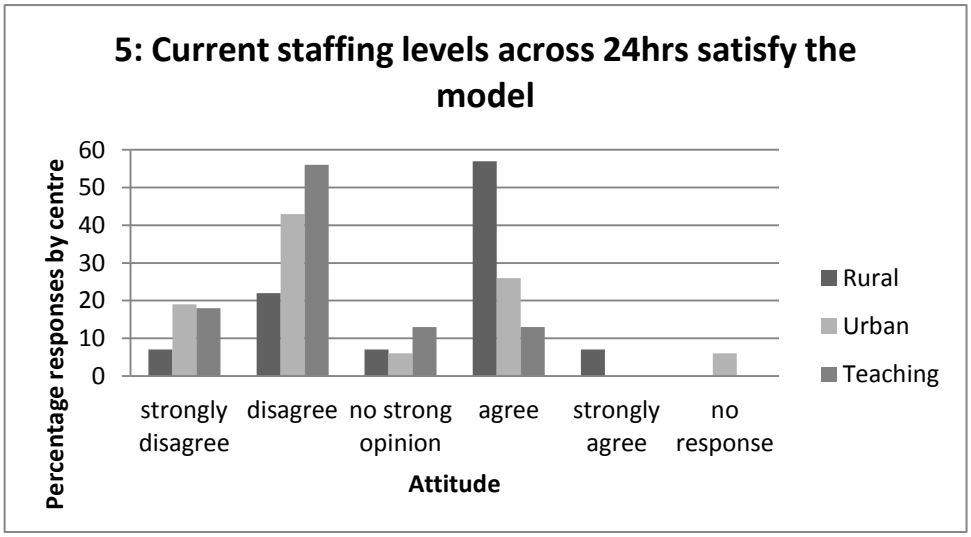


Figure 57: Staffing cover for the model across 24hrs

The "strongly agree" category had few responses. The low response in this category, caused the Chi-Square test to be invalid. The categories of "strongly agree" and "agree" were, therefore, merged and the Chi-Square test was re-run as below. There were sufficient numbers responding "strongly disagree" and "disagree" for these to remain as separate categories.

Minitab Output- Chi- Square

	Strongly disagree	disagree	No strong opinion	Agree/Strongly agree	Total
Rural	1	3	1	9	14
	2.37	5.93	1.19	4.51	
	0.794	1.449	0.029	4.475	
Urban	6	13	2	8	29
	4.92	12.29	2.46	9.34	
	0.239	0.041	0.085	0.192	
Teaching	3	9	2	2	16
	2.71	6.78	1.36	5.15	
	0.031	0.727	0.306	1.929	
Total	10	25	5	19	59

Chi-Sq = 10.298, DF = 6, P-Value = 0.113 7 cells with expected counts less than 5.

The Minitab calculation produces a Chi-Square p-*value* 0.113 (with 6 degrees of freedom); there is an 11% probability that, given the same sample size, a similar Chi-Squared test statistic value could have been generated purely by chance. This indicates, that the attitudes are not likely to be related to the characteristics of the hospital and could have been generated purely by chance. The statistical null hypothesis is therefore accepted. There is no significant relationship between the centres and whether or not staff believe there are sufficient staff to cover the 24hour model.

The top rows of each section show the observed range of responses. The middle row shows the expected range of responses. In both the rural and the teaching centre, the responses for the categories of agree/strongly agree and disagree, are considerably different from the expected responses. There is no obvious reason why this should be different from the urban centre.

Relating this to the percentage responses in the chart (figure 57), the majority of respondents in the study centres, disagreed that the current staffing levels in their centre, would accommodate the model across the 24hour period. The rural study centre appears to conflict with the majority trend of responses. The attitudes in the rural centre, indicate a majority of the respondents agree that the staffing levels in the rural centre, would provide satisfactory cover for the model across 24 hours. The Chi-Square statistics indicates, that there is no relationship between the study centre and the attitudes. Thus, it may be reasonable to assume that the differences in attitudes to radiographic cover, are dependent on local arrangements. OOH arrangements are currently locally agreed across the UK. The impact that OOH has on core hours is, therefore, also dependent on the local arrangements. This range of attitudes may then be generalisable across the wider radiographic public.

Researcher bias was considered here, as the principal researcher was based at the rural centre. However, while the staff were aware that the research was being undertaken, all work relating to the study was

undertaken in the researchers own time and, other than the few selected staff who piloted the questionnaire, the radiographers had not been exposed to the substance of the study.

Question 6 asks if the AfC bands in the model would not be appropriate for general radiography staffing levels in my centre

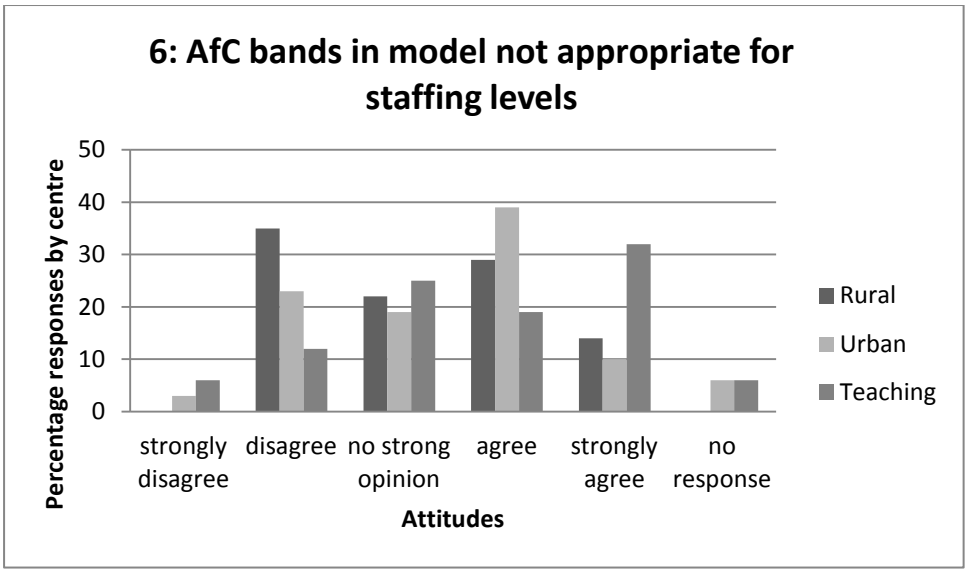


Figure 58: AfC bands in model appropriate for centre

The values for the category of "strongly disagree" were very low and caused the Chi-Square test to be invalid. Thus, the values for the category of "strongly disagree" and "disagree" were merged. Again, the responses at the opposite pole were not merged, as potential detail would be lost from the analysis.

Minitab Output: Chi Square test.

```
                1/2     3       4       5      Total

   Rural          5       3       4       2         14
                  3.86    3.14    4.59    2.41
                  0.335   0.006   0.075   0.071

   Urban          8       6       12       3        29
                  8.00    6.50    9.50    5.00
                  0.000   0.038   0.658   0.800

   Teaching       3       4       3       5         15
                  4.14    3.36    4.91    2.59
                  0.313   0.121   0.745   2.253

Total             16      13      19      10        58

Chi-Sq = 5.416, DF = 6, P-Value = 0.492, 8 cells with expected counts less than 5.
```

Column Key (attitudes)

1/2-Strongly disagree/disagree

3 - No strong opinion

4- Agree

5- Strongly agree

The Chi-squared *p-value* of 0.492 (with 6 degrees of freedom) indicates that there is a 49% probability that, given the same sample size, a similar Chi-Squared test statistic value could have been generated purely by chance. This indicates that the attitudes are not affected by the characteristics of the hospital. The statistical null hypothesis is therefore accepted, there is no significant relationship between the centres and the attitude that AfC bands would not be appropriate for the staffing levels in the model.

The expected responses are broadly similar to the actual responses, with the exceptions being, the responses for agree (urban) and strongly agree (teaching) are a little higher than expected.

Relating the above to the chart (figure 58), the majority of radiographers, in the rural study centre, hovered around the central tendency, with a slight majority percentage of respondents, disagreeing with the statement that the AfC bands in the model, would not be appropriate for general radiography staffing levels, as specified in the model.

The percentage distribution of respondents, in the urban centre, demonstrates a majority percentage who agree that the AfC bands in the model, would not be appropriate, for general radiography staffing levels, as specified in the model.

Correspondingly, there is a similar trend in the percentages of respondents in the teaching centre, who strongly agree with the statement that the AfC bands in the model, would not be appropriate for general radiography staffing levels, as specified in the model.

Across the three study centres, there is no clear percentage majority attitude. This may be due to lack of experience in understanding and visualising AfC bands within the model. There are currently no assistant practitioners (AfC band 4 staff) employed in the rural centre. There may be assistant practitioners (AfC band 4) employed in both the urban and teaching centres but not necessarily undertaking general radiography and not across the 24 hour horizon. Alternatively, as the implementation of the 4 tier structure is still in its infancy in Scotland, it may be difficult to grasp the functionality of the AfC bands within the model in the study centres (NES, 2006). This distribution may be generalisable across the wider radiographic population.

Question 7 considers whether there are currently insufficient staff of each AfC band employed in each centre to accommodate the model

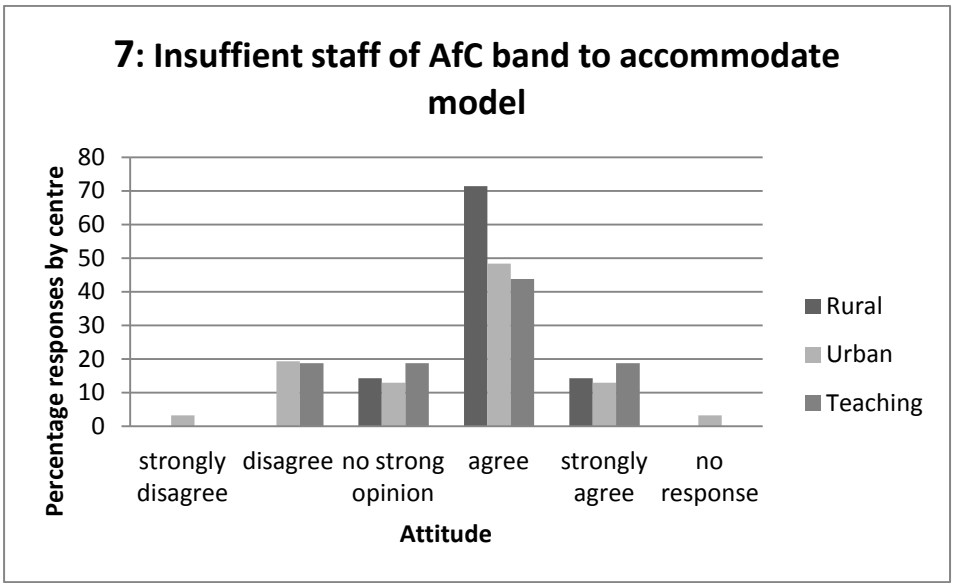


Figure 59: Insufficient staff AfC band to accommodate model

The counts for strongly disagree were so low as to invalidate the Chi square calculation. Thus "strongly disagree" counts, were added to "disagree" counts, to make 6 degrees of freedom. Yet again, the responses at the opposite pole were not merged to avoid potential loss of fine data.

Minitab Output: Chi Square test

	1/2	3	4	5	Total
Rural	0	2	10	2	14
	2.33	2.10	7.47	2.10	
	2.333	0.005	0.860	0.005	
Urban	7	4	15	4	30
	5.00	4.50	16.00	4.50	
	0.800	0.056	0.063	0.056	
Teaching	3	3	7	3	16
	2.67	2.40	8.53	2.40	
	0.042	0.150	0.276	0.150	
Total	10	9	32	9	60

Chi-Sq = 4.793, DF = 6, P-Value = 0.571 8 cells with expected counts less than 5.

Column Key (attitudes)

1-Strongly disagree

2- Disagree

3- No strong opinion

4- Agree

5- Strongly agree

The top rows of each section show the observed range of responses for each centre. The middle row shows the expected range of responses. The rural centre responses show a lower value from the expected range in attitude 2, (disagree) and a slightly higher value from the expected range, for attitude 4 (agree).

The urban range of responses shows a slightly higher value from the expected, in attitude 2 (disagree). The teaching centre responses show a slightly lower value from the expected range of responses, in attitude 4 (agree)

The Chi-Squared *p-value* of 0.571 (with 6 degrees of freedom) indicates that there is a 57% probability that, given the same sample size, a similar Chi-Squared test statistic value would have been generated purely by chance.

The null hypothesis is therefore accepted, there is no significant relationship between the centres, and the attitude that there is insufficient staff of each AfC band to accommodate the model.

The rural study centre indicated the highest percentage majority of radiographers, who considered that there was an insufficient number of each AfC band, employed to accommodate the model in that centre. The attitudes of radiographers, in both the urban centre and the teaching centre, echoed the same sentiment but with a smaller percentage majority. As above, there are currently no assistant practitioners (AfC band 4 staff) employed in the rural centre; however, there may be assistant practitioners (AfC band 4 staff) employed in both the urban and teaching centres. Looking at the percentage responses, the generalisable attitude of radiographers, is that there are currently insufficient staff of each AfC band employed in each centre, to accommodate the model. This may support the analysis of responses for Question 6. If there is insufficient staff of each AfC band employed in each centre, then it would be more difficult to visualise the functionality and appropriateness of the AfC bands, within the model.

This prompts consideration across the wide radiographic population, that the model identifies professional issues, in relation to employment of assistant practitioners in general radiography and recruitment in general. In larger centres, there may be sufficient workload to support employment of adequate radiographic staffing to facilitate supervision of assistant practitioners. However, in reality there may be insufficient radiographic staff employed in each centre. This supports the analysis of Question 5, where there are a mixed percentage of responses, with the urban and teaching centre study centres indicating that there are insufficient staff, currently employed, to staff the model across the 24 hour period. In particular, it may not be the case, in smaller centres with a lower workload throughput, that adequate numbers of radiographers are employed to supervise assistant practitioners. An additional issue in smaller centres might be that, if roles undertaken by radiographers are filled by assistant practitioners, this reduces the overall population of radiographers within that centre. In small centres, this may reduce flexibility of cover for other modalities.

Question 8 asked respondents whether the staffing levels in their centre (general radiography) do not reflect the cover specified in the model during core hours

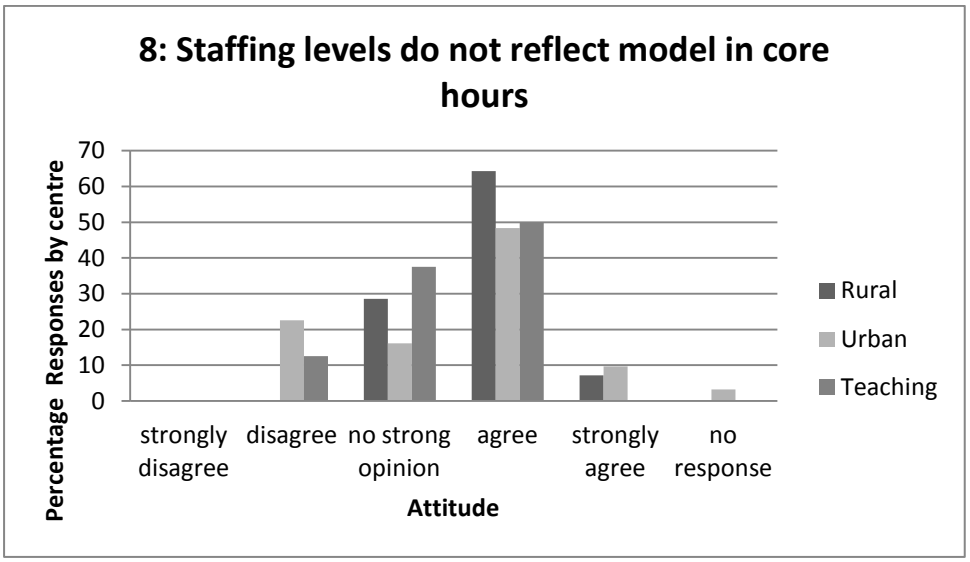


Figure 60: Staffing levels do not accommodate cover for model during core hours

The category of "strongly disagree" was zero and was therefore ignored, as this would have invalidated the Chi-Square test. The category of "strongly agree" was merged with the category of "agree", to ensure that the low value would not invalidate the Chi-Square test.

Minitab Output: Chi Square test

	2	3	4/5	Total
Rural	0	4	10	14
	2.10	3.50	8.40	
	2.100	0.071	0.305	
Urban	7	5	18	30
	4.50	7.50	18.00	
	1.389	0.833	0.000	
Teaching	2	6	8	16
	2.40	4.00	9.60	
	0.067	1.000	0.267	
Total	9	15	36	60

Column Key (attitudes)

2- Disagree

3- No strong opinion

4- Agree

5- Strongly agree

Chi-Sq = 6.032, DF = 4, P-Value = 0.197 5 cells with expected counts less than 5.

The rural centre responses were lower than expected, for the category of "strongly disagree/disagree" and were slightly higher than expected, for the categories of "strongly agree/agree". The urban range of responses, shows marked difference from the expected range, across all attitudes. The teaching centre responses show a slightly higher than expected value in category "no strong opinion", and a slightly lower than expected value, from the expected range of responses in category "strongly agree/agree".

The Chi-squared *p-value* of 0.197 (with 4 degrees of freedom – no responses for attitude 1- strongly disagree) indicates that there is a 19% probability that, given the same sample size, a similar Chi-squared test statistic value, could have been generated purely by chance. The null hypothesis is therefore accepted, there is no significant relationship between the centres and the attitude that staffing levels do not reflect the model during core hours.

The majority of radiographers, in all of the study centres, agree that the staffing levels do not reflect the cover specified, in the model, during core hours. This would appear to be a generalised attitude across the wide radiographic population. This perception of lack of staff, may arise from experience and day to day workload management, rather than a determination of the cover identified in the model. This might be the situation in centres where workload analysis has not been undertaken. This information has not been captured in this study.

Question 9 explored whether the staffing levels in each centre (general radiography) reflect the model during Out of Hours duty

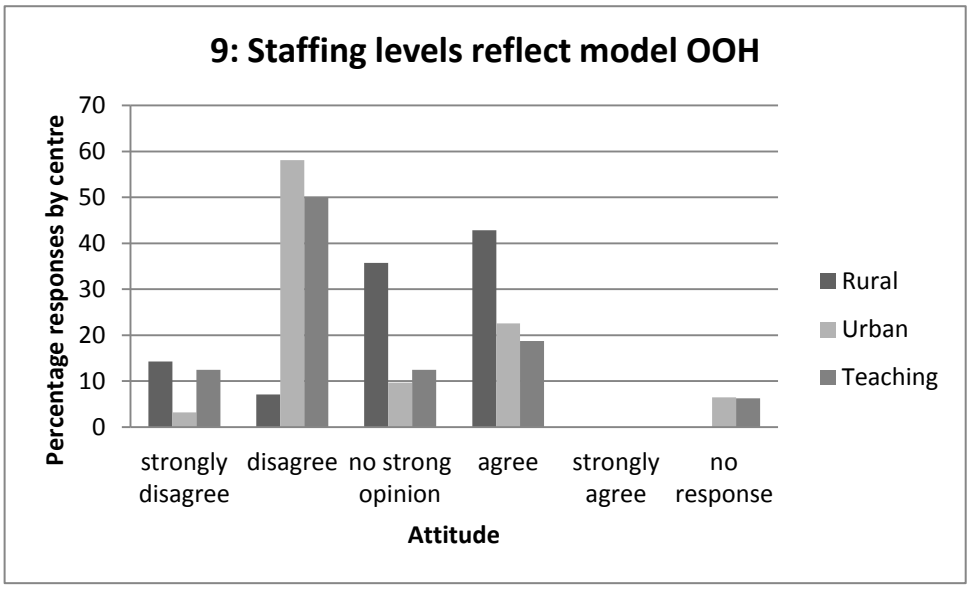


Figure 61: Staffing levels reflect model OOH

Categories "strongly disagree and disagree" were merged, as the responses were so low that the Chi-Square test was invalid. "strongly agree" was zero. The Chi-Square test was re-run as below.

Minitab Output: Chi Square test

```
             1/2     3       4       Total

  Rural       3       5       6       14
              7.72    2.41    3.86
              2.889   2.771   1.183

 Urban       19       3       7       29
             16.00    5.00    8.00
             0.563   0.800   0.125

Teaching     10       2       3       15
             8.28    2.59    4.14
             0.359   0.133   0.313

Total        32      10      16       58

Chi-Sq = 9.136, DF = 4, P-Value = 0.058 4 cells with expected counts less than 5.
```

Column Key (attitudes)

1-Strongly disagree

2- Disagree

3- No strong opinion

4- Agree

The rural centre responses, show a marked difference from the expected range in attitude, across the range of attitudes. The urban range of responses shows a little difference from the expected range across all attitudes. The teaching centre responses, show a little difference from the expected range of responses, across the range of attitudes.

The Minitab calculation produces a Chi-squared *p-value* of 0.058 (with 4 degrees of freedom – no responses for attitude 5- strongly agree); that is, there is a 5.8% probability that, given the same sample size, a similar Chi-Squared test statistic value, could have been generated purely by chance. This borderline Chi-square would indicate that the attitudes may be affected by the characteristics of the hospital, and not generated purely by chance. The statistical null hypothesis is therefore rejected; there may be a borderline significant relationship between the centres and the attitude towards the staffing levels reflecting the model OOH.

Minitab Output: Cramer's V

```
Rows: Characteristics   Columns: Attitudes

                   1   2   3   4  Missing  All

Rural              2   1   5   6        0   14

Teaching centre    2   8   2   3        1   15

Urban DGH          1  18   3   7        2   29

All                5  27  10  16        *   58

Cell Contents:      Count

Cramer's V-square  0.115963
```

Cramer's V test was performed to determine the strength of the borderline relationship. Though the Cramer's V value of .1159 shows a relationship between attitudes and the characteristics of the hospitals (study centres), it is very weak, in keeping with the borderline Chi square above.

The majority of responses from both the urban and teaching centres, disagree that the staffing levels reflect the model during OOH. In contrast, the percentage majority of responses from the rural study centre agree that the staffing levels reflect the model OOH. When these responses are related to Question 5 and Question 8 above, it may be surmised that the generalised attitude regarding staffing levels in the urban and teaching centres, do not currently reconcile with the proposed levels identified, within the models across the 24 hour horizon. However, in the rural centre, the staffing levels reconcile with the proposed resource identified in the model OOH, but do not reconcile with the proposed resource identified in the model during core hours.

There may be a variance in perception of the workload in the study centres. In the rural study centre, there may be heightened awareness and understanding, of the workload statistics that underpinned the model, due to consecutive OOH negotiations. This is a component of the local negotiations of an alteration of workpattern, that all staff have been encouraged to study and digest to allow informed discussion. There may be less awareness and perception of the workload statistics, from the urban and teaching centres, as a result of the larger staff base. As the model is based on an incremental staff base, dependent on increasing workload, understanding the workload analysis is an essential component. Lack of grasp of this facet of the model, may reflect in a mis-perceived attitude of staff shortage.

The attitudes above, are a worrying attitude, that all study centres consider at least core hour radiographic cover is under resourced, and the model could not be applied with current staffing levels. This may be due to recruitment difficulties. There may be real effort to recruit to available vacancies but there may be a more sinister underlying reason. The NHS across Britain is facing budgetary cuts and constraints. The perceived deficit in staffing, may be as a result of vacancies that are frozen, either temporarily or permanently.

Question 10 enquired whether respondents considered that their PDP would be adversely affected by the modular system if implemented in their centre

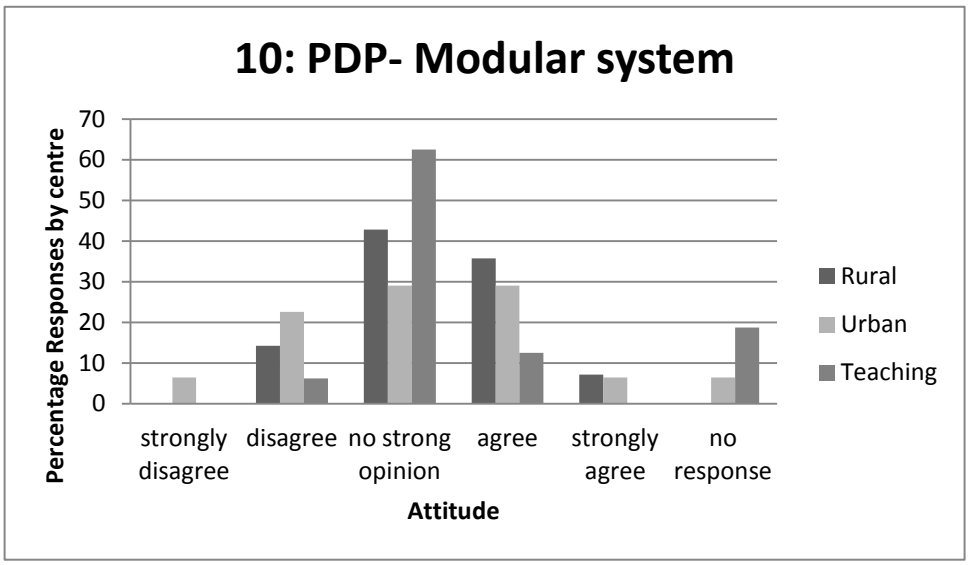


Figure 62: PDP adversely affected by modular system

Minitab Output: Chi square test

	1/2	3	4/5	Total
Rural	2	6	6	14
	3.38	6.03	4.59	
	0.563	0.000	0.436	
Urban	11	9	11	31
	7.48	13.36	10.16	
	1.653	1.424	0.070	
Teaching	1	10	2	13
	3.14	5.60	4.26	
	1.457	3.450	1.198	
Total	14	25	19	58

Chi-Sq = 10.251, DF = 4, P-Value = 0.036 4 cells with expected counts less than 5.

Column Key (attitudes)

1-Strongly disagree

2- Disagree

3- No strong opinion

4- Agree

5- Strongly agree

The rural centre responses show, a higher value for the category of “strongly agree/agree”, than the expected range. The urban range of responses, shows a higher value for the category of “strongly disagree/agree”, than the expected range and a lower value for the category of “no strong opinion”. The teaching centre responses show a marked difference from the expected range of responses across the range of attitudes.

The Chi-squared *p-value* of 0.036 (with 4 degrees of freedom) that is, there is a 3% probability that, given the same sample size, a similar Chi-squared test statistic value, could have been generated purely by chance. This would indicate, that the attitudes are affected by the characteristics of the hospital and not generated purely by chance. The statistical null hypothesis is therefore rejected; there is a relationship between the centres and the attitude that personal development plans (PDP) would be affected by the modular system, supported by the model.

Minitab Output: Cramer's V

Rows: Characteristics Columns: Attitudes

	1	2	3	4	5	Missing	All
rural	0	2	6	5	1	0	14
teaching centre	0	1	10	2	0	3	13
urban DGH	2	7	9	9	2	2	29
All	2	10	25	16	3	*	56

Cell Contents: Count

Cramer's V-square 0.0858309

Cramer's V was undertaken to demonstrate the strength of the relationship. Though the Cramer's V value of .0858 shows that the relationship between attitudes and the characteristics of the hospitals (study centres), it is very weak.

The majority of respondents, in all of the study centres, tend toward either no strong opinion or agree that the modular system would adversely affect their PDP. A specialist interest, or role development, as identified in a PDP, can often be an activity that takes place during core hours. Thus, undertaking regular OOH duties, may cause issues with continuity of training, development, maintenance of competence or consistency of service. Within the rural centre, the attitudes hovered around the central tendency but of those who expressed a negative or positive response, there was a majority of radiographers, who indicated that their PDP would be affected by the model. The urban centre attitudes also hovered around the central tendency but with a small majority agreeing that the model would adversely affect their PDP. The teaching centre had a majority attitude of no strong opinion. Of the radiographers who indicated that they either agreed, or strongly agreed, that their PDP would be adversely affected by the modular system, approximately 50% of the respondents were AfC band 5 and approximately 30% were AfC band 6/7. Thus, it may be that the AfC band 5 radiographers, most of whom have identified a specialist interest in their PDP, are aiming to train and to develop their career to achieve a higher AfC band and may consider that the modular system may detrimentally affect their career prospects. The AfC band 6/7 radiographers may

have achieved their AfC band as a result of their specialist interest or activity. This activity may be embedded in service delivery and thus, participation in the modular system by these radiographers might not only affect maintenance of competence in their specialist activity but would compromise consistency of service delivery. Of the respondents who had no strong opinion, 40% were AfC band 5 radiographers and 60% were AfC band 6/7 radiographers. The majority of these AfC band 5 radiographers indicated that they had no specialist interest identified within their PDP. Thus, the modular system may have no impact on their PDP. The AfC band 6/7 radiographers, who had no strong opinion on whether the modular system would have an adverse effect on their PDP all indicate a specialist interest within their PDP. It may be that the specialist interest for these radiographers can accommodate the modular system, without adversely compromising their PDP. This may be due to local service arrangements and staffing rotations.

Question 11 explores respondents attitudes to whether their personal circumstances require workpattern flexibility

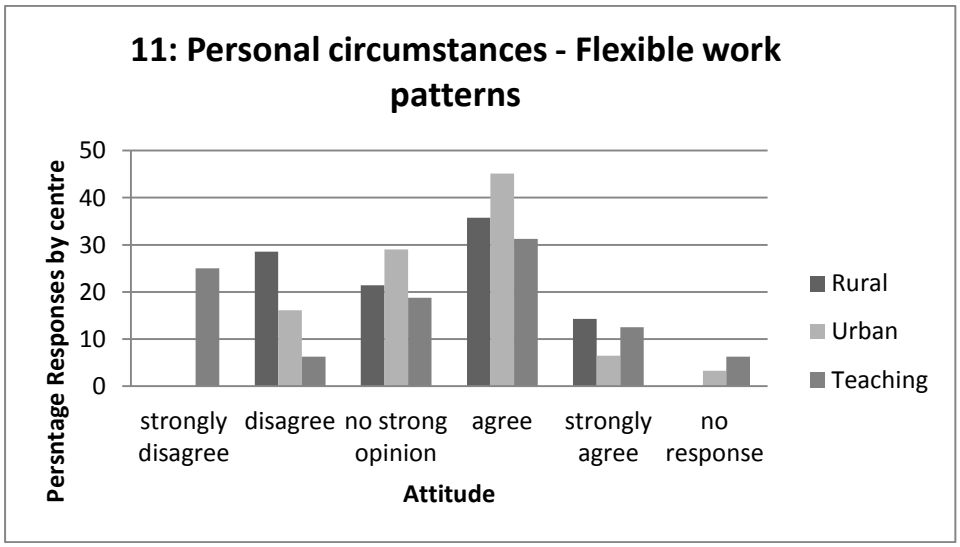


Figure 63: Personal circumstances require workpattern flexibility

The response rate for category “strongly disagree”, was so low as to invalidate the Chi-Square test. Thus, the categories of “strongly disagree” and “disagree” were merged and the Chi-Square test re-run as below.

Minitab Output: Chi Square test

	1/2	3	4	5	Total
Rural	4	3	5	2	14
	3.32	3.56	5.69	1.42	
	0.138	0.088	0.085	0.233	
Urban	5	9	14	2	30
	7.12	7.63	12.20	3.05	
	0.631	0.247	0.265	0.362	
Teaching	5	3	5	2	15
	3.56	3.81	6.10	1.53	
	0.583	0.174	0.199	0.148	
Total	14	15	24	6	59

Column Key (attitudes)

1-Strongly disagree

2- Disagree

3- No strong opinion

4- Agree

5- Strongly agree

Chi-Sq = 3.152, DF = 6, P-Value = 0.790 7 cells with expected counts less than 5.

The rural centre responses are roughly similar to the expected responses. The urban range of responses are a little lower than the expected range, with the exception of the category of "strongly agree". The teaching centre responses show a little variation from the expected range, in all of the categories.

The Chi-squared *p-value* of 0.790 (with 6 degrees of freedom) indicates that there is a 79% probability that, given the same sample size, a similar Chi-squared test statistic value could have been generated, purely by chance. The statistical null hypothesis, is therefore accepted, there is no significant relationship between the centres and the attitude that personal circumstances require flexible work patterns.

The percentage responses across the study centres, indicate a majority opinion, that radiographers' personal circumstances require workpattern flexibility (figure 63). Workpattern flexibility is relevant to many staff at all stages of life. Radiographers returning from maternity leave can seek alteration in workpattern to accommodate childcare issues. Family friendly policies can accommodate further family based needs, by flexibility of working patterns. Literature indicates that flexibility is required throughout the life cycle but that the flexibility requirement evolves as the personal agenda alters. Within the rural centre there is a high proportion of part time radiographers. Staff who choose to work part time, usually make this choice to accommodate a work-life balance. This may be a childcare issue or an issue relating to other dependents or an extra-curricular activity. These circumstances may require regular workpatterns or may require an agreed flexible arrangement. This supports literature, that requiring flexibility throughout the worklife cycle, is a changing but worklife long requirement (Taylor, 2001). This is a generalisable attitude across the wider radiographic population.

Question 12 asks respondents whether the modular system of the model would not accommodate their personal circumstances

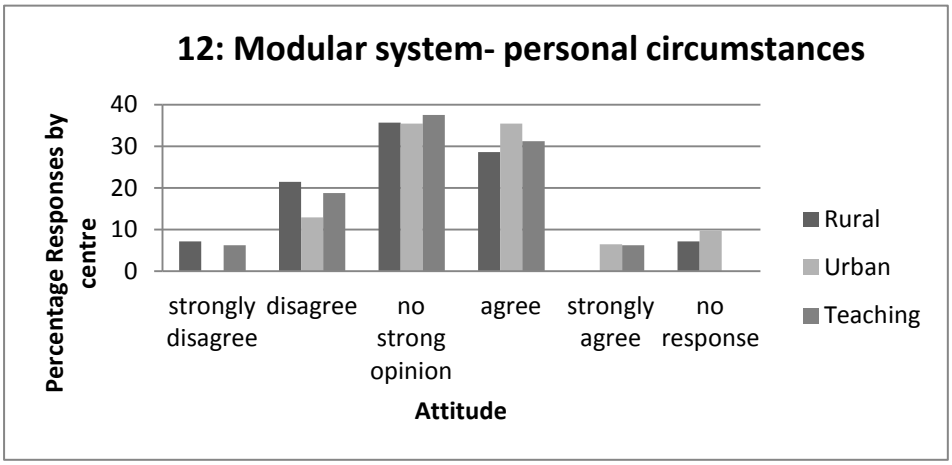


Figure 64: Modular system will not accommodate personal circumstances

The response rate for the categories of "strongly disagree" and "strongly agree", were so low as to invalidate the Chi-Square test. These categories were merged with "disagree" and "agree", and the Chi-Square test was re-run.

Minitab Output: Chi square test

	1/2	3	4/5	Total
Rural	4	5	4	13
	2.74	5.02	5.25	
	0.583	0.000	0.296	
Urban	4	11	13	28
	5.89	10.81	11.30	
	0.609	0.003	0.256	
Teaching	4	6	6	16
	3.37	6.18	6.46	
	0.118	0.005	0.032	
Total	12	22	23	57

Column Key (attitudes)

1-Strongly disagree

2- Disagree

3- No strong opinion

4- Agree

5- Strongly agree

Chi-Sq = 1.903, DF = 4, P-Value = 0.754 2 cells with expected counts less than 5.

The rural centre responses, show a slight variance, from the expected range in attitudes at both ends of the range. The urban range of responses also show a slight variations, at both ends of the range. The teaching centre responses, are very similar to the expected responses.

The Chi-squared *p-value* of 0.754 (with 4 degrees of freedom) indicates that there is a 75% probability that, given the same sample size, a similar Chi-squared test statistic value could have been generated purely by chance. The statistical null hypothesis is therefore accepted, there is no significant relationship between the centres and the attitude that the modular system would not accommodate personal circumstances.

The percentage responses from all of the centres, indicate a majority opinion of no strong opinion, closely followed by agreement that the modular system of the model, would not accommodate personal circumstances. This may then represent a mix of opinion. A majority of the respondents may not comprehend the impact that a modular system would have on personal circumstances, as they have no experience of this pattern of work. This supports the West of Scotland review, (West of Scotland Regional Planning Group, 2009) requirement, that a representative rota must be provided, to allow radiographers to consider the impact and flow of any proposed roster. A further cohort may grasp the potential impact that a modular system may have on personal circumstances, or have had experience of a modular system or other similar shift pattern. The attitudes regarding the implementation of a modular application of the model, is generalisable across the wider radiographic population.

Table 15 below indicates the mode responses for Section 2 of the questionnaire across the three centres

Question	Mode Response
The staffing numbers would currently provide satisfactory radiographic cover for the model across 24 hours in my centre	Disagree
The AfC bands in the model would not be appropriate for general radiography staffing levels in my centre	Agree
There are currently insufficient staff of each AfC band employed in my centre to accommodate the model	Agree
The staffing levels in my centre (general radiography) do not reflect the cover specified in the model during core hours	Agree
The staffing levels in my centre (general radiography) reflect the model during Out of Hours duty	Disagree
My PDP would be adversely affected by the modular system if implemented in my centre	No strong opinion
My personal circumstances require workpattern flexibility	Agree
The modular system of the model would not accommodate my personal circumstances	No strong opinion

Table 15: Mode Reponses Section 2

The responses to the questionnaire do not support the model. There may be many reasons for this but, anecdotally, the most likely would be the great culture shift from a standard Monday through Friday working week, with OOH covered by a local overtime regime, to a shift system. Unlike nursing, radiography has no historical background in any shift pattern. Regardless of whether the staffing within the model would be appropriate for the workload and whether the modular application of the model would support the working day, radiographers will have difficulty in conceptualising the effect that this will have on worklife balance.

In addition, assistant practitioners (Band 4) staff are a recent concept in the Scottish workforce and are not yet widespread. Thus, radiographers may have real difficulty in practical comprehension of the model. A recent evaluation exercise identified that, there had been no detrimental effect in the introduction of Band 4 staff in Scotland, but it was difficult to demonstrate cost effective improvement (Miller et al, 2011). The evaluation recommended that, if further role development is agreed, this be discussed with managers, to ensure cohesive training, by agreeing departmental priorities. Perhaps an implementation strategy for developing the role of the Band 4, assistant practitioner role, in a format that aligns with the model would be necessary for radiographers to fully comprehend the effect of the model.

Section 3 – Attributes of respondents

Question 13 asks "Which AfC Band" the respondent is.

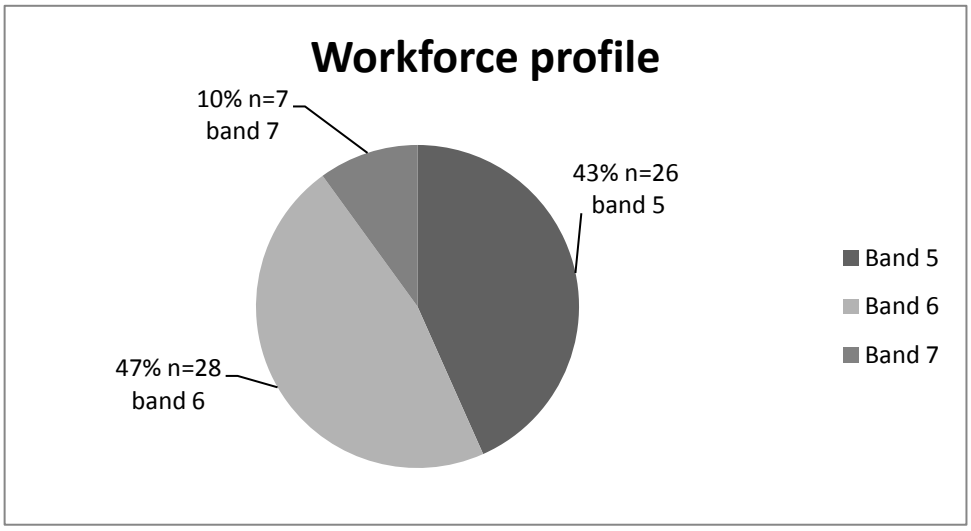


Figure 65: Workforce profile

The workforce profile for the respondents, is as shown in Figure 65. 43% of the respondents were AfC band 5, 47% AfC band 6, 10% AfC band 7. Though the numbers of respondents from the rural centre and the urban centre, was considerably different, the proportional representation of AfC bands was very

similar. The workforce profile for the respondents in the teaching centre, was a little different. Only band 5 and 6 radiographers responded in the teaching centre.

Question 14 enquired about the respondents age group

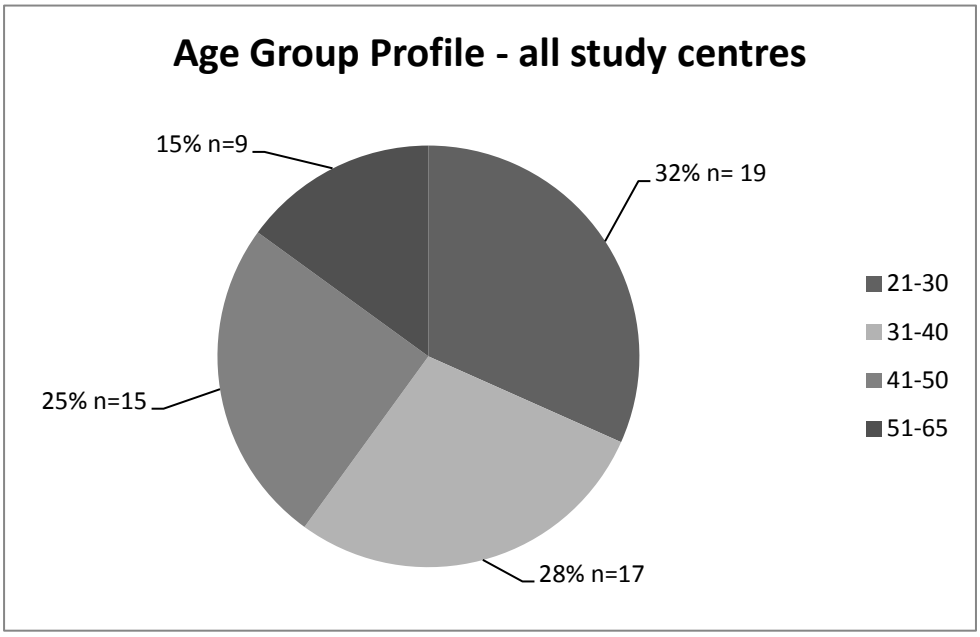


Figure 66: Age profile

The age group profile is shown above in Figure 66, 32% of the respondents were between 21 and 30 years of age, 28% between 31 and 40 years of age, 25% between 41 and 50 years of age and 15% between 51 and 65 years of age. The age group profile of the teaching centre, is a little different from the other study centres. There were no radiographers older than age 50 years old, who responded from the teaching centre. In the rural centre, there were few respondents in the two younger age groups. In contrast, the majority of the respondents from the rural study centre, were equally distributed between the older two age groups. The urban centre respondents were drawn, in the majority, from the younger two age groups, with the third and the fourth age group, making up a third of the respondents.

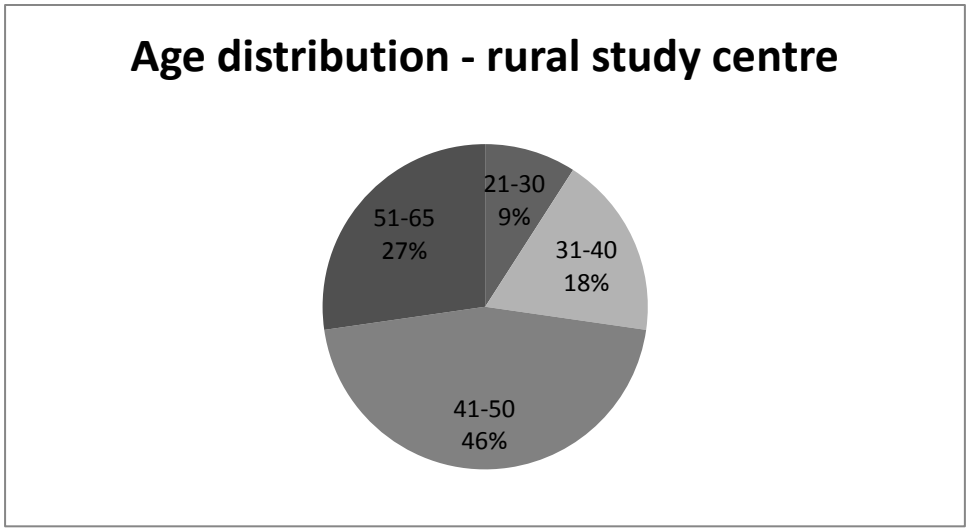


Figure 67: Age distribution Rural Study Centre

Issues related to age groups, such as recruitment, experienced specialist practice and succession planning must be considered within the local context. As an example of local context Fig 67 above, using data from Appendix 1, illustrates the age profile of the rural study centre for all staff. This demonstrates, that there is a high proportion of mature staff. The likelihood of these mature staff being settled in their current role for the remainder of their career, is higher than for younger age groups.

Question 15 enquired about the household status of the respondent

Option	Number of respondents	Comments
Living with a partner	25	
Lives alone	6	
Responsible for dependents	5	
Living with partner and responsible for dependents	15	
Other	8	Living with parents Living with friend, lodger, flat share Single parent Children with special needs Living with grown up children
Question not answered	2	

Table 16: Household demographics

The household status question indicated very few respondents who were “free agents” (Table 16). Only 10% of respondents, indicated that they lived alone. A further few respondents indicated that they lived with parents, or a flat share, or lived with friends. The remainder of the respondents, either lived with partners and therefore, presumably, would wish to have a workpattern that accommodated shared leisure time, or were responsible for dependents. This may require some structured workpattern, to accommodate a care schedule for that dependent. Those respondents who indicated they were “free agents” worked in either the teaching centre, or the urban centre. Thus, the rural centre responses cannot be generalised to the wider radiographic population. This may be a similar situation across Scotland in small departments.

Section 4 - Any further comments

This section offered radiographers the opportunity to raise any issues, or make any comments, in relation to the model that may be relevant to their circumstances or centre.

The themes have been extracted and discussed below. The comments have been reproduced verbatim in Appendix 2.

Theme 1: The application of the workpattern model in departments with fluctuating workload.

The theory of the workload model could be applied cumulatively (per hospital), or per site (separate departments within one hospital). The workload could be analysed in totality, with a total workforce resource identified. The workforce could then be deployed, per site, on the basis of the workload per hour, per site. However, the model could be applied per site, i.e. the workload per site could be analysed and the workforce identified per site. (This would be an elemental component of the total workload and workforce analysis as above). The application of the model, per site, may prove to be an essential component of staff deployment, over multiple small sites with low workload and workforce. A low total workload would require a low staff resource but where that staff resource has to be deployed over multiple smaller sites, the cumulative application would adversely affect staffing in each site. In these situations the workload/workforce analysis, per site, would be essential.

The workload model was developed, using the frequency distribution of patient episodes, over time periods from a year to a day and to a night. The distribution pattern is similar across all the time periods. The patient episode numbers have also been plotted across 24 hours, for several weeks, with minimum, maximum and average statistics generated. The question was exploring staff attitudes to whether they considered, in their opinion, that the staffing levels in their specific centre, reflected the staffing levels in

the model. Staff who work OOH, would have an opinion on whether radiographer staffing levels in their centre, reflected the staffing levels in the workload model, in relation to the workload in their centre.

The workload model was developed, to demonstrate an incremental increase in the number of radiographers for an expected increased throughput of patient episodes. Thus, if a workload analysis identified a high expected throughput of patient episodes (a busy department), the workload model would indicate a proportional number of radiographers to be available to deal with this workload.

Looking at data across a representative timescale, is an essential factor in statistical analysis and understanding data prior to developing a model. Thus, the data was investigated across seasonal portions (dividing the year into quarters) as well as considering cyclical variations, across a longer timescale. Trends were identified but as staff are employed on contract not on temporary or locum "as needed" basis, the workload forecasting was done by time series decomposition, to smooth out the seasonal variations.

Theme 2: A further theme identified was the variable length of the patient episode.

The research behind the workload model, considered the quality and the number of examinations and thus the time per patient episode. This was reflected in the section on patient episode times. This was also the underpinning for the frequency distribution, which demonstrated the Pareto principle or principle of imbalance (80/20). Research indicates, that frequency distribution approximately follows the 80/20 split and plotting activity across several 24 hour periods, would demonstrate an activity curve that follows a normal distribution. Any activity involving workload or workpattern modelling recommends exploring local data as an initial step. Each department would require to undertake a frequency distribution and adaptive planning study in their department before implementing the workload model.

The frequency distribution charts, demonstrate the spread of the episode, times both in core hours and OOH. The workload model is built on the frequency distribution, e.g. in the primary study centre approximately 80% of patient episodes were completed in 10 minutes or less, with the remaining 20% being completed in an average of 47 minutes. Thus, the workload model was developed with the reasonable expectation of a radiographer, with no peer or admin support, being able to examine 4 patients per hour, thus, allowing the remainder of the time to aggregate, in order to facilitate the remaining percentage of patient episodes, that require an extended timescale. This local data analysis, should be undertaken in centres, to ensure that any local variations in implementation of the workload model would be identified e.g. a high number of theatre cases in a specific centre that may require a radiographer for a complete duty period.

Unpredictability of workload, is a point that has often been raised in the unscheduled care collaborative (Scottish Government, 2004). However, a point that was also identified, is that the unscheduled workload pattern is often more predictable than the scheduled workload. Unscheduled care workload studies into ED plotted activity over 24 hour periods and across each day of the week, over a representative time period (Scottish Government, 2004). Trends were clearly identified, rather than attempting to calculate averages of workload. Nursing workpattern models are based on these studies. It is however, important to undertake local data collection as, while the trends are reliable, the numerical element of the workload is locally relevant to the application of the workload model.

Theme 3: Staff allocation dependent on the workload

The model is based on frequency distribution of patient episode times and identifies that there is a repetitive pattern to the frequency distribution. The Pareto principle, the principle of imbalance and an intrinsic principle of natural distribution (80/20 rule); thus, if all patient episodes were of a uniform timescale i.e. 100% of patient episodes being completed in either less than or equal to 10 minutes then radiographers would expect to undertake 6 patient episodes, per hour, single handed. However, the data analysis demonstrates that 80% of patient episodes are completed, in less than or equal to 10 minutes and the remaining 20% are completed, in an average time interval of 47minutes. During core hours, the workpattern model of one radiographer, with full administrative and peer support, undertakies 5 patient episodes in one hour, allowing a cumulative time to facilitate the extended time patient episodes. During the OOH period this expectation of 5 patient episodes, was reduced to 4 patient episodes per hour per radiographer, as there was no administrative support and limited peer support. This allows for the cumulative time period, to facilitate the extended time element of the patient episodes. A cost effective plan is required, to support the lone radiographer in extraordinary circumstances. This is often a radiographer on call, from home, who is also covering other duties. This is the situation in the principal study centre.

The workpattern model specifies 6 imaging staff (4 radiographers of band 5/6 and 2 assistant practitioners band 4) for throughput of 26 patients, in core hours, with full administration and peer support, or 7 imaging staff OOH (4 radiographers of band 5/6 and 3 assistant practitioners of band 4) for throughput of 26 patients OOH, with no administrative support. The respondent who questioned this aspect, may have been employed in a centre where Band 4 assistant practitioners are not yet employed and thus found it difficult to understand the reality of the workpattern model.

An advantage of using the patient episode as above, as well as commonality across Scottish NHS Boards, is the ability to determine the episode time, rather than a simple numerical count of examination types. E.g.

a chest image undertaken on a fit co-operative patient, who walks in to the department, will take a very short time to complete. However, a chest image on an unwell patient, who has severe learning difficulties, would take a very long time to complete in comparison, due to the extenuating circumstances. Similarly an image of an extremity on a fit patient would take a short time but in comparison the same examination on an aggressive patient, suffering from the effects of access alcohol, would take a considerably longer time scale to complete.

Theme 4: The Modular application of the workpattern model was a recurrent theme

The modular application of the workpattern model is for local discussion and relevance. The number of modules per day and the start times for these modules would all be dependent on the local data analysis and the workforce contracts. Thus, the local flexibility of the modular application is determined by local requirements

As has been mentioned above, this proposed modular application of the workpattern model, is for local implementation. Many workpattern models are based on a statistical structure. Local data analysis of workload and understanding of workload needs are the local variables. Thus, timings and start/end times of duties are for local debate, dependent on adaptive planning based on local analysis and circumstances. The frequency distribution for this centre would define the workforce requirements determined by the workload in accordance with the workpattern model.

The explanation of the workpattern model was a synthesis of several chapters, of statistical analysis distilled into two tables. The modular application of the workpattern model was then described as an example of implementation.

The main aim was to determine the workpattern model over an hourly period and then by adaptive planning, to apply this workpattern model in the most cost effective manner, to suit local requirements. Thus, the timings for module start/finish times can be determined locally to suit local conditions, providing the workload data analysis had been undertaken to determine the workload profile.

Theme 5: Data collection

Two of the respondents identified an issue that the number of examinations, might be clearer than the number of patient episodes. This may have been optimum data points, however, the data extract for the radiology information system, that is used in the majority of NHS Scotland radiology departments, gives detailed data in patient episodes, rather than in examinations. It would be possible, but complicated, to lift certain data points by examination, rather than by patient episode. In order to facilitate a common

currency across Health Boards, for the purposes of local data analysis, it was decided to accept the limitations of the data extract and use the statistics for patient episodes. Thus, the application of the model can be considered by means of this commonality. A further point is that patients (actual people) are examined in departments. By using the patient episode, rather than the examination, the model is given a holistic patient focus.

Theme 6: A comparison of the workpattern model with an abstract theory

Central place theory is an abstract concept of relative locations, populations, economic functions and services of differing sizes of urban settlements, within larger regions. Recently central place theory has become more economically relevant in retail terms, by underpinning the economics of retail developments. However, the workpattern model postulated, is not an abstract concept but a mathematically derived formula. A similar example model from planned care would be DCAQ theory. Activity "A" might be a 15 minute unit of activity, thus there could be 4 units of activity per hour and 14 units of activity in a 3.5 hour session. With 2 sessions in a typical day this would give 28 units of activity per day. There may be an identified demand "D", of 84 units of activity per day. To ensure that no queue "Q" develops, capacity "C" of 84 units per day, must be identified. Thus 3 radiographers who can all undertake 14 units per session and can commit to 2 sessions per day would be required. It is not possible to develop a model in general radiography using the same principle. As stated above, patients may be fit or unfit, there may be few, or many examinations required per episode. Examinations may be of short duration or be time consuming. Demand also fluctuates, not only per day but throughout the day and night. Thus, there is no average workload unit that can be used in a demand/activity formula. The workpattern model postulated was developed by frequency distribution of patient episode time, superimposed on workload analysis over the 24 hour period, across the roster horizon for a relevant time period. This allowed for a staffing resource profile, that was itself set within a modular system, to provide cost effective, appropriate numbers of suitably skilled workforce over the 24 hour period. The aim of the workpattern model is a formula that can be applied to all departments, to suit local requirements, using a modular application following local data analysis.

8. Discussion

8.1 Summary of findings

Critical evaluation of current literature surrounding workload, workforce planning, government policies and healthcare priorities, was carefully undertaken for comprehension of workforce planning, local and national policies and in particular methods of workpattern modelling. Lowden et al, (1998) underpinned all of the points that local staff identified; whether implicitly by worries through requests for altered work patterns, or explicitly by response to the questionnaire (Appendix 1). Literature also indicated, and radiographers confirm, that though there may be issues with workpatterns and workload, there is concern that any alteration in workpattern to improve conditions would be viewed negatively by radiographers, if the alteration would have a financial penalty (Taylor, 2001). Successful workpatterns are shown in literature to be related to the natural lifecycle of the radiographers in terms of career progression and worklife balance (Jones et al, 2007). The need for flexible workpatterns may be determined by worklife balance but care must be taken to ensure succession planning for service sustainability (Nicol and Botterill, 2004).

Unscheduled care must align with planned care, thus staff resource for OOH duties must align with staff resource during core hours, both for general radiography and for modalities that involve planned care (Bloor and Maynard, 2003). Accordingly, the allocation of workforce for all modalities was discussed and literature relating to structured methods of resource allocation, to deploy staff resource across the modalities was evaluated (Ernst et al, 2004). Different options are applicable to diverse centres. A relational database meets most resource deployment heuristics; however, software to facilitate this approach is not commercially available (Meyer and Markowitz, 1997).

Retrospective analysis of local workload and demand data, by time series analysis, was undertaken for comprehension of workload. This understanding, is essential in developing a cost effective workpattern model based on statistical evidence (Jenkins-Clarke, 1992). Future workload demand prediction, by time series forecasting, using Minitab Statistical package was undertaken. The forecasting of future workload is a crucial element of the study; workforce planning requires solutions that are future proofed (Ernst et al, 2004). Potential workforce planning decisions must therefore take cognisance of workload projections in a timescale appropriate to the plan. In the principal study centre, the forecasting for core hours, showed a slightly decrimental trend over a year however, this pattern is then repeated the following year, with the workload at the earlier sector of the year noted to be a little elevated from the study year statistics, but within the forecasted margin. This validated the forecast. This may represent cyclic trends of ice related

injuries and winter illnesses. The weekend duties show a slightly incremental trend throughout the year, that may represent the pattern of sport related injuries, associated with the sporting calendar. The overnight duties demonstrate a very slightly decrimental trend throughout the year and this reflects the core hours cyclic trend for similar reasons.

Workpattern models from other professions were considered. It is not possible, in general radiography, to set a maximum limit on the caseload, in unscheduled care radiography, by vetting referrals against criteria. The patients are reviewed by clinicians, prior to referral, to ensure that referral for imaging against guidelines is appropriate (RCR, 2008) but this does not alter the unscheduled nature of the demand. Neither is it possible, to limit the workload, by determining a maximum workload, as unscheduled care is immediate and demand led (Alfares, 1998). Limiting the workload, by time component modelling activity, is not appropriate for unscheduled care, again due to demand led nature of the workload. The final model considered, was detailed analysis of current and historical workload and forecasting of future workload, to assess resource requirements (Lane et al, 2000).

A workpattern model was derived. This can be utilised in all centres, to determine appropriate staffing levels for general radiography in relation to local workload. This was developed from the episode demand frequency distribution, superimposed on workload analysis and utilising the principles of crew pairing and adaptive planning; this is an effective deployment of radiographer skills and experience (AfC bands). The model identified a strategy for utilising the lowest band (and therefore the most cost effective), compatible with the workload, required experience and the supervision constraints of the 4 tier structure (NES, 2007). The model, unlike broad theories, is designed to facilitate application in individual workplaces with differing centres of delivery, differing workloads and client bases, and was projected in relation to workload data from the study centres. The workpattern model adjusts the required staffing resource incrementally, or decrementally, in relation to alterations in the demand. Accordingly, planning a satisfactory workforce to implement the workpattern model, is inextricably linked to the workload measurement and forecasting (Jenkins-Clarke, 1992). Thus, the model determines a future proofed, cost effective and satisfactory skills base to support the working day in all centres. The modular application of the model, that can be utilised as a function of implementation of the workpattern model in all hospitals, was developed (Kulatunga et al, 2009). The modular application allows a range of rostering options, to support the working day, across the roster horizon in diverse centres. This modular application was proposed on the background of a local and national review of OOH working terms and conditions (West of Scotland Regional Planning Group, 2009)

The questionnaire to ascertain radiographers' attitudes, to the proposed workpattern model, was undertaken as mini case studies, in three study centres of diverse characteristics. Their attitudes to the application of the modular system, to both the study centres and to the radiographers' work life balance were sought. The characteristics of the study centres were a rural centre, urban general hospital and a teaching centre. The aim was, to ascertain any relationship between these attitudes and the characteristics of the study centres. This would determine generalisability of the attitudes to the wider radiographic population. The notable results from the attitude questionnaire are;

- The only occasions where there was a relationship between the study centres and the attitudes reported, was related to the staffing levels OOH, and whether the modular application of the workpattern model affected the radiographers' PDP.
- The modular application of the workpattern model, would support alignment of planned and unscheduled care, but would impact on worklife balance.

There are concerns across the diverse characteristics of hospitals, that radiographer staffing levels do not currently reflect the workpattern model in general radiography. This has been tested by Chi Square test of association and this indicates that the concerns are echoed through the three case studies of hospital surveyed. This is a particular concern, currently due to the constraints of funding in the NHS. Raising staff resource to meet the levels stated, in the workpattern model, will prove challenging. However, the workpattern model, in combination with local workload analysis, will act as a benchmark for future resource planning.

8.2 Strengths

This study, due to the quantitative methodology, is valid and reliable evidence for Scottish health boards. It is essential for health boards to have a defined structured mechanism, to determine the most appropriate staffing levels, to support a cost effective service with the most effective staff skills mix to respond to the workload. This staff resource, must be embedded within a workpattern model, that is sufficiently flexible to accommodate an incremental and decrimental future workload. The workpattern model developed in this study fulfils this criteria. The modular application of the workpattern model, facilitates operational management in all Scottish heath boards, as the application is determined by local workflow; this workflow can be measured using the national RIS.

The workpattern model is patient focussed, being defined by numbers of patients and can therefore be applied to any Scottish health board and centre, due to the common currency of patients. Though the RIS is

a Scotland wide initiative, data analysis of examinations performed is calculated by variable methods. However, there can be no variability in the data analysis of the number of patient episodes.

In the process of undertaking this study, the components of the analysis have facilitated local OOH negotiations. The principal investigator, as a member of the steering group, used these components to facilitate comprehension of workload, workpattern and modular application. The comprehension of skills mix was particularly important in the negotiations, as the implementation of the 4 tier structure is not embedded in Scotland.

This study, will be identified to NHS Education Scotland, in relation to future training of assistant practitioners. The evaluation report, on the introduction of assistant practitioners into imaging departments in Scotland (Miller et al, 2011), recommended that, discussions regarding plans for cost effective integration of assistant practitioners into health boards staff resource, must be undertaken, prior to further training programmes. Across Scotland the implementation of the 4 tier structure is inconsistently applied. Advanced practice is measured by the accreditation facility of the College of Radiographers (CPD now) which determines the standard required of advanced practitioners. However, the reality of the advanced practice contribution to the radiology service, is also inconsistent (NES, 2006). This is likely to be related to the lack of backfill for the task drift process, caused by the inconsistent integration of assistant practitioners. This study will support an implementation strategy for the 4 tier structure across Scotland, thus, supporting advanced practice by the integration of assistant practitioners. This advanced practice will strongly support the radiologist fraternity, releasing these medical colleagues to concentrate on roles that require medical expertise. Roles that can be accommodated by advanced practitioners will be reliably undertaken, when the 4 tier structure is embedded. The career progression opportunities to achieve advanced practice, should address issues related to recruitment and retention, in the profession of radiography.

The model will support issues of professional concern, regarding the role of the assistant practitioner in the workplace, by structuring their place in the workforce ladder. Concerns relating to a two tier workforce profile (registered and unregistered staff) have been anecdotally identified, but not previously addressed, as there is no cohesive implementation strategy for assistant practitioners into the workplace (Bennion and Irvine, 2011). In addition, there are worries of task drift and backfill for the tasks previously undertaken by assistant practitioners, when they undertook the role of radiographer helper; this highlights the workload balancing aspect of workload modelling (Tsushima et al, 1989) that must be considered as a component of the implementation strategy.

The process of workload analysis, has proved to be invaluable in several local situations. The method of demonstrating the frequency distribution of the time components of procedures, meshed with the demonstration of the trends of the workload, over the working day, whether this is core hours or across the 24 hour period, has supported a workforce planning and profiling review. This is a component of efficiency planning, that is a common activity across disciplines in Scotland. In addition to providing evidence for workforce planning in the radiology department of the principal study centre, the data analysis method as described in this study, has been employed by managers to identify trends in the laboratories and in the physiological medicine departments, both of which have a non deterministic workload, with procedures of differing time frames required.

An inherent strength of the study, is the case study approach. In the targeted selection of the three centres of different characteristics, the characteristics of all hospitals in Scotland, have been represented.

A short explanatory leaflet (Appendix 3) has been developed that can act as an information resource and quick reference guide, for managers and professional bodies.

8.3 Limitations

The initial limitation on the study, was the limited time span on which the data extract was undertaken. This was due to the RIS being updated to a national standard database, just prior to the study being undertaken. This was unfortunate timing for the study, as the previous database had been in use for several years and would have afforded an excellent timescale to consider trends. It would also have afforded great historical data, as a basis for forecasting future workload; however, the two databases were not entirely comparable and did not report statistics in a comparable manner, additionally, several policy changes altered workload in the period following the cessation of the previous system. The most notable of these policy changes is the referral guidance from the RCR (2007) which altered the workload considerably. New service users also altered the referral practice for general radiography; the historical data would not reflect this picture. Shortly after the study started, there was a further notable policy change. This was SIGN guideline 110, Early Management of Patients with a Head Injury (2009). This guideline has reinforced referral changes that were being introduced during the study period. Literature, in relation to workpattern modelling and forecasting, indicates the importance of understanding past data and more importantly good recent data is essential, as more current data is weighted as more significant (Xue et al, 2001). These reasons indicated that, despite the shorter timescale of current data, it was more appropriate for the study to proceed with the new RIS data extract, rather than the historical sample. The advantage of this decision, as has already been mentioned, is the new RIS is a national database,

standardising data collection. Thus, reliable data analysis can be undertaken in other health boards across Scotland. As the aim of this study is to develop a work pattern model to meet the changing service requirements in Scottish radiology departments, the common currency of data would increase the reliability of the study. The forecasting is based on the extract from the new RIS, the forecast displays a slightly decreasing workload. This, of course, would never decrease to zero, as the duration of the forecast must be considered in relation to the duration of the data used to predict the forecast. The decreasing workload is only valid for one year. If there had been a longer timescale, the decrease in workload over the extract period would have been absorbed in the context of several years of data. The validation of the data describes a similar trend in the following year but in the context of an elevated initial value, which is within the limits of the forecast. This validation suggests that the decrimental trend, identified in the study, is a cyclic phenomenon and more traditional models should be developed in future work as more data becomes available.

Another limitation of the study, is the unvalidated theatre workload data. The snapshot of the data gives a good estimate of the theatre workload and this was considered realistic by the radiographers. However, this was not considered in the development of the model due to the lack of validation. However, there is must be accord between the theatre workload and the model, as OOH there may be a lone worker to deal with both workstreams. The important fact regarding theatre radiography, particularly when the radiographer is a lone worker, is that theatre is remote from the main base for radiographers. Thus, this removes the radiographer from controlling both the workflow and workload, until the theatre case is complete. This lack of control of the workflow, in combination with the lack of control regarding the timescale of the theatre case, adds to the stress during OOH. The theatre workstream is not reflected in the model and must considered in accordance with the model. The stress of managing the remote episode, in the context of demand, is difficult to quantify.

The limitations of the attitude questionnaire are varied. Interviews might have given more in depth data and expanded on the emotions and reasons behind responses, but would have identified personal agendas that would be difficult to generalise; only a smaller, less relevant sample, would have been possible, if interviews had taken place. Undertaking the questionnaire by postal administration, rather than electronic web ink was controversial and may have reduced the sample of radiographers that responded. The decision was taken, due to the need to target the population of radiographers who undertake general radiography. The subject matter is currently emotive, as there is a Scotland wide move to redesign the OOH service. The service managers, in the selected centres, were keen to support the study and to obtain feedback. Thus, the relevant population of radiographers were targeted, by the service managers and encouraged to participate. This may be perceived as a threat, but the responses

were collected anonymously and without intimidation. The response rate of over 58.3%, justifies the decision to administer by post and to make the personal approach. Response rates of 18% (Liu and Arnett, 2000) to 55% (NHS, 2009) identified from web link administered questionnaires, have been reported. The response from the postal questionnaire in the study at 58.3% was, therefore, above the upper margin of this range. However, the percentage response rate was quite different from each centre. It was not considered appropriate to undertake a further round of the survey, in an attempt to increase the response rate, from centres with specific characteristics. This may have had an impact on the results. Revisiting the study with a view to increase the response rates from centres with specific characteristics might have been viewed as an attempt to affect the outcome of the study. The decision to remain with the findings from the initial round of the survey, was supported by the response rate.

The analysis of the data identified a consideration, that may be an unexpected limitation of the study. Specialist interests, that were identified as a component of individuals' PDP, may have differing impacts, dependent on the individual centre. In small centres, and certainly in the rural centre in the study, radiographers, who have specialist interests or role developments, still undertake general radiography and most of them undertake general radiography OOH. This may not be the case in all centres. Thus the reflection that radiographers, who have a specialist interest or role development, may not undertake general radiography must be considered. As such, this group of radiographers would have been excluded from participation in the questionnaire. Thus, the enquiry into whether the model and the modular application of the model, would accommodate individual radiographers' specialist interest, might be valid within the population but may not be reliable in the wider radiographic population. However, this does highlight important, indirect information on role development, skills sustainability, recruitment and retention and career progression and succession planning.

9. Conclusion

The aim of this study, was to develop a workpattern model and to facilitate the re-design of the service, to meet the changing service requirements, with respect to patient and staff needs in Scottish radiology departments.

A workpattern model has been developed, that can be applied to all centres.

The workpattern model that has been developed differs slightly in the OOH situation when there is limited administrative or peer support for the radiography staff. The two tables below, that have been presented earlier as Table 10 and Table 11, demonstrate the workpattern model.

Additionally, a modular application of the staffing rota has been developed to complement the workpattern model that will facilitate the re-design of the service

9.1 Workpattern Model (Core Hours)

Patient Activity per hour	Clinical Support staff Band 1-3	Administrative support staff Band 2-4	Radiographer/ assistant practitioner assignment
1-5 patients	Yes	Yes	1x band 5/6
6-10 patients	Yes	Yes	2x band 5/6
11-15 patients	Yes	Yes	2x band 5/6 1x band 4
16-20 patients	Yes	Yes	3x band 5/6 1x band 4
21-25 patients	Yes	Yes	4x band 5/6 1x band 4
26-30 patients	Yes	Yes	4x band 5/6 2x band 4
Managerial, supervision and education			Band 7/8

- If the average activity, in a specified hour is less than 5 patients, assign a band 5/6.
- When the activity increases, by multiples of 5 patients, assign a further band 5/6, followed by a band 4.
- Ratio of 2:1 band 5/6: band 4 to ensure adequate supervision if a radiographer requires to undertake a remote task.

A band 7/8, as the most expensive resource, should be assigned within core hours for supervision, managerial and specialist guidance and to buffer excesses in demand.

9.2 Workpattern Model (OOH)

Patient Activity per hour	Clinical support staff Band 1-3	Administrative support staff Band 2-4	Radiographer/ assistant practitioner assignment
1-4 patients	No	No	1x band 5/6
5-8 patients	No	No	2x band 5/6
9-12 patients	No	No	2x band 5/6 1x band 4
13-16 patients	No	No	3x band 5/6 1x band 4
17-20 patients	No	No	4x band 5/6 1x band 4
21-24 patients	No	No	4x band 5/6 2x band 4
			Band 7/8 (only if specific skills required)

- If the average activity, in a specified hour is less than 4 patients, assign a band 5/6.
- When the activity increases, by multiples of 4 patients, assign a further band 5/6, followed by a band 4.
- Ratio of 2:1 band 5/6: band 4 to ensure adequate supervision as previously mentioned.

A band 7/8, as the most expensive resource, should only be assigned if the particular centre requires managerial, or specialist support in the OOH period.

9.3 Modular Application

A modular application, of the workpattern model, was developed to achieve the study aim. This modular application can be modified to suit local workload fluctuation. The table below (shown already as Table 12) demonstrates the working week as modules.

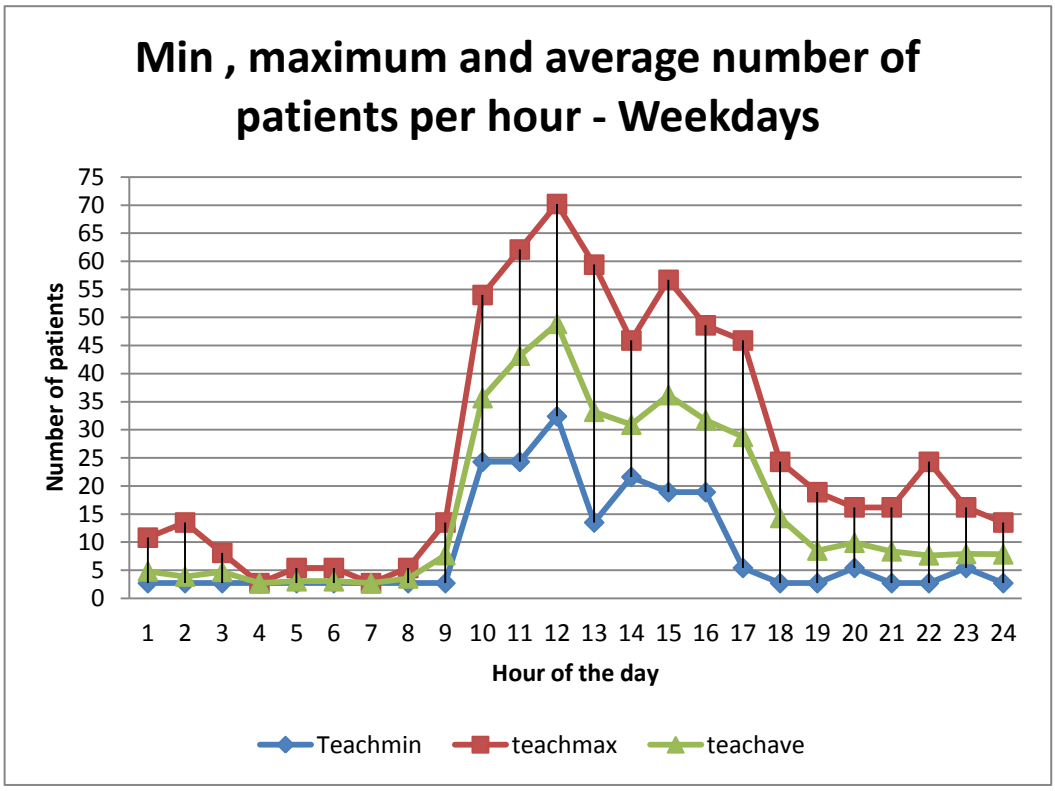
Weekly contract	Module duration	Total duty time	Modules per week
Full time (37.5hrs) + breaks	4 hours (3hrs 45mins + 15 min break)	40 hours	10 modules
30 hrs + breaks	"	32 hours	8 modules
22.5 hrs + breaks	"	24 hours	6 modules
15 hrs +breaks	"	16 hours	4 modules
7.5 hrs + break	"	8 hours	2 modules

The modules can be combined to suit local requirements e.g. full time duty may be 2 modules per day for 5 days, or 2 modules for two days, followed by 3 modules per night for two nights. Both of these roster patterns would total 10 modules.

The modular system supports skills mix, by ensuring substantial core hour placement.

The modular system is also sympathetic to part time staff who work divisions of 37.5 hours.

Modules can have varying and flexible start and finish times to suit local requirements. The chart below (shown earlier as Figure 40) demonstrates an example of the manner that workload increases and decreases throughout the day, in response to demand. Local data analysis can demonstrate the local daily trends, thus, allowing the modular system to be tailored, by adaptive planning, to local needs in terms of numbers of modules per duty period, and start and finish times for these modules.



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This modular application, supporting the workforce model, provides the framework for a sustainable, patient centred, cost effective 24 hour service, without the need for compulsory overtime.

Thus, by way of the Reliabilist theoretical perspective and by embracing the scientific, analytical and deductive approach, the study has achieved the aim of developing a workpattern model. This can be applied in every centre, regardless of workload. The modular application of the workpattern model supports local service redesign, to meet the changing service requirements surrounding advancements in NHS Scotland, for the benefit of both patients and staff in Scottish radiology departments.

10. Recommendations

The major recommendation in any workload, workforce and workpattern modelling, is understanding local data. The workpattern model is a formula that can be applied to all centres, regardless of the workload of that centre. The modular application of the workpattern model can, following local data analysis, support a cost effective sustainable service.

1. It is recommended, that all centres undertake local workload statistical analysis, on an hourly and daily basis across 24 hours, for a representative time period. As shown in the data analysis (Chapter 7), this will demonstrate the workpattern over the 24 hour period. This will facilitate derivation of the workforce required, for the workload, across the 24 hour period and support the application of the workpattern model, by adaptive planning.
2. It is recommended that workload statistical analysis is undertaken in all sites, where centres have multiple sites which undertake general radiography. The process, described above, should be undertaken for each site in each centre, unless the workload can be aggregated across sites and the workpattern across 24 hours is replicated across sites.
3. A further recommendation is that the workforce required, according to the model, should be plotted for a representative timescale. This will allow visualisation of the roster horizon and thus support the staff to envisage the roster, on an individual basis. This is essential to allow staff to appreciate the effects of the culture change, of moving to shift patterns.
4. It is recommended that skills mix must be evaluated. The workforce profile, required to deliver planned care must be considered in relation to the workforce profile, required to deliver the unscheduled care (general radiography). Lines of work across the roster horizon, for each centre, will facilitate evaluation of the skills resource.
5. The structure of the modular implementation of the workpattern model, should be considered on a local centre basis. Local workload structure and skill mix, may determine “best fit” of the modules, by adaptive planning for service sustainability.
6. Qualitative study regarding the professional concerns of the integration of assistant practitioners, in the workplace should be undertaken. There is little research, to date, into this aspect of skill mix. The model describes the skills mix required but does not address the professional issues related to the integration.
7. The methods of analysing the workload data, should be considered for workpatterns outwith radiography, with unscheduled demand and activity.

11. References

Ackroyd D, Caison A, Adams R (2002) **Patterns of Burnout among US Radiographers** Radiologic Technology Volume 73, No 3

Alfares, HK (1998) **An efficient two-phase algorithm for cyclic days-off scheduling** Computers and Operations Research; Volume 25, Issue 11: November 1998, Pages 913-923

Audit Scotland (2002) **Planning Ward Nursing – Legacy or design**

Audit Scotland (2008) **Review of NHS Diagnostics services**. ISBN 9781906752170

Azad, K (2009) **Understanding the Pareto Principle (80/20 rule)** http://betterexplained.com/articles/understanding-the-pareto-principle-the-8020-rule/ (accessed 30/12/2010)

Bach J (1999**) Heuristic Based Risk Testing**. Software Testing and Quality Engineering Magazine 11/99

Baldwin P, Newton R, Buckley G, Roberts M Dodd M, (1997) **Senior House Officers in Medicine: postal survey of training and work experience** BMJ; 314:740 (8 March)

Barnes S (2001) **Survey design Bristol Online**. Surveys knowledgebase and support http://www.survey.bris.ac.uk/support/survey-design accessed 15/7/10

Bennion C, Irvine F (2011) **Embedding the assistant practitioner role within the clinical department: a qualitative study.** Radiography volume 17; issue 4 p292-296

Bennis W (1961) **Revisionist Theory of Leadership**. Harvard Business Review

Bignardi GE (1996) **Cultural conflict in a bacteriology department**. Journal of Management in Medicine Volume: 10 Number: 3p: 49-58

Blaug R, Kenyon A, Lekhi R (2007) **Stress at Work**. The Work Foundation

Bloor K, Maynard A (2003) **Planning human resources in health care: towards an economic approach. An international comparative review**. University of York, Canadian Health Services Research Foundation

Bosanquet N, Haldenby A, Zoete H, Fox R (2006) **Staffing and Human resources in the NHS- facing up to the reform agenda**. Reform (April)

Botteri E, Sandri MT, Bagnardi V, Munzone E, Zorzino L, Rotmensz N, Casadio C, Cassatella MC, Esposito A, Curigliano G, Salvatici M, Verri E, Adamoli L, Goldhirsch A, Nolè F. (2009) **Modelling the relationship between circulating tumour cells number and prognosis of metastatic breast cancer**. Breast Cancer Research and Treatment. December

Boynton P, Greenhalgh T (2004) **Selecting, designing and developing your questionnaire**. BMJ vol 328 May. London

British Medical Association (BMA) (2006) **Joint Position Statement on on-call Rooms** http://www.bma.org.uk/ap.nsf/Content/jntposstmtsleep (accessed 18/6/08)

British Society of Gastroenterologists (2001) **Provision of Endoscopy Related Services in District General Hospitals**. BSG Working Party Report.

Buffa E, Cosgrove M, Luce B, Ellewood S (2007) **An integrated work shift scheduling system**. Decision Sciences Volume 7, Issue 4; 620-630

Cancer Services Collaborative (2005) **Introduction of a booking and scheduling system evens out workload and reduces stress on nursing staf**f. NHS Chemotherapy Services

Caplan D (2003) **Management accounting: concepts and techniques Part 3: Product costing and cost allocations.** Oregon State University. http://classes.bus.oregonstate.edu/spring-06/ba422/Management%20Accounting%20Chapter%2012.htm (accessed 12/6/10)

Chartered Institute of Personnel and Development (updated January 2009) **Psychological contract** http://www.cipd.co.uk/subjects/empreltns/psycntrct/psycontr.htm?IsSrchRes=1 (accessed27/5/09)

Chatfield C (2004) **The analysis of time series, an introduction** 6th edition. New York Chapman and Hall

Clinical Molecular Genetics Society (CMGS) (2004-5) **Workload Units Scheme**

Conway, N. and Briner, R. (2005) **Understanding psychological contracts at work: a critical evaluation of theory and research.** Oxford: Oxford University Press.

Coombs C R, Park J R, Loan-Clark J, Arnold J, Preston D, Wilkinson A J, (2003) **Perceptions of Radiography and the National Health Service: a qualitative study,** Radiography, 9(2), pp. 109–122

Coyle-Shapiro J, Kessler I (2000) **Consequences of the psychological contract for the employment relationship: a large scale survey**. Journal of Management studies 37:7 0022-2380

Crotty, M (1998) **The foundations of social research** Sage: London

Curvefit.com (1999) **The difference between Linear and non-linear regression**. http://www.curvefit.com/linear_vs__nonlinear.htm (accessed December 2009)

Day P, Ryan D, (1997) **Flight attendant rostering for short-haul airline operations.** Operations Research October: 45; 5

Department of Health (1991) **Hours of Work of Doctors in Training: working arrangements of Doctors and Dentists in Training**. NHS Management Executive

Department of Health (2003 -1) **Radiography Skills Mix:** London. Department of Health

Department of Health (2003- 2) **Modernising Medical Careers**: Department of Health

Department of Health (2004) **Agenda for Change** (Final Agreement): London. Department of Health.

Department of Health (2006**) Combined Predictive Model** – Final Report: London. Department of Health

Department of Health (2007) **The Ionising Radiation (Medical Exposure) Regulations (IR(ME)R, 2000/2006 (together with good practice notes).** http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4007957

Direct Gov (2008) **Working Time Limits (48 hour week)** http://www.direct.gov.uk/en/Employment/Employees/WorkingHoursAndTimeOff/DG_10029426 (accessed 10/3/09)

Dodin B, Eliman A, Rolland E (1998) **Tabu search in audit scheduling.** European Journal of Operational Research 106 p373-392

Downsland K (1998) **Nurse scheduling with tabu search and strategic oscillation**. European Journal of Operational Research. 106; 393-407

Downsland K, Thompson JM (2000) **Solving a nurse scheduling problem with knapsacks, networks and tabu search.** Journal of Operational Research 51; 825-833

Doyle L, Cameron A (2000) **Reshaping the NHS Workforce**. British Medical Journal 320; 1023-1024

Emerald Group Publishing Ltd (1997) **Engaging with Staff.** Leadership in Health Services. Volume 21; Issue 4. ISSN 1751-1879

Ericksen CA, Kecklund G (2007) **Sleep, sleepiness and health complaints in police officers: the effects of a flexible shift system**. Industrial Health 45, 279-288

Ernst AT, Jiang H, Krishnamoorthy M, Sier D (2004) **Staff Scheduling and rostering: a review of applications methods and models**. European Journal of Operational Research 153; 3-27

eSurveysPro.com (2008) **Writing great questions for surveys**. http://free-questionnaire-templates.esurveyspro.com/index.php/2008/10/08/survey-design-writing-great-questions-for-online-surveys/ accessed 15/6/10

Evans, GJ (1995) **Organisational Change** CVR/IT Consulting

Gillespie DR (1991) **Burnout among health service providers.** Administrative Policy in Mental Health 118:161-171

Guest, D.E. and Conway, N. (2002) **Pressure at work and the psychological contract**. London: CIPD

Hardcastle JD, Chamberlain JO, Robinson MH, Moss SM, Amar SS, Balfour TW, James PD, Mangham CM.(1996) **Randomised controlled trial of faecal-occult-blood screening for colorectal cancer**. Lancet. Nov 30; 348(9040):1472-7

Hassan TB, Smith MR, Lovell S, McMaster R, Stevens D, Khan A, Crane S, Gray A, Hamer DW(2001) **Clinical decision units in Emergency Medicine - How to make them work.** Leeds Teaching Hospitals

Hassan TB (2003) **Clinical Decision Units in the Emergency Department: old concepts, new paradigms and refined gate keeping**. Emergency Medicine Journal 20:123-125

Hayes C, Weathington B (2007) **Optimism, Stress, Life satisfaction and job burnout in Restaurant Managers** The journal of Psychology 141(6) 565-579

Health and Safety at Work Act (1974) Legislation.gov.uk http://www.legislation.gov.uk/ukpga/1974/37/contents (accessed 30/12/2010)

Health and Safety Executive (2009) **Working Alone** ISBN 978 0 7176 6371 2.

Healthlink (1999) **Sleep and Circadian Rhythm.** Medical College of Winsconsin. http://healthlink.mcw.edu/article/922567322.html (accessed 16/8/08)

Health, Social Services and Public Safety (2008) **Caseload Management Model** HSS (OSUIDE/RIT) 1-2008 www.dhsspsni.ov.uk

Hedges, A (1997) **Testing to Destruction Institute of Practitioners in Advertising.** Colourtech Group Ltd. London

Henderson S, Mason A, Ziedins I, Thomson R, (1999), **A Heuristic for Determining Efficient Staffing Requirements for Call Centres,** School of Engineering Technical Report 594.

Higgs J, Horsfall D Grace S (2009) **Writing Qualitative Research on Practice** Sense Publishers Rotterdam/Boston/Taipei

High Investments Group (2009) **Technical Analysis Glossary** http://www.trading-glossary.com/s0259.asp (accessed 12/12/09)

HMSO (1998) **Working Time Regulations** Statutory Instrument 1998 No. 1833

Hom J (2003) **Heuristic Evaluation** http://jthom.best.vwh.net?usability/heuristic.htm (accessed 14/7/09)

Hospital Services- National Statistics Online (2003) www.statistics.gov.uk/cci/nscl.asp?ID=6404 *(*accessed 18/9/09)

Howitt D, Cramer D (2000) **First steps in research and statistics.** London. Routledge.

Human Resource Development (HRD) Group (2005) **Attitude survey.** http://www.attitudesurvey.co.uk?as_why/as_why_01.htm accessed 15/7/10

Hutt R, Buchan J (2005) **Trends in London's NHS Workforce**. King's Fund Working Paper

Iglesias C. Torgerson D. (2000) **Does length of questionnaire matter? A randomised trial of response rates to a mailed questionnaire.** Journal of Health Services & Research Policy; **5**: 219-21.

Ionising Radiation (Medical Exposures) Regulations

ISD (2000) Scottish Health Statistics, Section M12, Diagnostic services. http://www.isdscotland.org/isd/files/M12_2000.pdf (accessed 16/7/10)

ISD (2006) National Census of Allied Professionals http://www.isdscotland.org/isd/data-development-dev-info.jsp?pContentID=1359&p_applic=CCC&p_service=Content.show& NHS Services Scotland (accessed 15/7/09)

ISD (2008-1) Radiology tables - costs and activity. http://www.isdscotland.org/isd/costs-book-detailed-tables.jsp?pContentID=3582&p_applic=CCC&p_service=Content.show& (accessed 16/7/10)

ISD (2008-2) AHP workforce information http://www.isdscotland.org/isd/5332.html (accessed 16/7/10)

ISD (2008-3), Radiology Statistics http://www.isdscotland.org/isd/3582.html NHS Services Scotland (accessed 15/7/09)

Jenkins-Clarke S (1992) **Measuring Nursing Workload: A cautionary tale.** Centre for Health Economics: University of York

Jones A, Visser F, Coats D, Bevan S, McVerry A, (2007) **Transforming work: reviewing the case for change and new ways of working**. The Work Foundation Equal Opportunities Commission.

Judge TA, Locke EA, Durham CC (1998) **The dispositional causes of job satisfaction: A core evaluations approach.** Research in Organisational Behaviour 19, 151-188.

Kecklund G, Eriksen CA, Akerstedt T (2008) **Police officers attitude to different shift systems: association with age, present shift schedule, health and sleep/wake complaints.** Applied Ergonomics; 39 565-571

Knauth P and Hornberger S (2003) **Preventive and compensatory measures for shift workers**. *Occupational Medicine*; 53:109–116.

Kulatunga H, Knottenbelt WJ Kadirkamanathan *V* (2009) **Adaptive Planning of Staffing Levels in Health Care Organisation Imperial College London.** www.doc.ic.ac.uk/~hkulatun/papers/eHealth2009.pdf (accessed 10/7/10)

Lancaster University (2000) **Workload Measurement Scheme** www.lancs.ac.uk/sci-tech/docs/**workload measurement** policy.pdf (accessed 11/7/10)

Lane, DC Monefeldt C and Rosenhead JV (2000) **Looking in the wrong place for Health Service Improvements: A system dynamics study of an Accident and Emergency Department**. Journal of the Operational Research Society 51; 518-531

Lewin K (1948**) Resolving Social Conflicts: Selected Papers on Group Dynamics**. New York: Harper & Row.

Lindsay JK (2004) **Statistical Analysis of Stochastic Process in Time**. Cambridge University Press ISBN 9780521837415

Liu C, Arnett K (2000) **Exploring the factors associated with Web site success in the context of electronic commerce.** Information and Management 38, 23-33

Loucks J, Jacobs F (2007) **Tour Scheduling and Task Assignment of a Heterogeneous Work Force: A Heuristic Approach.** Decision Sciences Volume 22 Issue 4, P719 - 738

Lopez-Casasnovas, G (1998) **Cost -containment in health care: The case of Spain from the eighties up to 1997**. Economics Working Paper 278 Centre de Recerca en Economia i Salut Working Paper 6

Lowden A, Kecklund G, Axelson J, Akerstedt T (1998) **Change from an 8 hour shift to a 12 hour shift, attitudes, sleep, sleepiness and performance**. Scandinavian Journal of Work, Environment and Health; 24 suppl 3:69-75

Mansuri, N (2009) **Weighed down by caseloads** http://www.communitycare.co.uk (accessed 25/8/09)

Mark A, Spallek M, Kessel R, Brinkman E (2006) **Shift work and pathological conditions**. Journal of Occupational Medicine and Toxicology 1:25

Maslach C (1982) **Burnout: a social psychological analysis cited in Sanders G, Suls J The Burnout Syndrome** Park Ridge: London House 1982

Mather H (2001) **The RCP Specialist Registrar Shift Survey**. The Royal College of Physicians. London

McLoughlin M, Armstrong P, Byrne M, Heaney D, O'Brien N and Murphy AW (2005) **A comparative study on attitudes, mental health and job stress amongst GPs participating, or not, in a rural out-of-hours co-operative** Family Practice 22(3):275-279;

Meyer J, Markowitz R (1997) **A database Program for Management of Staff Scheduling in a Radiology Department**. American Journal of Radiology: 169 December.

Miller L, Price R, Hicks B, Higgins T (2011) **Second phase evaluation of the introduction of Assistant Practitioners in Imaging Services in Scotland: Final report to NES.** Institute for Employment Studies

Milne J (1999) **Advantages and Disadvantages of questionnaires**. Evaluation cookbook. Learning Terminology Dissemination Initiative. Aberdeen University

Mind tools (1995-2009) **Heuristics Methods** http://www.mindtools.com/pages/article/newTMC_79.htm (accessed 14/7/09)

Mind Tools Ltd (1995-2010) **Cost Benefit Analysis** http://www.mindtools.com/pages/article/newTED_08.htm (accessed 6/7/10)

Mogey N (1999) **So you want to use a Likert Scale**. Evaluation Cookbook. Learning Terminology Dissemination Initiative. Herriot Watt University

Mountford, L (2004) **Using an assessment tool for mental health referral**. Nursing Times. Net**.** http://www.nursingtimes.net

Mudvalley Marketing Community (2009) **Designing a Questionnaire.** http:// www.mudvalley.co.uk/collateral/content/51.htm (accessed 15/9/10)

Murray A, Pounder R, Mather H, Black C (2005) **Junior doctors' shifts and sleep deprivation.** BMJ. June 18: 330(7505): 1404

Napier University (2007/8) **Workload Allocation model**

NHS (2009-1) Staff survey http://www.nhsemployers.org/EmploymentPolicyAndPractice/staff-engagement/NHS%20staff%20survey/Pages/Staff%20survey%20results%202009.aspx (accessed 30/10/10)

NHS (2009-2), **What are Health Resource Groups (HRG**). The information Centre for Health and Social Care. http://www.ic.nhs.uk/services/the-casemix-service/new-to-this-service/what-are-healthcare-resource-groups-hrgs (accessed 15/12/09)

NHS (2011)
http://www.connectingforhealth.nhs.uk/systemsandservices/data/nhsdmds/faqs/atoz/radiology
(accessed 10/4/11)

NHS 24.com (2008) **Health Advice and self help information for Scotland**
http://nhs24.com/content/default.asp?page=s24 (accessed 16/6/08)

NHS Education Scotland (NES) (2006) **Role Development for Radiographers, & Radiography Support Staff within Scotland** NES, Edinburgh.

NHS Education Scotland (NES) (2007) **Skills Maximisation Toolkit**. www.nes.scot.nhs.uk (accessed 13/4/10)

NHS Hospital at Night (2008) http://www.healthcareworkforce.nhs.uk/hospitalatnight.html (accessed 15/6/08)

NHS Networks, (2009) **Combined Predictive Model** www.networks.nhs.uk
(accessed 25/8/09)

NHS Scotland (2008) **Developing Workforce Planning Capability in Scotland** The Knowledge Network
http://www.workforceplanning.scot.nhs.uk/home.aspx

NHS Scotland (2011) **MDICN** http://www.imagingnetwork.scot.nhs.uk/ (accessed 20/5/11)

NHS Tayside (2009) **Bowel Screening Programme- Report on the Pilot 2001-2007**

Nicol A, Botterill J (2004) **On-call work and health: a review**. Environmental Health: A Global Access Science Source 2004, 3:15

Nolan M (2009) **Organising the workload of Individual Workers: The effects of a workload model**. University of Hull

North Bristol Trust (2009) **Questionnaire Design Helpsheet** Research@NBT

O'Brian-Pallas L, Birch S, Baumann A Tomblin Murphy G(2001) **Integrating Workforce Planning, Human Resources and Service Planning.** World Health Organisation Department of Organisation of Health Services Delivery

Open University: **Key Skill Assessment unit** (2007) Learning Space.
http://openlearn.open.ac.uk/mod/oucontent/view.php?id=398952&direct=1 (accessed 18/7/09)

Oxford Journals (2009) **Multiple Regression Analysis Oxford University Press**
http://www.oxfordjournals.org/tropej/online/ma_chap3.pdf (accessed 7/12/09)

Palmer (1989) **Occupational Stress quoted in Blaug et al (2007) Stress at Work**. The Work Foundation

Pearl, J (1983). **Heuristics: Intelligent Search Strategies for Computer Problem Solving.** New York, Addison-Wesley, p. vii.

Puffer S. Porthouse J. Birks Y. Morton V. Torgerson D (2004). **Increasing response rates to postal questionnaires: a randomised trial of variations in design**. Journal of Health Services & Research Policy; **9**: 213-7.

Rail Safety and Standards Board (RSSB) (2004) **Feeling Tired – Fatigue and shiftwork** www.rssb.co.uk/pdf (accessed 16/6/08)

Raymond (2000) **Stress the Real Millenium Bug, Health and Safety Executive quoted in Blaug et al (2007) Stress at Work.** The Work Foundation.

Richardson G. (1999) **Identifying, evaluating and implementing cost-effective skill mix.** Journal of Nursing Management Sep; 7(5):265-70

Royal College of Radiologists (1999) **Workload and Manpower in Clinical Radiology RCR** London

Royal College of Radiologists (2007) **Making the best use of clinical radiology services 6th edition.** RCR London

Royal College of Radiologists (2008) **Clinical Imaging Requests from Non Medically Qualified Clinicians**. London ISBN 1-904114-39-3

Royal College of Radiologists (2008) **How many radiologists do we need? A guide to planning hospital services.** RCR London

Ryan DM (1992) **The Solution of Massive Generalised Set Partitioning Problems in Aircrew Rostering.** Journal of Operations Research Vol 43, No5 pp459-467

Saunders M Lewis P Thornhill A (2007). **Research methods for business students.** 4th ed. London: Prentice Hall.

Scottish Government (2002) **Resource Use Measure (RUM)** Circular No CCD 9/2002

Scottish Government (2004) **Decide to Admit V Admit to Decide** Unscheduled Care Collaborative

Scottish Government (2005**) An Introduction to Unscheduled Care Programme** http://www.scotland.gov.uk/Resource/Doc/141079/0034895.pdf (accessed 18/6/08)

Scottish Government, (2006-1) **The Planned Care Improvement Programme: Go with the Flow** ISBN 0-7559-5156-5

Scottish Government (2006-2) **Diagnostics Collaborative Project Plan** www.scotland.gov.uk/Publications/2006/03/.../2 (accessed 13/5/10)

Scottish Government, (2007-1) **Unscheduled Care Collaborative Programme: Local Changes for Improvement: The Journey, Ideas and Accomplishments: Case Study Examples**. ISBN 978-0-7559-5583

Scottish Government, (2007-2) **National Benchmarking Project** http://www.scotland.gov.uk/Publications/2007/04/02091848/1 (accessed 16/6/11)

Scottish Government, (2008-1) **Diagnostics Collaborative Programme: Delivering Better Patient Care in Diagnostics** ISBN 978-0-7559-5576

Scottish Government (2008-2)**18 weeks: The Referral to Treatment Standard**. ISBN 978-0-7559-5683 8

Scottish Government (2009) **NHS Scotland. Report of the Diagnostics Steering Group.** Blackswells. Edinburgh.

Scottish Intercollegiate Guidelines Network (2009) **Guideline 110, Early Management of Patients with a Head Injury**. NHS Quality Improvement Scotland

Smith FJ (2005) **Conducting your pharmacy practice research project**. London: Pharmaceutical http://www.scotland.gov.uk/Publications/2007/04/02091848/1Press.

Smith, M (2008) **Sleep and Circadian Rhythm Disorders**. http://www.webmd.com/sleep-disorders/guide/circadian-rhythm-disorders-cause (accessed 26/11/09)

Society of Radiographers (2005) **Implementing Radiography Career Progression: Guidance for Managers**. London

Society of Radiographers (2008) **Around the clock A negotiators Guide to the working time regulations; shift work and flexible working.** London

Society of Radiographers (2010) **Medical Image Interpretation by Radiographers: Definitive Guidance**. London

Stanford Encyclopaedia of Philosophy (2005) **Epistemology** http://plato.stanford.edu/entries/epistemology/#JTB

Stubbings L, Scott J (2004) **NHS Workforce issues: implications for future practice.** Journal of Health Organisation and Management Vol18 No 3 p179-194

Taylor, R (2001) **The Future of Worklife Balance** Economic and Social Research Council

Trochim W (2006) **Type of Questions**. Research Methods Knowledge Base: web centre for social research methods http://www.socialresearchmethods.net/kb/questype.php

Tsushima I, Komoda N, Yagi M, Kusuzaki (1989) **Job Scheduling and method system**. US Patent 4,852,001

Thomas, C and Slater, R (2009) **Introduction to Questionnaire Design**. The Open University. U501 workshop

Unison (2008) **Progress report on safeguarding**. Unison memorandum to Lord Laming

Wanless D (2002) **Securing our Future Health: taking a Long Term View**. The Public Enquiry Unit. HM Treasury London

Wedderburn A, Smith P (1998) **Case Study**- Journal of Employee Relations vol 20 no 5 ISSN 0142-5455

Weller D, Alexander F (2003) **Evaluation of the UK Colorectal Screening Programme**. The UK CRC Screening Pilot Evaluation Team

West of Scotland Regional Planning Group (2009) **Radiography Out of Hours Framework**

Whitmore D (2008) **Heuristics**. Mangers Net http://managers-net.org/heuristics.html (accessed 15/7/09)

Xue J, Ma J. Louis T, Collins, A (2001) **Forecast of the Number of Patients with End-Stage Renal Disease in the United States to the Year 2010** Journal American Society of Nephrologists 12:2753-2758

12. Appendix 1 Principal Study Centre- local foundation research

12.1 Staff Opinions – OOH duties

The majority of radiographers, in the local study centre, are clear that the OOH burden is frustrating, trying, tedious and thankless. A survey of staff opinions on issues relating to OOH, was undertaken by staff representatives, in the principal study centre, as a prelude to considering the redesign of the OOH duties in this centre. This was intended as a focus, or wish list, to act as a background to later discussion and was an anonymous survey. The survey was simply administered by an open question, that sought radiographer concerns, in relation to OOH work in general radiography and a further survey, with a similar question, regarding additional issues of CT on-call. Most of the radiographers who undertake CT on-call duties, are also required to undertake general radiography OOH, in the principal study centre. This has the difficulty of ensuring that the two duty rosters are aligned and increases the perceived pressures of duties required, in addition to normal working hours. A further component of the survey, sought radiographers' perceptions of solutions to the issues of concern. It was therefore, useful to consider the themed issues raised by the radiographers, in relation to the literature. This allowed a baseline investigation of attitudes in the principal study centre, that will offer background information to this study.

12.1.1 General radiography issues

Risk of mistakes

This point was raised as there has been an increase in the number of administrative mistakes, during the periods of OOH duty. These mistakes carry clear potential clinical risk, in that the wrong patient may be examined (which is a radiation hazard), or an image may be wrongly identified, leading to the wrong patient having treatment. BMA, (2006) indicates that the number of mistakes increases with tiredness, as the body is not as alert during the night time hours.

Safety issues;

Lone working, unescorted patients, manual handling issues and security issues, are points that were raised several times, and are all related to the issue of working alone. The OOH cover in the principal study centre, is a lone working radiographer. Team working, is noted as a support mechanism for working OOH, and for reducing the risks associated with tiredness e.g. Hospital @Night Team (NHS, 2008). Radiographers are not included as part of this team and work in isolation.

Complexities of general radiography on-call rota

The length of duties is too tiring. This point was raised by many staff. As literature indicates, on-call is an acceptable and cost effective method of covering essential duties OOH, when the workload is insufficient to warrant a full shift system (Nicol and Botterill, 2004). However, Nicol and Botterill (2004) also indicate that when the calls for duty exceed occasional calls and sleep is regularly disturbed, then the duty becomes the equivalent of an overtime duty and a night shift.

The staff are of the opinion, that there are insufficient staff on the rota. Hutt and Buchan, (2005) suggest that staff shortages have detrimental effects on retention, and that this subsequently affects recruitment. Skills mix (NES, 2006) requires specific training, and necessitates staff to be available to deliver planned care. This restriction imposed by skills mix requirements, exacerbates rota cover by limiting the staff who are available for OOH duties. There is disturbance of sleep hours, several times every night (Smith, 2008). The extent of the disturbance (how long each episode of each sleep disturbance lasted) is more difficult to identify, but contributes to the perception of chronic sleep deprivation. The additional factor of lone working and tiredness, increases the effect of the workload and indeed, individually perceived stress levels. The definition of stress (Raymond, 2000) indication that stress is the individual reaction to excessive demands, when they worry that they cannot cope, may explain staff discomfort during this period. Taylor, (2001) discusses flexible working and indicates, that there are situations where flexible working, addresses a personal agenda at a specific time. The literature also warns of the pitfalls, of trying to alter the flexible arrangement when the agenda changes. It can be difficult to reverse the trends. Rostering of the OOH duties and integrating part time duties with skills mix dutie,s offers very little flexibility within the current regime.

12.1.2 Additional issues for Ancillary on-call (CT rota)

Many of the issues above are relevant, also, to the ancillary on-call rota e.g. potential long and tiring duties, risk of mistakes and safety issues. In addition, many of the staff who undertake OOH duties, within the general radiography department, also have a commitment to OOH duties within the CT department. This is a requirement for the radiographer wishing to extend their role into CT scanning.

CT on-call further limits the social activities that can be undertaken and thus increases the stressors in work-life balance. Literature regarding on-call, indicates that the circle of family and friends, of the individual undertaking the on-call commitment, require to accommodate the on-call rota when scheduling day to day social activities (Nicol and Botterill, 2004). Nicol and Botterill, (2004) indicates that

on-call is a cost effective arrangement for businesses, where there requires to be cover for immediate situations but there is insufficient work to warrant a full shift system. This is the case with CT on call though, the payment is not perceived to reflect the disruption to family and social arrangements.

Complexities of Ancillary on call rota (CT)

The CT on-call staff, provide a backfill for the main department radiographer, on occasions when the workload cannot be managed by a lone worker e.g. Road traffic trauma. This cover is an additional pressure on the CT radiographers, who already cover their own share of general department on-call, and their share of CT department on call. This again, raises the perceived stress, for the CT radiographers who undertake general OOH.

Staff consider, that participation in both the CT and general department weekend rosters, is unfair in terms of commitment. This sentiment is understandable. The contract requires participation in OOH duties, however, all staff are required to have a nominal participation in the general OOH duties, as these are heavy and tiring duties and the maximum number of staff are required to dilute the frequency of these duties. However, a condition of training and participating in CT and so enhancing career prospects, is to participate in CT OOH duties. Conway and Briner, (2005) indicates, work- life balance and the psychological contract, is an important, though not legally binding contract. When staff consider that the management do not appreciate the stress of the duties involved, then they can take a different view on the requirements of the duties. There is no easy solution to the OOH issue, as measures that would reduce stress to one group of staff, will increase stress to another.

12.1.3 Suggestions

The radiographers suggested some solutions to the perceived issues. These are discussed below, as there may be some elements that can inform the development and implementation of the workpattern model.

Staff resource

Jenkins-Clarke, (1992) indicates that studying local data and understanding the data, in the context of the individual study centre, is of paramount importance, in ensuring that there is sufficient, but not excessive, cost effective resource to match workload. The local workload data will facilitate workpattern modelling.

Experience of other centres, indicates that OOH duties, are sometimes covered by staff, specifically employed for these OOH duties. Theoretically, this can work. However, it must be understood by staff, that these hours become core hours of duty. When the staff employed to cover these duties, are either

sick, or on annual leave, these duties must be covered by the main cohort of staff. This often then makes this an unpopular option. This arrangement can be considered as flexible working, that suits personal agendas for childcare etc, but undertaking OOH duties, as the core component of the role, may offer few opportunities for career development or training. It may be difficult to move away from the flexible duties, when the personal agenda alters (Taylor, 2001). Part time staff being recruited for an evening shift, has been suggested by staff. The notion of recruiting part time staff for this twilight duty, has the same problems as employing staff for OOH as above. These duties, would have to be covered by the main cohort of staff, when twilight duty staff, are either sick or on annual leave.

There was a suggestion of an alteration in roster alignment, to align a limited CT commitment and a limited general radiography commitment. This is understandable, and the ethos of this is laudable. This all agrees with Taylor, (2001) that flexibility is often challenging, when unpopular duties require to be covered, during periods of annual leave and sick leave. A further suggestion was a single roster encompassing CT, and general department on-call. This is, perhaps, the most logical but the most challenging suggestion raised. In this case, skills mix and the requirements of an ancillary rota, have a great impact on the cover OOH, as well as an impact on core duty hours. In developing a workpattern model, the requirements for many of the pool of staff, to provide ancillary (CT) on-call cover, must be appreciated and integrated. There are no easy solutions to the very sensible suggestion, but the ethos of this suggestion should be embedded in the workforce model developed.

Financial recompense;

Nicol and Botterill, (2004) indicates, that on- call, is a cost effective method of ensuring round the clock coverage, when the workload does not warrant a full shift system. The workload in the principal study centre, may be considered to be more than an on-call requirement, and not properly recompensed for the work involved.

The reference to financial recompense, may represent, the concern that on-call is an essential method of topping up the salary. A component of the staff, are worried about any proposal, which would reduce the financial uplift of OOH duties. This extreme viewpoint would seem to be in the minority, however, must be considered in relation to any change management and implementation strategy. This is a factor mentioned by the Society of Radiographers, (2008) where staff must fully agree, that shift systems are to be established, due to the potential loss of the financial uplift from on-call.

12.2 Local topical research

Mudvalley, (2009) recommend exploratory research, before designing a questionnaire or survey for quantitative analysis. The exploratory phase described above, was aimed at obtaining a broad understanding of the subject. This gave the general picture, from which more detailed and defined questions were formulated. In the principal study centre, the initial exploratory research, was undertaken by a committee, formed at management request, to represent the radiographers. The feedback from the exploratory research, identified topics that were of concern across the staff group. It was of interest, that all of the factors identified in the exploratory research, had been addressed within the literature, as broad issues pertaining to workforce in all industries. However, this research was mainly undertaken to consider issues regarding the OOH duties, with no particular focus on how the OOH duties impact on role development and vice versa. The research identified the broad topics; nevertheless, it was important to explore the issues in greater depth and broader context, and to look for correlations of characteristics (Howitt and Cramer, 2000).

Thus, a small local survey by questionnaire, was developed by the principal investigator in this study, with the intention of exploring the radiographers attitudes, in more detail and by quantitative analysis. This study will also explore correlation of characteristics. The questionnaire was administered to radiographers in the principal study centre. The data gleaned from this staff attitude survey, based on the topics identified in the exploratory research, will inform on issues related to the application of the workpattern model (Kecklund et al, 2008). The effect that undertaking OOH duties has on work-life balance, skills mix and role development, was also explored, as service sustainability, staff health and well being, must be considered when reviewing service.

There was no application for research permission submitted, as this a service review. The questionnaire was submitted to the local Clinical Governance Department, to ensure that no questions were considered inappropriate to the circumstances. The proposal to administer the questionnaire, was discussed with the radiographers in the local study centre. This opportunity to voice anonymous opinion to hospital management, was grasped with enthusiasm. The usual standards for questionnaire administration were observed. The responses were anonymous. Cross referencing of attributes to attitudes, was not undertaken, as this would compromise anonymity due to the small staff complement. The responses were presented to both the staff representatives, and to hospital management, during the workup to the OOH review.

12.2.1 OOH Questionnaire

Section 1. This relates to the Hospital where you currently work and to the duty pattern. Please tick the relevant option(s)

1. Do you undertake OOH duty by (tick all relevant)

☐ shift (weekday)

☐ shift (weekend)

☐ standby (residential on call)

☐ on call

☐ do you undertake duties involving lone working

2. Do you undertake a role development or have a specialist radiographic interest or skill

☐ yes ☐ no

Section 2. This section involves statements that are related to how you perceive workload stressors of the OOH duties and the relation of OOH to role development. Please circle the response closest to your opinion

"Stress is the reaction people have to excessive pressures or other types of demands placed upon them. It arises when they worry that they cannot cope" (Raymond, 2000).

3. Lone working does not put patients at risk

Strongly disagree disagree no strong opinion agree strongly agree

4. Lone working is a risk to my health and safety

Strongly disagree disagree no strong opinion agree strongly agree

5. The workload OOH is too diverse (many points of delivery) to deal with

Strongly disagree disagree no strong opinion agree strongly agree

6. OOH workload can be prioritised and managed without problem

Strongly disagree disagree no strong opinion agree strongly agree

7. I often feel stressed when working OOH

Strongly disagree disagree no strong opinion agree strongly agree

8. OOH duties are too long

Strongly disagree disagree no strong opinion agree strongly agree

9. The frequency of OOH duties is about right

Strongly disagree disagree no strong opinion agree strongly agree

10. I am tired because of the length of the duty

Strongly disagree disagree no strong opinion agree strongly agree

11. It is easy to sleep after OOH duty

Strongly disagree disagree no strong opinion agree strongly agree

12. I feel that it takes several days to recover from an OOH duty

Strongly disagree disagree no strong opinion agree strongly agree

13. It is difficult to arrange time off around the duties.

Strongly disagree disagree no strong opinion agree strongly agree

14. I feel that OOH duties are shared out equitably

Strongly disagree disagree no strong opinion agree strongly agree

15. Generally, OOH duties interfere with maintaining skills in my specialist interest

Strongly disagree disagree no strong opinion agree strongly agree

16. My developed role can be organised around OOH duties

Strongly disagree disagree no strong opinion agree strongly agree

Section 3. This section involves statements that relate to work/life balance. Please circle the response closest to your opinion

17. The financial uplift from OOH duties is very important to me to support my work/life balance

Strongly disagree disagree no strong opinion agree strongly agree

18. I am satisfied with the current work schedule

Strongly disagree disagree no strong opinion agree strongly agree

19. I get full value from my free time

Strongly disagree disagree no strong opinion agree strongly agree

20. I am too tired to value my free time

Strongly disagree disagree no strong opinion agree strongly agree

21. I feel stressed balancing work and other responsibilities

Strongly disagree disagree no strong opinion agree strongly agree

22. Do any of the following hinder you in balancing your work and personal relationship commitments?

	Yes	**No**	**Not applicable to me**
Negative attitude of managers			
Negative attitude of colleagues			
Negative attitude of team members			
Long work hours culture as the accepted norm			
Other (specify)			

23. Do any of the following hinder you in balancing your work and personal relationship commitments?

	Yes	No	Not applicable to me
Long work hours			
Compulsory standby/on call			
Weekend work			

Section 4. The following pairs of statements are aimed at eliciting your personal preferences to workplace models. Please tick the statement from each pair that is nearest to your personal preference.

24. ☐ I like the challenge and responsibility of working alone

☐ I prefer the support of team working

25. ☐ I like the flexibility of working OOH duties

☐ I prefer the workplace structure of core daytime duties

26. ☐ I like working core daytime hours

☐ I prefer working OOH

27. ☐ I like the responsibility of a developed role

☐ I prefer the confidence of being "one of the team"

Section 5. The following questions relate to training and development within your job. Please circle the option closest to your opinion

28. I am satisfied with the training and development opportunities made available to me

Strongly disagree disagree no strong opinion agree strongly agree

29. My commitment to OOH adversely affects my training and development opportunities

Strongly disagree **disagree** **no strong opinion** **agree** **strongly agree**

30. My training, learning and development has helped me to do my job better.

Strongly disagree **disagree** **no strong opinion** **agree** **strongly agree**

31. My training, learning and development has helped me stay up-to-date with my job.

Strongly disagree **disagree** **no strong opinion** **agree** **strongly agree**

32. My training, learning and development has helped me stay up-to-date with professional requirements.

Strongly disagree **disagree** **no strong opinion** **agree** **strongly agree**

Section 6. The following questions are about you

33. Which AfC Band are you?

5 ☐ 6 ☐ 7 ☐ 8 ☐

34. Age: 21-30☐ 31-40☐ 41-50☐ 51-65☐

35. Health

Overall, how would you rate your health? (please circle appropriate response)

Excellent **Good** **Fair** **Poor** **Very poor**

36. What is your household status? (tick all that apply)

☐ Living with a partner

☐ Live alone

☐ Responsible for dependents (either children, elderly relatives or disabled persons)

☐ Other (please specify)

37. If there is anything further that you would like to say regarding on-call or the relationship of on-call to role development, please add comments here. Please feel free to continue on a blank sheet of paper

Thank you for your time

Fiona Hawke

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12.2.2 OOH Questionnaire Findings

Questionnaire Report – Radiology OOH Steering Group

Executive summary

Aim

Recent advances in role development and the introduction of the 4 tier structure have altered the balance of duties undertaken by radiographers to meet service requirements. This alteration in duties has a potential impact on the staffing of the radiographic service OOH.

This questionnaire seeks to consider staff attitudes to the current OOH service provision and the impact of role development

Correlation

It was agreed that, due to the small local sample, correlations between attributes and attitudes would not be undertaken, as this may result in anonymity being compromised.

Correlations are made only to illustrate specific responses.

Response rate

24 questionnaires were administered with 23 being returned to the collection point. However 1 questionnaire was submitted (in a sealed envelope) completely blank. Therefore 22 questionnaires were submitted with responses. This is an excellent response rate of 91.66% and reflects the importance that staff attaches to this topic.

Review of Section 1

Section 1 relates to the current duty pattern worked by the individual

18 out of 22 respondants undertake OOH duties by shift arrangements. 16 of these respondents also undertake stand by duties. 10 respondents undertake on-call. This may be in addition to stand by and/or shift arrangements.

18 respondants indicate that they undertake duties that involve lone working.

20 of the 22 respondants indicate that they have either a developed role or a specialist interest

Review of Section 2

Section 2 involved statements that are related to how workplace stressors are perceived in the OOH situation and the relation of OOH to role development.

A definition of stress was provided as a standard.

Staff attitudes identified that

- Lone working puts patients at risk
- Lone working is a risk to their individual health and safety
- The workload is too diverse to deal with
- There may be difficulties in prioritising and managing the workload
- Many staff feel stressed when working OOH
- The OOH duties are too long
- The frequency of the OOH duties is not an issue
- The OOH duties are tiring due to the length of the duties
- The OOH duties disturb sleep patterns following the duties
- It takes several days to recover from the OOH duties
- There is no problem in arranging time off around OOH duties
- There is a majority agreement that OOH duties are shared out equally
- There is a majority agreement that OOH does not interfere with maintenance of specialist skills
- There is a majority agreement that developed roles can be organised around OOH duties

Review of Section 3

Section 3 involved statements that relate to work/life balance

Staff attitudes identified that

- The majority of staff consider that the financial uplift from OOH duties is very important to their work/life balance
- The majority of staff appear to be happy with their work schedule.
- However, some of the staff who indicated that the financial uplift from OOH duties was very important to them (question 17), indicated that they were not satisfied with their current work schedule.

- The majority of staff indicate that they do get full value from their free time.

- One member of staff consistently diagreed with 17, 18 and 19.

- Several staff who agreed that the financial uplift was very important to them were dissatisfied with their work schedule and did not feel that they got full value from their free time.

- A few members of staff agreed consistently with 17, 18 and 19.

- The majority of staff are not too tired to value their free time.

- However, there is a significant cohort of staff who are dissatisfied with the current work schedule and who agree with the statement, that they feel too tired to value their free time.

- There is a majority of staff who feel no stress in balancing work and life balance.

- There is a cohort that are dissatisfied with the current work schedule, who agree that they feel too tired, to value their free time and who agree that they feel stressed, balancing work and other responsibilities.

- There is no specific staff group that hinders balancing work and personal commitments.

- There is a split in opinion that the culture of long working hours hinders balancing work and personal commitments.

- There is a split in opinion that long hours, compulsory stand by/on call or weekend hours hinder balancing work and personal commitments.

Review of Section 4

Section 4 aims to elicit personal preferences to worklplace models

Staff attitudes indicate that

- The flexibility of OOH working meets personal agendas.

- However, the majority of staff prefer to work core daytime hours.

- Fewer staff prefer the challenge and responsibility of working alone over the support of team working.

- More staff prefer the responsibility of a developed role, that may require the challenge and responsibility of working alone rather than as part of a team.

Review of Section 5

Section 5 relates to training and development

Staff attitudes indicate that

- A majority of staff are satisfied with the opportunities made available to them.

• A majority of,a significant number have conflicting attitudes. Further investigation would be required into the level of development, before any assumptions could be made.

• The vast majority of staff consider that training and devlopment opportunities help them to do their job better.

• The majority of the staff consider that the development opportunities help stay up to date with the job.

• All staff consider that the opportunities available to them keep them up to date with professional requirements.

Section 6

Section 6 involves staff attributes and, as mentioned above, no correlations have been undertaken

Section 7 **Section 7 allows staff the option to mention anything in relation to OOH and role development that has not been covered anywhere else in the questionnaire**

Section 1

Section1 relates to the current duty pattern worked by the individual

Question 1 and Question 2

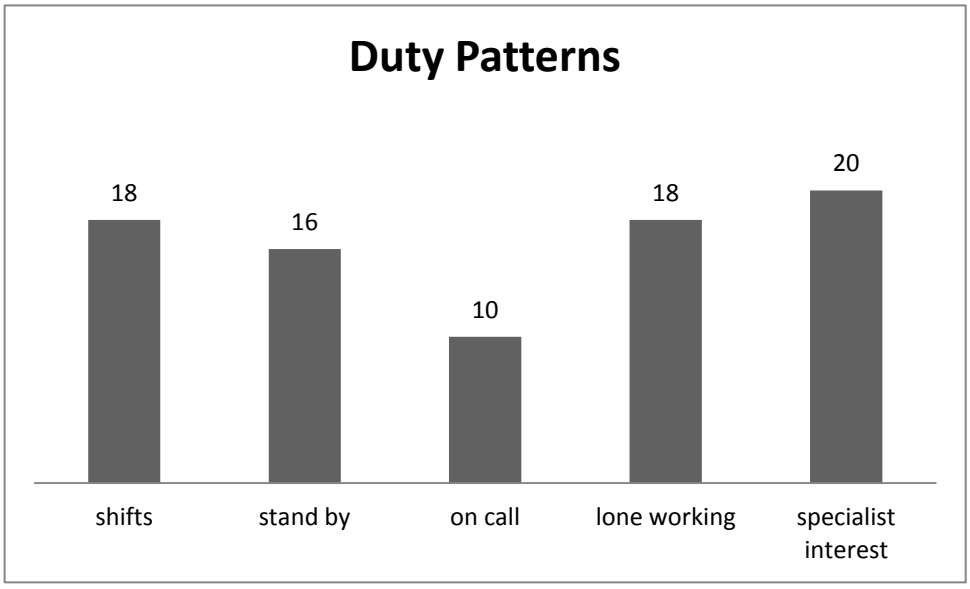


Figure 68: Duty patterns

Figure 68 relates to the number of responses. 18 out of 22 respondants undertake OOH duties by shift arrangements. 16 of these respondents also undertake stand by duties. 10 respondents undertake on- call. This may be in addition to stand by and/or shift arrangements.

18 respondants indicate that they undertake duties that involve lone working.

20 of the 22 respondants indicate that they have either a developed role or a specialist interest

Section 2

Section 2 involved statements that are related to how worklplace stressors are perceived in the OOH situation and the relation of OOH to role development.

A definition of stress was incorporated. " Stress is the reaction people have to excessive pressures or other types of demands placed upon them. It arises when they worry that they cannot cope" (Raymond, 2000)

Question 3 . Lone working does not put patients at risk

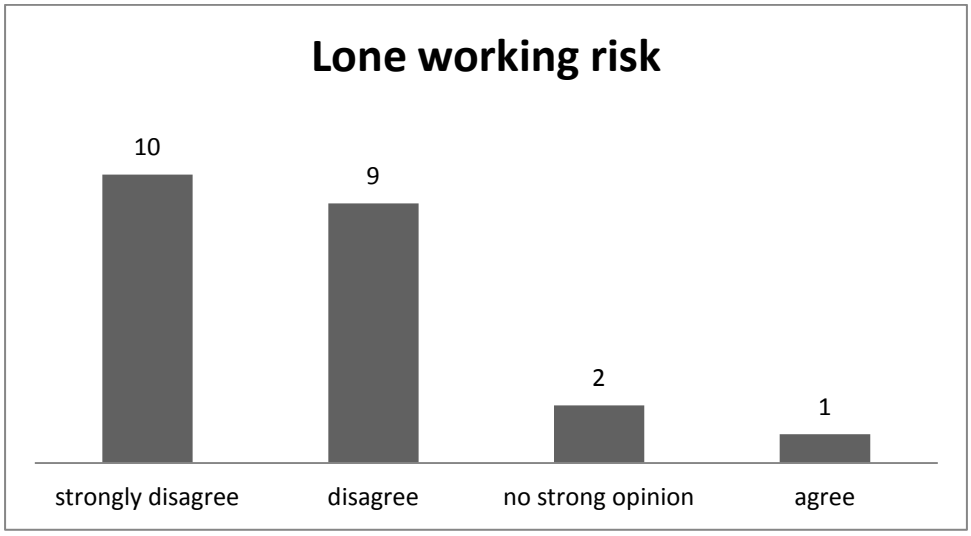


Figure 69: Lone working risk

Figure 69 displays the range of attitudes to question 3. The attitude of the staff indicates that they consider that lone working does put patients at risk.

Question 4. Lone working is a risk to individual health and safety

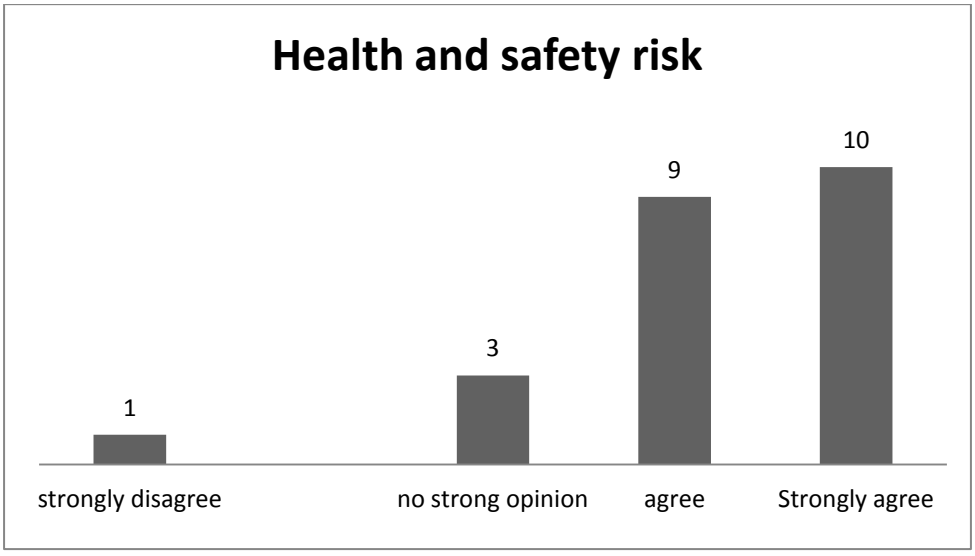


Figure 70: Health and Safety risk

Figure 70 displays the range of staff attitudes to question 4. The staff indicate that they consider that lone working is a risk to individual health and safety.

Question 5. The workload OOH is too diverse with many points of delivery to deal with

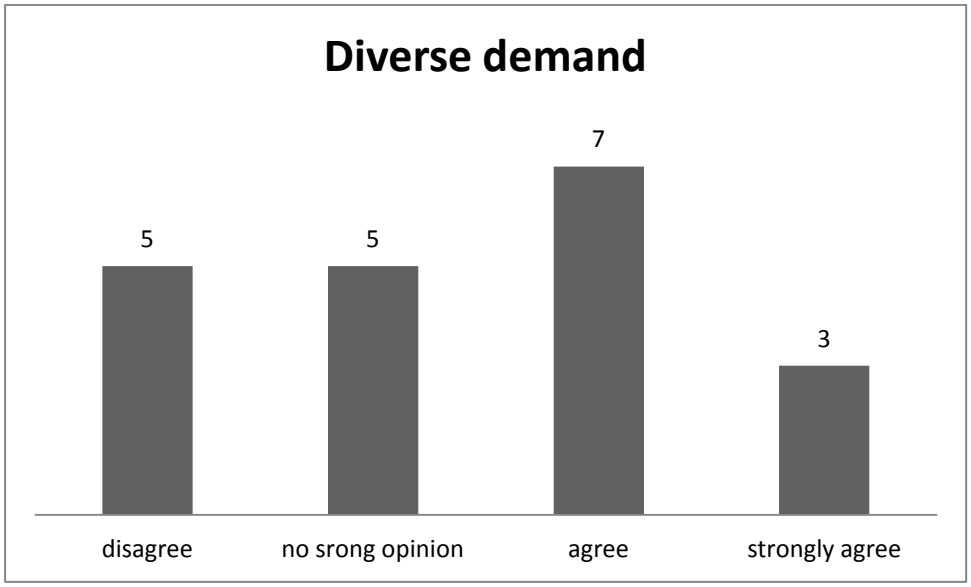


Figure 71: Diverse workload demand

Figure 71 displays the range of staff attitudes to question 5. There is a spread of attitudes with a slight majority of the staff considering that the workload is too diverse to deal with. There were some respondents who did not answer this question.

Question 6 . OOH workload can be prioritised and managed without problem

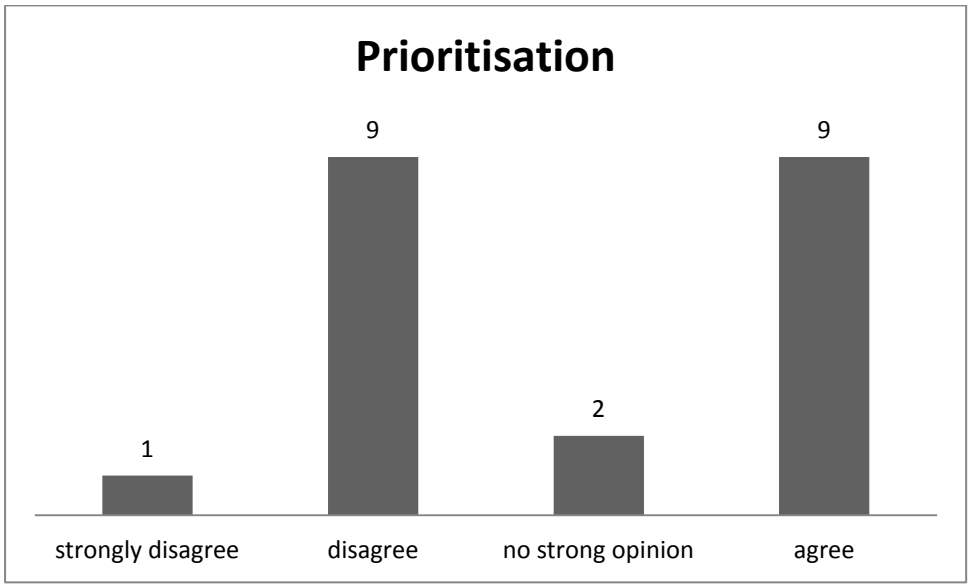


Figure 72: Prioritisation of workload

Figure 72 displays the staff attitudes to question 6. There appears to be a split of attitude in relation to whether the workload can be prioritised and managed. Not all respondents answered this question

Question 7. I often feel stressed when working OOH

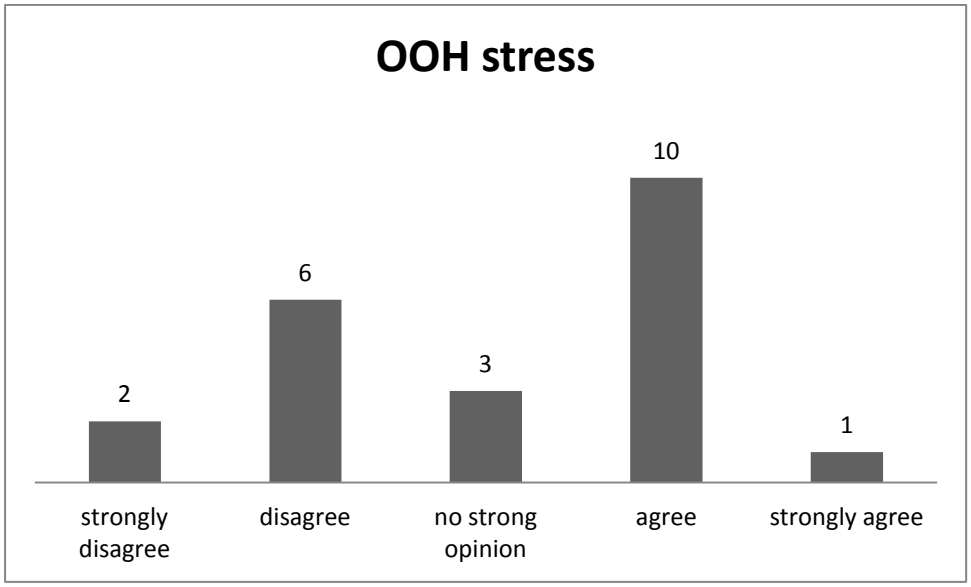


Figure 73: Stress - OOH

Figure 73 displays the staff attitudes to question 7. There appears to be a majority of attitudes towards feeling stressed when working OOH

Question 8. OOH duties are too long

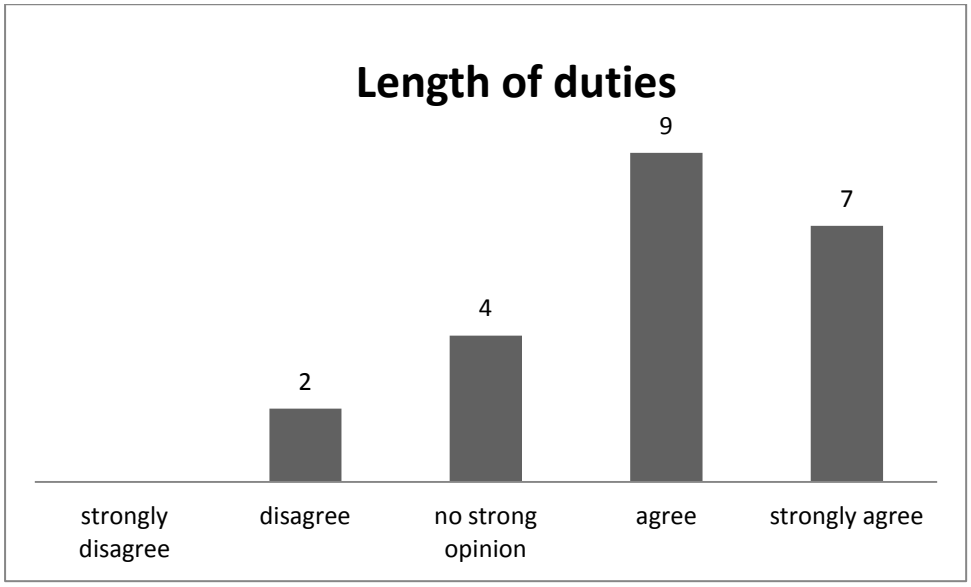


Figure 74: Length of OOH duties

Figure 74 displays the staff attitudes to the length of the OOH duties. There would appear to be a majority opinion that the OOH duties are too long.

Question 9. The frequency of OOH duties is about right

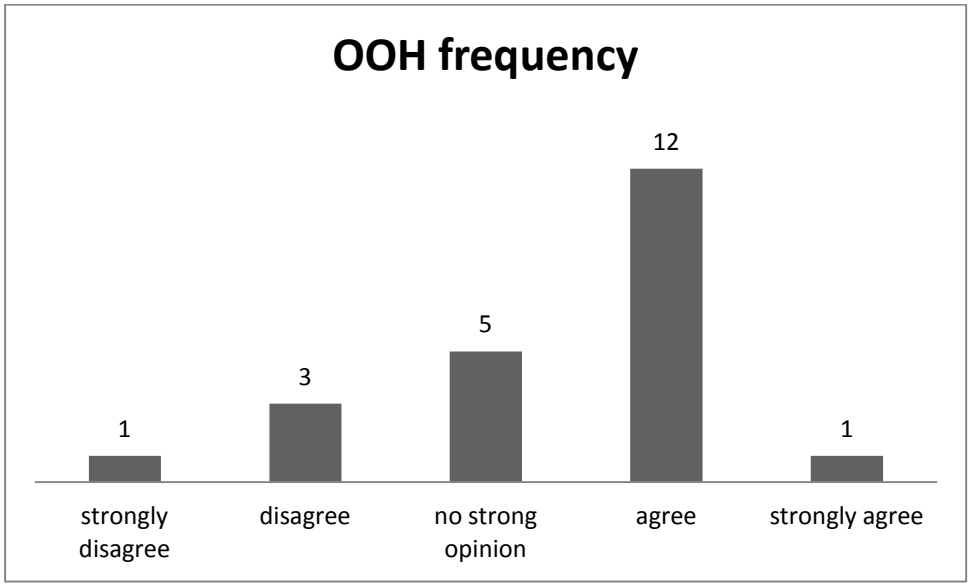


Figure 75: Frequency of OOH duties

Figure 75 displays the staff attitudes to the frequency of the OOH duties. There would appear to be a majority opinion that the frequency of OOH duties is not an issue.

Question 10. I am tired because of the length of the duties.

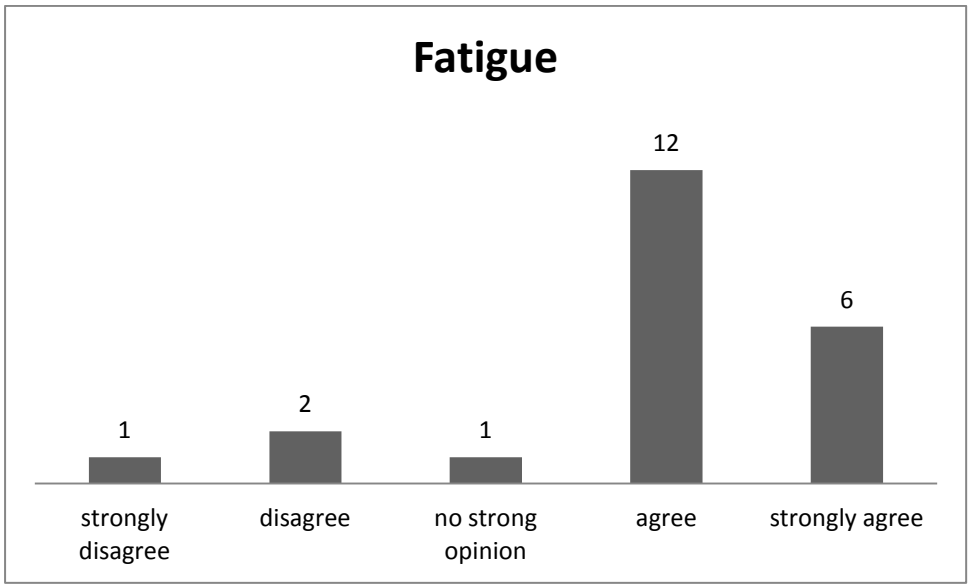


Figure 76: Tiredness

Figure 76 displays the staff attitude to the length of the OOH duties. There is no doubt that staff consider that the length of the OOH duties are tiring.

Question 11. It is easy to sleep after OOH duty

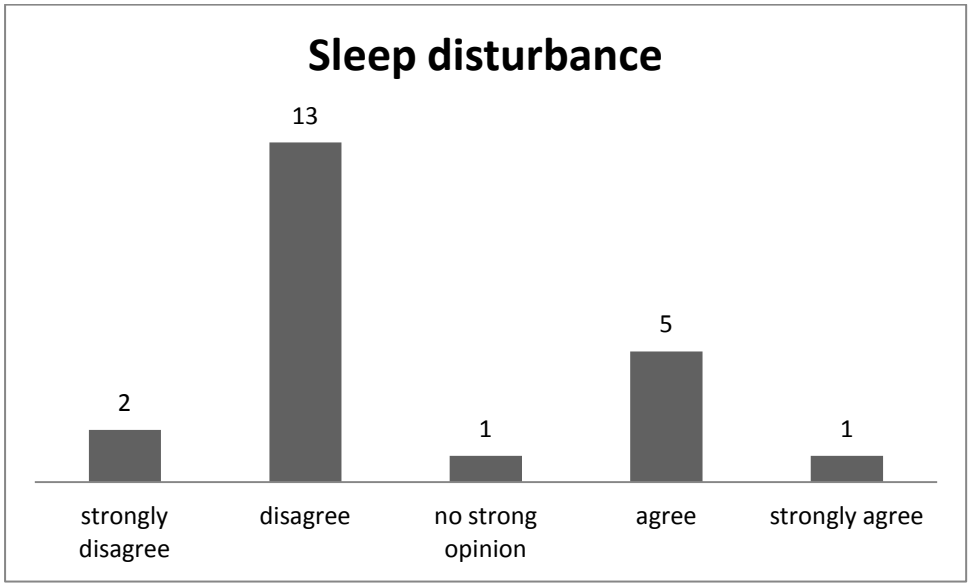


Figure 77: Sleep disturbance

Figure 77 displays the staff attitudes to question 11. It is clear that staff consider that OOH duties disturb sleep patterns

Question 12. I feel that it takes several days to recover from OOH duties

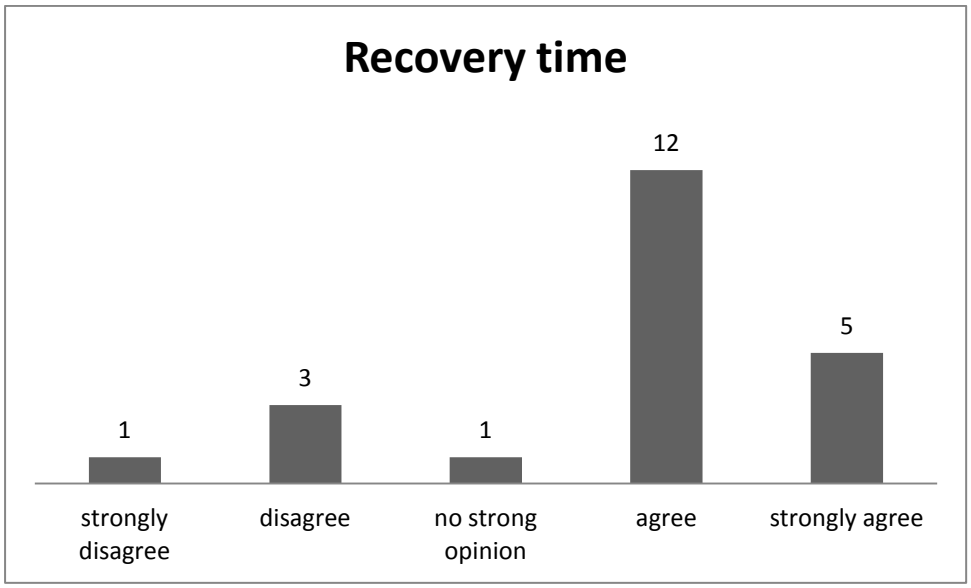


Figure 78: Recovery time

Figure 78 displays the staff attitudes to question 12. It is clear that the majority of staff consider that it takes several days to recover from OOH duties

Question 13. It is difficult to arrange time off around OOH duties.

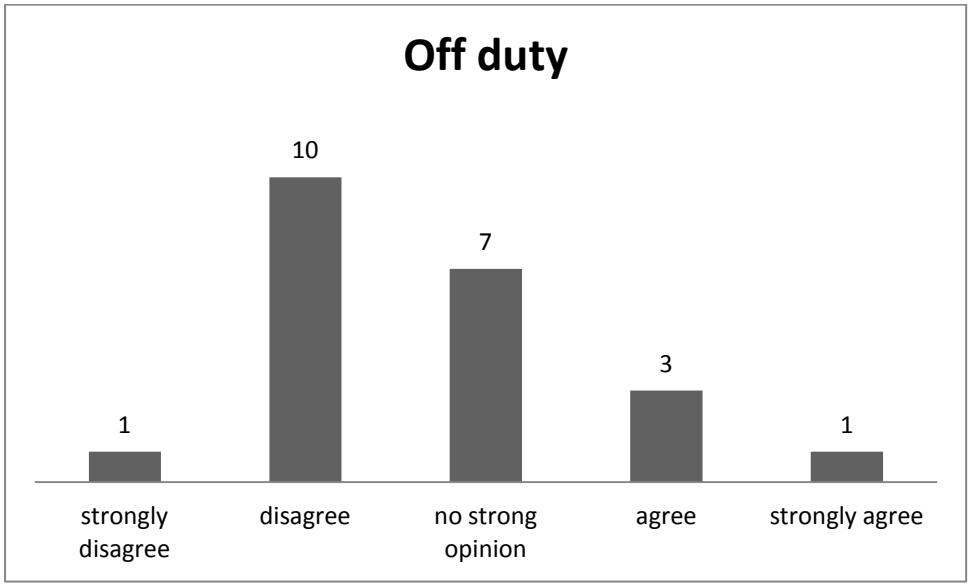


Figure 79: Time off around OOH

Figure 79 displays the staff attitudes to question 13. There appears to be no perceived problem with arranging time off around OOH duties.

Question 14. (Not all staff answered this question) I feel that OOH duties are shared out equitably

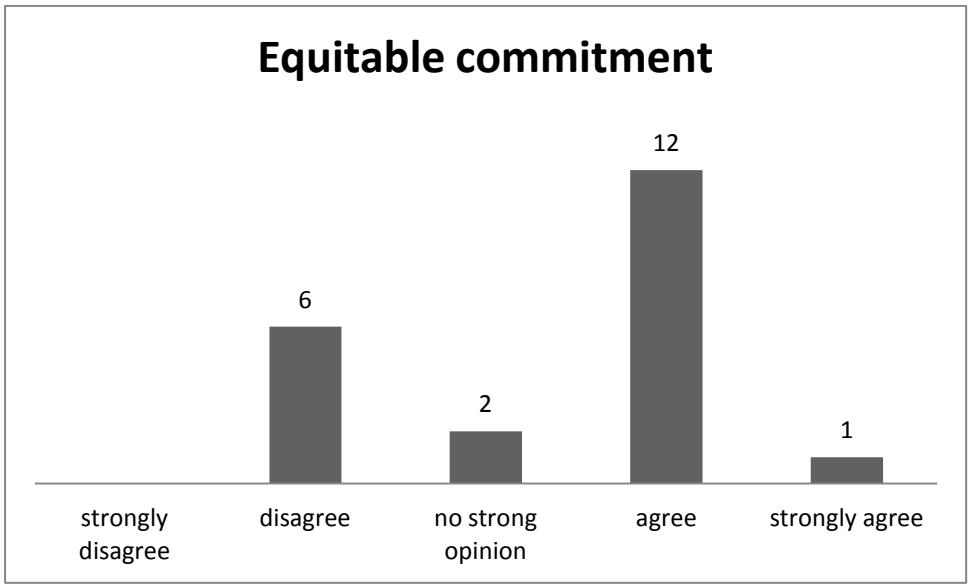


Figure 80: Equitable commitment

Figure 80 displays the attitudes of staff to question 14. The majority of staff agree that OOH duties are shared out equitably. Of the 6 staff who disagreed, 3 staff also undertake on-call in addition to standby duties.

Question 15. Generally, OOH duties interfere with maintaining skills in my specialist interest

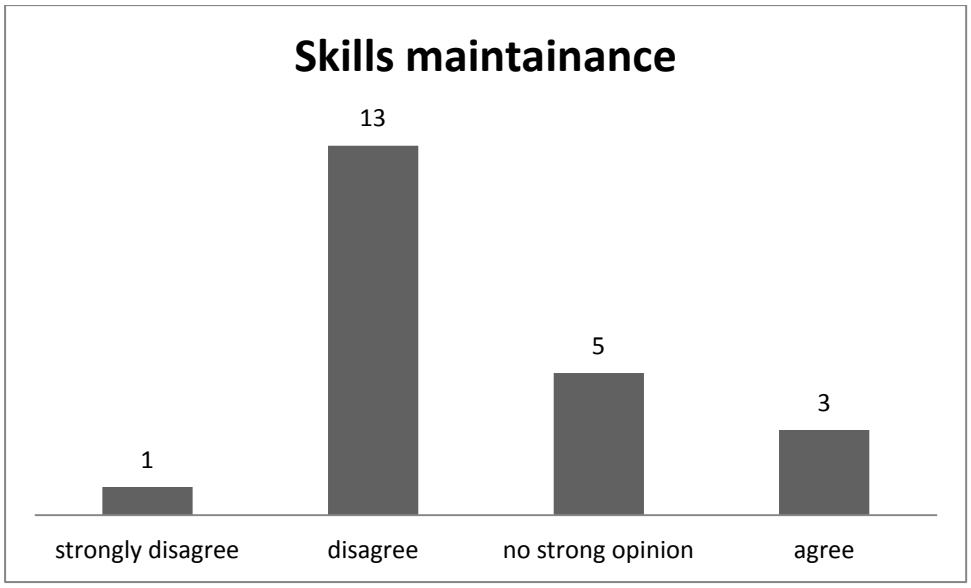


Figure 81: Skills maintenance

Figure 81 displays staff attitudes to question 15. There is a majority attitude that OOH does not interfere with maintaining specialist skills.

Question 16. My developed role can be organised around OOH duties

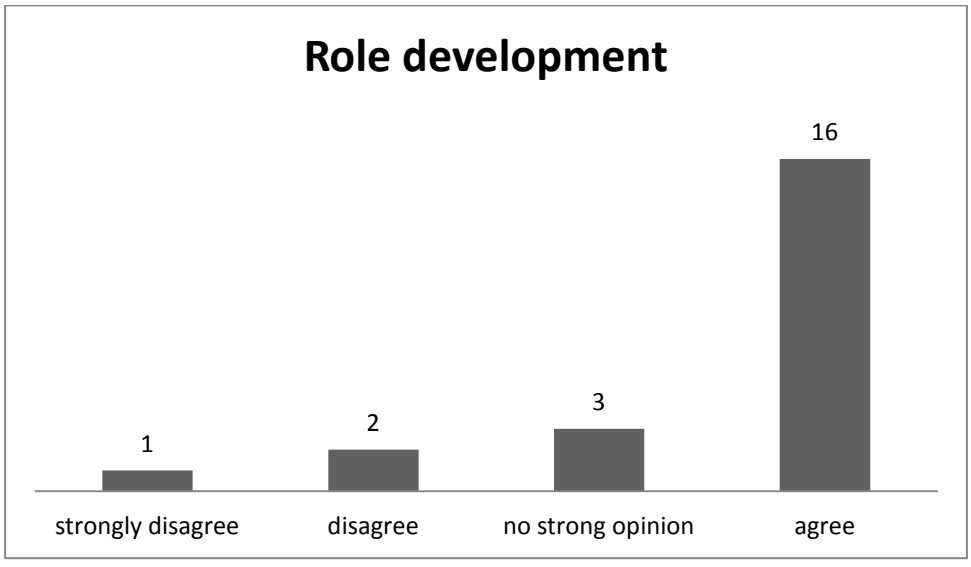


Figure 82: Role development

Figure 82 displays the staff attitudes to question 16. The majority of staff indicate that their developed role can be organised around OOH duties.

Section 3

Section 3 involved statements that relate to work/life balance

Question 17. The financial uplift from OOH duties is very important to me to support my work/life balance.

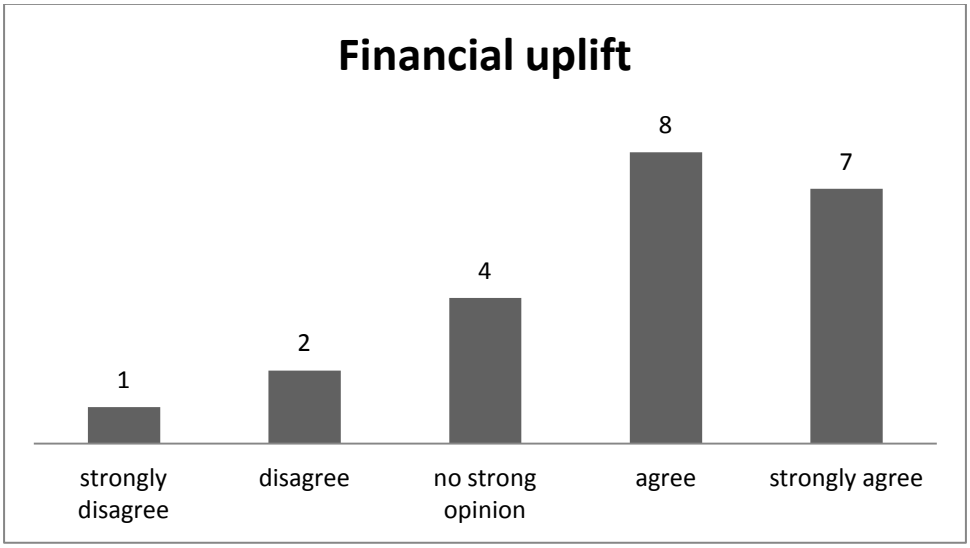


Figure 83: Financial uplift

Figure 83 displays the attitudes of staff to question 17. The majority of staff consider that the financial uplift from OOH duties is very important to their work/life balance

Question 18. I am satisfied with the current work schedule

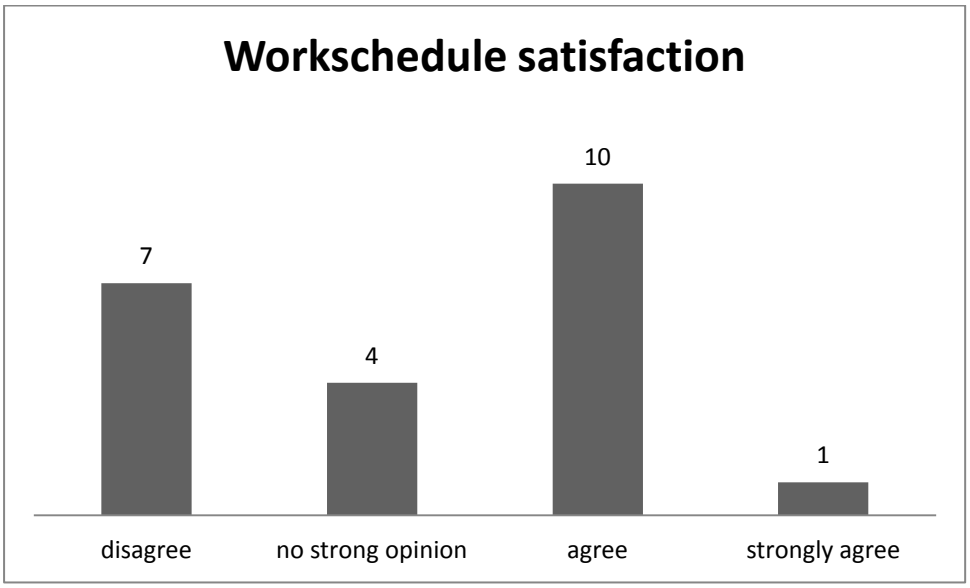


Figure 84: Satisfaction with work schedule

Figure 84 displays the attitudes of staff to question 18. The majority of staff appear to be happy with their work schedule. However, some of the staff who indicated that the financial uplift from OOH duties was very important to them (question 17), indicated that they were not satisfied with their current work schedule.

Question 19. I get full value from my free time.

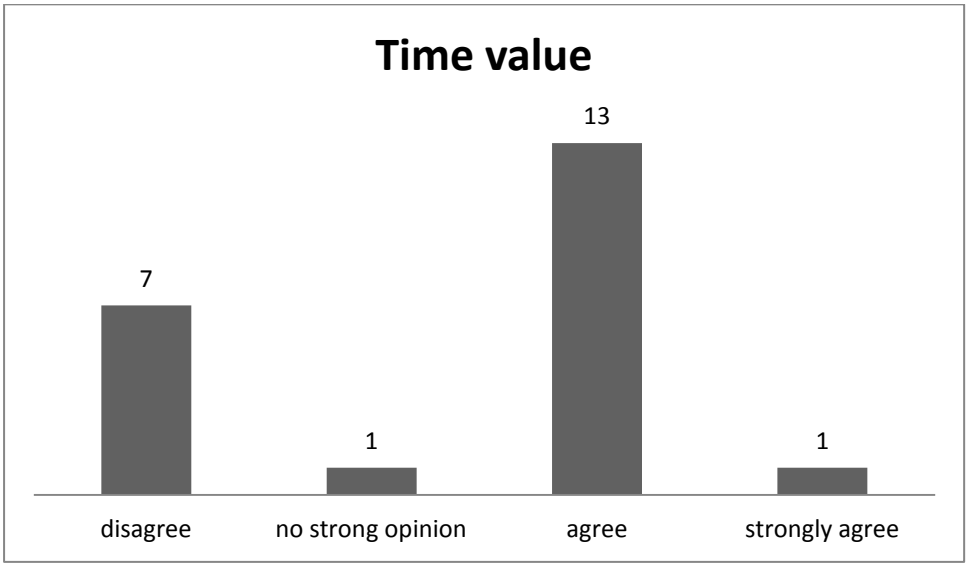


Figure 85: Value from free time

Figure 85 displays the attitudes of staff to question 19. The majority of staff, indicate that they do get full value from their free time. One member of staff consistently disagreed with 17, 18 and 19. Several staff who agreed that the financial uplift was very important to them, were dissatisfied with their work schedule and did not feel that they got full value from their free time. A few members of staff agreed consistently with 17, 18 and 19.

Question 20. I am too tired to value my free time

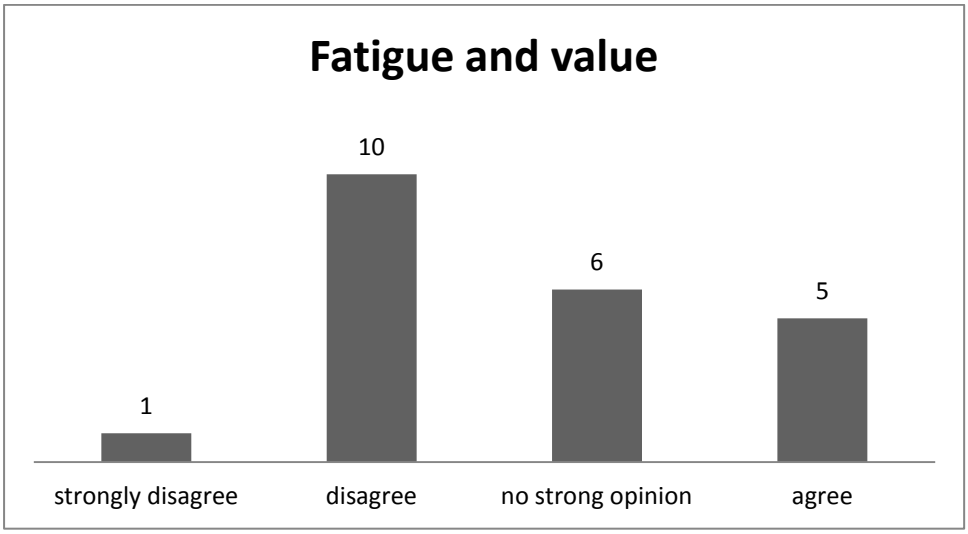


Figure 86: Fatigue and value from time off

Figure 86 displays the attitudes of staff to question 20. There appears to be a majority attitude indicating that staff are not too tired to value their free time, however there is a significant cohort of staff who are dissatisfied with the current work schedule and who agree with the statement that they feel too tired to value their free time.

Question 21. I feel stressed balancing work and other responsibilities

Figure 87: Work-life balance

Figure 87 displays the staff attitudes to question 21. Though there is a majority of staff who feel no stress in balancing work and life balance, there is still the same cohort that are dissatisfied with the current work schedule, who agree that they feel too tired to value their free time and who agree that they feel stressed balancing work and other responsibilities

Question 22 addresses cultural aspects of the workplace in relation to balancing work and personal commitments Do any of the following hinder you in balancing your work life commitments?

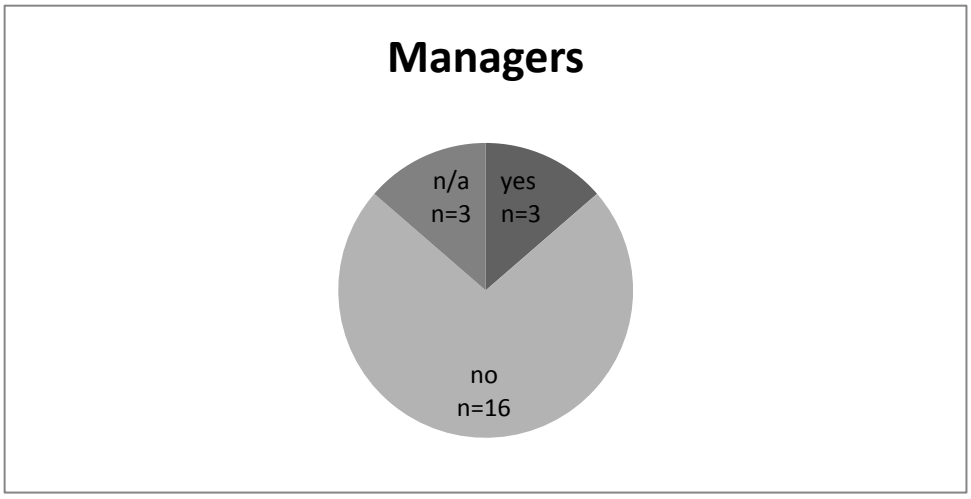


Figure 88: Negative attitude of managers

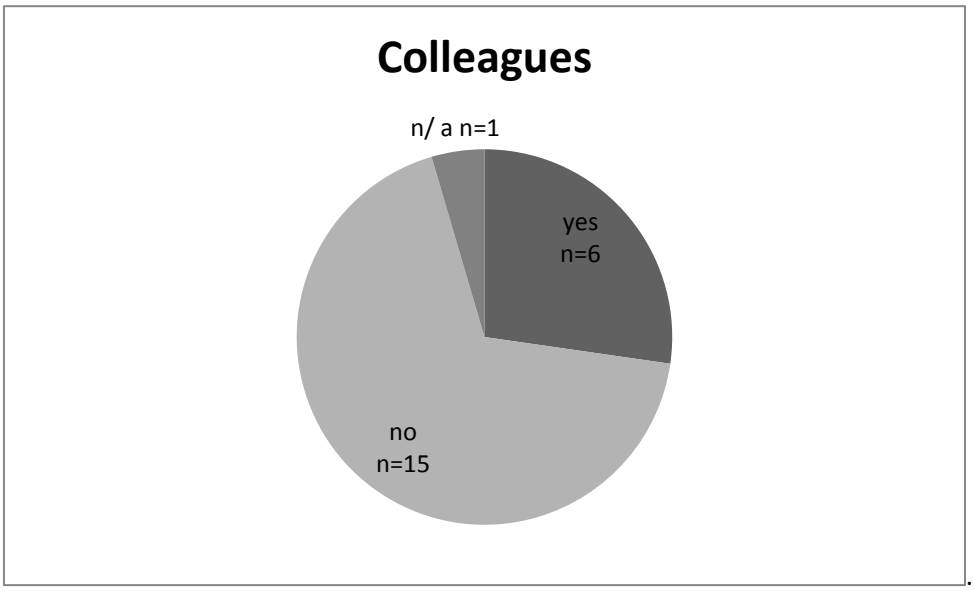


Figure 89: Negative attitude of colleagues

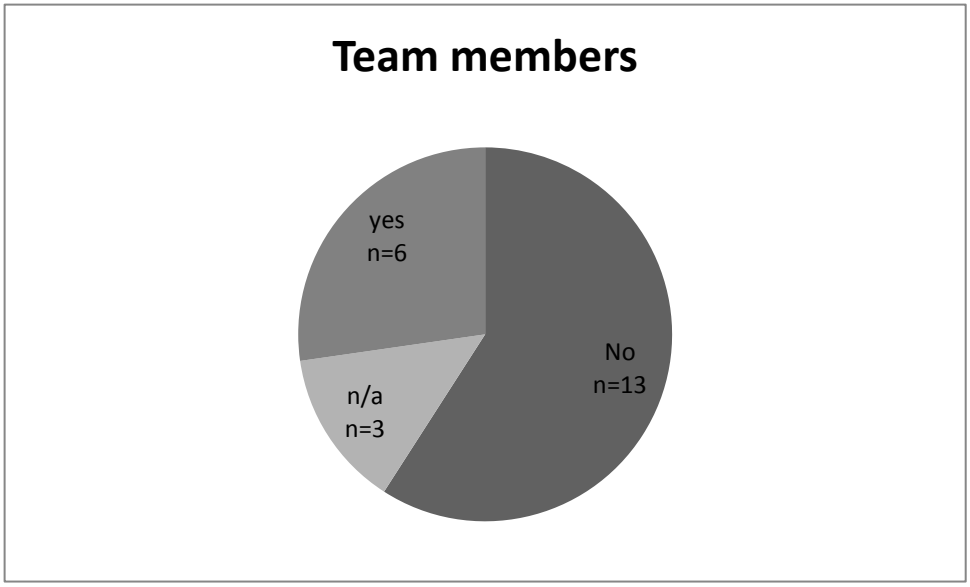


Figure 90: Negative attitude of team members

Long working hours culture as the accepted norm

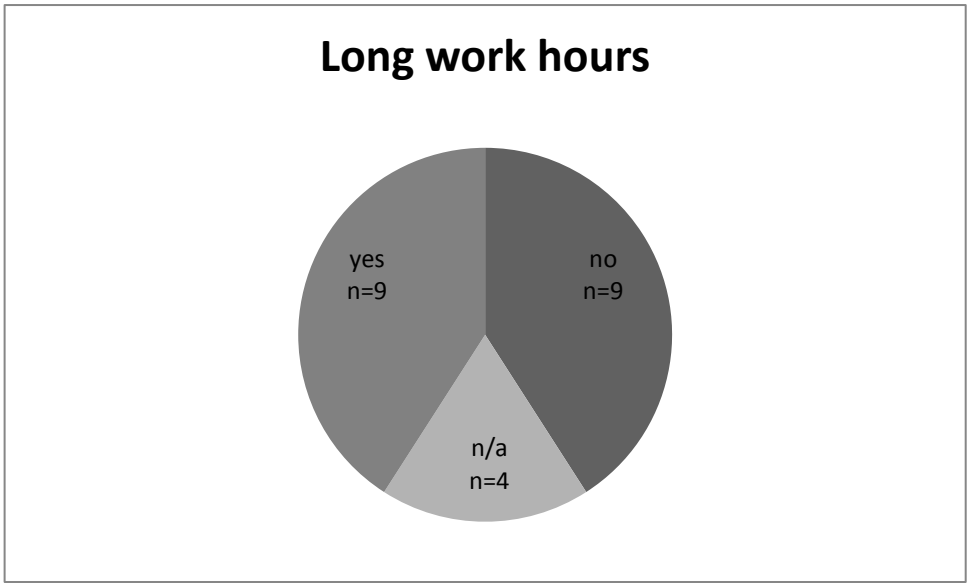


Figure 91: Long working hours culture

Question 23 relates to the elements of the OOH work. Do any of the following hinder you in balancing your work and personal relationship committments?

Long work hours?

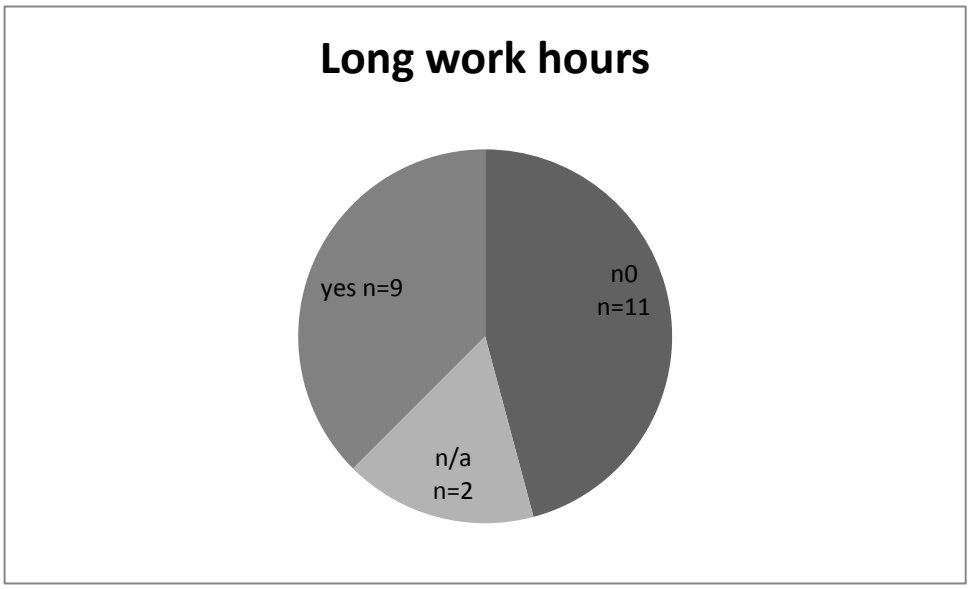


Figure 92: Long work hours

Compulsory standby/on call?

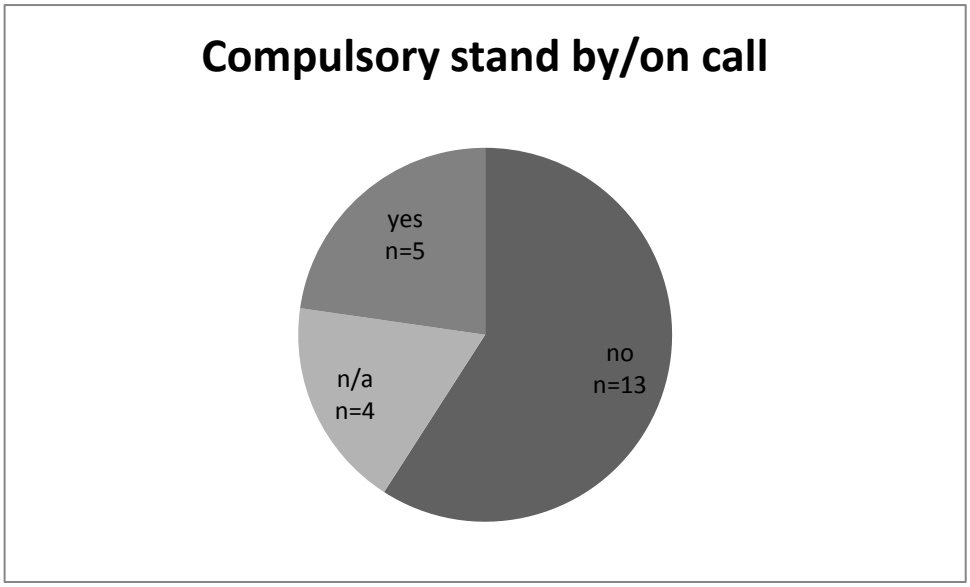


Figure 93: Compulsory overtime

Weekend work?

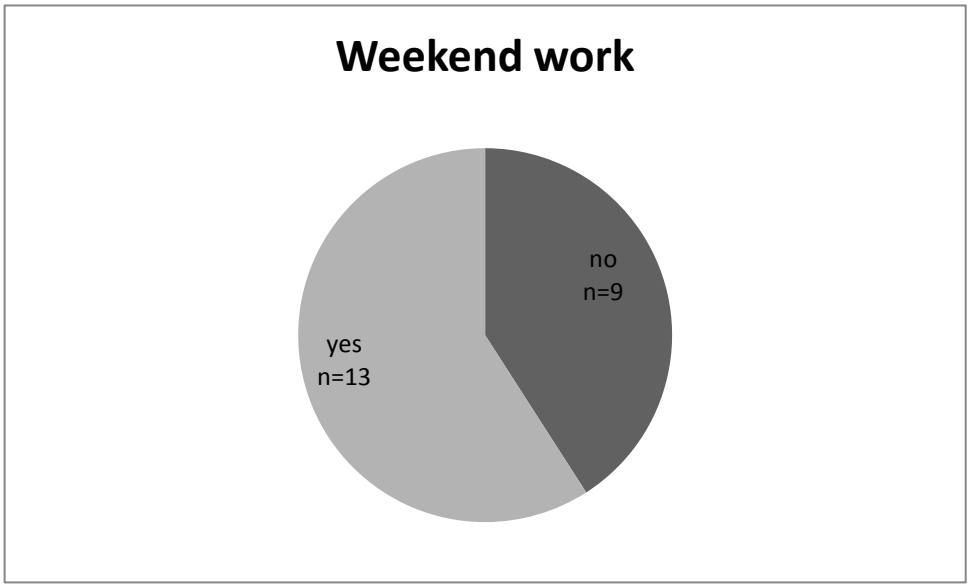


Figure 94: Weekend work

Section 4

Section 4 aims to elicit personal preferences to workplace models

24 a I like the challenge and responsibility of working alone

b I prefer the support of team working

25 a I like the flexibility of working OOH duties

b I prefer the workplace structure of core daytime duties

26 a I like core working daytime hours

b I prefer working OOH

27 a I like the responsibility of a developed role

b I prefer the confidence of being one of the team

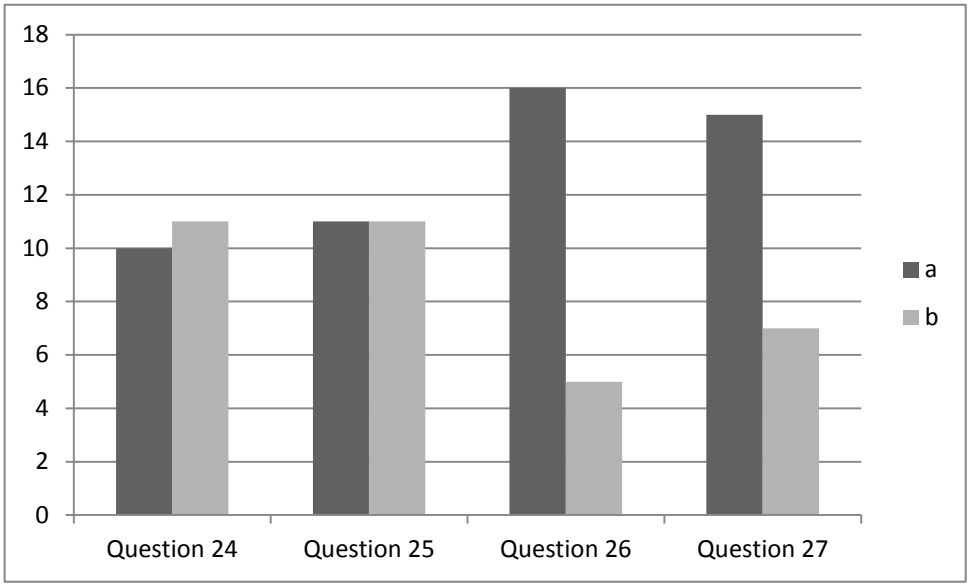


Figure 95: Preferences and work-pattern models

Figure 95, above, displays the range of personal preferences. In particular questions 25 and 26 may indicate that that the fexibility of OOH working meets personal agendas, however the majority of staff prefer to work core daytime hours.

It is interesting that in question 24, fewer staff prefer the challenge and responsibility of working alone, over the support of team working but more staff prefer the responsibility of a developed role (question, 27), that may require the challenge and responsibility of working alone rather than as part of a team.

Section 5

Section 5 relates to training and development

Question 28. I am satisfied with the training and development opportunities made available to me.

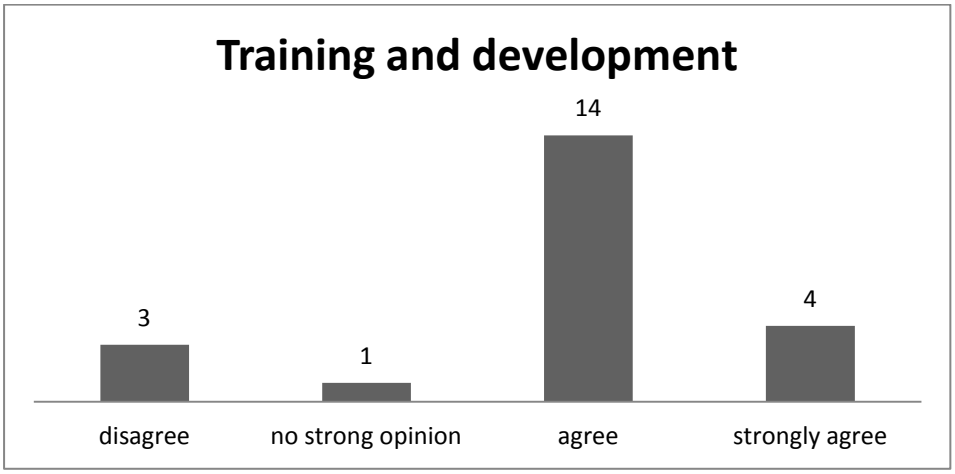


Figure 96: Training and Development

Figure 96 displays the attitudes to the training and development opportunities. A majority of staff are satisfied with the opportunities made available to them.

Question 29. My committment to OOH adversely affects my training and development opportunities.

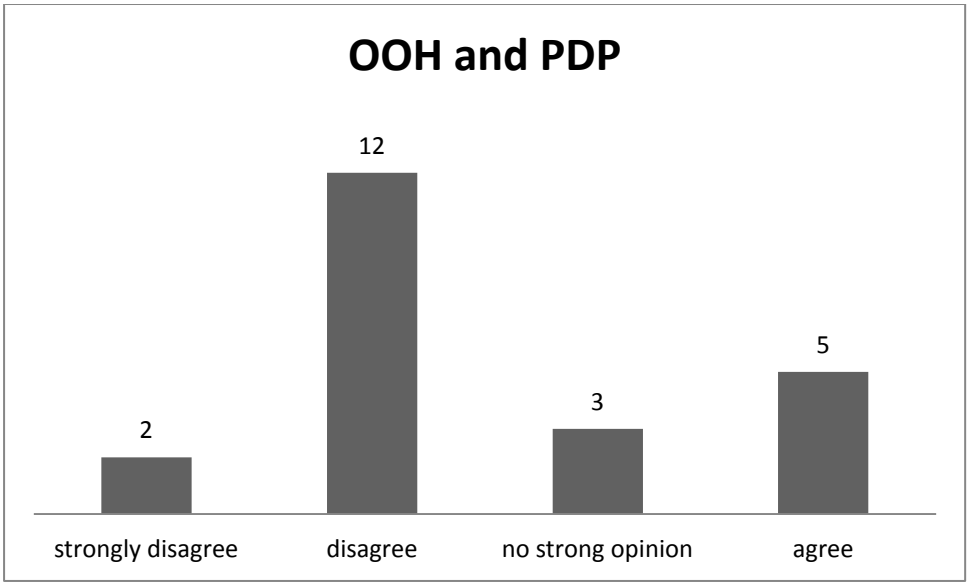


Figure 97: OOH disadvantages training and development

Figure 97 displays staff attitudes to question 29. A majority of the staff consider that undertaking OOH does not compromise their development, however a significant number have conflicting attitudes. Further investigation would be required into the level of development before any assumptions could be made.

Question 30. My training, learning and development has helped me to do my job better.

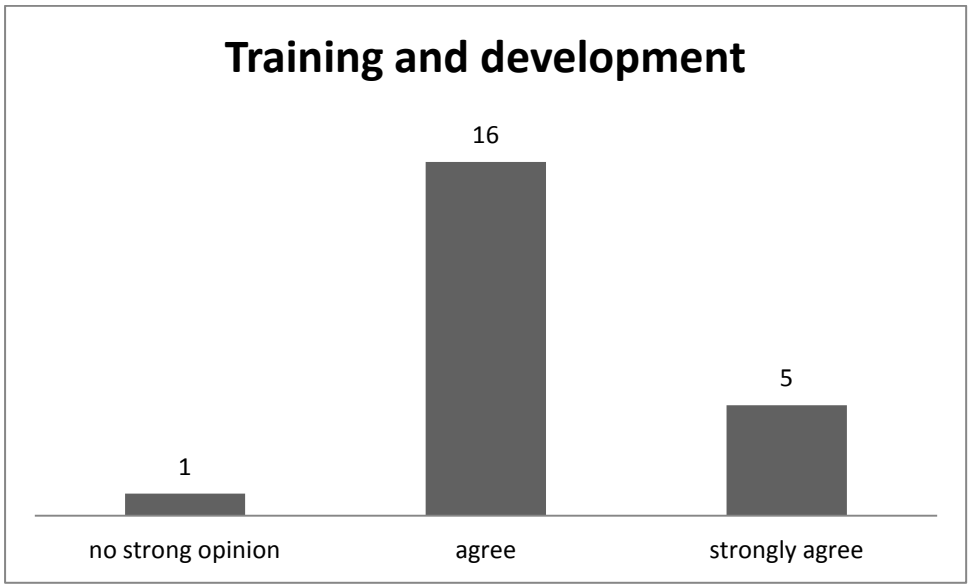


Figure 98: Training and Development - competence

Figure 98 displays the attitudes of staff to question 30. It is reassuring that the vast majority of staff consider that training and devlopment opportunities help them to do their job better

Question 31. My training, learning and development has helped me to stay up to date with my job

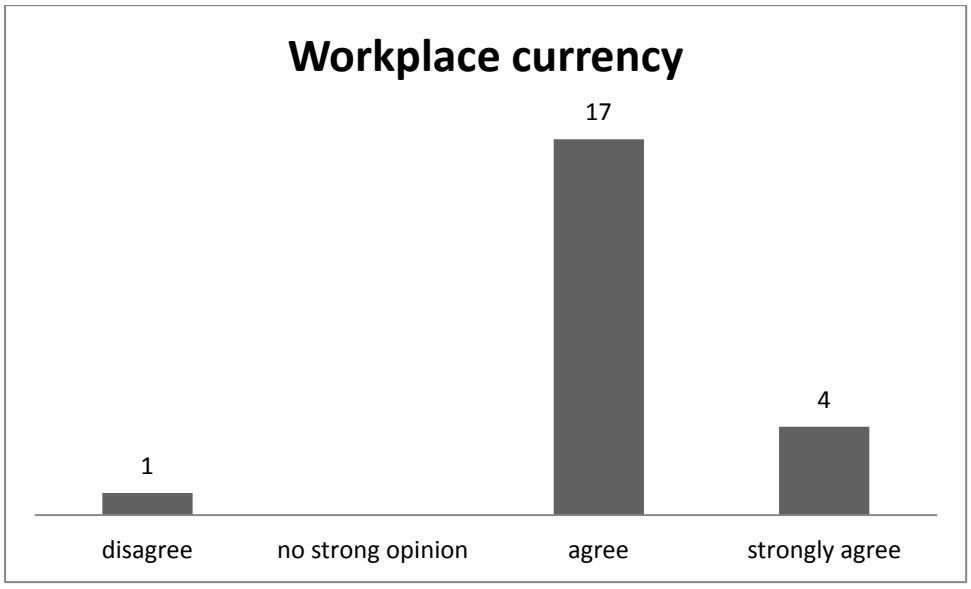


Figure 99: Training and Development - Workplace Currency

Figure 99 displays the staff attitudes to question 31. Again, reassuringly, the majority of the staff consider that the development opportunities help stay up to date with the job. However, one member of staff disagrees with the statement as well as expressing concern regarding development opportunities.

Question 32. My training, learning and development has helped me stay up to date with professional requirements

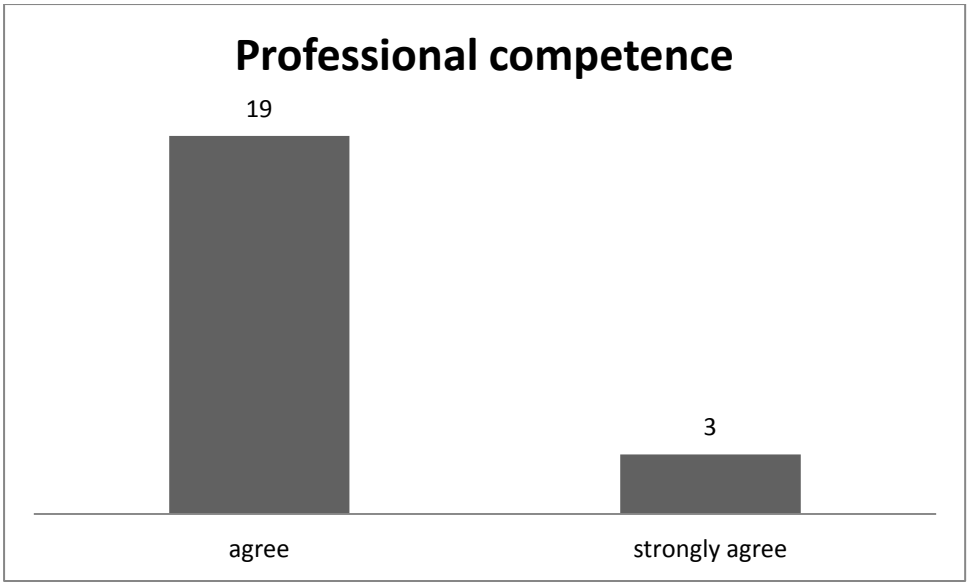


Figure 100: Training and Development- Professional Currency

Figure 100 displays staff attitudes to question 32. All staff consider that the opportunities available to them keep them up to date with professional requirements

Section 6

Section 6 relates to staff attributes

Question 33. Which staff band are you?

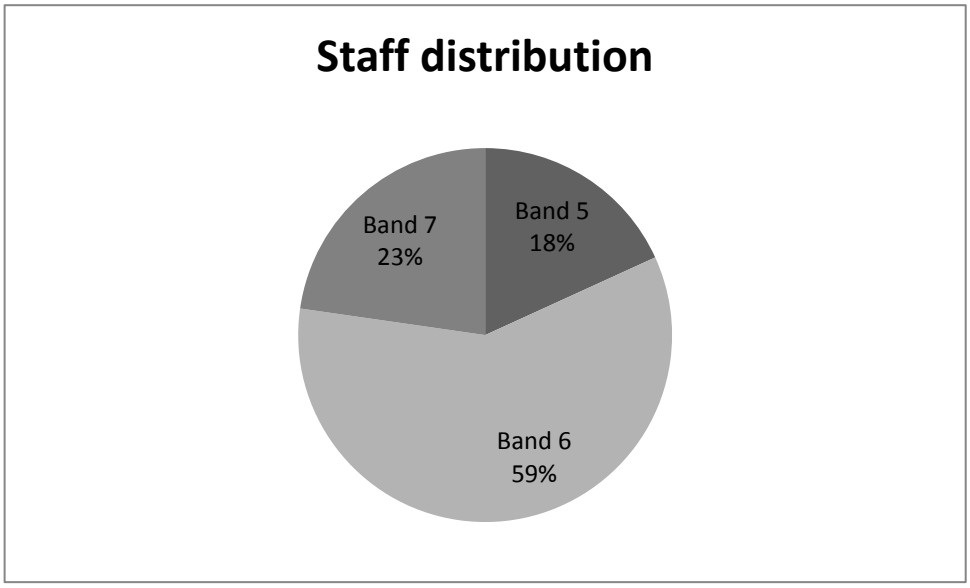


Figure 101: Workforce Profile

Figure 101 displays the staff distribution of the respondents.

Question 34. What age are you?

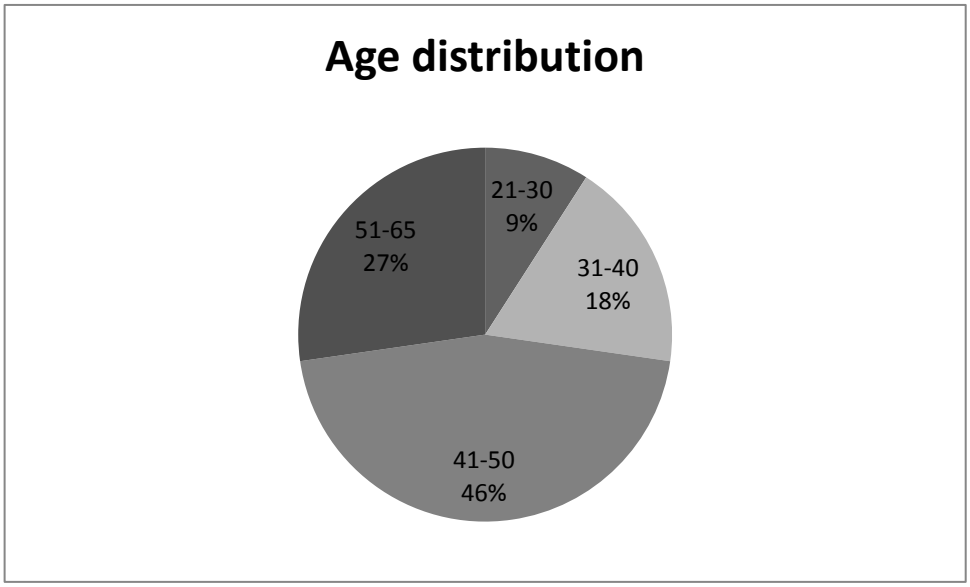


Figure 102: Age distribution

Figure 102 displays the age distribution of the staff

Question 35. How would you rate your health?

Figure 103: Health Status

Figure 103 displays the staff self perception of their health

Question 39. What is your household status?

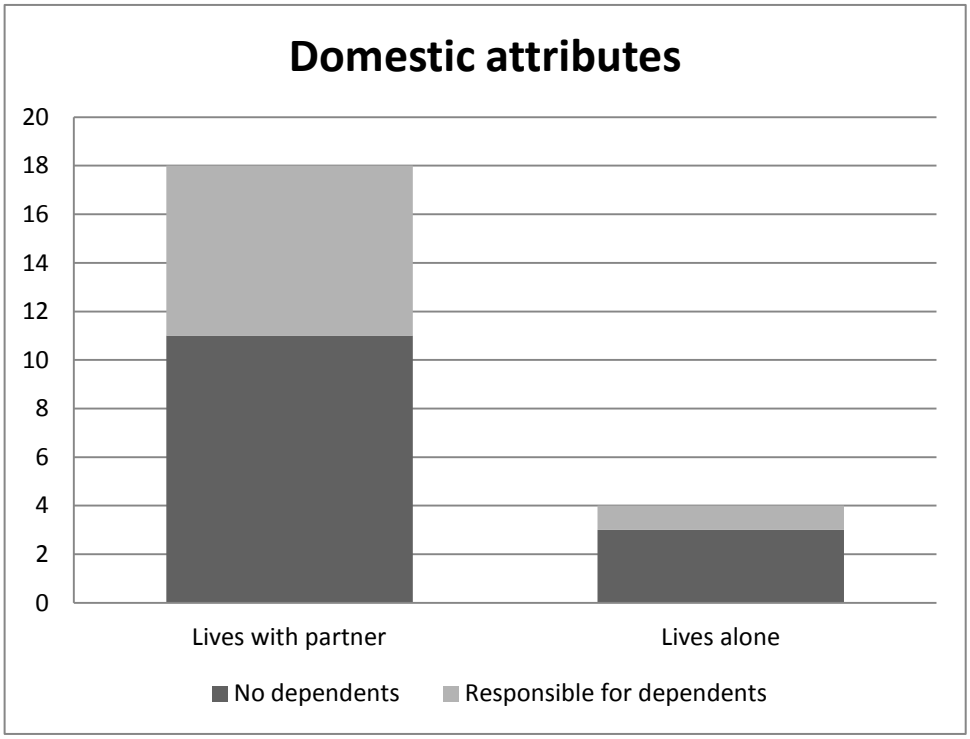


Figure 104: Domestic attributes

Figure 104 displays the domestic attribute of respondents

Section 7

Further comments:

"Working part time means that some of the answers previously given are different to those I would give as a full time staff member"

This respondent indicated a positive attitude to work life balance.

" Q.23 I may feel differently if I worked full time. Also the situation is made easier as colleagues are very helpful at swapping duties when necessary.

Q 25-27 Difficult to answer. The atmosphere in the hospital overnight is good- very much a team, but I don't prefer it as the length of duty (4.40-8.30 next day) is far too long. Also I do enjoy my other roles but perhaps they can't be described as developed on my banding".

This respondent indicates a positive response to the work/life balance statements and also a positive response to the training and development section

" Loathe the concept of compulsory overtime that is required to provide 24/7 service"

This respondent is dissatisfied with the current work schedule, disagrees that they get full value from free time and feels stressed balancing work and other responsibilities

" In my centre OOH/on call is compulsory and is in addition to normal hours. This is absurd, we need to move away from compulsory overtime. However ,we need to provide a balanced service OOH. How to do this is a big headache!"

This respondent indicated a neutral attitude to work life balance but expressed the opinion that the negative attitude of colleagues, compulsory standby/ on call and weekend work hindered their balance of work and personal relationship commitments

"OOH restricts the availability of role development. OOH restricts the value of specialist skills and therefore wastes training money. The department is not benefiting from the financial input"

This respondent is dissatisfied with the current work schedule and does not get value from free time. long work hours, compulsory standby/on call and weekend work stesses this respondent in balancing work and other responsibilities.

"Lack of funding for external courses is a big problem, especially for senior staff who are more experienced- you really need to travel to external courses to move practice forward. Internal CPD is excellent but you can't get everything cutting edge internally"

This respondent considers that negative attitude of colleages and team members hinder their balance of work and personal relationship commitments. They are also dissatisfied with the training and development opportunities made available to them.

" Section 4 is difficult to answer as both statements can apply eg enjoy lone working when working OOH but wouldn't wish to do all of the time. Enjoy being part of the team when working core hours. Feel that weekday standby is too long. Would not wish a bigger committment to weekend working.

OOH working can clash with CPD talks as does annual leave but hopefully arrangements can be made sometimes to repeat certain CPD talks"

This respondent indicated that they often feel stressed when working OOH due to the diverse nature of the calls for work. Weekend work hinders them from balancing work and personal relationship commitments.

" Although lone working has been used in this context, may I point out that in all cases a porter is present after 10pm-6am. In the case of a difficult patient ie drunk, a second body is present"

This respondent indicated a positive attitude to work-life balance.

12.3 Relevance to the current research

The analysis of the questionnaire above, while not contributing to the development of the workpattern model, has informed on aspects of practice, that will support a perception of the effects of the application of the workpattern model. In addition, the staff have appreciated the visualisation and quantification of attitudes to aspects of the OOH practice that have been discussed and debated at length. This has informed the OOH review, in a more qualitative manner than the statistical analysis in the main body of the study, and has supported further focussed discussion. These discussions have underpinned the ownership of the OOH review proposals; staff now have more appreciation that, while the OOH review is the emotive issue at the forefront of staff anxiety, the OOH workpattern is a component of the 24 hour workpattern. Discussions regarding service sustainability and skills mix, have been undertaken, thus encouraging an all encompassing approach to service redesign, rather than embarking on OOH negotiations, as an isolated subject with consecutive dialogue, to repair contributory effects in other quarters.

13. Appendix 2 – Attitude Questionnaire

13.1 Participant Information Letter

Participant Information Sheet

The Study

Development of a work pattern model to meet the changing service requirements with respect to patient and staff needs in Scottish Radiology departments

Purpose of the study

This study seeks to consider staff attitudes to the model and to assess whether these attitudes are applicable across the wide radiographic community. This study will be undertaken in three Scottish hospitals (two general hospitals of differing populations and a teaching centre). This is to capture a broad range of radiographic opinion.

Why have I been invited?

Your opinion and attitude to the model is important in researching attitudes across a broad spectrum of radiographers. All radiographers, who undertake general radiography, in the three study centres are invited to participate.

Do I have to take part?

Participation is entirely voluntary. If you agree to participate, you are free to change your mind at any time without any repercussions.

It would be appreciated if you would complete all of the questions so that correlation of attributes with attitudes can be explored, but if there are questions that you do not wish to answer then your answers to the other questions would still be very valuable.

How long will I be involved?

You are asked to complete the attitude questionnaire which should take around 15 minutes. This is the only event in which you will be asked to participate.

What are the possible risks?

There are no perceived hazards or risks anticipated in this study, however if you have any concerns regarding any of the questions, or if you require further information about the study please contact myself, the principal investigator, on the contact details below.

What are the possible benefits of taking part?

There are no tangible benefits of you taking part, however, the results of the study will be disseminated to the participating centres and also to the Society of Radiographers in order to inform both local and national policy makers. This allows you the opportunity to indicate your attitudes both locally and nationally.

Will my information be confidential?

No participant identifiable data is involved in this survey. The hospital will only be identified by code. The data will be analysed on an NHS password protected computer that is sited within a locked office. The hard copy of the questionnaires are also kept within a locked cabinet in the same office and will be destroyed after three months

Should any further detail or information be required regarding the study, I, as the principal investigator will be happy to provide this.

My e-mail address is fiona.hawke@borders.scot.nhs.uk

Many thanks for your support and participation

Fiona A Hawke

Superintendent Radiographer

01896 826453

Workpattern Model

Figure 1, below, demonstrates the general radiographic activity over a specific time period in the principal study centre. The activity is a proxy measure for the demand in the principal study centre as the general radiographic service is demand led.

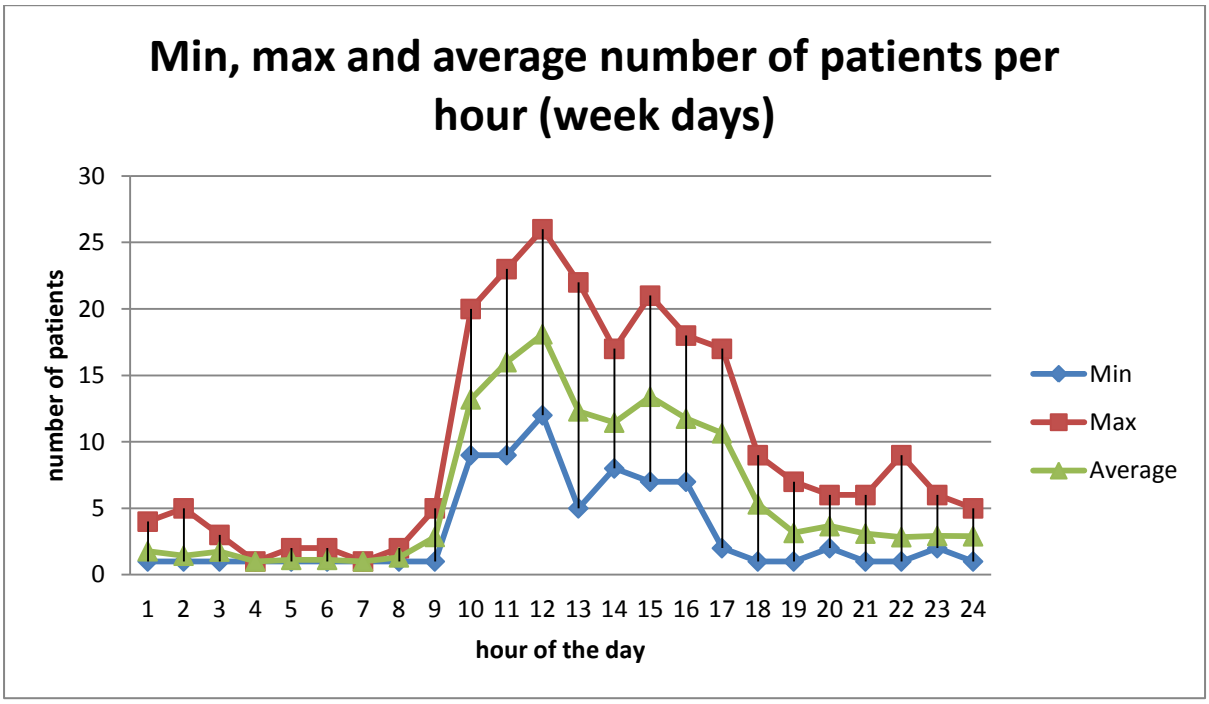


Figure 1

A workpattern model and modular application have been developed that aims to align both core hours and out of hours (OOH).

The staffing allocation for the Workpattern Model is demonstrated in Figure 2 and Figure 3, below

Workpattern Model - Core Working Hours (General Radiography)

Patient activity per hour	Clinical Support staff Band 1-3	Administrative support staff Band 2-4	Radiographer/assistant practitioner assignment
1-5 patients	yes	yes	1x band 5/6
6-10 patients	yes	yes	2x band 5/6
11-15 patients	Yes	Yes	2x band 5/6 1x band 4
16-20	Yes	Yes	3x band 5/6 1x band 4
21-25	Yes	Yes	4x band 5/6 1x band 4
26-30	Yes	Yes	4x band 5/6 2x band 4
Management, supervision and education			Band 7/8

Figure 2

Workpattern Model OOH (General Radiography)

Patient Activity per hour	Clinical support staff Band 1-3	Administrative support staff Band 2-4	Radiographer/assistant practitioner assignment
1-4 patients	No	No	1x band 5/6
5-8 patients	No	No	2x band 5/6
9-12 patients	No	No	2x band 5/6 1x band 4
13-16	No	No	3x band 5/6 1x band 4
17-20	No	No	4x band 5/6 1x band 4
21-24	No	No	4x band 5/6 2x band 4
			Band 7/8 (only if specific skills required)

Figure 3

The application of the workpattern model in the workplace is a modular system based on 4 hour modules (sessions of 3 ¾ hours with a 15 minute break) Figure 4. The sessions facilitate 24 hour cover.

Weekly contract	Module duration	Total duty time	Modules per week
Full time (37.5hrs) + breaks	4 hours (3hrs 45mins + 15 min break)	40 hours	10 modules
30 hrs + breaks	"	32 hours	8 modules
22.5 hrs + breaks	"	24hours	6 modules
15 hrs +breaks	"	16hours	4 modules
7.5 hrs + break	"	8 hours	2 modules

Figure 4

Full time staff would work 10 modules per week and part time staff would be employed on contracts that align with the modular system. The start times for the modules (e.g. 8am, 9 am or 10am), the number of modules worked on each shift (e.g. 2 modules for an 8 hour duty or 3 modules for a 12 hour duty) and the number of staff required for each module would be dependent on local workload analysis. Figures 5 and 6, below, demonstrate the application of the model, in the principal study centre. The modular system may be locally applied in individual centres, following workload analysis.

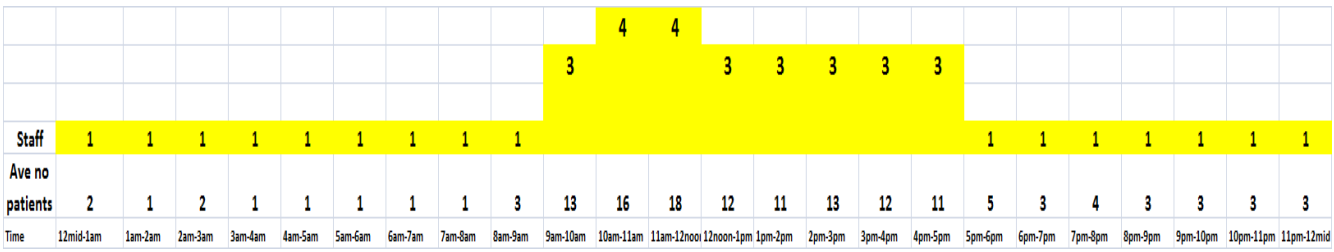


Figure 5

Figure 5 above, demonstrates the number of staff required to deal with the average general radiographic demand, in the principal study centre, in accordance with the Workpattern Model developed in the study.

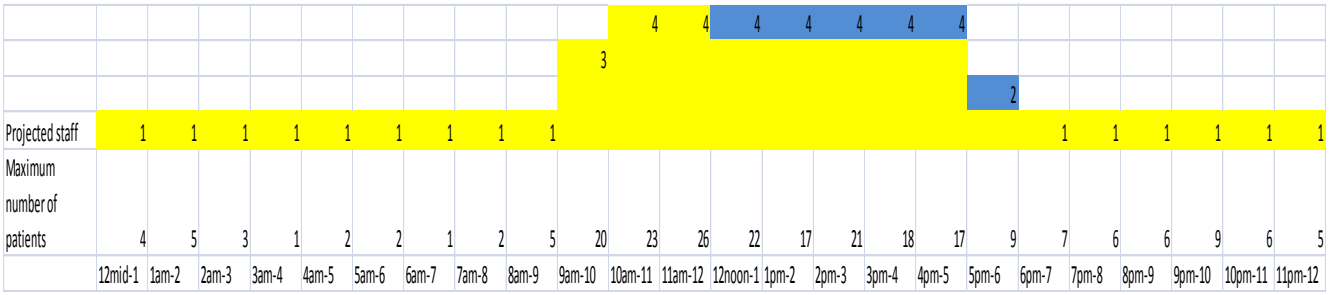


Figure 6

Figure 6 above, demonstrates a situation, where additional staff resource, has been invested to facilitate queue management when there is maximum demand. The additional staff resource has been applied from 12 noon till 6pm (highlighted) to meet the additional demand. This has a financial resource implication, that would be calculated and considered in the management plan, in relation to the number of times the maximum demand is identified. This may result in wastage of staff resource on occasions when demand is less than maximum.

Undertaking an hour by hour assessment of workload, in each individual centre, would identify the staffing required for general radiography, in accordance with the workload model. It would then be possible to calculate the total daily staffing required, throughout the roster horizon, within individual centres. This would be done by adding the staffing levels for modalities such as CT, MR – (identified from the capacity planning initiatives, undertaken by the diagnostic collaborative (Scottish Government, 2008)), to the staffing levels for general radiography, from the workpattern model above.

Reference

Scottish Government, (2008) Diagnostics Collaborative Programme: Delivering Better Patient Care in Diagnostics ISBN 978-0-7559-5576

The study

Development of a work pattern model to meet the changing service requirements with respect to patient and staff needs in Scottish Radiology departments

The questionnaire

This questionnaire will have been offered to you by your manager. I would appreciate if you would complete all of the questions, however if there are some questions that you would prefer not to answer, that is perfectly fine and your responses to the remainder of the questions would still be very useful.

It is likely to take about 15 minutes to complete the questionnaire.

Section 1 relates to the hospital where you work at the moment

Section 2 relates to the model as described in the Participant Information Sheet

Section 3 asks you to reflect on your personal and professional attributes

Section 4 offers you the opportunity to make any comments about the model

Section 1

This section relates to the hospital where you currently work

1. Do you work in

☐ A rural district general hospital

☐ A teaching centre

☐ An urban general hospital

2. Do you undertake general radiography within core hours?

Yes ☐ No ☐

3. Do you undertake general radiography Out of Hours?

Yes ☐ No ☐

4. Does your PDP identify a role development or a specialist radiographic interest or skill?

Yes ☐ No ☐

Section 2

This section related to the model as described in the Participant Information Sheet

Please circle the response nearest to your attitude, to the following statements in relation to your centre

5. The staffing numbers would currently provide satisfactory radiographic cover for the model across 24 hours in my centre

Strongly disagree disagree no strong opinion agree strongly agree

6. The AfC bands in the model would not be appropriate for general radiography staffing levels in my centre

Strongly disagree disagree no strong opinion agree strongly agree

7. There are currently insufficient staff of each AfC band employed in my centre to accommodate the model

Strongly disagree disagree no strong opinion agree strongly agree

8. The staffing levels in my centre (general radiography) do not reflect the cover specified in the model during core hours

Strongly disagree disagree no strong opinion agree strongly agree

9. The staffing levels in my centre (general radiography) reflect the model during Out of Hours duty

Strongly disagree disagree no strong opinion agree strongly agree

10. My PDP would be adversely affected by the modular system if implemented in my centre

Strongly disagree disagree no strong opinion agree strongly agree

11. My personal circumstances require workpattern flexibility

Strongly disagree **disagree** **no strong opinion** **agree** **strongly agree**

12. The modular system of the model would not accommodate my personal circumstances

Strongly disagree **disagree** **no strong opinion** **agree** **strongly agree**

Section 3

The following questions are about you

13. Which AfC Band are you?

5☐ 6☐ 7☐ 8☐

14. What age group are you:

21-30☐ 31-40☐ 41-50☐ 51-65☐

15. What is your household status? (tick all that apply)

☐ Living with a partner

☐ Live alone

☐ Responsible for dependents

☐ Other (please specify)

Section 4

If there is anything further that you would like to say regarding the model, please add comments here. Please feel free to continue on a blank sheet of paper

Please seal this completed questionnaire in the envelope provided and return to your manager.

The manager will forward all of these sealed envelopes to me.

Thank you very much for completing this questionnaire.

A copy of the analysis of the questionnaire responses will be sent to your centre

13.3 Section 4 - Comments

"I feel that the model is clear and pertinent: it could really be applied to my department. How would this model apply to multiple departments on one site? There is a possibility that there could be a detrimental effect on staffing if workload is the defining measure".

"Question is ambiguous. The workload can be different on different nights"

"I feel that our departments are too busy throughout the day to carry out this model".

"Does the model accommodate seasonal fluctuation in patient numbers? (Winter- ice slips summer increase in child patients)"

"The model is basically good but does not allow for the quality of patient or the number of examinations each patient undergoes. Working in a busy hospital where many patients have very poor mobility and many patients undergo multiple examinations as many as 7 or 8 at a time, the model requirements would be insufficient in almost every department."

"OOH can be unpredictable. OOH work can reflect few numbers but can be long theatre cases therefore 1 patient can be 1 hour of work"

"It would be difficult to work out the average workload such as AE because of the uncertainty of the workload. We also have very little information of which clinics are running on a daily basis".

"The graph for the primary study centre shows that there is an average of less than or equal to 5 patients per hour between 6pm and 10pm. This would allow for 1 radiographer during these hours but does not accommodate theatre/mobiles. I feel that 2 radiographers during these hours would be beneficial. Also does the staff allocation allow for theatre/mobiles during core hours?"

"Don't feel that you could x-ray 26 patients per hour with 4 staff (unless all walking chest patients)"

"Patient type can vary and perhaps would be better if examination type looked at as time varies from 5 minutes for minor injuries to major trauma taking 40 minutes-1 hour"

"Didn't understand the question. Does the question relate to the model or the centre?"

"I think it would allow some flexibility for staff if they were allowed to choose how many modules they wanted to do in a day"

"In our centre our peak time for the maximum numbers of patients would be later than 12 noon (e.g. 2pm). Numbers of staff may be less as 2-3 staff will be on theatres and mobiles"

"The explanation of the model was very complex. Module start times were not very clear (e.g. could they also start at 12noon)"

"I feel that no. of patients does not reflect no of examinations which would be better"

“The number of exams rather than number of patients. I find it very difficult to imagine what it would mean”

“The problem with most such models is that they never reflect the real world across the board. (A bit like central place theory) You can find where they do work by chance but in reality cannot be delivered across wider areas”

14. Appendix 3 – Manager Leaflet

Logo

Workpattern Model

The purpose of this Workpattern Model is to describe a framework that determines an appropriate cost effective staffing level in general radiography for all centres and sits within a modular application providing a sustainable service. The staffing as determined by the Workpattern Model increases with increased activity. Thus local staffing complement can be determined by relating the Workpattern Model to local workload analysis.

The Workpattern Model describes assignment of the lowest appropriate AfC band compatible with levels of supervision required. Band 7/8 is assigned during core hours to support managerial, supervisory or specialist skills. Band 7/8 should only be assigned during OOH if the centre required specialist skills.

Patient Activity per hour	Clinical Support staff Band 1-3	Administrative support staff Band 2-4	Radiographer/ assistant practitioner assignment
1-5 patients	Yes	Yes	1x band 5/6
6-10 patients	Yes	Yes	2x band 5/6
11-15 patients	Yes	Yes	2x band 5/6 1x band 4
16-20 patients	Yes	Yes	3x band 5/6 1x band 4
21-25 patients	Yes	Yes	4x band 5/6 1x band 4
26-30 patients	Yes	Yes	4x band 5/6 2x band 4
Managerial, supervisory or specialist skills			Band 7/8

Workpattern Model – Core Hours

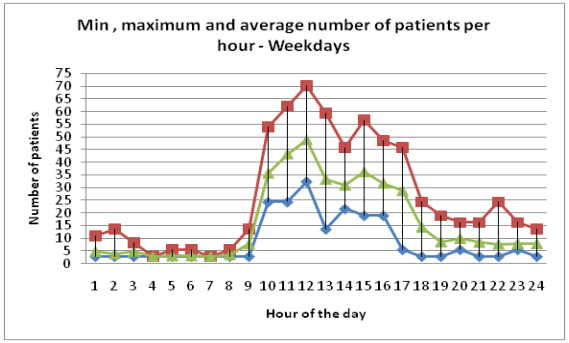
Patient Activity per hour	Clinical support staff Band 1-3	Administrative support staff Band 2-4	Radiographer/ assistant practitioner assignment
1-4 patients	No	No	1x band 5/6
5-8 patients	No	No	2x band 5/6
9-12 patients	No	No	2x band 5/6 1x band 4
13-16 patients	No	No	3x band 5/6 1x band 4
17-20 patients	No	No	4x band 5/6 1x band 4
21-24 patients	No	No	4x band 5/6 2x band 4
Only if specialist skills required			Band 7/8

Workpattern Model - OOH

Weekly contract	Module duration	Total duty time	Modules Per week
Full time (37.5hrs) + breaks	4 hours (3hrs 45mins + 15 min break)	40 hours	10 modules
30 hrs + breaks	"	32 hours	8 modules
22.5 hrs + breaks	"	24hours	6 modules
15 hrs +breaks	"	16hours	4 modules
7.5 hrs + break	"	8 hours	2 modules

Modular Application

The modular application is based on a 4 hour modular system. The number of modules in a duty may be 1, 2 or 3 (4 hours, 8 hours or 12 hours) to suit local situations.



The start and finish times for the modules are also dependent on local situations and can be determined from local data analysis of the workflow.