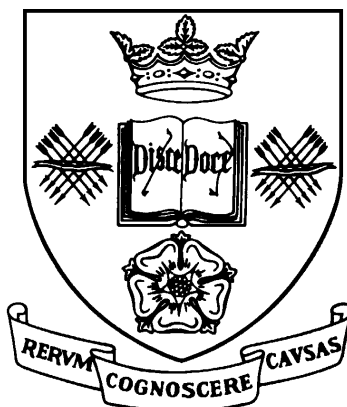


University of Sheffield



The benefits and costs of workload forecasting in the health service: an exploratory study

An independent research study carried out by the Medical Care Research Unit of the University of Sheffield, on behalf of the Met Office. The views expressed are those of the authors and not necessarily those of the Met Office.

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January 2003

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1. EXECUTIVE SUMMARY

There is increasing interest in the potential for forecasters to predict not only the weather, but also the health and workload consequences of changing weather conditions for health services. This possibility has been under investigation by the Met Office since 1996.

Although the findings of the Met Office's work to date are encouraging, there remains considerable uncertainty about whether health services are, in practice, able and willing to act on workload forecasts, and about the range of costs and benefits – including health and economic benefits for individuals and the NHS – which might follow from the introduction of such a service. The purpose of the study reported here was therefore to model the likely costs and benefits which might follow the introduction of routine workload forecasting in the NHS. However, as the project progressed it became clear that the primary issue was the degree to which services were able and willing to respond to forecasting at all.

The study was conducted in three stages: a literature review, a small number of semi-structured interviews with selected NHS managers in immediate care services, and the development of a quantitative model estimated the potential costs and benefits of forecasting, based on responses to a small survey of managers.

Both the qualitative and quantitative data suggested that, at present, NHS managers are highly risk averse in responding to forecasts, and see a range of practical and policy-related obstacles to making any response at all. When they do respond, they are more likely to “staff up” to meet predicted high demand than to “staff down” to meet predicted low demand.

Nonetheless, the quantitative modelling we have undertaken suggests that in the short term a forecasting service could achieve an improved match of service capacity to demand, at some net financial cost. The size of this improvement depends upon the value to the service of advance notice and the accuracy of the forecast provided, but is potentially substantial. In the limited time available to us for this work we have been able to express this improved match only in terms of hospital staffing, but of course it is possible that the benefits of a forecasting service may extend much more widely than this.

In the longer term, as the NHS gains experience in the use of forecasts, it is possible that services may become more flexible in response to forecasts and so the net benefits in relation to costs might be expected to increase correspondingly.

This exploratory study has generated a range of insights into the possible effects of forecasting which, though encouraging, remain essentially hypothetical. We would therefore recommend that the next step, in research and development terms, should be a carefully evaluated controlled trial of the service on a limited geographical basis in which a wide range of relevant outcomes are measured in intervention and control sites before and after the scheme. Important outcomes are likely to include measures of forecast performance and

service performance indicators such as emergency and elective waiting times, staff stress and patient satisfaction. Importantly, an economic evaluation will be required alongside any trial in order to identify all of the important costs and benefits of the scheme.

2. INTRODUCTION

The NHS has a long history of suffering “winter crises” precipitated by sharp increases in emergency medical and trauma admissions during periods of cold weather, alongside similar increases in primary care workload during influenza outbreaks. The winter pressures are attributed largely to increased incidence of cardiovascular and respiratory disease, but also due to other factors such as delayed discharge and other bed management issues.¹ In recent years such crises have led to cancelled elective admissions, difficulties in admitting emergency patients, falling staff morale and much adverse media coverage.

In the light of this, there has been increasing interest in the potential for forecasters to predict not only the weather, but also the health and workload consequences of changing infectious disease and weather conditions for health services. This possibility has been under investigation by the Met Office since 1996, and pilot forecasting projects of increasing sophistication have been undertaken during the winter months of 1999/2000 (Berkshire only), 2000/01 (five pilot sites in England), 2001/02 (30 GP co-ops, 30 hospitals and various NHS Direct regions) and 2002/03 (a wider range of volunteer sites). Evaluations of both the 2000/01 trial and 2001/02 pilot project have been published.^{2, 4}

Although the findings to date are encouraging and the pilot forecasts have been welcomed by NHS managers, there is considerable uncertainty about whether health services are, in practice, able and willing to act on workload forecasts and if so, what their actions might be. In addition, there is a need to begin to understand the range of costs and cost consequences – including the health and economic consequences for individuals and the NHS – which might follow from the introduction of such a service. These issues are the focus of the study reported here.

Much research has been undertaken and reviewed on the associations which may exist between weather conditions and health-related events, but this is not addressed in the current study. Nor are we concerned with the degree to which either weather or health events can be predicted with any useful degree of accuracy. (This latter issue is currently the focus of research by the Yorkshire Health Economics Consortium.) For our purposes, we take the existence of weather and health forecasts, of some assumed degree of accuracy, as a given. The question addressed here is: how is the NHS likely to respond, and to what effect?

3. AIMS AND OBJECTIVES

The initial aim of the study was to model the likely costs and benefits (both economic and health outcomes) which might follow the introduction of routine workload forecasting in the NHS. However, as the project progressed it became clear that the primary issue was the degree to which various services were able and willing to respond to forecasting at all. This became a central theme of the research.

The more specific objectives of the research were:

- a) to undertake a literature review to identify any previous experience of, or research into, using weather or workload forecasting to plan health services;
- b) to undertake a series of semi-structured interviews with key NHS staff in first-contact services to identify the opportunities, constraints and potential benefits to the use of workload forecast data; and to establish what approaches to workload planning are currently in place;
- c) to use the results of a) and b) above to inform an economic model of the possible costs and consequences of routine workload forecasting to the NHS, with the aim of furthering our understanding of the key factors which might influence the impact.

4. METHODS

4.1 Literature review

The initial aims of the literature search were to identify:

- any previous experience of using weather forecasting or seasonal trends to plan health care
- any literature discussing the ability of immediate care services to respond to forecasts.
- any related economic evidence on the potential costs and benefits of using weather forecasting or seasonal trends.

Due to the lack of literature available on the above subjects, we extended the searches to include forecasting, response to forecasting and economic evidence on costs and benefits of forecasting not specifically related to weather or seasonality.

The following databases were searched: Medline, Embase, Web of Science and HMIC DoH & King's Fund database. No additional meteorological databases were identified by the Met Office as having potentially relevant articles. The reference lists of all retrieved articles were also scanned in order to identify further articles of interest.

We did not search for articles reporting on the link between morbidity, mortality and the weather, as these feel outside the scope of the current study. Likewise, we did not review articles relating to methodological issues around forecasting, although we examined any that related to the use of seasonal trend in forecasting. However, some of these articles were reviewed where it was felt they would provide information relevant to our objectives.

4.2 Interviews with health service managers

We originally planned to carry out the interviews in two stages. We expected to undertake a number of pilot interviews with relevant personnel locally and analyse these before developing a revised schedule which we would use to carry out a further set of interviews in order to obtain the principal data for the model.

At a meeting of the project team on 7 October 2002, we agreed that further interviews would not be the most appropriate method of obtaining information to inform the model. While the interviews were important in identifying the opportunities, constraints and potential benefits to the use of workload forecast data qualitatively, it was considerably more difficult to elicit information that could realistically feed into the model. We found that the most appropriate people to be able to inform us of the potential uses of the health forecasting, were those in senior management who had limited time to participate in interviews. We felt it would be

unrealistic to ask them both the qualitative questions mentioned above and also to provide quantitative information to inform the model.

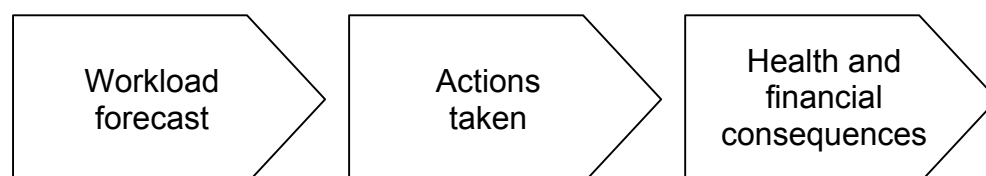
Instead, we developed a survey to provide data to feed into the model of costs and consequences. This is discussed in section 4.3 below.

We undertook seven interviews with health service managers from the local GP co-op (two interviewees), ambulance service, A&E department, PCT, NHS Direct, one major acute teaching hospital and one district general hospital. We designed a semi-structured interview schedule to establish managers' previous experiences of workload forecasts, how they currently plan services, how they would use different types of forecasts, how confident they would be in the forecasts, what benefits and constraints might apply to using the forecasts and how the forecasts may be improved (see Appendix A for interview schedule). The interviews each took 40-80 minutes. Due to time constraints within the interviews, the entire schedule was not completed in every interview.

The interviews were tape recorded, transcribed verbatim and checked by the interviewer (FS). They were analysed using framework analysis to examine whether there were any underlying themes relating to barriers or opportunities of using the forecasts.

4.3 Survey of health service managers

It is self-evident that attempts to forecast workload can only have an effect on the operation of the NHS if the forecasts lead to actions which would not otherwise have occurred. This simple idea is illustrated below.



Although there are considerable uncertainties in each of these steps, the greatest uncertainty is probably in determining the actions which managers might take in response to forecasts. The purpose of the survey of managers was to estimate, in a simple way, how managers might respond.

4.3.1 Survey development

We surveyed a small number of health service managers from GP co-ops, ambulance services, acute hospital trusts and A&E departments. We aimed to contact managers from 30 acute hospital trusts, 20 GP co-ops, 20 ambulance trusts and 20 A&E departments. Names of managers were provided by the Met Office for all 30 acute hospital trusts, 16 co-ops, 5 ambulance trusts and all 20 A&E departments. We understand that these were all registered

users of the *Forecasting the Nation's Health* web site, and thus might be expected to be familiar with the proposed forecasting service.

Data collection forms were drawn up and shared with the Met Office. Although similar in structure, the data collection form for each of the four services differed in the details of the actions which might be taken in each case. The forms are included within appendices B-E.

The survey aimed to find out what actions managers would take given various levels of *predicted* increase or decrease in workload, with various numbers of days notice of the change and under two different assumptions of forecast accuracy level.

We also asked what changes they could make *without* any advance warning of a change in workload, and what the potential consequences of an unpredicted increase in workload might be. We asked only about the consequences of an unpredicted increase in demand since we felt that there would be no particular consequences of an unpredicted decrease in demand on the day, simply those of reducing staffing levels or the service being more able to cope.

In order to maximise the response rate it was considered important to produce a survey that was as simple as possible, particularly given the short timescale in which a response was required. We asked respondents to consider the actions they might take given forecast changes in workload of four different amounts (two increases and two decreases) and with three different periods of advance notice. We asked respondents to consider these scenarios twice, under two different levels of assumed forecast accuracy. Even under these limited assumptions, each survey involved 24 different scenarios to consider for each possible action that might be taken.

The accuracy rates we asked respondents to consider were 90% and 60%. The former was felt to represent a high level of accuracy and would enable managers to consider what actions they would undertake if they were "almost sure" the forecast was correct. We aimed to use this to elicit the actions managers might realistically make given that they have a high degree of belief in the forecast. The 60% level was used because it was considered by the Met Office to represent the most likely actual level of accuracy at present.

The lead times of forecasts were set at 24 hours, 3-5 days and 10 days (which was the maximum on the mock-up forecasts provided by the Met Office). We also asked what changes people might realistically make in response to workload changes "on the day" as this would provide us with information as to how changes in workload are currently managed.

The percentage change figures of $\pm 15\%$ and $\pm 30\%$ from expected workload were estimated from graphs of emergency admissions within the Stage II Review (July 2002) and were agreed with the Met Office. Unfortunately real data on the potential ranges in 'difference from expected' were not available at the time of piloting the data collection forms.

4.3.2 Survey implementation

We made our initial contact with interviewees differently for each service, depending upon how easy it was to speak to the relevant person.

For GP co-ops, we phoned a sample of 20 GP co-ops, using the list of co-ops which had been issued with a Met Office password. We asked to speak to the general manager in each co-op.

For hospitals, we e-mailed the named contact in each of the 30 hospital pilot sites, explaining the research we were carrying out and asking for the name of the most appropriate person within the organisation to answer the survey. When we received a response, we faxed the survey to the named person and arranged a time to explain it over the phone.

For ambulance services, we telephoned 20 services and asked to speak to the director of operations. Because it was often difficult to get hold of this person, we faxed the survey to the trust and asked the director of operations to telephone to say whether or not they could participate in the research.

For accident and emergency departments, we telephoned the A&E department at 20 hospitals and asked to speak to the clinical director. Where we could not speak to the clinical director, we spoke to their secretaries and faxed the survey through to them.

Following explanation of the survey on the telephone, we asked each respondent to fax or post the completed survey back to us.

4.3.3 Survey analysis

Due to the small number of respondents, (Table 5-1) we summarised the data qualitatively. In order to provide estimates of changes that managers may make for the model, we calculated the average changes for a population of 1 million.

Comments made by managers on the telephone or within the free text boxes of the surveys were noted and summarised qualitatively.

4.4 Economic model of workload prediction

4.4.1 General approach

There are a large number of possible approaches to modelling the potential impact of workload forecasting, ranging from simple deterministic models through to complex simulation methods. One characteristic that all such approaches would share in this context is the hypothetical nature of the model, since by definition – because this is a new and untried service – we have no empirical data on which to base the likely response of the NHS.

In view of this, and in the light of other uncertainties (such as the likely performance of the forecasts, the developmental and evolving nature of the service, and the lack of quantitative data on the relationship between workload, capacity and service outcomes) we have opted for a simplified approach using a spreadsheet model.

The advantage of this approach is that the “inner workings” of the model remain transparent and easy to alter. While, as we will see, not all elements of the problem can be quantitatively modelled, even a simple modelling approach can provide valuable insights into how workload forecasting might impact upon NHS behaviour and costs.

The general steps involved in developing an economic model can be summarised as follows:

- Conceptual clarification and schema development
- Identification of all costs and consequences
- Measurement and valuation of costs and consequences
- Development of model structure in software
- Population of model with known quantitative parameters
- Exploration of key variables and sensitivity analysis.

4.4.2 Conceptual schema

A simplified flow chart of the conceptual schema is shown below (Figure 4-1), based on data from the initial interviews with health service managers and discussions within the research team. Some initial points of explanation are necessary.

There are two alternative entry points at the top of the model. In the first, no forecast is available and health services react as they do now: no advance planning can be made, workload of a given level occurs and the service responds as best it can on the day. This may involve making no attempt to change service capacity at short notice – if demand has gone up, then simply “getting by”, or if demand has gone down, then finding alternative productive uses of spare capacity, if possible. If the service does attempt to alter capacity – for example, by bringing in extra staff to meet demand – this clearly carries a financial cost. In practice, it may be difficult or impossible to change capacity at such short notice, and if this is the case then unwanted outcomes may occur, such as increased waiting times or adverse clinical events (shown by the grey boxes).

In the second entry point in the schema, a forecast change in workload is available in advance. Based on this, managers may take action to change service capacity to meet forecast workload, which will carry its own financial consequences. Subsequently, workload of a given level occurs (which may or may not match that predicted), and the service responds, as above, to any difference between workload and the capacity available.

Thus, for any given scenario, we can compare the likely costs and consequences with or without forecasting. This is important since, in practice, we are interested not in the absolute costs and consequences of forecasting, but in the likely *change* in costs and consequences which would result in introducing such a service. Clearly, if for example workload prediction is already good enough for practical purposes, or few actions can be taken in reality, then the marginal benefits of a forecasting service are likely to be small.

The double-bordered diamond at the centre of the model indicates the decision point where expected workload is compared with that which actually occurs. In the spreadsheet model, we will model five levels of expected workload and five levels of divergence from the expected, so that 25 workload scenarios are modelled in all. Of course, we expect some of these to occur commonly and others to occur less commonly or rarely, and we make assumptions in the model about their relative frequency.

The rounded boxes to the right of the flowchart represent the financial (white boxes) and other (grey boxes) consequences of any given situation. It is important to appreciate that these consequences occur to different degrees according to the management actions that are taken and that, in general, the financial consequences are inversely related to the other consequences. This is indicated in the figure by the dotted arrows.

For example, assume a service which is completely flexible in capacity. On any day, if demand were to be greater or less than expected, managers might increase or decrease capacity to match demand perfectly. If this were the case, then there would be financial costs or savings, but no other consequences since demand would be perfectly met. By contrast, if managers were unable or unwilling to match capacity exactly to demand, then the financial costs or savings would be smaller, but other consequences (such as signs of service strain, or service overcapacity) would appear. In the extreme (which may actually be the everyday in the NHS) if there were no attempt to match capacity to changing demand, then there would be no short term financial cost or saving but maximal over/undercapacity consequences.

This general principle applies both to the response “on the day” to changing demand, and to the response to the forecast of demand in advance.

To follow this line of reasoning further, it becomes clear that, if a service were perfectly flexible, and the costs of changing capacity were the same whether changes had to be made in advance or “on the day”, then there would be no benefit from forecasting demand. Since, in fact, this is not the case we can see that the potential benefits of forecasting follow from two realities:

- Services are not perfectly flexible and, in general, greater flexibility in capacity can be gained from some advance notice – for example, allowing time to book locum or agency staff in advance, or time to plan alternative uses of spare resources;

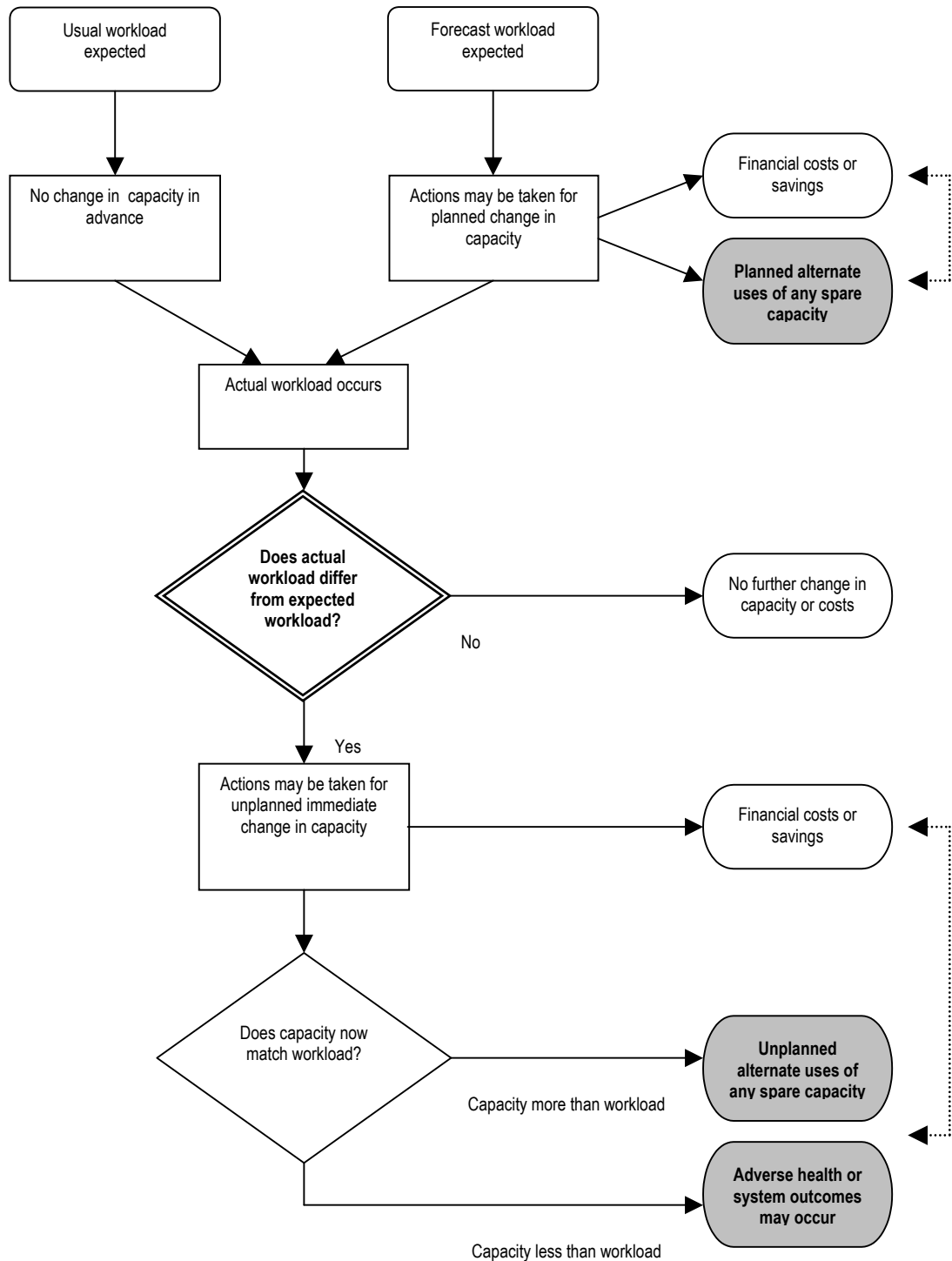
- The costs of changing “on the day” are almost always higher than the costs of planning a change in advance – for example, locum rates are higher where no notice can be given.

Thus, the greater the differences in achievable flexibility of capacity, and in costs, between the forecast time and the actual demand time, the greater the net benefit of forecasting is likely to be. If a service is equally *able* or *unable* to change its capacity whether “on the day” or given 10 days notice, then the net benefits of forecasting are likely to be small. It is therefore the case that very inflexible services, as well as very flexible services, will find forecasting of correspondingly small benefit. In practice, most NHS services are probably somewhere between these extremes.

In regard to modelling this situation, it proves to be relatively straightforward to model the *financial* savings or costs of management decisions to change capacity in quantitative terms, subject to a number of simplifying assumptions. However, the *service and health* consequences of such actions are less clear. In order to model these quantitatively, we would need to determine the size of the service over/under-capacity remaining after some change in capacity had been made. Then we would need to model the relationship between this and the likely consequences in terms of, for example, increased waiting times, staff strain, or adverse health outcomes. Finally, we may wish to value such outcomes in monetary terms.

Although no data is available to allow quantitative modelling of these relationships, we can make some qualitative assumptions about how these outcomes are likely to change in response to forecasting. This issue will be discussed further below.

Figure 4-1: Simplified conceptual schema for economic model development



4.4.3 Identification of costs and benefits

With a broad understanding of the problem in place, we turn to the identification of all costs and benefits to be modelled.

The focus here is on the costs and benefits which may follow the introduction of the service to the NHS, but not upon the direct costs of providing the service itself. This is taken as a given.

The conceptual outline above indicates the general areas in which costs and benefits will occur and must be identified. The table below lists these in greater detail, following a similar structure.

Table 4-1: Costs and benefits of forecasting

	If advance notice is given	If no advance notice is given
Financial costs/savings of increasing capacity	Staffing costs of booking locum or standby doctors, bank or agency nurses, extra reception staff, admin staff or driver shifts Bringing additional clinical areas into service: beds, heating, lighting Bringing additional vehicles into service, fuel and servicing costs	Similar costs charged at a "same day" (higher) rate
Financial costs/savings of decreasing capacity	Reduction in medical, nursing, admin and driver staffing costs Possibly additional staff costs to gain flexible contracts/shift patterns Savings on fuel, lighting, heating	Similar costs/savings where changes can be made
Consequences of capacity in excess of demand	Alternative uses of physical facilities or staff which can be planned in advance, such as increase in elective admissions or day cases, time for staff training, service planning, audit or other activities Improvements in processes of care such as shorter waiting times for initial consultation, increased staff time per patient, speedier consultations Improvements in outcomes of care such as increase in patient satisfaction, better health outcomes for time critical conditions Improvements in staff morale and retention	More limited range of alternative uses which can be made without any advance notice Staff dissatisfaction if unnecessarily on duty or on call Similar improvements in processes and outcomes of care
Consequences of capacity insufficient to meet demand	Deterioration in processes of care: increased waiting times, less staff time per patient, slower consultations Deterioration in outcomes of care: poorer patient satisfaction, increased risk of adverse events, clinical errors, or death Deterioration staff morale: staff more stressed, poorer retention of staff	Similar deterioration without warning. Likely increased staff stress.

As we have noted above, many of the financial savings or costs identified here can be quantified for modelling purposes. While the non-financial consequences can be identified, they can not be straightforwardly modelled in the absence of data.

However, by making various assumptions about the “target level” of staffing which services would like to achieve to meet demand, it is possible to model, albeit in a simplified way, the impact of forecasting on how often services are able to match their capacity to the demand they experience. This allows us to begin to quantify the potential non-financial benefits of forecasting.

In order to do this we took managers’ reports of staffing changes they would make given the (90%) accurate forecast they have most confidence in, and the greatest (10 days) period of notice available, as an approximation of the optimal staffing level they would like to achieve. We simplified the staffing levels by considering two types of staffing: medical and nursing. While this does not account fully for the effects of skillmix, it provides an initial approximation of numbers of staff required.

Then, for each of the 25 forecast/actual workload scenarios we calculated the difference between this optimal level and the staffing level which is actually reached. This information was summarised as the number of days in a year on which actual staffing matched optimal staffing, and the number of days on which it was over or under the optimal level by up to five, or more than five, staff members.

4.4.4 Measurement and valuation of costs and benefits

The costs and benefits which occur in any scenario are a combination of the management actions taken (either in advance, or “on the day”) and the costs and consequences of these actions. We consider these in turn.

Management actions in each scenario

The results of the survey of health service managers are used to indicate the range of actions which may occur in each scenario. Thus, for each level of expected or actual workload respondents have indicated quantitatively the size of each action they might take. For modelling purposes, the mean response per million population is taken as the central estimate for each action, and the range of responses provides the range for sensitivity analysis. Where the absolute variation in actual workload is outside the range of scenarios for which we have respondent data, we take a linear extrapolation to determine the expected actions taken.

Costs and consequences of various actions

A simple approach to modelling the financial costs of each action taken has also been adopted. For each change in staffing or other resources, we simply multiply the change in resource by the unit cost of that resource, taken from published sources. While this may

reasonably reflect some costs – for example, the cost of an additional locum doctor or agency nurse – it may be less realistic as a way of modelling savings, since reduced staffing on any day will not save money directly (unless staff are paid as casual workers) but still reflects a real resource which can be reallocated to other tasks or other times.

Unfortunately, within the scope of this project it was not possible to model the full range of *non-financial consequences* – such as changes in waiting times, health outcomes, other uses of the same resources, satisfaction or morale – in similarly quantitative terms, since we had no data to model a quantitative relationship between workload, capacity and such consequences. Although some attempts have been made to use simulation modelling to examine how waiting times might change in A&E as a result of staffing changes, this is insufficient for current purposes.³ In principle, simulation or other models could be undertaken to estimate quantitative relationships but this would be well beyond the scope of the current study.

Nonetheless, results from the interviews do provide some useful insights into the range of benefits and costs which might flow from implementing workload forecasting.

4.4.5 Development of model structure in software

The model was implemented as a simple spreadsheet model in Microsoft Excel, along the lines shown in Figure 4-2 below.

The figure shows the basic outline of the model. The model can be run for six different scenarios: forecasts with 24 hours notice, 3-5 days notice and 10 days notice, and for each of these, assuming a 90% and a 60% accuracy level. It can also be adapted to include different inputs as required.

There is also a separate model set for each of the four services under consideration: GP co-operatives, hospital admissions, ambulance services and accident and emergency departments.

Figure 4-2: Model structure

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
What is the forecast?	How often does the forecast suggest this level of change?	How did the actual change relate to the forecast change?	How often does this difference occur?	Actual change in workload experienced	How often would this happen?	How much would responding to the workload (D) cost, given no forecast?	Additional cost of adverse events	What is the expected cost of having no forecast?	What costs are incurred from acting on the forecasts?	What additional costs will be incurred on the day?	Additional cost of adverse events	What is the expected cost of having a forecast?	What is the net annual cost / saving of the forecast?	Net annual cost/saving for population of 1 million
<p style="text-align: center;">= B * D</p>						<p>= COST OF ACTION ON THE DAY</p> <p>= COST OF ADVERSE EVENTS</p> <p>= G + H</p>			<p>= COST OF CARRYING OUT ACTIONS OF FORECAST</p> <p>= COSTS OF ADDITIONAL ACTIONS NEEDED ON THE DAY</p> <p>= COST OF ADVERSE EVENTS</p> <p>= J + K + L</p> <p>= Σ (M - I) * F * 365</p> <p>= N * scaling factor</p>					

Throughout the model we refer to three different levels of workload:

- **expected** –the ‘status quo’, i.e. the level of demand that managers anticipate without the forecast, for example, based on last year’s experience;
- **forecast** –the level that the Met Office forecast predicts;
- **actual** – the workload level that actually occurs in practice.

In each model, 25 possible workload scenarios are suggested. For each of these, the model compares the actions and costs which might occur if there were no forecast available with the actions and costs which might occur given such a forecast. These elements of the model are now reviewed in turn.

Workload scenarios

Columns A to F of the model refer to the various combinations of forecast and actual workload we assume, and their expected relative frequencies of occurrence. The assumed levels are discussed below under “Populating the model”.

Actions and costs in the absence of a forecast

Columns G to I estimate the costs in the absence of a forecast. In column G we estimate the cost of the changes that might be made “on the day” to respond to actual workload. This is calculated from looking up the actions which would be taken to respond to the level of workload experienced and calculating the cost of providing that level of activity on the day.

In column H one would want to estimate the cost of any adverse consequences of being unable to meet the actual demand, or the opportunity cost of having unused capacity which cannot be deployed elsewhere.

Column I is simply the sum of these costs.

Actions and costs in the presence of a forecast

Columns J to M examine the costs which might follow from a forecast being provided. In essence, these are the costs of acting in advance, on the basis of the forecast (column J), and then the cost of making any necessary additional changes “on the day” to meet actual workload (column K).

Intuitively, one might guess that this should be calculated from the cost of providing the level of service for the *difference* in actual from forecast (i.e. column C). But this is to assume that changes are made as a result of the forecast in order to match forecast demand exactly, and so any costs incurred on the day should match the difference in demand on the day.

Consider a forecast 15% reduction in demand. If the actual demand turns out to be no different from the expected (usual) demand, it would appear that there is a 15% shortfall in

capacity. In reality, of course, services may have made no reductions in staffing, so that staffing levels are sufficient for the eventual workload.

Similarly, managers may not staff up fully if they do not believe a forecast, which needs to be reflected in the model. For example, given a forecast of +15% and an actual increase of +30%, we cannot assume that the additional staff required on the day are those needed to meet a 15% shortfall, as this assumes that the manager has acted fully on the forecast. If the manager has not acted on the forecast at all, the increase in staffing required on the day is that required for a 30% shortfall.

Importantly, the model should demonstrate that *the costs of not acting on a forecast are the same as those incurred in not having a forecast at all* – i.e. the only cost will be that of actions required on the day. We therefore took the “additional costs on the day” to mean the following:

- Where the actual demand on the day is greater than expected (usual): staffing levels should be greater than or equal to those when there is no forecast at all. Where the levels of staffing from acting on the forecast were lower than those needed on the day, we took the additional staff needed as the difference between the actual requirement and the forecast level. Where the forecast level of staffing was higher than the actual requirement on the day, we took the forecast level.
- Where the actual demand on the day is lower than expected (usual): staffing levels should be less than or equal to those incurred when there is no forecast at all. Where the levels of staffing from acting on the forecast were higher than those needed on the day, we took the additional staff as the difference between the actual requirement and the forecast level. Where the forecast level of staffing was lower than the actual requirement on the day, we took the forecast level.

Consider a forecast for an increase of 30% in demand. If the actual increase was only 15%, we do not consider capacity to be reduced on the day. This is intended to reflect the fact that there may be limitations as to the amount of changes in staffing levels that can actually be achieved on the day.

However, the model is symmetrical in that it will overestimate where there is an increase in workload and underestimates where there is a decrease in workload. Therefore, if managers found it equally possible to staff up and down to meet demand appropriately, the net effect of these potential inaccuracies will be zero.

Internal and external staff

When calculating the additional numbers of hospital staff, we also needed to take account of the balance between internal (bank) staff and external (agency) staff. As managers are likely to use internal staff as a first option and then external staff as a second option, we felt this

needed to be reflected within the model. Therefore when calculating the numbers of additional staff needed on the day, we adjust the calculations so that the maximum numbers of available internal staff are used before external staff.

1) We calculated the numbers of additional internal staff as follows:

Where the levels of internal staff from acting on the forecast were lower than those needed on the day, we took the additional staff as the difference between the actual requirement of internal staff and the forecast level of internal staff. Where the forecast level of staffing was higher than the actual requirement on the day, we took the forecast level.

2) We calculated the numbers of additional external staff as follows:

Where the total levels of external and internal staff from acting on the forecast are lower than the total number of external and internal staff needed on the day *plus* additional internal staff (as calculated in 1), we took the additional external staff as the difference between the actual requirement of all staff and the sum of the forecast level of all staff and additional internal staff.

Estimated annual cost or saving for a population of 1 million resulting from the forecast

Columns N and O provide estimates of the total annual costs or savings resulting from the forecasts. Column O adjusts the estimate in column N to provide a figure for a population of 1 million.

Detail of spreadsheet content

The spreadsheet contains different sheets for different functions. The cells within the model are colour-coded to enable the user to enter different information from that assumed within the scope of this project (Table 4-2)

Table 4-2: Colour coding of spreadsheet cells

White	include calculations behind the model. Do not alter the content of any cells which contain calculations
Yellow	cells which can be altered by the user
Red	indicates cells that should be checked when yellow cells have been altered by the user
Blue	include calculations which should not be changed, but which give important information as to what assumptions are being used
Pink	results

Table 4-3 describes the content of each of the model's spreadsheets.

Table 4-3: Individual worksheets in the Excel workbook

Name	Purpose
Model summary sheets	
Hospmod	This is the main sheet summarising the costs of the workload forecasts for the acute hospitals - referred

	to as 'the model'. Enter the scenario you wish to consider in the drop down box and the results will appear in the pink cells (columns N-O).
Coopmod	This is the model for the GP co-ops. Works identically to the Hospmod sheet.
Ambmod	This is the model for the ambulance services. Works identically to the Hospmod sheet.
A&Emod	This is the model for accident & emergency departments. Works identically to the Hospmod sheet.

Actions in response to forecasts

Hospact	This contains the information about what actions managers would undertake for each of the six scenarios given. The results are those provided by the surveys, but these can be overwritten. Columns A-F and N-Y hold the results from the surveys, but these can be overwritten. The scenario labelled 'manual' in columns H-L holds blank cells which can be filled in with your own information if you choose the 'manual' scenario option.
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Cell B24 shows the population covered by the services included within the survey results. If you put in a manual scenario, you should alter this to the population size which your assumptions cover (e.g. if you are looking at the results of one hospital which covers 250,000 patients, enter 250,000 in the cell). This figure is used to adjust the total costs to provide a cost per million population (**column O in the model**)

Columns AA to AT hold the costs associated with the no forecast actions (same day actions) and the chosen forecast actions. These are based upon the unit costs provided in the Unit Cost sheet and are fed into the Hospmod sheet (**columns G and J of the model** respectively).

For costs where the % change in workload forecast is different from those for which survey data was available, we assumed that the changes made (and relevant costs) would be linearly related. We therefore estimated the costs for a 45% and 60% increase to be 1.5 and 2 times that of a 30% increase.

These assumptions may not be realistic as the true thresholds for change will differ. For example, while we have considered a 60% increase to have double the costs of a 30% increase, this may not be the case as there may not be sufficient staff, or managers may be more wary about increasing staffing levels to such a degree based on the forecast. The probability of changes of $> \pm 30\%$ are small and as such the consequence of these assumptions are not considered to be important. However, these figures can be altered within the spreadsheet if different assumptions are required (yellow cells in columns AB to AT).

Coopact	Contains the information as to what actions would be undertaken by GP co-ops. Works identically to the Hospact sheet.
Ambact	Contains the information as to what actions would be undertaken by ambulance services. Works identically to the Hospact sheet.
A&Eact	Contains the information as to what actions would be undertaken by A&E services. Works identically to the Hospact sheet.

Actions "on the day"

Hospadd	This is the sheet that calculates what additional changes will be needed "on the day" to meet the actual workload. This provides the information for column K of the model .
Coopadd	Calculates the additional changes on the day for GP co-ops. Whilst this works identically to the Hospadd sheet, the calculations within are different. (see Actions and costs in the presence of a forecast...)
Ambadd	Calculates the additional changes on the day for ambulance services. Whilst this works identically to the Hospadd sheet, the calculations within are different. (see Actions and costs in the presence of a forecast...)
A&Eadd	Calculates the additional changes on the day for A&E services. This works identically to the Hospadd sheet.

Other underlying data

Scenario	This lists the names of the different scenarios that are included within the model. There are seven scenarios listed: 90% accuracy – 24 hours, 90% accuracy – 3-5 days, 90% accuracy – 10 days, 60% accuracy – 24 hours, 60% accuracy – 3-5 days, 60% accuracy – 10 days and manual. If you wish to look at a scenario using your own information, use the manual option. You do not need to use this sheet as the names are chosen from the drop down menu in the main model sheet.
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Unit costs	This provides the unit costs upon which all calculations are based. The costs that are fed into the model are those in columns E and G. Further explanation of these costs is provided in section 5.4.1.
Accuracy	<p>This contains information on the assumed relative frequencies of each level of forecast and actual workload.</p> <p>The proportion of days which the forecast predicts the five levels of change (column B of the model) are derived from figures input into B2:B5 of this sheet. The number of days in each of the categories can be altered, but the user should ensure that the figure in cell B7 is 365.</p> <p>The assumed accuracy of the prediction (column D of the model) is derived from the cells B12:N23. Where a manual scenario is examined, the model takes the accuracy rates from the proportions typed into the yellow cells in rows 19-23. The user should ensure that these numbers add up to 100.</p> <p>Where other scenarios are used, the model takes the information from rows 12-16. For 90% or 60% accuracy scenarios, this assumes the number of times the % different from expected is 0 is 90% or 60%. The other four levels are calculated so that the total adds up to 100 and the number of times the forecast is $\pm 15\%$ from expected is double the number of times the forecast is $\pm 30\%$ from expected.</p>
Optimal	This contains the information about the optimal level of staffing that would be achieved. This is currently set at the level of the 90% accurate, 10 day forecast, but can be altered.
Hospdocs	This provides results of how many days in a year the hospital service could expect to be understaffed or overstaffed according to the optimal levels of medical staffing set in the previous sheet. The results for each of the scenarios can be examined by changing the entry in the drop down box. Results are provided in cells S41:AC41.
Hospnurses	This provides the same information as Hospdocs, but for nursing staff.

4.4.6 Populating the model

Workload scenarios

As mentioned above, the model considers actions and resultant costs under 25 different workload scenarios.

First, we assume five different levels of forecast workload: no change, +15%, +30%, -15%, or -30% in expected workload. We assume such forecasts occur with known relative frequencies 53%, 28%, 14%, 3% and 2% respectively. These were derived from the forecast verification check sheet of the Winter 2001 pilot.⁴ We calculated the number of times the model forecasted a rise, fall and steady for the three areas combined. This was taken to be the annual frequency of falls and rises. Where the forecast was 'rise', we assumed a 2:1 ratio for the 15%: 30% split. Similarly, for a forecast of 'fall', we assumed a 2:1 ratio for the -15%: -30% split. Naturally, as data is collated from actual experience of forecasting these relative frequencies can easily be adjusted in the model. These frequencies are clearly biased towards forecasting an increase rather than a decrease in workload. The reasons for this are currently unknown.

Second, we assume five different levels of variation of the actual workload experienced from that predicted. Thus, the forecast workload could be correct, or could over-predict or under-predict by 15% or by 30%. Each of these possibilities is also assigned a relative frequency, which again can be taken from actual experiences of forecast accuracy as it accrues. For current purposes, we have assigned relative frequencies to these possibilities, based upon the level of accuracy of each scenario. So, for example, if a 60% accurate scenario is

selected, the model will assume that each level of forecast is accurate 60% of the time, and that the proportion of times the forecast deviates by ± 15 or $\pm 30\%$ is distributed in a 2:1 ratio.

Finally, for each possible combination of predicted workload and actual workload experienced, there is then a relative frequency of occurrence, given as the product of the two.

Management actions

GP co-op

We included changes made in terms of administrative staff, GPs on rota, GPs on standby, GPs on emergency pay, nurses (internal and external) and numbers of vehicles mobilised.

Within the model, we did not assign a cost to the numbers of vehicles mobilised, as it was assumed the cost of these would be the cost of staffing the vehicle. However, as managers may have included the drivers within the number of administrative staff, we did not want to double count and therefore excluded these costs. We have included an option where the cost of the drivers can be included by changing a yes/no box.

Hospital

We included changes made in terms of nursing staff (d-f grade and g-h grade), junior doctors, middle grade doctors and consultants. For all staffing levels we asked for internal and external staffing numbers separately. As there may or may not be cost implications to increasing or decreasing numbers of internal staff, we included an option where the cost of internal staff can be included by changing a yes/no box.

We also asked managers how many beds they would open or close given different changes to staffing levels and how many elective surgery sessions they would increase or decrease by. We did not include a separate cost for the beds as this cost would be largely the cost of staffing the bed, although there may be a small overhead cost. Similarly we did not assign a cost to carrying out additional elective surgery sessions or cancelling elective surgery. Increasing the numbers of elective cases due to a forecast of low demand may result in shorter waiting lists, or in trusts saving money by not treating these patients privately or under “waiting list initiative” budgets. Decreasing numbers of elective cases due to forecast of high demand may result in fewer patients being cancelled on the day of the operation. We do not have any way of quantifying the implications of these changes in theatre management and have therefore not included them within the model. Also, there are likely to be costs associated with acting on incorrect forecasts, with theatres being unused when elective surgery has been cancelled inappropriately and potential clinical implications of bed shortages when additional elective cases have been taken on due to an incorrect forecast of reduced workload.

The cost implications for hospital trusts included within this model is therefore that of potential savings due to maximising the numbers of internal staff and minimising numbers of external staff required.

A&E

We included changes made in terms of care assistants, nursing staff (D-F grade and G-H grade), junior doctors (house officers and senior house officers), middle grade doctors and consultants. For all staffing levels except for care assistants, we asked for internal and external staffing numbers separately. As there may or may not be cost implications to increasing or decreasing numbers of internal staff, we included an option where the cost of internal staff can be included by changing a yes/no box.

Ambulance trusts

We included changes made in terms of control staff, paramedics, crew technicians, ambulances, fast response vehicles and patient transport vehicles.

As with the GP co-op model, we did not assign a cost to the numbers of vehicles mobilised, as it was assumed the cost of these would be the cost of staffing the vehicles. The costs associated with the ambulance services are therefore the costs of changes in numbers of staff employed. As discussed earlier, these costs may not be realisable as hours used or reduced will be borrowed or owed to a pool of contracted hours for contracted staff. However, this will indicate if savings could be achieved if some staff are employed on a more casual basis (i.e. agency workers).

4.4.7 Exploration of key variables and sensitivity analysis

In order to assess which variables have the greatest effect upon the results, the model is set up so that parameters can be altered and different scenarios examined. Within the results, we report the costs associated with undertaking the actions reported by respondents to the survey. We also provide results of changing certain assumptions, such as altering staff costs or changing the proportion of times each level of forecast is expected.

4.4.8 Costing methods

The cost of the actions which might be taken by service managers with and without the benefit of workload forecast have been estimated by multiplying the resource use consequences by national average NHS unit costs. The resource use consequences have been limited to changes in the staffing levels in A&E departments, wards, GP co-operatives and ambulance services. These staff changes were obtained from the survey described in section 5.3.2. NHS staff costs have been costed using established methods published by Netten *et al*⁵ for hospital and ambulances services and Pickin *et al*⁶ for GP co-operatives. These costs include the full employment costs of NHS staff, including wages/salary, on-costs and costs of training and are listed in Table 5-14. All costs have been inflated to 2001/2002

prices using the NHS price deflator. It was not possible to obtain a national estimate of the additional costs of agency staff and therefore the economic model explores a range of assumptions, taking a 30% premium as the central estimate for nurses and 100% for locum doctors. This figure can be altered within the model if different assumptions are available.

5. RESULTS

5.1 Literature review

The databases searched and keywords used are described in Appendix A. Where possible, searches were restricted to studies published from 1992 to date (i.e. ten years). Search results were reviewed by the authors. Very few references matched the stated criteria despite comprehensive lists of search terms.

We specifically excluded articles reporting on the link between morbidity, mortality and the weather but included a small number of papers which reported on the link between weather or season and the demand for healthcare.

5.1.1 Use of weather forecasting or seasonal trends in planning health care

No articles were identified that evaluated the use of a forecasting model in planning health care. A small number of articles, mainly US based, broadly discussed the use of forecasting as a tool or examined the impact of seasonality upon demand.

A small number of papers discussed the importance of forecasting to enable managers to improve planning of services. Beech⁷ discusses the use of market-based demand forecasting, aimed at enabling managers to develop a strategic financial plan and relating specifically to the market system in the US. Benefits are discussed purely in financial terms and there is no discussion of the potential benefits of forecasting in managing workload. Two further US based articles discuss different basic forecasting methodologies to assess healthcare demand.^{8,9} Both acknowledge the importance of incorporating seasonality into forecasting and advocate the use of this type of forecasting. Again, there is no specific discussion of how forecasting can actually affect the way health services are managed. Also, season was defined in terms of time of year, and not related specifically to weather variables.

Three papers attempted to quantify demand for emergency walk-in demand, using seasonal variables to explain variance in demand. Rotstein et al¹⁰ found day of week, month and holidays explained 65% of the variance in patient visits to an emergency department in Israel. Two further studies included weather variables within their models and found that calendar and weather variables explained 77% and 84% of daily variance in walk-in clinics in the US^{11,12}. Both studies found the majority of the variance was explained by calendar variables, with only a slight proportion of variance explained by weather variables alone. Holleman et al¹² estimated that staffing according to predicted volume could have decreased overstaffing from 59% to 15% of days, but would have increased understaffing from 2% to 18%. These figures relate to a US veterans Affairs Medical Centre and results are therefore unlikely to be generalisable to a UK setting, particularly considering the high proportion of days on which the clinic was overstaffed.

5.1.2 Ability of immediate care services to respond to forecasts

We did not identify any literature which specifically discussed the ability of immediate care services to respond to forecasts. Kusters et al¹³ briefly discuss managers responses to their hospital admissions model. They state that their system was “after a while, accepted” in two of the three test environments and that the third could not use it as it was not considered flexible enough. They acknowledge the limitations of the use of forecasting models, asserting that they will be used only to aid a management decision and not as a stand-alone tool. Finkler also reiterated the importance of managerial judgement and other knowledge in making managerial decisions using forecasts⁹.

5.1.3 Economic evidence on the potential costs and benefits of using weather forecasting or seasonal trends

Again, we did not identify any literature which provided economic evidence on the potential costs and benefits of using weather forecasting or seasonal trends.

There is a recognised lack of evidence quantifying the relationship between capacity, workload and service outcomes that would be of use in attempting to model the potential costs and benefits of using forecasting. Although some work is currently being carried out to assess the costs and clinical benefits of, for example, ambulance response times¹⁴, the current literature on the effects of workload and workforce issues upon quality of care and service outcomes is limited¹⁵.

5.1.4 Consideration of costs for general practice and the community

In identifying the costs and consequences of weather and health forecasting, we have concentrated primarily upon use of workload forecasts in managing the demand for services at GP co-ops, ambulance trusts, acute hospital trusts and A&E departments. The use of real-time daily reports of current NHS workload and respiratory infections, as provided by the Met Office forecasting service, may also however be of use to health care professionals in primary care and in the community. We have not included these costs as the impact they will have upon demand is currently difficult to quantify, due to the lack of literature on the subject. Here, we briefly explain the issues that may be considered relevant, but have been excluded from our modelling.

Importantly, primary care and community services may be able to reduce the demand for services required at other immediate care services. The use of real-time data may enable services to deal with increases in respiratory illness and influenza more effectively and therefore reduce the numbers of respiratory admissions expected. Potential changes identified include the following:

- Invoke procedures to manage patients in the community

- Target influenza immunisation at at-risk groups
- Reduce fractures by warning of risks of falling in icy conditions.

The impact of the FNH model in reducing numbers of fractures in icy conditions due to increased warnings is difficult to evaluate. Met Office warnings are currently in the public arena and the incremental benefit of increased warnings may not be significant.

For public health services, it is difficult to say what impact, if any, the information provided by the real time database would have, even if it were to be accessed by PCTs on a daily basis. Information from PHLS is currently supplied to public health and primary care professionals although this information may be slower getting through. Primary care services run influenza vaccination programmes targeting at-risk groups that run throughout the year and initiatives funded by winter planning budgets to reduce admissions to hospital are likely to take place throughout the winter anyway.^{16, 17} Although additional warning of flu epidemics may be useful and may help services to manage older people with chronic respiratory disease more proactively, there is as yet no evidence to indicate what impact this new information would have on services.

Initiatives funded by winter pressures money to improve discharge procedures, rapid response teams, increase social worker support etc are aimed at preventing bottlenecks in the system, particularly around January to March^{18, 19} Without these bottlenecks, the systems may be more stable and the risk of winter crises may reduce significantly. Similarly, the influenza vaccination programme launched in 1998/9 may decrease the numbers of admissions significantly. If these initiatives are successful in reducing admissions, then the need for a model to help to reduce the impact of winter crises may also be reduced, impacting upon the cost-effectiveness of the FNH model. However, there is currently little evidence of effectiveness of these programmes designed to reduce admissions and it is not possible to say what effect they would have upon admission rates or the cost impact of the FNH model.

5.2 Interviews with health service managers

None of the interviewees had used the FNH workload forecasts, although they were all aware of them to some degree. The PCT interviewee expressed an interest in using the information but felt he had not had any training on how to use the information.

5.2.1 Current methods of planning

All of the services for which the respondents worked utilise some form of modelling to estimate their workload requirements. The information used to predict workload varied between services but all used previous years data and date / day of week variables. The ambulance service and NHS Direct both had bespoke models for their specific services. The ambulance service used predictive analysis using 5 years of historical data and other local information (e.g. football matches) to provide information on where the next calls were expected and where to locate vehicles. It also used demand analysis which provides information on trends of demand which is used to assess staffing needs.

NHS Direct received forecasts of the numbers of calls they can expect to receive for each half hour period, for every day. These are produced centrally (for the network of 5 NHSD sites) three months in advance and then revised following submission of information of the numbers of staff the site has put on the rota. Rotas were planned and altered based upon these forecasts and the forecasts were mostly within 5% of the actual figures.

The hospital trusts used historical information as well as information on current bed status and current emergency and elective admissions profile to assess the potential workload. The GP co-op and A&E services used simpler methods of predicting workload, based upon historical information of attendances, and waiting times in A&E.

Weather variables were not used by most of the services, with the exception of the ambulance service, which used the Met Office for advice over busy periods and checked any severe weather warnings to help plan services.

"I have had colleagues ringing the Met Office in Sheffield or Leeds wherever it is, and saying what's the prediction for, certainly on the bad weather front, and I have moved four wheel drive vehicles round the country on the back of that, and staff as well. So you know we do have a degree in confidence in that." (3)

The value of information provided by the Met Office was conflicting. Some managers felt that the Met Office would be able to provide an extra variable to influence workload planning.

"I think I'd have confidence in the things you've just mentioned, in things like respiratory, cold weather etc, that they would be the best people to be able to tell you, when that's going to happen, cos you would expect like a flu epidemic in January. Now it could be that the weather is telling us there won't be one." (5)

“if they said that, you know, we anticipate that in the forthcoming two weeks there is going to be an increase in respiratory disease based on forecasting the weather, we’re expecting a cold spell or whatever, I’d like to be able to lift that information and put it into my report”(2)

However, the impact of season was felt to be different for different services and the influence of weather variables was questioned.

“while we do tend to gear up for the winter, however we define it, there is a feeling, certainly in the medical specialties, that the variability in the volume of work isn’t that great[...] With the weather forecasting, I’m not quite sure.” (7)

“contrary to public belief the variation isn’t as pronounced between the summer and winter as some people like to think” (6)

5.2.2 How might the forecasts be used?

The potential value of workload forecasts differed between sites. The interviewees were asked what changes they could make at 24 hours, 3-5 hours and 3-6 week forecasts of a change in demand. The changes identified by the interviewees are summarised as follows:

- **Ambulance service:** mobilise 4 wheel drive vehicles where snow is forecast, alert managers in A&E to turn vehicles around quickly, change shift hours slightly depending upon the time of day demand is expected, ask staff to work overtime, increase support facilities for crews, make provisions for crews to get meal breaks. Help hospitals with discharging patients. Take crews off for training when forecast of low workload. Longer term (3-5 days) – make changes to staff rotas and staffing arrangements, plan PTS workload.
- **GP co-op:** forewarn people of changes expected, put GPs on standby. Longer term – could change rota.
- **PCT:** Long-term (7-10 days) – could use within capacity / emergency planning report which is sent out to local health service managers.
- **A&E:** ensure staffing levels up to minimum, request locums at 24 hour notice, request extra anaesthetic cover if expecting increase in fractures. Longer term (3-5 days) – think about altering rota.
- **NHS Direct:** use bank staff, ask staff to do overtime, negotiate with network to take excess calls.
- **Acute hospitals:** make decision as to whether to cancel elective surgery. At 3-5 days, move people out into beds in the community, spot purchase extra beds and free up capacity. Could try to open beds in closed wards short term. Move patients between wards/hospitals. Alert staff to expect increase. Longer-term (1 week) link with primary care for discharge and support.

Each service had a different capacity to react to the different forecasts, with NHS Direct, the ambulance service and the GP co-op being particularly able to react at short notice.

“We can react within 24 hours, we’ve got procedures for if we need additional doctors during a shift, we’ve got emergency doctors. We operate a stand-by procedure anyway” (1)

“We can react to it without any problem, erm, I say without any problem, it would cause problems but we have the capacity to react to a cold spell because that’s what we’re good at. You know, the ambulance service has always been good at reacting.” (3)

The actions managers would undertake were mainly in reaction to an increase in workload forecast. They spoke less about how they could react to a reduction in workload forecast as they found it more difficult to make reductions at the last minute.

All of the managers referred to the additional benefit of forecasts given further in advance. Making actual physical changes to services (i.e. changing rotas, employing additional staff) was seen to be difficult with a short period of notice (i.e. 12-24 hours), but became more realisable with time.

“[a 3-5 day forecast] gives you more time so that you’ve got more chance of getting extra staff in place. [...] the more notice you have, the more chance you have of actually being able to make that change”(4)

Well at the moment we have to respond incredibly quickly so anything is better than where we are at now. Obviously the further in advance you can do it, the more centrally you can manipulate those staffing rotas (6)

“if you could get something reliant then you could change the rota for the following week. That is more useful in my mind. In a way we’ve got a procedure to react to the current difficulty, but it’s not ideal” (1)

The lead time required to make changes varied for each service, with the hospital-based services having less flexibility, particularly with regard to altering consultants rotas.

“The minimum really is a week” (3)

“[for locums] 24 hours is probably the absolute minimum. [...] Three to six weeks, you could think about making some minor alterations to the six month rota” (4)

5.2.3 How do managers use information to make decisions?

Throughout the interviews, many issues around the role of the forecast within the decision-making process emerged. One important consideration is the multi-factorial nature of decision-making. Information provided by the forecasts would be fed into the decision making process along with other sources of information, but would not be used alone. As the managers to whom we spoke already had a method of forecasting demand, they felt the additional information provided by the FNH model would add another element or factor into the decision-making process.

"I think they'd be foolish to use them other than as a, to lend a little bit of weight to the final outcome, anybody that says 'oh look at that, that says its going to full next week, we'd better cancel all the electives', would be a fool, because there is no scientific basis behind it. " (2)

"it's something that plays into a lot more information, you know, complements a lot more information, which enables us to make what we hope will be a rational decision at the end of that " (3)

It's sort of really a multi-factorial model that managers carry round in their own head, taking all these things into consideration. This would only be a part of that, but a new part, taking the information we have to make decisions"(4)

Managers spoke about the information or 'intelligence' they used to make their decisions, making use of various sources. The exact role of the forecast would be difficult to ascertain, as are the factors that influence the decision. In addition to 'concrete' evidence such as bed status of hospitals, or knowledge of elective activity levels, there was evidence that managers used many sources of evidence of workload levels to support their decisions.

"I think generally we'd be getting feedback from surgery as well so I don't think it would be just relying on that, I think we'd be getting more general feedback" (1)

"Normally anecdotally you know, for instance, if you know you're in the middle of the cold snap it's likely that orthopaedics are going to be slightly busier because the trauma will go up. If you know that there is a community borne infections around again, which normally seems to be related to cold snaps, it will get a mention"

There is also a subjective element to decision making, with managers using non-quantifiable factors such as experience, judgement or 'gut feeling'. The level to which they rely on a model to make decisions is therefore difficult to ascertain.

"even though you might have a forecast that would only lend to creating an attitude if you like. As opposed to a decision, so in other words it might give you a feeling about whether we ought, or ought not to, but the final decision could not be based on that, it would have to be based on definite information" (2)

"we still actually use them [forecast models] to inform the decision rather than to make it. Because occasionally your experience and gut feeling says that the model is wrong and occasionally it is wrong" (6)

The following quote provides evidence of the subtle nature of decision-making, and of the role of the forecast.

"if we knew, for instance, today it was fairly clear cut that we hadn't got many beds so it was a fairly easy decision to ask our surgical colleagues to look at their admissions, but if you've got that middling number of beds where you're not sure whether you will, and I'll sometimes say in the meeting 'do we feel brave today?' because you think well, if we only have an average admission rate we'll be fine, and that, you know, how brave do you feel? If we have some prediction that could give us an indication that tomorrow was more likely or less likely to an average day it would take a lot of that bravery out of the decision so for instance if the Met

Office said to me I was going to have a peak in respiratory problems tomorrow or the day after, I would be less brave than if they told me that there was no risk of that, if that makes sense. (6)

The forecasts would also act as a support for the managers, giving them a higher degree of confidence in their actions and allowing them to envisage problems before they arise.

"The more time you've got to think about it the more likely you are to making correct judgements in terms of how you manage particular situations and a lot of the time if you just knew what was going to hit you in the next 24 hours, you know, it'd make your senior managers like me have a few more sleeping nights rather than sleepless nights" (6)

"If you could link it in, and prove that it was effective, as with some of this predictive analysis stuff, in actual fact that would stand in good stead for making a decision because you could actually write into a protocol that if X is so and so and Y is so and so, then you could come out with an end result, and that would be acceptable I think and would stand up in court as well" (2)

Forecasts may be used therefore as a support to managers, to provide a back-up for their decision and to reduce the amount of uncertainty in the decision-making process.

5.2.4 Confidence in workload forecasts

The degree to which various sources of intelligence are used is highly dependent upon the level of confidence invested in them. It is therefore vital that managers have a high level of confidence in the results of the forecasts before they use them to influence workload planning.

From the interviews, there was evidence of a degree of scepticism towards the forecasts, and managers were clearly not yet convinced of their utility.

"I think this would be alerting us to it but then in terms of confidence you're always a bit uncertain" (1)

"It's interesting. I think it's got some way to convince us that it's going to be a really useful tool" (7)

Managers felt they would need to see proof of the accuracy of the forecast, based upon seeing comparisons of previous forecasts with the actual workload or knowing that they have been right in the past.

" I think it helps, predictions are a lot easier to justify, if you can look backwards as well and say 'this is where we were last week, we were saying this, it was this, next week we're saying this'." (1)

Interviewer: "What might increase your confidence in these forecasts?"

Manager: "If they're right and it's a chicken and egg thing isn't it? If you use a piece of information to inform a decision and that turns out to be a correct decision, then the next time you get that information you are more likely to act on it." (4)

Confidence in the forecast would improve with time and experience. Managers would need to have seen evidence of the forecast working for themselves before gaining confidence in allowing it to inform decisions.

“...if we could make it a routine task then they’d do it [use the forecast] but we’d still have an overview because if something came along and it said we need two extra doctors on Sunday then it would still be a management decision as to whether or not we take on the extra two. Until it’s fully tried and tested you wouldn’t fully automate everything.” (1)

They would also need a level of confidence before persuading other staff to act upon it.

“We’ve yet to try telling the doctors that we’re calling them in because of a forecast, [...] I don’t think it’s a problem but it’s a psychological thing. Do you trust it?” (1)

Confidence in the forecast also depended upon the length of lead time of the forecast and also potentially upon the type of weather conditions affecting the forecast.

“I think for a three week forecast, I would have no confidence at all [...] At 24 hours I’d probably be fairly confident of a weather forecast or snow and ice conditions.” (4)

“I have real concerns that you might be able to get a system that is fairly accurate to 24-48 hours, but just in the same way the model we’ve developed, the further you get away from now the more likely it is that a variable will get thrown in that you are not expecting and screw it up.” (6)

5.2.5 Managers reactions to example forecasts

We showed the interviewees examples of the Met Office forecasts and asked their opinions on different aspects of the forecasts. The use of previous years’ data was considered to be useful, in order for them to compare the current situation with what has happened previously. It was also suggested that the historical forecasts should be included on the graph so that the managers could see how accurate the forecast had been on similar occasions in the past.

“I also prefer something which has got some historical data on it, because confidence intervals are OK, but this shows me, or tells me that it has been fairly accurate”(3)

One manager expressed a need for a reasoned explanation of the meteorological factors that were influencing the workload forecast.

“as long as I knew the process and the methodology which had gone into reaching that decision, it wouldn’t have to be presented to me week in, week out, as long as I understand how you were reaching that conclusion, then I would accept that.” (3)

Another felt that the explanation was not as useful, and that the graph adequately summarised the information.

There were mixed opinions about the use of confidence intervals, with some managers finding them easy to understand and others having never encountered them before. The managers at the GP co-op liked the confidence intervals for their purposes, as it indicated the

likely minimum and maximum number of GPs they would need. However, for services where the upper and lower confidence intervals indicated a considerably wider change in workload, they were considered to be less meaningful.

“I mean in terms of planning health services, that gap is much too wide. [The confidence interval at day 1] you could probably cope with at the margins, but that gap there [confidence interval at day 10] is a step increase in service.” (3)

“The problem is what I’m seeing here will give me no more confidence than my professional judgement and experience does at 10 days.” (6)

It may be that a greater degree of accuracy would be required where the implications of the changes, or the scale of the changes to be made were greater.

The truth is, before you make hard and fast decisions to cancel people you’d have to be 99% confident your intelligence was useful. (6)

It might be noted that despite the scepticism of managers towards the forecasts without any proof of the accuracy, there was evidence to suggest they are currently using forecasting systems which have not been rigorously evaluated.

Interviewer: ...and how accurate is it?

Manager: Fairly, I’d give it seven out of ten

[...] Interviewer: And do you rely on it?

Manager: Yes (3)

This may demonstrate the importance of experience and judgement in decision-making. The managers appeared to have confidence in the systems they were using due to their past experiences of how useful they had been. It appears therefore that managers will make use of forecasts, but that it may take some time before they are convinced of the accuracy or the utility of a new forecast which is introduced to them. In addition, managers may need training in the use of forecasts if they are to become both confident and competent in acting on them routinely.

5.2.6 Barriers to implementation

Managers mentioned a number of factors that may limit the value of the forecasts, within the current NHS climate. These included issues of capacity, culture and conflicting DoH directives.

Staffing rotas

Managers cited a lack of flexibility within many aspects of the NHS which would limit their ability to change services to meet forecast demand. In order for the forecasts to allow managers to staff more appropriately, i.e. decrease as well as increase staffing levels, rotas would need a high degree of flexibility. However, there is currently a lack of flexibility, particularly with regard to reducing staffing levels.

"I can't with the contracts we've got at the moment, I can't reduce them, you can't say to somebody 'you're rostered tomorrow, don't come in, I want you to come in Sunday instead'. I haven't got that flexibility." (3)

"The obstacle would be if reducing [...], we haven't got a mechanism for reducing the number of doctors" (1)

Making changes to forecasts which were shorter than the lead-time required to change rotas would therefore impact on costs, due to the difficulties in reducing staffing.

"I mean if we knew it was going to be extremely busy then we would attempt to get additional staff for overtime, so there would still be a cost to it. Because the opposite doesn't work, if you ring up and say it's going to be a beautiful day tomorrow, there is going to be a 36% reduction in the number of people with breathing problems, I can't lay people off as it were, it's not that flexible. So there would be an additional cost to this, yes." (3)

This inability to be able to reduce the number of staff at short notice also impacts upon the ability or likelihood of the manager to increase the staffing levels based upon a forecast increase. In order to increase staffing to meet a predicted increase in demand, the additional staffing hours would be either worked as overtime (requiring additional funds) or be taken back in lieu, which was described as "robbing Peter to pay Paul". (6) However, due to the current problems with reducing staffing levels at short notice, increasing staffing levels for a forecast increase would be likely to have financial implications.

"you're making the assumption that we've got the staff to shift around the system, and you know we've got fairly set rotas and patterns, and we haven't really got the capacity, we can only just about manage the shifts we've got so if you're taking people off one particular shift, you're creating a gap somewhere else." (7)

Two managers spoke of a need for a more flexible staffing system which would enable them to use the forecast, either in terms of having annualised hours or having a proportion of hours that can be used flexibly.

"What I would have to do is I would have to look for increased flexibility within the workforce, and that would be around things like annualised hours, it would be around things like say, you know, instead of somebody on a Friday having a fixed start time, then you'd have them working on a Friday but I would confirm to them 24 hours before what time I wanted them to start. So it's that kind of flexibility. " (3)

Bed occupancy levels

Managers also spoke of the difficulties in making changes based upon a forecast due to the lack of flexibility within a hospital working to capacity.

"it would be a much more useful had we been working in a system that had a 90% bed occupancy, where we could have spare capacity we could turn on and off as we needed it. So if we got a system where we're running 80% bed occupancy we may decide, you know, to reduce the beds on a ward temporarily if we knew we were not going to be under pressure we

could turn them back on, assuming we had the staff. But the main problem is while you've got a system that's running in the way the current system's running currently at a 100% plus you certainly, if you cancel the whole load of electives, rescheduling them would be very difficult in terms of the deadlines we have to meet. Not particularly around bed capacity but theatre capacity. You could turn emergency, you can flex beds fairly easily between emergencies and electives that's why we have medical outliers and how we do it, but a theatre's a theatre and once it's being used it can't be used again." (6)

"the problem is that there are pressures that have been sort of brought to bear, waiting list targets etc, and because of those, the Trust is continually under pressure to maximise its efficiency" (2)

The influence of bed occupancy levels were reflected in the different responses of the manager of the DGH, with an average bed occupancy rate of 82%, compared with the teaching hospital running at over 95% occupancy. Interestingly, the manager at the DGH did not see as much value in the forecasts, as the increased flexibility means that they are less likely to suffer adverse consequences of having unexpected demand, saying "we haven't got the same pressures here, I don't think".

Interviewer: Do you ever do anything to change the elective/emergency split at the last minute?

Manager: No. The only thing we do in the winter, we sometimes reallocate some of the surgical beds to medicine from January onwards. (7)

"Because they (cities) have got so many hospitals, the tendency is to be more reactive, whereas if you get to smaller towns like Barnsley or Rotherham, or country hospitals and things like that, things are a lot, they've got a lot more spare capacity, as a percentage, generally not running at 98%, they are running at say 85%, so things are a lot more, laissez faire, more laid back and relaxed, so they have more time to be proactive, they're not having to be 'crisis lets deal with it, another crisis lets deal with it.'" (2)

For a service running at almost full capacity, managers would have to have a very high level of confidence in order to cancel elective surgery, due to the pressures of meeting waiting time targets. Services not running to capacity would not need to cancel elective activity.

So for instance, at the moment there's certainly an obsession with waiting times, if we actually got to a stage where we were cancelling large numbers of the middling waiters there is a real fear that we actually wouldn't be able to reschedule them to avoid them missing deadlines (6)

This in turn would have financial implications, as additional resources would be required to meet waiting time targets, where elective surgery has been cancelled unnecessarily.

And you keep coming back to this issue that unless we get to a situation where either we reduce activity so the current resource is only being utilised at something less than 100% or we have to increase the resource. (6)

Staffing shortages

Staffing shortages within the NHS would also impact upon the ability of managers to act upon forecasts. Even when a management decision to increase staffing levels has been made, the staff may not be available. Working time directives limit the number of hours junior doctors, nurses and paramedics can work, thereby limiting the amount of overtime that can be worked. There are also difficulties in finding part-time staff who can work additional hours and with finding, or funding agency or locum staff.

“So though the first thing you would do is you would use those 2 groups, bank and part time staff on overtime. What you would find is increasingly you can’t cover this with those people because there aren’t enough around, so then you’re looking at agency [...] but you get clobbered with anything up to a 30% agency fee on top” (6)

“Most shifts we have a stand-by anyway. It’s not always filled. [...] Not everybody likes to be on call.” (1)

“I think the biggest obstacle is the flexibility of the nursing rotas. Because historically they have so many rules and regulations, like not working early after lates, not working early after your day off, or on a late before your day off, and I’ve found that quite frustrating and that certainly is an obstacle and something that we have to work with to meet the needs of the service.” (5)

The shift of power from the management to staff as a result of staffing shortages also impacts upon the ability of managers to move staff around at short notice.

“It’s just at a difficult time because we don’t want them to turn away and say ‘sorry we don’t want to work here any more then’ We’ve got to try and manoeuvre them into working when we would like them to work and not upset them. At the moment they’re calling the shots because there are fewer doctors than demand requires” (1)

Current NHS policy on recruitment and retention of staff (the *Improving Working Lives* initiative) means that the system has to be responsive to the needs of staff.²⁰ As one manager pointed out:

“...some of the short supply professions don’t have any incentive to do that [have flexible pool of hours]. Because actually that runs a little contradictory to ‘Improving working lives’ and flexible working because that would be a system where the flexibility was very much set up for the benefit of the service where ‘Improving working lives’ is about setting up flexibility that’s going to benefit the staff. So there are contradictions there.” (6)

Potential of overreaction

Despite concerns as to the lack of flexibility of staff, managers felt that staff would be happier to put themselves out when the urgency is great enough. There appears to be a distinction between expecting staff to change their plans with little notice on a regular basis and expecting them to change their plans at the last minute on rare occasions when there is an extreme need.

“We haven’t got a robust system of saying, right OK, we need to crank it up at 12 hours notice by getting additional staff in to do routine work. You know, if the balloon goes up, staff come in, they’ve got major incident, the whole works in terms of major incident, management of major stuff, but we would be able to just simply crank it up like that. [...] but as I say, if the balloon went up there would be no questions asked, they would do it.” (3)

“It depends on, if somebody says ‘you’re going to have a major incident tomorrow’ then you can do anything, but it’s not going to be like that is it? Although having said that, some of the worst peaks in respiratory illness do cause as much organisational impact as a major incident does. [...] But it would have to be a very express major threat because you’re using people’s good will.” (4)

The impact of the workload forecasts would therefore be dependent upon the level and frequency of change managers make as a result of the forecasts. If managers frequently make changes to staffing levels to match the forecast demand, they may meet resistance from staff, as discussed previously.

The role of the forecast may be to give managers an indication of the scale or direction of change expected on a daily basis, but to motivate action where the change is of a higher degree.

“But you can’t do that [act on forecasts] often, because as I say, you are taking extraordinary measures and you don’t want to take those every week otherwise they aren’t extraordinary. [...] you can only react to extraordinary circumstances because peaks of admissions or problems of admissions are daily occurrences in winter time” (4)

5.2.7 Culture change

There was a suggestion that a change in mind-set might be necessary before people can make full use of forecasting models. People might find it difficult to get used to managing more proactively and there are other changes that need to take place to the NHS before this can be achieved.

“the other problem is that because we’re under such pressure and we’re reactive as opposed to proactive we’ve never really had time to sit down and start, you know, putting it into practice, which we’d love to do to be honest.” (2)

“what we need to do is start to manage more proactively our ability to respond to need, rather than react. And I think you know the whole of this approach to the predictive stuff, is really around getting into our ability to do things differently, rather than simply do more of what we do now.” (3)

Changes to the way winter pressures are managed generally were felt to be more important issues when managing increased winter demand. Managers mentioned a number of initiatives that are underway to some degree, that would be useful in dealing with increases in respiratory admissions or influenza outbreaks, such as community based care or improving hospital discharge procedures.

“There seems to be an assumption at the moment that if somebody has got some kind of respiratory problem that they automatically need to go in hospital. They don’t. More are better off being looked after at home. Now, we can do that, but at the moment we’re duty bound to take them to hospital if they dial 999. One of the things we are doing is starting to look at how we can respond more appropriately to their need, rather than simply sticking them in an A&E department. I think that there’s lots of other issues, lots of other areas that could be addressed in a very similar way.” (3)

5.2.8 Potential benefits of forecasts

Managers felt there would be both quantifiable financial benefits and non-quantifiable benefits to the forecasts. The principal effect on costs would be to do with changes to staffing levels. As mentioned previously, managers felt that the more notice they had of changes, the more likely they were to be able to change rotas and get bank staff to cover the additional hours. This might reduce the likelihood of having to employ agency staff or locums.

Managers spoke mainly about non-quantifiable benefits to having a correct forecast. If managers can make staff changes to meet the peaks and troughs in the service, this would lead to a better quality service and enable them to meet their key performance indicators. Patient satisfaction would be increased due to improvements in staffing during busy times and improvements in service quality.

“we provide a much better service for patients in South Yorkshire because we’ve got the right resource out there to meet the need.” (3)

“The millennium for example is a very good example of that were we knew there would be increased workload, we staffed up to meet that workload and said ‘why can’t we do this all the time?’ Because the service efficiency was fantastic, even though there were double what there would normally be on a New Years Eve.” (4)

Importantly, hospital managers felt that any decisions to cancel elective activity in advance and avoid cancellations on the day would reduce stress on patients significantly.

“we can cancel them [elective admissions] in good time, so that patients aren’t being cancelled within the last 24 hours, before being admitted and things, and that’s got to be an advantage because you’re not putting the patients through the same level of stress, so from the patient’s point of view, it’s got to be better.” (2)

“it’s the fact that that patient is cancelled after they’ve gone through all the sleepless nights before coming here, and all the traumas. If you’re going to have to cancel a patient then at least give the most notice you can. Cancelling somebody on the day is not, not good medicine for them, as an individual.” (6)

Staff satisfaction was seen as a particular benefit. If acting upon a correct forecast would mean that the services were more appropriately staffed, the staff would be working less hard and be under a lot less stress.

“the benefits to nurses themselves is that they’re not working under stressful conditions, because they see that queue growing and growing and they start to not take breaks [...] which in neither good for them nor the caller” (5)

Even where managers were not able to make any physical changes (e.g. employ additional staff), they spoke of the value of being forewarned of problems. They felt it helped to be able to inform staff that it was likely to be busy, or to ask staff if they would be prepared to work overtime if necessary.

This was particularly the case for the shorter forecasts, where changes may be difficult to carry out but the forecasts would serve to improve the quality of service for the staff, in terms of being prepared, and therefore for the patients.

“I think its always best to be forewarned than not to be, because you can be more positive, more proactive about how you manage it, rather than the crisis arises and then you’ve got to react, you might get to the end result, might be very similar in actual fact, but it’s a lot better to be in control rather than just reacting.” (2)

“Even in 12 hours you’d know you were forewarned that this was going to happen. If you’re in the department and it’s just happening to you and it’s one of those things that you don’t realise it’s happened until it’s too late in some ways, because you’re playing catch up when the demand is still coming in.” (4)

5.2.9 Risks of acting on an incorrect forecast

The risk of acting upon in correct forecasts are to some degree the reverse of the benefits of acting upon a correct forecast. So, for example, while a correct forecast will lead to more appropriate staffing, an incorrect forecast that leads to understaffing will lead to staff being busier, more stressed and less able to cope with the demand. The benefits of the forecast described in section 5.2.8 will therefore be reversed as risks of acting on an incorrect forecast.

Potential risks of an overestimated forecast

The risks of acting upon a forecast that overestimated the demand are primarily financial costs of having spare capacity that cannot be used. In the case where elective workload has been cancelled in preparation for expected emergency workload, there are implications for meeting waiting time targets. This is particularly problematic for hospitals with little spare capacity to carry out those elective cases elsewhere.

Manager: “Cancelling electives which you could have got in, and you’ve cancelled because you’ve anticipated you’re going to require those beds for emergencies and then they don’t get used.”

Interviewer: “So what sort of implications does that have?”

Manager: “ It’s got a knock-on effect, it’s going to affect your waiting list, surgeons and people that would have been doing those operations become redundant for periods of time when they would have been operating previously” (2)

“what you don’t want to do is turn off elective activity on the assumption that the day after tomorrow you are going to get clobbered with a 20% increase in emergencies only to discover that it doesn’t happen and you’ve got theatre sessions sat idle unnecessarily” (6)

Taking on additional staff in preparation for an expected increase may have cost implications, particularly where this involves paying overtime or enhanced payments, rather than changes to the rota.

An overestimate may have a positive immediate effect on patients, as there will be more staff than the demand requires. However, there is an associated opportunity cost, with staff not being able to be used in busier times.

“The actual risk in terms of how the A&E department is concerned would just be wasting money. You would have had to spend more money on getting locum doctors and nurses and if it doesn’t happen everyone’s happy because you’ve got more staff there. Patients who do attend get a better deal, the staff wouldn’t be hard-worked, but there would be an on-cost” (4)

“too many crews at a quiet time which depletes our resources at a busy time” (3)

“The risk of running out of budget, because you’ve staffed up, you’ve brought people in on overtime and you’re paying enhanced payments for weekend work [...] the actual demand is nowhere near as high as the forecasted demand.” (5)

Potential risks of an underestimated forecast

The risks of an underestimated forecast were considered to be higher, although there would not always be a financial cost associated. The risks varied considerably between services, with the GP co-op feeling they would probably be able to cope with increases, as they are dealing with such small numbers of staff anyway. The main risk would be the cost of having to get a doctor in on emergency pay, but the risks of any harm to patients was considered to be small. In contrast, the scenario whereby a reduction is forecast and the actual change is an increase was described as a “worst possible scenario” for the hospital based and ambulance services. This scenario could lead to potential problems for the patients, staff and for the service as a whole. As discussed previously, underestimating the demand could lead to cancellation of elective surgery on the day, which is distressing for the patient. All services spoke about a potential increase in waiting times for patients due to an underestimate in demand. Depending on the gravity of the situation, this could have an impact upon the health of patients who are not seen urgently enough.

“Well that would be the worst possible scenario because if we decrease staffing and there is an increase in workload then that means patients have to wait longer, they suffer.” (4)

“a real clinical risk in our case, because we might have the capacity to take the calls in but we haven’t got the capacity with the nurses, because we’re staffed up based on a forecast to actually deal with the calls safely because there are too many people waiting with critical conditions, in some cases emergency conditions” (5)

If patients suffer, the number of complaints will rise and the problems of the service may mean that services cannot meet targets for their key performance indicators (5)

Faced with unexpected demand on the day, managers may get extra staff in, which may have a cost impact if agency or locum staff are required, or staff are paid on overtime. Staff satisfaction will be reduced if staff have to come in at the last minute.

“These people have got lives to live and you can’t just, you’ve got to respect the fact that if they have planned their life around what they’re expected to work during the forthcoming week, if you start messing around with that, they’re going to get a bit annoyed.” (3)

If they cannot do this, for reasons discussed above, there will be extra work and stress for staff on duty. This again impacts upon staff satisfaction, and may impact upon the view of management.

You put incredible pressure on your staff because the staff who are there who, if you’ve only staffed them for 80% of the average and you’re doing a 120% of the average, they are going to be working phenomenally hard, and that won’t do a lot in terms of their job satisfaction and, you know, that could become very unrewarding. (6)

The consequences of a failure of one service to cope will impact upon other services. There is a significant relationship between the different services which means that if any of the services cannot cope with the demand, other services are likely to suffer as a result. In Sheffield, calls to NHS Direct that cannot be dealt with may be sent through to the GP co-op; patients who cannot get through to the GP co-op may turn up at A&E; ambulance services rely on quick turnaround times at A&E to deal with high demand; hospitals will require ambulance services to discharge patients before accepting new admissions. The impact of services having unexpected demand will therefore be higher than can be related by the manager of any individual service.

There were concerns about the impact that an inability to cope with demand would have on the NHS as a whole, with concerns particularly about political issues which are picked up on in the media.

“well there is all the political issues as well, you know, the trolley waits and things about cancelled elective, major political issues about cancelled electives and we all know how that’s addressed nationally on a political basis.” (2)

This could contribute to the psychological effect upon staff, and may impact particularly upon management and the trust as a whole.

“...you’re likely to find the situation where you’ve actually got patients physically arrived in the hospital only to discover that you haven’t got a bed to put them in, and therefore they are cancelled on the day which is worse for the patient, a lot worse for the patient and actually in terms of the perception of the trust at the centre of the NHS rapidly loses you stars!” (6)

“12 hour trolley waits lose chief execs their jobs. Lots of 12 hour trolley waits in a hospital that hasn’t previously had them definitely would lose a chief exec his job. “ (6)

There are different levels of risk of an underestimate. At low levels of understaffing, staff will be busier but will cope. Quality of service may be impaired but there will be no significant adverse effects. However, at very high levels, the worst case scenario can lead to significant problems in terms of services being unable to cope with the volume of patients, potentially resulting in deaths.

“Well its never happened in Sheffield but it has happened in other parts of the country, because they’ve no beds left, they can’t cope with any more situations they’d close the casualty, the knock on effect on that is its going to then cause patients to be diverted to other casualties outside their own immediate area, now as far as the ambulance service is concerned there has always been historically a requirement to take patients, emergency patients, 999 patients to the nearest casualty, you can’t pass a casualty to go to another casualty, they have to go to the nearest casualty, because the implication of that is if the patient died you’re looking at litigation” (2)

“I suppose ultimately, the problem is that someone could die, or someone could take some litigation against us because they’ve suffered some kind of long term detriment to health because we haven’t got them to A&E in time.” (3)

This extreme situation where patients suffer serious adverse effects and the possibility of litigation occurs as a result of understaffing are likely to be rare, but the risk associated with such an event are serious.

5.2.10 Risk taking behaviour

The impact of these risks would hinder managers’ propensity to act upon a forecast in which they were not entirely confident. Although acting upon a correct forecast would increase managers’ chances of being able to meet the required demand, acting upon an incorrect forecast would have other serious implications.

Managers expressed concerns about recruiting extra staff to meet an anticipated increase in demand, where not absolutely necessary. In addition to the potential financial implications of this, they were conscious of the psychological effect of making unnecessary demands upon staff.

“If you’re acting on something that doesn’t happen however, there’s perhaps a more serious issue in that you’re calling wolf. So that staff would be less likely to respond to a similar request in future. And that’s important. People usually don’t mind if you say it will be terrible and people make a sacrifice to meet that threat, and the threat comes and they meet it, well that’s satisfying. However, if they make the sacrifice and nothing happens, then they feel a bit cheated in some way.” (4)

“you can’t start sending alerts out, if there is no validity in them [...]they would say ‘well, that was a load of rubbish’ and they’ll take no notice in the future” (2)

While staff morale may increase as a result of acting upon a correct workload forecast, with the service being better able to meet demand, the converse would mean a decline in staff morale due to poor management decisions based upon incorrect forecasts. Being unable to meet demand or targets as a result of a bad management decision was seen as more harmful to management than being unable to meet demand due to an unexpected event occurring.

“Staff would be under pressure and would know they were under pressure because of a wrong management decision which would not do a lot for street cred.” (4)

“Against that background of very stiff targets in the first place that are going to be incredibly difficult to meet anyway, the people are going to be very averse to doing anything that’s risky. Because what they don’t want to do is, while they are trying to improve that situation they don’t want to do anything that has a potential risk that it would make it worse. Because almost failing to achieve the target is bad, deteriorating from where you were in the start is even worse.” (6)

Management credibility therefore emerged as a concern and, perhaps more seriously, managers were aware of how they are accountable for any decisions they make. The need to be able to justify decisions would inevitably lead them to act in a risk averse manner.

“at the end of the day, any team of managers making a decision, whatever that decision is whether its to reduce the number of elective admissions or increase them or whatever, can only base that decision on the information they have got, but at the end of the day, it’s their responsibility, and of course at the end of the day they’re accountable for any decisions they have made, so they would be foolish to make a decision based on something that they weren’t almost one hundred percent certain about”(2)

“if the demand is there and you’ve spent that budget to meet it, then you’re actually getting good value for money, and you can justify that whereas if it isn’t you can’t as a manager” (5)

“...because if we are actually going to be manipulating staffing the first and obvious place to start manipulating staffing around demand are the front door services. They are equally going to be the hardest people to convince that the information that has been provided is robust, because they are not, although they work in that sort of area, they are actually not intrinsically risk takers. They all want to go for the safe option, they won’t be so worried about increasing the staffing when they think it’s going to busy, but they quid pro quo won’t be saying well we are likely to be quiet so we’ll have less staff on. It’s a big risk for them” (6)

This risk averse attitude will make managers less likely to act upon a forecast of reduction in workload. The risks involved in reducing staffing or increasing elective activity when a reduction in workload is forecast are greater than those involved in taking on extra staff or decreasing elective activity when expecting an increase. The risks of having too many staff, or not being able to meet waiting time targets are principally financial, whereas the risks of being understaffed or having to cancel elective surgery on the day are primarily clinical or risks to the patient. The manager has to effectively balance the risks of undertaking different actions unnecessarily.

“it’s a balancing act between the risks of acting and the risks of not acting. If you act and you cancel admissions then the waiting lists start to grow. If you don’t act and the A&E department has 12 hour waits then you get hung.” (4)

5.2.11 Summary of interviews

The provision of a forecasting model that could inform managers of when to expect changes in demand would be welcomed by managers. The benefit of foresight would create benefits for staff and patients, even within a few hours of change. The scale of changes and benefits would increase with the amount of notice given, particularly in terms of being able to get internal staff to cover busy periods.

Managers felt they would need to have a lot of confidence in the forecast if they were to use them. They felt that the confidence intervals around the example forecasts were too wide for them to be of much use currently. Confidence would be increased by seeing retrospective proof of the forecasts being accurate, and would increase further as managers use and benefit from correct forecasts. It appears unlikely that managers would have sufficient trust in the forecasts to use them as a stand-alone tool, but would use the information in combination with other sources to aid decision-making, and may require training in the effective use of forecasts.

Many barriers to the use of forecasts emerged from the interviews. Staffing rotas are currently very inflexible within many services, and there would be particular problems with reducing staffing numbers. Employing extra staff is likely to have cost consequences, as part-time staff often cannot be flexible and therefore full time staff would have to be paid overtime rates. If rotas were rearranged, managers would have to be very confident in the forecast as there would be opportunity costs to staff not being used appropriately. Employing additional staff may also be problematic due to staff shortages and limitations to working hours set out by working time directives.

Although hospitals with little spare capacity would be most likely to benefit from being able to manage demand appropriately, they appear to have greater risks associated with acting inappropriately. Bed occupancy levels and waiting time targets were therefore seen as limiting the ability of managers to act upon an increased level of risk.

Managers would be more likely to act upon a forecast of increase in demand than a decrease, due to the nature of the risk of the forecast being incorrect. An overestimate would lead to financial losses, whereas an underestimate may lead to more serious, clinical adverse events. Managers need to be risk averse and appear to be highly conscious of the implications of acting upon a forecast that is then incorrect. They would need a forecast to have a very high level of accuracy and may benefit most from acting upon infrequent forecasts of extreme changes in demand.

5.3 Surveys of health service managers

We contacted managers in 30 hospitals, 20 A&E departments, 20 ambulance services and 20 GP co-ops. The numbers of surveys returned was low for all services (see Table 5-1), for reasons detailed below.

Table 5-1: Survey response rates

	Hospital	A&E	Ambulance	GP co-op
Number contacted (method)	30 (e-mail)	20 (fax)	20 (fax)	20 (18 telephone, 2-e-mail)
Faxed survey	16	20	20	13
Explained the survey by telephone	12	1	1	11
Refused	0	9	1	5
Returned the survey	5	2	6	7

5.3.1 Ability of health service managers to respond to such surveys

We had considerable difficulty in obtaining responses to this survey. Managers in the GP co-ops were the easiest to get hold of, as they were most often on site when we telephoned. Hospital managers were rarely available at their extension and required several telephone calls before we got to speak to them. However, even after speaking to managers and explaining the survey, and follow-up reminder telephone calls, only low response rates could be achieved. In the A&E departments and ambulance services, we were able to speak to very few managers directly. The refusal rate in the A&E departments was highest, with nine refusals out of 20 people contacted. Refusals in all services were due to other higher work priorities and a lack of time.

The difficulties in gaining responses may have been due to various factors. First, the period during which we were contacting people was during the fire-fighters strike, which was adding to the workload in hospital trusts in particular. Second, there were additional pressures with people trying to get work finished for the Christmas break. However, even after Christmas our requests to return surveys did not result in any more surveys being returned.

Respondents commented upon the value of the survey and of the forecasts in general, but found it hard to quantify the actual changes that they would make for a given change in workload. They highlighted the complexities of the system of bed planning that would make the effects of a 30% increase in demand completely different for different days, depending upon factors such as the ability to discharge patients, the capacity of the private sector and community discharge locations. However, they have provided responses that are indicative of the changes that may be made.

A small number of people commented that they already have forecasts that predicted their workload and that it would therefore be unlikely to suggest a change in workload of $\pm 30\%$.

Their expected value of workload was therefore at a level that would be equal to the forecast level for other trusts.

Where we could not speak to people on the phone, we could not guarantee that they understood fully how to fill in the survey. It is probable that the length of the survey, even in such a simplified form, deterred many managers from answering it.

The results of this survey cannot be taken as the definitive results of what managers would do in reaction to forecasts. They provide an indication of the levels of change at which people would act, the value of different lengths of forecast and the levels of response to forecasts of different levels of accuracy.

It is difficult to say what actions people would make on the basis of a forecast, as the decision to act will not be based solely upon the forecast, but upon a range of factors.

5.3.2 Survey results

GP co-operatives

A total of seven GP co-ops completed the survey. When asked what actions they could undertake on the day, one respondent said they would not make any changes on the day. Two respondents said they would change the number of admin staff for a reduction in workload but none would reduce the numbers of clinical staff. For an increase in workload of 15%, one respondent would bring in another GP on standby, and for a 30% increase, six would bring in additional staff.

With a forecast of 90% accuracy, only one GP co-op would reduce staffing levels for any of the notice periods given or increase staffing for a 15% increase. One further co-op would reduce staffing for a 30% reduction forecast at 10 days only. All would make changes for a 30% increase in demand. Five of the respondents would make exactly the same increases for each of the notice periods.

With a forecast of 60% accuracy, two of the co-ops would not respond at all. Four co-ops said they would make exactly the same changes as they would for the 90% accuracy and one would put a GP on standby rather than on rota.

The changes for a population of 1 million were as follows:

Table 5-2: GP co-op actions undertaken on the day

No notice (N=)	% change in actual workload			
	-30%	-15%	+15%	+30%
Admin staff	-0.8	-0.3	0	2
GPs on rota	0	0	0	3.5
GPs on standby	0	0	0.5	3.5
Nurses (internal)	0	0	0	0.5
Nurses (external)	0	0	0	0
GPs emergency	0	0	0	1
Vehicles mobilised	0	0	0	1

Table 5-3: GP co-op actions taken with 24 hours notice

24 hours notice (N=)	% change in actual workload							
	90%				60%			
	-30%	-15%	+15%	+30%	-30%	-15%	+15%	+30%
Admin staff	-0.5	-0.5	1	3.5	0	0	0	2
GPs on rota	-0.5	-0.5	1	4	0	0	0	3
GPs on standby	-0.5	-0.5	1	2.5	0	0	0	1.5
Nurses (internal)	0	0	0	0.5	0	0	0	0.5
Nurses (external)	0	0	0	0	0	0	0	0
GPs emergency	0	0	0	0	0	0	0	0
Vehicles mobilised	0	0	0.5	1.5	0	0	0	1

Table 5-4: GP co-op actions taken with 3-5 days notice

3-5 days notice (N=)	% change in actual workload							
	90%				60%			
	-30%	-15%	+15%	+30%	-30%	-15%	+15%	+30%
Admin staff	-0.5	-0.5	1	3.5	0	0	0	2
GPs on rota	-0.5	-0.5	1	5	0	0	0	3.5
GPs on standby	-0.5	-0.5	1	2.5	0	0	0	1.5
Nurses (internal)	0	0	0	1	0	0	0	0.5
Nurses (external)	0	0	0	0	0	0	0	0
GPs emergency	0	0	0	0	0	0	0	0
Vehicles mobilised	0	0	0.5	1.5	0	0	0	1

Table 5-5: GP co-op actions taken with 10 days notice

10 days notice	% change in actual workload							
	90%				60%			
	-30%	-15%	+15%	+30%	-30%	-15%	+15%	+30%
Admin staff	-1	-0.5	1	3.5	0	0	0	2
GPs on rota	-1	-0.5	1	5	0	0	0	3.5
GPs on standby	-1	-0.5	1	2.5	0	0	0	1.5
Nurses (internal)	0	0	0	0.5	0	0	0	0.5
Nurses (external)	0	0	0	0	0	0	0	0
GPs emergency	0	0	0	0	0	0	0	0
Vehicles mobilised	-0.5	-0.5	0.5	1.5	0	0	0	1

None of the co-ops felt that any adverse consequences would occur as a result of a 15% increase in workload. The adverse consequences that would occur as a result of a 30% increase in workload were longer response or call-back times, extra pressure on staff and the increased cost of paying an emergency GP.

Benefits mentioned included an improved service due to matching of GPs to demand, and therefore less stress for staff. Savings could be made if reductions in activity could be forecast accurately.

Managers also commented about the flexibility of their service. One suggested that reducing staffing levels is impractical as co-ops run on minimum levels necessary to provide a competent service. Although GP rotas are fairly inflexible and difficult to change, co-ops have stand-bys and do not have significant problems in mobilising extra staff at short notice. One manager commented “we are a co-operative after all”.

Ambulance service

A total of six ambulance services returned the survey. One stated that they already have a very accurate forecasting system, which allows them to match resources to demand accurately and they did not therefore consider the questions to be relevant. They did not quantify any changes within the survey and the survey was therefore excluded from the results below.

Only one service said they would make any changes on the day in response to an increase in workload. One service said the only changes they could make would be changing the numbers of relief staff at 10 days notice with 90% accuracy, increasing and reducing staff by the same amount for increase and reductions in workload forecast. For the other four services, none would make any reductions due to a decrease in demand and all would make the same increases for a 3-5 day as a 10 day notice period. Two would make less or no

changes at 24 hours. One would not make any changes given a forecast of 60% accuracy, and three would make reduced changes.

The changes for a population of 1 million were as follows:

Table 5-6: Ambulance service actions taken on the day

No notice (N=5)	% change in actual workload			
	-30%	-15%	+15%	+30%
Control staff	0	0	0	0.3
Paramedics	0	0	0	0.5
Crew Technicians	0	0	0	0.8
Ambulances	0	0	0	0.5
Fast response vehicles	0	0	0	0.3
PTS transport vehicles	0	0	0	0

Table 5-7: Ambulance service actions taken with 24 hours notice

24 hours notice (N=5)	% change in actual workload							
	90%				60%			
	-30%	-15%	+15%	+30%	-30%	-15%	+15%	+30%
Control staff	0	0	0.3	0.7	0	0	0.1	0.4
Paramedics	0	0	0.5	3.6	0	0	0.3	2.6
Crew Technicians	0	0	0.8	2.5	0	0	0.4	1.8
Ambulances	0	0	0.5	2.5	0	0	0.3	1.6
Fast response vehicles	0	0	0.3	1.2	0	0	0.1	0.8
PTS transport vehicles	0	0	0	0.3	0	0	0	0.3

Table 5-8: Ambulance service actions taken with 3-5 days notice

3-5 days notice (N=5)	% change in actual workload							
	90%				60%			
	-30%	-15%	+15%	+30%	-30%	-15%	+15%	+30%
Control staff	0	0	0.3	1.2	0	0	0.1	0.4
Paramedics	0	0	0.9	5.5	0	0	0.3	2.9
Crew Technicians	0	0	1.0	3.5	0	0	0.4	2.1
Ambulances	0	0	1.1	3.5	0	0	0.3	1.8
Fast response vehicles	0	0	0.3	1.4	0	0	0.1	0.8
PTS transport vehicles	0	0	0	0.3	0	0	0	0.3

Table 5-9: Ambulance service actions taken with 10 days notice

10 days notice (N=5)	% change in actual workload							
	90%				60%			
	-30%	-15%	+15%	+30%	-30%	-15%	+15%	+30%
Control staff	0	0	0.4	1.2	0	0	0.1	0.4
Paramedics	-0.8	-0.4	1.0	5.3	0	0	0.3	2.9
Crew Technicians	-0.8	-0.4	1.2	3.7	0	0	0.4	2.1
Ambulances	-0.8	-0.4	1.5	4.4	0	0	0.3	1.8
Fast response vehicles	0	0	0.3	1.5	0	0	0.1	0.8
PTS transport vehicles	0	0	0	0.3	0	0	0	0.3

Two services said they would suffer adverse consequences due to a 15% increase in workload, but all said they would at 30%. These included delays in responding to calls, an increase in turnaround times and performance standards being compromised. They may have to cancel non-urgent hospital appointments. Staff may have to work over shift hours and miss meal breaks, leading to increased stress and poor morale.

One manager pointed out the problems with quantifying the adverse clinical consequences, as the ambulance service is performance driven and there is currently a lack of evidence on the effect of performance standards upon clinical outcomes.

Benefits mentioned included improved targeting of resources (ambulances/crews) and therefore improved response times, which would lead to better patient care.

Other changes that were not costed within that were mentioned by managers were as follows:

- Use of support agencies (Red Cross)
- Cancellation of training courses to maximise staffing available
- Possible readjustment of shift patterns, given more than 24 hours notice
- Shortfalls in the rota may be left unfilled if reductions are planned (difficult to quantify as is dependent upon what shortfalls are)

Managers mentioned a lack of flexibility in the service. One manager mentioned that they currently have winter pressures crews in winter anyway, which means they work to maximum capacity due to limited vehicle fleet availability. Any increase in activity would therefore have to be small and short-term. Another said they have no flexibility in the staffing rotas due to strict contracts.

The issue of confidence was mentioned as being the most important factor and a high level of confidence would be needed for managers to feel they did not have to fill empty shifts.

Hospital

There were five responses from hospital managers. However, two of the responses did not quantify any changes they would make and were therefore excluded from the figures reported in tables Table 5-10 to Table 5-13. They are included in the following summary of actions.

One hospital said they could not make any changes on the day. The other four would increase staff as a result of an increase in demand but would not make any reductions due to a decrease. Three hospitals said they would increase the number of elective surgery sessions if they could, given a 90% accurate prediction of a 30% reduction in workload. The numbers increase with more notice.

Three hospital managers said they would not make any changes given a 60% accurate forecast. One would make fewer changes than those made for a 90% forecast. Another said they would cancel elective surgery sessions for a 30% increase and cancel agency staff where possible, given a 30% reduction.

The changes for a population of 1 million were as follows:

Table 5-10: Hospital actions taken on the day

No notice (N=3)	% change in actual workload			
	-30%	-15%	+15%	+30%
Beds	0	0	6.2	34
elective surgery sessions	0	0	1.5	-3
Nursing staff (d,e,f) - internal	0	0	4.6	11
Nursing staff (d,e,f) -external	0	0	0	3
Nursing staff (g,h) - internal	0	0	0	1
Nursing staff (g,h) -external	0	0	0	0
Junior doctor - internal	0	0	0	0
Junior doctor - external	0	0	0	0.8
Middle-grade doctor - internal	0	0	0	0
Middle-grade doctor -external	0	0	0	0.8
Consultants - internal	0	0	0	0
Consultants - external	0	0	0	0

Table 5-11: Hospital actions taken with 24 hours notice

24 hours notice (N=3)	% change in actual workload							
	90%				60%			
	-30%	-15%	+15%	+30%	-30%	-15%	+15%	+30%
Beds	0	0	7.7	29.2	0	0	4.6	11.5
elective surgery sessions	0.8	0	0	-6.2	0	0	0	0
Nursing staff (d,e,f) - internal	0	0	4.6	10.8	0	0	3.1	7.7
Nursing staff (d,e,f) -external	0	0	0	0	0	0	1.5	1.5
Nursing staff (g,h) - internal	0	0	0	0.8	0	0	0	0.8
Nursing staff (g,h) -external	0	0	0	0	0	0	0	0
Junior doctor - internal	0	0	0	0	0	0	0	0
Junior doctor - external	0	0	1.5	4.6	0	0	0.8	2.3
Middle-grade doctor - internal	0	0	0	0	0	0	0	0
Middle-grade doctor -external	0	0	0	0.8	0	0	0	0
Consultants - internal	0	0	0	0	0	0	0	0
Consultants - external	0	0	0	0.8	0	0	0	0

Table 5-12: Hospital actions taken with 3-5 days notice

3-5 days notice (N=3)	% change in actual workload							
	90%				60%			
	-30%	-15%	+15%	+30%	-30%	-15%	+15%	+30%
Beds	0	0	7.7	40.8	0	0	4.6	11.5
elective surgery sessions	3.1	0	0	-6.2	0	0	0	0
Nursing staff (d,e,f) - internal	0	0	4.6	14.2	0	0	3.1	7.7
Nursing staff (d,e,f) -external	0	0	0	0	0	0	1.5	1.5
Nursing staff (g,h) - internal	0	0	0	0.8	0	0	0	0.8
Nursing staff (g,h) -external	0	0	0	0	0	0	0	0
Junior doctor - internal	0	0	1.5	1.5	0	0	0	0
Junior doctor - external	0	0	0	3.1	0	0	0.8	2.3
Middle-grade doctor - internal	0	0	0.8	0.8	0	0	0	0
Middle-grade doctor -external	0	0	0	0.8	0	0	0	0
Consultants - internal	0	0	0	0	0	0	0	0
Consultants - external	0	0	0	0.8	0	0	0	0

Table 5-13: Hospital actions taken with 10 days notice

10 days notice (N=3)	% change in actual workload							
	90%				60%			
	-30%	-15%	+15%	+30%	-30%	-15%	+15%	+30%
Beds	0	0	7.7	40.8	0	0	4.6	11.5
elective surgery sessions	6.2	0.8	0	-6.2	0	0	0	0
Nursing staff (d,e,f) - internal	0	0	4.6	14.2	0	0	3.1	7.7
Nursing staff (d,e,f) -external	0	0	0	0	0	0	1.5	1.5
Nursing staff (g,h) - internal	0	0	0	0.8	0	0	0	0.8
Nursing staff (g,h) -external	0	0	0	0	0	0	0	0
Junior doctor - internal	0	0	1.5	1.5	0	0	0	0
Junior doctor - external	0	0	0	3.1	0	0	0.8	2.3
Middle-grade doctor - internal	0	0	0.8	0.8	0	0	0	0
Middle-grade doctor -external	0	0	0	0.8	0	0	0	0
Consultants - internal	0	0	0	0.0	0	0	0	0
Consultants - external	0	0	0	0.8	0	0	0	0

Other changes which may be made, that were not reflected in the costings of the model included cancellation of agency staff where a reduction in workload is forecast, or allocating annual leave to nurses where 10 days notice is given. One manager spoke of how the case mix of surgery may be altered if an increase in workload were expected. Given 3-5 days notice they could cancel long-stay elective operations and replace the theatre sessions with

day cases. Similarly, given a reduction of 30% one manager said they would attempt to get in extra short stay elective cases, but the number would be limited as people do not wish to be called in at short notice.

Two managers said they would suffer adverse consequences due to a 15% increase in workload, and four said they would suffer due to a 30% increase. Potential adverse consequences included cancelling of elective activity, opening extra beds in second-choice wards or moving patients between wards, which would mean patients were not receiving the optimal care. They may need to employ temporary staff, which again is not ideal for patient care. Patients may have to wait longer for beds and beds may have to be purchased from the private sector. Extra pressure would be put on staff throughout the trust, affecting staff morale.

The benefits that may arise from the forecast included a reduction of cancellation of surgery on the day, financial savings from using internal staff instead of agency staff and benefit for managers in knowing when a reduction in workload is expected.

Managers commented upon the accuracy of the forecast, saying they must be accurate to give staff confidence to act on them. One manager commented “people always remember a wrong forecast and would be loathe to act again”. Another commented that a 60% forecast would not be useful as they would not be able to run the hospital efficiently with such a low level of confidence.

Actions undertaken would depend upon the day of week and time of year. One pointed out that a 30% increase would be manageable in July but not in December, and that the decisions as to what actions are undertaken would depend upon what day it is (i.e. near a weekend). The effect of increases in workload may be lessened for Trusts who employ Winter pressures staff already.

A&E Departments

We received only two responses from A&E departments. One did not quantify any changes they would make on the day, or in response to the forecasts. For the 90% accurate forecasts, they may not get locums to fill vacancies where reductions are forecasts. At 10 days they may also encourage annual leave to be taken. For the 60% accurate forecast, they would do nothing as “60% is = to tossing a coin!”.

The other respondent quantified the following changes:

For a 30% increase, they would increase nursing staff by one internal and one external lower grade nurse on the day. Given a 90% accurate forecast and 24 hours notice, they would make the same changes but also employ one locum junior doctor and one care assistant. Given 3-5 days or 10 days notice they would employ one care assistant and two internal lower grade nursing staff.

Given a reduction of 30% they would reduce the number of internal lower grade nurses by one and given 3-5 days notice, would cancel any locum nurses if booked.

The same changes would be made if given a 60% forecast, although the locum would not be employed.

Adverse consequences include delays for patients waiting to be seen, possible backlog of minor injuries patients and delays in treatment. There may be an impact upon staff morale and job satisfaction.

The benefits that may arise from acting upon the forecast would be due to staffing being able to cope better with demand, leading to a better service and improved patient and staff satisfaction. Savings may be made from not filling vacant slots on rotas and better matching of demand if staff can be encouraged to take annual leave where a reduction in workload is forecast. However, it was pointed out that an increase in workload would probably mean other surrounding hospitals would be experiencing the same increase, which would impact upon the ability of managers to employ extra staff.

The results of the surveys and comments made by managers reinforced the findings of the semi-structured interviews reported in the previous section. Having a high level of confidence in the forecast was clearly important and the inflexibility in reducing staffing levels and risk averse nature of management decisions were reflected in the survey results.

5.4 Economic model of workload prediction

5.4.1 Cost data

The unit costs of resources included in the economic model are listed in Table 5-14, below.

Table 5-14: Unit costs of resources modelled

Resource	Cost per day at 2001/02 prices (£)	Source
Hospital (Ward and AED)		
Care Assistant	84.59	Based on employment costs using methods in Netten et al (2001)
Nursing staff (d,e,f)	133.60	
Nursing staff (g,h)	166.19	
Junior doctors	305.09	
Middle grade doctors (Specialist Registrar)	341.86	
Consultants	545.28	
GP Co-operatives		
Admin. staff	85.00	Employment costs taken from Pickin et al (2001)
GPs on rota	267.75	
GPs standby	307.88	
GPs on emergency	428.4	
Nurses	166.19	
Driver	90.67	
Ambulance		
Control staff	111.77	Based on employment costs using methods in Netten et al (2001)
Paramedics	111.77	
Crew technician	105.20	
Ambulance vehicles	243.00	Staff costs only
PTS transport vehicles	128.69	

5.4.2 Model results: costs

The model has been provided as an accompanying disk and is designed to allow the user to examine the potential cost impact of various responses to the workload forecasts. Below, we summarise the bottom line annual costs per million population, based upon the results of the surveys. For each service, we look at each of the six scenarios considered, and show the results of simple sensitivity analyses. The changes made within the sensitivity analyses were as follows:

- Excluding internal staff costs (hospital) or including drivers cost (GP co-op)
- Increasing agency costs for staff employed on the day (hospital)
- Reversing the proportion of days the model predicts forecasts of $\pm 15\%$ and $\pm 30\%$ (i.e the frequencies mentioned in Section 4.4.6)
- Lowest individual estimate
- Highest individual estimate

The financial consequences of responding to forecasts under the various scenarios are given for each service in the tables below. It should be noted that these costs are calculated as the *difference* between responding to demand with a forecast, compared to doing so without a forecast.

Table 5-15: Hospital results

N=3	Including internal staff costs	Excluding internal staff costs	Reversing % of days expect each forecast level	Increasing the agency cost on the day by 50%	Lowest estimate	Highest estimate
90% accuracy - 24 hours	£260,619	£255,575	£33,022	£247,266	£0	£614,769
90% accuracy - 3-5 days	£220,625	£82,373	£28,221	£203,594	£-28,822	£532,503
90% accuracy - 10 days	£220,625	£82,373	£28,221	£203,594	£-28,822	£532,503
60% accuracy - 24 hours	£104,124	£90,940	£12,988	£91,363	£0	£246,111
60% accuracy - 3-5 days	£104,124	£90,940	£12,988	£91,363	£0	£246,111
60% accuracy - 10 days	£104,124	£90,940	£12,988	£91,363	£0	£246,111

Table 5-16: Ambulance service

N=5	Central estimate	Reversing % of days expect each forecast level	Lowest estimate	Highest estimate
90% accuracy - 24 hours	£45,445	£5,738	£0	£149,008
90% accuracy - 3-5 days	£70,620	£9,024	£0	£149,008
90% accuracy - 10 days	£87,380	£-6,691	£0	£154,034
60% accuracy - 24 hours	£24,953	£3,229	£0	£64,786
60% accuracy - 3-5 days	£27,983	£3,645	£0	£64,786
60% accuracy - 10 days	£27,983	£3,645	£0	£64,786

Table 5-17: GP co-op results

N=7	Excluding cost of driver	Including cost of driver	Reversing % of days expect each forecast level	Lowest estimate	Highest estimate
90% accuracy - 24 hours	£60,957	£67,711	-£38,117	£5,597	£581,611
90% accuracy - 3-5 days	£78,052	£84,806	-£35,770	£5,597	£655,381
90% accuracy - 10 days	£71,782	£77,727	-£52,120	£5,597	£627,128
60% accuracy - 24 hours	£14,460	£15,386	£1,985	£0	£46,009
60% accuracy - 3-5 days	£15,828	£16,754	£2,172	£0	£46,009
60% accuracy - 10 days	£15,828	£16,754	£2,172	£0	£46,009

As there was only one usable response from A&E departments, we have not reported these results.

Overall, these results indicate a net financial cost to acting on forecasts, rather than a net saving. This is a consequence of the tendency of managers to “staff up” to meet forecast of high demand but not to “staff down” to meet forecast of low demand.

However, one result of this is that managers are likely to increase the number of days per annum on which they have the capacity to meet demand (depending on forecast accuracy). Given a 90% accurate 3-5 day forecast, based on our assumptions of staffing levels, hospital managers are able to decrease the number of understaffed days from 157 to 18, at a net cost of about £220,000 per million population per annum. These results may differ if the forecast distributions from the 2002/03 quantitative forecasts are used, as costs are highly sensitive to these distributions. The high costs may be partly due to the forecasts being biased towards increases rather than decreases (see section 4.4.6).

5.4.3 Model results: staffing

Table 5-18 and Table 5-19, below, show the degree to which optimal staffing levels are reached (in hospital services only), both without forecasting and under a range of forecast scenarios. As discussed above, these figures are calculated using simple assumptions and very limited data from managers, and should therefore be taken as indicative rather than definitive. Nonetheless, if treated with appropriate caution they provide a basis for discussion of the possible effects of forecasting on different services.

A number of points should be made to assist interpretation of these results. First, because of the way we have constructed the basic forecast and actual demand scenarios, the variability in demand modelled under the 60% accurate forecast scenarios is different (and greater) than that under the 90% accurate scenarios. Thus, valid comparisons in outcomes cannot be made between these scenarios. However, comparisons can be made across scenarios with the same forecast accuracy levels.

Thus, looking at the results for hospital medical staffing, we can see that without forecasting we expect staffing to match demand on 208 days in the year, and to be below that required on 157 days, on the basis of the responses provided by managers. With a 24 hour forecasting service, we expect a large drop in the number of very understaffed days, with a corresponding increase in the number of moderately understaffed days (and the appearance of some days which, due to incorrect forecasts, are overstaffed). However, once forecasts at least three days in advance are introduced, there is a substantial increase in the number of adequately staffed days and corresponding fall in understaffed days.

In the 60% forecast accuracy scenarios, managers indicated that they were far less likely to take action, and their actions did not differ with increasing lead time. Thus, we find that under these scenarios the provision of forecasts of any lead time produce more modest results, which are the same for all lead times. Again, the forecast leads to a reduction in the number of the most severely understaffed days, but because of the poorer forecast accuracy there is no improvement in correctly staffed days and the appearance of a substantial number of days on which overstaffing occurs.

Table 5-18: Frequency of hospital medical over and understaffing under different forecast scenarios

	Overstaffed by more than five	Overstaffed by up to five	Staffing matched demand	Understaffed by up to five	Understaffed by more than five
90% accuracy model					
No forecast	0	0	208	100	57
24 hour forecast	1	5	204	149	6
3-5 day forecast	1	5	342	12	6
10 day forecast	1	5	342	12	6
60% accuracy model					
No forecast	0	0	196	95	74
24 hour forecast	0	17	186	118	44
3-5 day forecast	0	17	186	118	44
10 day forecast	0	17	186	118	44

Table shows number of days per annum on which the indicated level of staffing will occur.

The results for nursing staffing, shown in table Table 5-19 below, are rather counterintuitive and require additional explanation. On the basis on managers' responses, our model predicts that correct nurse staffing levels can be achieved on all days of the year. This occurs because managers believe that they can always add additional nurses at short notice, either from an internal hospital pool or from external agencies. In addition, as we have noted previously, they tend not to reduce staffing when demand falls below capacity. When a forecasting service is provided, however, nurses are booked in advance for days of forecast high demand, and "topped up" on the day if necessary. Thus, we find that forecasting leads to the appearance of

some days (as for medical staff) when overstaffing occurs. Because of the flexibility in adding nurses at no notice, no days of understaffing appear. As we might expect, under less accurate forecasting scenarios, the degree of correct staffing worsens further.

Two points should be noted. First, as we have argued in developing the conceptual schema, services which are highly flexible or highly inflexible stand to gain the least from workload forecasting. The situation modelled here is, according to the data collected from managers, one of great flexibility in staffing, in which nurses can be added on the day very easily (though not taken away). Under these conditions, these results suggest that forecasting may actually worsen the match of capacity to demand. Clearly, the less accurate the forecast the more likely this is to occur.

Second, the costs of achieving the staffing match under these scenarios should be considered. Because adding staff in advance is cheaper than adding them on the day, there may in fact be some financial gains from acting on the forecasts, even if they seem to worsen the staffing numbers. This could be explored by adding some additional detail to the existing model.

Table 5-19: Frequency of hospital nursing over and understaffing under different forecast scenarios

	Overstaffed by more than five	Overstaffed by up to five	Staffing matched demand	Understaffed by up to five	Understaffed by more than five
90% accuracy model					
No forecast	0	0	365	0	0
24 hour forecast	3	3	359	0	0
3-5 day forecast	3	3	359	0	0
10 day forecast	3	3	359	0	0
60% accuracy model					
No forecast	0	0	365	0	0
24 hour forecast	10	14	341	0	0
3-5 day forecast	10	14	341	0	0
10 day forecast	10	14	341	0	0

Table shows number of days per annum on which the indicated level of staffing will occur.

These results are based upon a number of assumptions as to the maximum number of staff who could be brought in or reduced “on the day”. Similarly, we have assumed the optimal level of staffing required is that of the 90% accurate, 10 day forecast level. These are likely to overestimate the number of staff required when a reduction in activity occurs, as the forecast did not reduce staffing levels when expecting a reduction.

6. DISCUSSION

6.1 Summary of findings

It is clear from the limited evidence identified from the literature review that the study we have undertaken here breaks new ground in exploring, qualitatively and quantitatively, how a routine workload forecasting service might impact upon the NHS. Given the exploratory nature of the study and the limited time available it is clear that our results are far from definitive, yet some clear messages emerge and a number of lines of further inquiry are suggested.

In essence, both the qualitative and the quantitative data we have presented suggest that, at present, NHS managers are highly risk averse in responding to forecasts, and see a range of practical and policy-related obstacles to making any response at all.

Nonetheless, the quantitative modelling we have undertaken suggests that in the short term a forecasting service could achieve an improved match of service capacity to demand, at least in some services, at some net financial cost. In the limited time available to us for this work we have been able to express this improved match only in terms of hospital staffing, but of course it is possible that the benefits of a forecasting service may extend much more widely than this. In the longer term, as the NHS gains experience in the use of forecasts, it is possible that the net benefits in relation to costs might increase.

We have noted that routine forecasting is likely to lead to a net financial cost to the NHS, as managers increase staffing numbers on days of forecast of high demand. However, the change in costs is very sensitive to the initial forecast distribution assumed and should not be taken as definitive. Balancing this cost is a predicted reduction in the number of days on which services are understaffed in relation to demand. The size of this reduction depends upon the value to the service of advance notice and the accuracy of the forecast provided, but is potentially large.

We have been unable to model quantitatively the impact that this improved match of capacity to demand might have, but one would expect to see immediate consequences in terms of decreased waiting times for services, and possibly a decrease in the incidence of adverse health events and clinical errors (such as “near misses”).²¹ Such outcomes might well be judged to be worth the net financial costs we have predicted.

6.2 Limitations of this study

The study reported here suffers from a number of limitations. In interviewing health service managers, we have relied on the views of a small number of managers, all based in South Yorkshire. It is possible that their views are unrepresentative of the wider service. Similarly, in

undertaking the postal surveys, we have sampled only from people who had had previous contact with the *Forecasting the Nation's Health* project in its pilot stages, and under the circumstances we were able to achieve only a poor response rate. It is thus possible that the views of those we have contacted are, in unknown ways, unrepresentative of the NHS as a whole. However, the qualitative responses to the surveys largely supported the findings from the interviews, suggesting that these views have a reasonable degree of representativeness.

In order to keep the surveys as simple as possible, we had to sacrifice some detail in data collection which may, in future modelling exercises, become important. For example, our simple data collection instrument did not ask respondents to distinguish between those actions constrained by willingness, and those constrained by ability, to make changes.

In terms of the modelling, we have made simplifying assumptions at various stages which could be improved upon in further versions of the model. For example, we model each service as a separate entity and do not consider system-wide issues such as staff shortage, nor integration issues between services. We consider different forecasting periods discretely and have not attempted to model the effects of an ongoing series of forecasts. We have also ignored the issue of the duration of change which a forecast may predict. This is important since the range of responses available to deal with very short term changes in demand are clearly different to those for more sustained changes lasting several days or months. We have assumed a simple forecasting model relating to a day at a time.

Similarly, we have made many important assumptions in calculating numbers of staff who could be employed 'on the day', which will affect both the costing and the staffing results.

The model is clearly hypothetical, since we have no existing data on how managers react to forecasts in reality. In general, we have modelled staffing results but not the impact on other expensive scarce resources such as hospital bed utilisation, theatre time, NHS supplies or logistics as we judged this would require a far more complex model beyond the scope of this project. A range of potential costs and benefits may therefore have been excluded. In addition, we have had to make assumptions about the relative frequencies of forecast changes, their accuracy, and the thresholds which might be meaningful to services. These will all need reviewing in the light of actual experience of the service, since, as we have noted, these assumptions may make a large difference to the costs or savings which result.

Finally, we have been able to model quantitatively financial costs and savings, and the immediate effect on the match of staffing to workload, but not the wider service and health outcomes. This probably means that the model is biased towards placing more emphasis on costs rather than benefits, although it should be noted that, in principle, the financial and non-financial consequences of forecasting may be inversely proportional (as we argued above in setting out the conceptual schema). However, the potential, but unquantified, benefits which we have discussed above should be borne in mind and set against the modelled costs when interpreting the results.

6.3 Conclusions

6.3.1 Economic issues

In reasoning about the structure of the model, a number of essential economic truths became clear, as we have discussed above. Briefly, these are that forecasting brings marginal benefits to the service to the extent that flexibility in capacity arranged in advance is greater than that possible at short notice, and that the cost of such flexibility in advance is lower than that at short notice. These benefits are realised as some combination of financial savings, additional output (alternative uses of spare capacity) and avoided system strain (and therefore avoided adverse processes or outcomes of care), recognising that the financial benefits are, in principle, inversely proportional to other benefits.

It seems likely that much of the existing variation in day-to-day demand in the NHS is already well known to managers and clinicians and therefore spare capacity which occurs in a predictable way may already be used productively. For example, quiet periods on inpatient wards may be used for administration, teaching or administrative tasks. Thus, some of the benefits which could result from forecasting workload variation may already be being realised in practice.

This suggests that the marginal benefits of a forecasting service will also depend on the extent to which the forecasts provided are more informative than existing formal or informal approaches to workload prediction. This may depend very much on the degree to which adding infectious disease and weather-related data to a forecasting model improves its accuracy. If the largest proportion of workload variation is determined by day-of-week and month-of-year effects, then forecasts may add little additional information to that already observable and used by services. On the other hand, if the addition of infectious disease and weather variables improves accuracy, there is scope for making changes to service planning which would not otherwise occur.

It might be argued, of course, that even if weather variables add little, the existence of a formal forecasting service in itself might prompt managers to take greater and more systematic account of workload variation than they have done previously.

6.3.2 Service issues

The issue of service flexibility, in terms of increasing or decreasing capacity over short timescales, or making alternative uses of available resources, has emerged as a central concern in our study. Much of this flexibility must focus on staffing, although vehicles, beds, theatres and so on would also need to be available.

It is clear that some services are far more flexible in capacity than others, particularly at short notice. For example, general practitioner co-operatives are able to respond to additional demand by calling in a standby doctor, or asking further non-standby doctors to come on

duty, with little or no notice if necessary. Of course, this carries a financial cost. On the other hand, there may be very little that can be done to increase the capacity of trauma services at short notice, since the supply of available operating theatres, intensive care beds, theatre staff and trauma surgeons is effectively fixed in the short term.

We have argued above that services which are very flexible, and those which are very inflexible, are likely to benefit the least from forecasting. The greatest benefits will result where there is a difference between what can be done “on the day” and what can be done in advance. The idea of individual services as part of a larger system, however, adds new potential to what might be gained, since immediate care services, in particular, are affected by the capacity of others in the system. Thus, matching capacity to demand in out-of-hours primary care might lead to benefits in terms of avoiding emergency admissions, which would help constrain variation in demand for emergency ambulances and inpatient beds. More complex modelling than we have been able to undertake here would be required to explore this issue.²²

Since staffing is the most important factor in service capacity, in order to routinely act on forecasts it would be necessary to move towards services in which at least a proportion of staff can be drawn on in a flexible manner. In general, this is likely to prove unpopular with these staff and may carry additional costs in terms of recruitment, retention and pay. We have not modelled such costs in the current study, but they should be borne in mind in future work. In addition, as some interview respondents noted, the idea that staff should be called upon with limited notice in order to respond to forecasts may conflict with national policy in favour of “family friendly” working.²⁰

6.3.3 Management issues

Much of the current study has focused on the responses of health service managers to workload prediction, giving us some insight into managerial incentives and decision-making. A number of key findings have emerged.

First, managers broadly welcome the idea of being forewarned of changes in workload, whether or not they can take any action in advance. In part this is because they can then, in turn, forewarn staff of increased demand. It seems that information *per se* is seen as valuable to clinicians and managers alike.

Second, our interviewees and survey respondents proved to be highly conservative, arguing for extreme caution in taking any action at all on forecasts. They demanded a high degree of certainty in forecasts before they felt they would act, and even a “belief in the methods” which had been used to develop the forecasts. In addition, they perceived there to be personal and organisational risks in acting on forecasts which meant that, other things being equal, it was generally safer to do nothing than to do something.

Third, managers showed a strong tendency both in interviews and in the survey to “staff up” (increasing capacity to meet forecast high demand) but not to “staff down” (decreasing capacity to meet forecast low demand). There was an evident asymmetry in their responses to workload changes of the same magnitude in different directions. This may be the result of asymmetry in the risks they face in each case. Interestingly, the asymmetry of forecast distributions may indicate a similar risk aversion on the part of the forecasters.

If high demand is predicted, they face the risk of adverse service and clinical events (such as long trolley waits, critical media reporting and even patient deaths) if they do not staff up and the forecast proves correct, against unnecessary financial costs if they do staff up and the forecast proves incorrect. The balance is in favour of action. On the other hand, if low demand is predicted they run similar service and clinical risks if they staff down and the forecast proves incorrect. Again, the desire to avoid adverse events outweighs financial risks and the balance is in favour of inaction.

The net effect is to “play safe”, increasing financial costs while avoiding adverse events and, to some degree, increasing service outputs. Thus, on this reading, the overall effects of forecasting will be to increase both the capacity and costs of services, on the average. This conclusion is strengthened by the observation that the pilot forecasting service⁴ forecast more days where a ‘rise’ in activity was expected than a ‘fall’ in activity, i.e. it was more likely to overestimate than to underestimate demand.

Fourth, managers made clear that they would treat forecasts not as the definitive guide to action, but as “another piece of the puzzle” which would be placed alongside other information and viewed in the context of a range of competing pressures. In many ways this is analogous to the way in which clinicians, responding to the outputs of the evidence-based medicine industry, attempt to integrate “the evidence” with a range of other relevant considerations such as patient preferences, ethical issues, resource constraints and the like.

Related to this, many managers pointed out that they already had some system of demand prediction in place, ranging from the crude to the sophisticated (and in some cases already making some use of weather forecasts). We have noted above that a formal forecasting service is likely only to bring benefits to the extent that it improves on these, *and* is seen by managers as doing so.

Finally, our respondents made a strong distinction between forecasts of unusual and imminent periods of very high demand (crises) and forecasts of sustained change in demand over coming weeks or months. In the former case, they judged that they would be very likely to react by staffing up to cope, but could do so only on occasion and if they had a high degree of confidence in the forecast, or else they would be seen as “crying wolf”. They pointed out that they could not do this very often. In the latter case, they felt that forecasts would be useful because they would help in planning the use of fixed resources such as hospital beds.

These kinds of forecast might therefore be considered as alternatives or supplements to the existing three to 10 day forecasting service.

6.3.4 Research issues

Some of the limitations to the current study, and in particular the modelling, which we have discussed above could, in principle, be overcome. For example, greater complexity could be added to the current model in terms of more detailed costing algorithms, making different assumptions around staffing levels and further, more detailed and specific data could be collected from a larger number of health service managers on how they might respond to forecasts.

In addition, other modelling approaches might be considered, such as simulation modelling which could take account of system-wide issues and interactions between different services. Detailed simulation models of individual services could help us to quantify the (probably non-linear) relationships between service capacity, demand and adverse system outcomes such as lengthening waiting times.

While this would undoubtedly lead to greater insight into how services may perform, the models would still be inherently limited because the data on how services react remains entirely hypothetical. We would therefore argue that the next step, in research and development terms, should now be a carefully evaluated trial of the service on a limited geographical basis in which a range of relevant outcomes are measured and comparisons are made before and after the scheme, and compared with control (no forecast) sites. Important outcomes are likely to include measures of forecast performance (accuracy, precision) and measures of service performance such as waiting times, staff stress and patient satisfaction. Importantly, an economic evaluation would be required alongside any trial which measured all of the potential costs and benefits of the scheme.

7. ACKNOWLEDGEMENTS

We would like to thank Danielle Roach, William Bird and other staff at the Met Office for their support for this research. We would also like to thank all the individuals who participated in interviews and provided data for our model.

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See, for example, the simulation modelling carried out by Dr Val Lattimer and others at Southampton University for Nottingham NHS.