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THE EFFECTIVE MANAGEMENT OF INTENSIVE CARE: A CASE STUDY INTEGRATING HARD AND SOFT METHODS

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ABSTRACT:

The provision of an intensive care service is extremely costly and demand for the service is increasing. Because of the complexity within intensive care, quantitative methods and qualitative methods are used together to develop understanding of the factors affecting ICU management and to identify ways in which performance can be improved.

The successful management of intensive care is dependent upon a complex and interacting set of factors. Insights drawn from combining quantitative and qualitative methods are relevant for strategic policy making, as well as to support and challenge decisions at an operational level.

The potential for the integration of quantitative and qualitative methods to provide greater understanding and support for proposed improvements within a complex healthcare system is highlighted. This paper also discusses the benefits and possibilities of developing qualitative skills within OR, to be used in combination with quantitative skills.

KEYWORDS:

Health Service, Methodology, Intensive Care, Quantitative, Qualitative

INTRODUCTION

There are relatively few reports of the integrated use of quantitative and qualitative methods in the operational research literature. The study described in this paper uses such an approach and aims to improve the provision of intensive care.

Previous OR studies aimed at improving the provision of intensive care focus on the use of mathematical modelling for planning, for example planning bed capacity[1] [2], nurse staffing capacity[3] or modelling admission and discharge procedures[4] for particular intensive care units (ICUs). All these studies investigate the management of intensive care and are focused at an operational level. In this study, the quantitative data used have been collected at national level and qualitative data

comes from a number of intensive care units. This research explores the management of intensive care at a strategic or policy level. The decision to use both quantitative and qualitative methods in this study arose from the strategic level of the analysis involved.

As well as aiming to improve the provision of intensive care, at a methodological level this study also aims to extend knowledge in the OR community of the combined use of qualitative and quantitative methods. In the next section we discuss the OR literature on the use of multiple methods before moving on to describe this particular study of intensive care. We then examine the implications of the study for ICU management, and finally discuss the usefulness of the approach taken and the implications for future research.

QUALITATIVE AND QUANTITATIVE METHODS IN OR

Mingers et al[5] propose two reasons why one might choose to use a mixture of quantitative and qualitative methods. Firstly, they suggest that the problem situation has material, social, and personal aspects and that these different characteristics need different approaches. Secondly, they suggest that the research goes through different stages - understanding the situation, analysing information, looking at different options, and acting to bring about change - and that these different stages require different methods or methodologies.

In a recent survey of the use of multi-methodology in OR[6] the qualitative methods investigated were all problem structuring methods. In relation to this limited set of methods, the researchers found that mixing quantitative and qualitative methods was relatively rare. Earlier surveys of the use of OR methods[7 8] focused primarily on the use of hard OR methods. Other papers which discuss the use of quantitative and qualitative methods in OR tend to focus on a particular technique, for example the use of qualitative and quantitative aspects of system dynamics[9 10]or the use of discrete event simulation in facilitation[11]. Occasionally a technique such as interviewing is discussed but it is often the case that the interviews themselves have had a very specific focus, for example to derive a more accurate conceptual map as the basis for a computer model[10]. Francis et al[12], discussing the role of the operational researcher in performance management, highlight the need for qualitative methods and comment "Only by understanding *how* exemplary performers achieve desirable outcomes can one make significant improvements" (original italics) (p 286).

Other qualitative techniques are rarely discussed explicitly in the operational research literature. When OR first started it was intended to be multidisciplinary, but

particularly in academia it is now viewed more narrowly[13]. This has been seen by some to be a problem for a long time, for example in 1961 Ackoff argues:

> "When one lists the types of variables which actually appear in OR models, the absence of psychological and social variables is conspicuous. Correspondingly, when one lists the disciplinary origins of operations researchers, few are found with backgrounds in the behavioral sciences. These facts seem inconsistent with the interdisciplinary principle and the avowed concern of OR with the human components of systems."[14] (p26)

OR's multidisciplinarity is in evidence, in that it encompasses ideas from mathematics, statistics and systems, but the links between OR and social science are less well defined. This may in part be because the background of most OR practitioners is mathematical[15].

Some attempts have been made to develop stronger links with social sciences, including two conferences entitled "Operational Research and the Social Sciences"[16]. However, despite the good intentions at the first conference in 1964, the second conference 25 years later showed limited development of joint work between operational research and the social sciences[15]. One particular project which focused on multidisciplinary work highlighted the difference in aims of the disciplines of OR and social science as a reason to try to work together: "the OR approach was seen by some academic colleagues as placing its emphasis mainly on achieving effective action rather than on more reflective research considerations" while "the social science research proposed sometimes appeared to place too much emphasis on observation, description and reflection, with an avoidance of any direct involvement with managerial action in the situations studied" [13](p 454-455). Though successful, this type of study does not seem to have been repeated.

An alternative option for OR is to do as it has done with methods from other disciplines and develop these skills further within the discipline. As Ackoff argues "If OR is to survive it must maintain a strong problem orientation, not a technique orientation. It must *expand* its methods and techniques to fit the problems and not contract the problems to fit available methods and techniques" [14] (p 30) (italics added).

BACKGROUND ON INTENSIVE CARE

Critical care is provided for those whose needs are severe but who are likely to recover with major intervention, and includes the care provided on ICUs and high dependency units (HDUs). If you were admitted to hospital with a life-threatening

condition, needing constant close monitoring and support to keep your normal bodily functions going, you would be likely to see the inside of an ICU. High dependency care is "a standard of care intermediate between the general ward and full intensive care"[17] and is provided for patients whose condition is more stable but who remain at risk of organ failure. Patients in HDU require close monitoring but do not require organ support.

There are many reasons for studying the effectiveness of critical care provision. It is a particularly expensive service - the intensive care service in hospital usually accounts for only 6% of its budget, but it is about six or seven times more expensive to treat patients in ICU than to treat that same patient in the ward environment[18]. There is an increasing demand for the service, as advances in technology and medicine make it much more feasible to do a wide range of operations[19]. The age of the population in many countries is also increasing[20], yet they are physically well for longer, allowing for surgery later in life. In addition, this is a highly political area, in that mistakes that are made in critical care, usually related to managerial problems such as bed shortages, tend to hit the headlines. Problems that arise from inadequate numbers of intensive care beds include postponement of elective surgery; no intensive care beds for patients; transfers; early discharges and resulting readmissions.[21] In this context it becomes increasingly important to provide the service as effectively as possible.

The management of critical care is a very complex process because there are so many different factors that affect the outcomes from it. These factors may relate to resources; to demands on the service; they may be linked to policy decisions, at unit, local or national level; some factors may even be related to the organisational structures within the hospital. There are also many different outcomes that can be seen as measures of success, including patients' survival; cost-effectiveness; and the provision of quality care to both patients and relatives.

Effectiveness and intensive care

The effectiveness of health care provision has become increasingly important in recent years. Research into managerial effectiveness within intensive care is limited. Mitchell et al's[22] study of the impact of organisational structures and processes on outcomes used measures extracted from a survey of managers, nurses and doctors alongside a range of outcomes, and concluded that the structure and processes of a unit affect staff satisfaction rather than clinical outcomes. Knaus et al[23], linking patient outcome to quality of care, found no factors that accounted for variation in patient outcome. They investigated other factors drawn from

questionnaire data and concluded (based on qualitative analyses) that the most important factors were the use of clear standards and effective communication and collaboration between nurses and doctors. As part of the APACHE III study in the United States[24], Shortell attempted to link outcome with unit management. He used questionnaires of nurse and physician opinion[25]. A variety of statistical methods were used as well as some observation and interviewing[26]. Some relationships were found between outcomes and unit management, but the study concluded that good units could not be identified by looking at output measures, such as mortality, but outputs could be linked with some "superior practices". They concluded that their analysis was unable to take into account the many factors that affect intensive care.

In summary, existing studies of managerial effectiveness in intensive care have been largely unable to link outcomes to unit management. On the whole, the studies have taken place in the United States and most have used survey data based on nurse and physician opinion. Some have combined this with a little qualitative analysis - observation and interviewing - and have been able to say a bit more about these relationships. In terms of improving the management of intensive care, the key objective of our work was to further develop understanding of the relationship between different factors in ICU management, and so identify ways in which the performance of ICUs can be compared and improved.

USING QUANTITATIVE AND QUALITATIVE METHODS

Because this research is concerned with the strategic management of a complex service as well as its operational management, a key decision at the start of the project was to use both quantitative and qualitative methods. The research aims both to identify the factors that affect outcome from intensive care and to understand why they do so. While quantitative analysis might identify these factors, it is less likely that it will also identify the underlying causal mechanisms that explain these relationships.

A description of the quantitative and qualitative data and methods used follows. When combining different types of method, one of the key issues is how to support the use of multiple methods and combine them in a way which adds value to the research, so this issue is also discussed.

Quantitative data

The Intensive Care National Audit & Research Centre (ICNARC) is a national organisation linked to the Intensive Care Society and focuses exclusively on data collection and research in intensive care. Increasing numbers of ICUs are sending

data to ICNARC on every patient they admit. ICNARC provided access to their own anonymised data linked to data from an Audit Commission Survey from 1998 of 250 ICUs across England and Wales. Hence information was available on outcomes from intensive care as well as details of a range of resources used to provide it, from staffing levels to trust involvement to facilities for relatives. In our analysis, these resources have been seen as inputs to the system, while the outcomes from intensive care are seen as outputs and are used as measures of performance. 57 of the ICUs in the Audit Commission Survey had a significant amount of validated data collected by ICNARC, so these became the datasource for the quantitative analysis. See table 1 for a list of the input measures and performance indicators identified and the variables used to represent these measures.

One of the key performance indicators in relation to intensive care is mortality. The output immediately available to represent effectiveness was the observed number of survivors. However, our preliminary analysis of this data showed that the expected number of survivors (based on a calculation using the APACHE II method[27] which takes the severity of illness, i.e. case-mix, into account) explained approximately 99% of the variation in observed mortality, see Figure 1. Since case-mix dominated the analysis to such a large extent, the observed number of survivors was standardised for case-mix, and survival rate (i.e. observed/expected number of survivors) was used as the output.

Table 1: input measures and performance indicators

Input Measure	**Inputs**
Unit size	No. of beds
Staffing levels	No. of nursing staff
	Nursing staff budget /nurse
	Nurses/bed
	Nurses/occupied bed
	Medical - no. of sessions covered
Budget	Nursing staff budget
	Nursing staff budget/bed
Workload	No. of patients
	Patients /bed
Case-mix	Average no. of organ failures/patient
	Elective patients (%)
Timing	Night-time admissions (%)
Diagnostic diversity	No. of specialties treated
Effect of other units	Transfers in (%)
Responsibility for care	Level of external user consultant involvement
Trust	Trust size
Unit type	ICU / mixed ICU & HDU
Work routine	Organisation of medical cover
Technology level	Presence of haemofiltration
Structure	Directorate to which unit belongs
	Presence of another unit in Trust
	Nearby HDU
	One doctor in charge of directorate
Type of budget	Type of contract
External contact	University affiliation
Policies in use	No. of guidelines in use
	Level of post-basic nurse training
	Presence of Trust-wide development strategy
	Presence of business plan
Flexibility	Ability to flexibly open beds
Performance Indicators	**Outputs**
Effectiveness	Survival rate
Efficiency	Difference between unit occupancy (%) & standard set by Intensive Care Society
	Transfers out (%)
Customer satisfaction	Level of relatives' facilities
	Presence of a follow-up service
	Presence of bereavement counselling
Staff satisfaction	Sickness (%)
	Turnover (%)
Growth	Level of post-basic nurse training
	Presence of intercollegiate recognition, i.e. recognition as an ICU by Intensive Care Society

FIGURE 1: LINEAR REGRESSION TO IDENTIFY THE EFFECT OF CASE-MIX

The regression equation is
Actual Number of Unit Survivors = - 9.11 + 0.974 Expected Number of Unit Survivors

Predictor	Coef	Stdev	t-ratio	p
Constant	-9.109	4.398	-2.07	**0.043**
ExpSurvi	0.97384	0.01167	83.47	**0.000**

s = 18.05 R-sq = **99.2%** R-sq(adj) = 99.2%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	2269559	2269559	6967.96	0.000
Error	55	17914	326		
Total	56	2287473			

Other candidate variables that might have represented input measures or performance indicators well could not be used because the data was incomplete. This included data on readmissions, refusals of patients and cancellations of elective admissions, and no financial data was available. The variables chosen to represent customer satisfaction focus primarily on the facilities available, but were the closest representation of customer satisfaction in the dataset.

Intensive care clinicians were consulted to ensure that the input measures and performance indicators and the variables chosen to approximate them made sense. The variables listed include variables based upon their suggestions and the intensive care literature.

Qualitative data

Qualitative data was collected at five different hospital trusts. A case study approach was used at the first trust, a district general hospital; that is the ICU was studied within its immediate context using a variety of methods, including observation of directorate meetings, observation of the ICU and interviewing, to enable extraction of rich information. This case study was used to identify many issues that affect ICU management as well as to generate understanding of the way in which intensive care fits within its directorate and Trust. Further details of this study, which took place over a period of 2 years, can be found in Kowalczyk[28].

The qualitative data collection at trust 1 took place in parallel with the quantitative data collection and analysis. Whilst the case study at trust 1 enabled the identification of many issues that affect ICU management, trust 1 is situated in a particular context. To investigate the extent to which these issues can be generalised to other trusts in other contexts, further qualitative data collection at other trusts was needed. Four further trusts were selected, three of which were district general

hospitals and the fourth was a larger teaching hospital, from which Lead Clinicians, Directorate Nurses and Directorate Managers were interviewed.

An interview guide was used for interviews at all five trusts to ensure that particular topics were discussed. Initially topics for discussion were based upon the research questions and early interviewees' views on the important issues for intensive care. This guide was developed as the research progressed, in that earlier interviews raised issues that were then discussed in later interviews. Questions were open in style and each interview concluded by asking the interviewee whether any important issue had been omitted. See table 2 for a list of the principal topics covered and some specific open questions used. The notes on early interviews and periods of observation were hand-written but later interviews and meetings were taped and transcribed, increasing the quality and quantity of textual data available for analysis.

TABLE 2: PRINCIPAL TOPICS AND SPECIFIC OPEN QUESTIONS

The principal topics covered
Intensive care development – national or local The impact of changes in Government policy High dependency care Intensive care and the wards Nurses & doctors
Some specific open questions
What affects the quality of care received? What kinds of things cause the most difficulty day-to-day? Can you think of a recent change that has affected the way you work on the unit? Give me an example of a difficult decision What other important issues are there for intensive care?

Quantitative analyses

Whilst the quantitative data used was the best available, like much health data there were quite severe limitations on the level of rigorous analysis that it could support. It is often the case in health service research that the researcher is faced with a complex, interacting set of variables. As noted earlier, only 57 of approximately 250 potential units could be included in the analysis and at times the variables available were less than ideally suited to the research. Therefore it was not expected that quantitative analysis would prove anything, but that it would provide partial evidence on some issues, which could be combined with qualitative evidence.

It is in this spirit that multivariate statistical methods were used to identify possible relationships between inputs and outputs, and DEA was used to look for evidence of high and low performing ICUs. Further details of this study, and particularly of the application of DEA, which is not discussed here, can be found in Kowalczyk[28]. Relationships between inputs and outputs are taken as showing that they are associated with each other rather than that one has caused the other. The complex interactions of a large number of variables imply a reduction in explanatory power of any variable in isolation, so a 10% level of significance was used.

Pearson correlations were used to identify relationships between the different outputs and between each output and the different non-categorical inputs. Multiple regression and ANOVA were then used to ascertain how these correlated variables interact with each other in relation to each output. The complexity that existed within the quantitative data resulted in the presence of a large number of relationships between the quantitative variables. A summary of the positive and negative relationships between input and output variables is given in Appendix 1.

Significant relationships were then looked at in more detail for each of the output variables. For example, table 3 shows the significant Pearson correlations between survival rate and other input variables, while table 4 shows the significance levels for one and two-way analysis of variance of survival rate against the categorical input variables.

TABLE 3: PEARSON CORRELATIONS WITH SURVIVAL RATE

	Survival rate	
% Night-time admissions	-0.47	*
% Transfers In	-0.417	*
Patients/bed	0.408	*
Contract	-0.258	**
Post-basic Training	0.252	***
% Elective patients	0.237	***
Trust Size	-0.236	***
% Refusals (35units)	-0.448	*
Organ Failure (25units)	-0.556	*

Significance levels: 1% = *, 5% = **, 10% = ***

TABLE 4: SIGNIFICANCE OF ONE AND TWO-WAY ANOVA FOR SURVIVAL RATE

	One-way	Two-way					
		Unit type	Block Rota	Surgical or Own Directorate	Part of larger contract	Flexible opening of beds	Nearby HDU
Unit type (ICU or mixed)	0.002*		N/A	0.008*	0.014**	0.002*	0.019**
Block Rota	0.01*	N/A		0.024**	0.003**	0.01*	0.008*
Surgical or Own Directorate	0.017**	0.049**	0.047**		0.033**	0.033**	0.011**
Part of larger contract	0.022**	insignificant	0.006*	0.046**		0.032**	insignificant
Flexible opening of beds	0.037**	0.026**	0.036**	insignificant	0.054***		0.063***
Nearby HDU	0.018**	insignificant	0.013**	0.013**	0.098***	0.031**	

N/A as only one type of unit has doctors working weekly block rotas

The second column of table 4 shows the p-value for the categorical variable (in the first column) when considered on its own, while the later columns show each categorical variable's p-value when considered in combination with another categorical variable (indicated by the column headings). For example, one-way ANOVA shows that survival rate in ICUs is significantly different (0.2% level) from that in mixed units, while survival rate in units which have a nearby HDU is significantly different (1.8% level) from those without. The corresponding two-way ANOVA results show that when 'unit type' and 'nearby HDU' are both taken into account only 'unit type' has a significant relationship (1.9% level) with survival rate.

Regression analyses were also used to investigate relationships between output and input variables, for example when standardised survival rate is regressed against multiple variables three factors had significant positive relationships - a higher ratio of patients/bed, fewer night-time admissions and fewer transfers into the unit, as shown by the regression equation:

'Survival rate = 1.04 + 0.000974 Patients/bed - 0.00376 %Night -0.00246 %Transfers In' (1)

These three variables explain approximately 36% of the variation in unit survival rate.

Below are some examples of the results drawn from these analyses:

- We can see from table 4 that units that treat high dependency patients as well as intensive care patients (referred to as mixed units) have a higher survival rate. Since mixed units have a much higher turnover and many more elective patients than ICUs, the relationships between the ratio of patients/bed and the proportion of elective patients to survival rate, both shown in table 3, are entirely consistent with the relationships between mixed units and survival rate;

- Table 4 shows that units that belong to their own directorate have lower survival rates, while those that are part of a larger contract have better survival rates;

- We can see from table 3 that units that take a lot of transfers in have lower survival rates, although, as indicated by equation (1), there are clearly other factors at work as well;

- Table 4 shows that doctors working week blocks has a positive impact on survival rate, suggesting that continuity of medical care is important. However this type of medical rota only occurs on mixed units, and while the relationship between this medical rota and survival remains significant, it is much less so (significant at 10%) when only mixed units are considered [28].

These are a small sample of the extensive results generated by the quantitative analyses, which are fully documented in Kowalczyk[28]. As the primary aim of this paper is to demonstrate the complementary use of quantitative and qualitative approaches, we have focussed on one output variable only. We now go on to show how these particular results can be combined with some parallel qualitative analyses.

Qualitative analyses

It would have been possible to develop more sophisticated uses of multivariate statistical analysis but their value would always have been severely limited by the quality and quantity of the data. Instead the view was taken that more progress would be made by adding qualitative approaches to the research.

The aim of the qualitative content analysis of the textual data was twofold: to generate a deeper understanding of why certain factors noted in the quantitative analysis as impacting on outcomes did so; and to triangulate, and so 'confirm', ideas generated by textual data from different sources. Content analysis implies taking a systematic approach to the analysis of the content of the interview transcripts and

notes on periods of observation, using codes to classify repeated occurrences of the same themes. The final result of the textual analysis was a multi-layered coding scheme (see Appendix 2). It was obtained by a process of trial and error in which repeated occurrences of similar themes were grouped and re-grouped under higher level themes until a reasonably concise and meaningful coding scheme emerged.

The final coding scheme shown in Appendix 2 consists of four key themes: Policy and practice; Boundary-spanning activities; Roles & relationships; and Integration. These four themes emphasise the importance of viewing intensive care as insular, with a critical boundary between an ICU and its healthcare context. The four themes represent respectively: the external factors that impact on ICU, the activities that take place at the boundary between ICU and its context, the relationships inside the ICU and the issue of insularity versus integration.

This coding scheme provides an overview of a much richer set of data, which can be drilled into as appropriate. For example, looking at high dependency care using the qualitative analysis highlighted a range of problems. The number of high dependency care beds available was seen to be inadequate. ICU nurses disliked working in high dependency care and the relationship between ICU and ward staff had worsened because of the additional interaction. Table 5 gives three examples from the qualitative data on each of these issues.

In each case, the three examples are taken from different interviews (or periods of observation), demonstrating how triangulation is used to strengthen tentative conclusions drawn from the qualitative data.

The introduction of directorates had also increased the interaction between ICU staff and other parts of the hospital, but, in contrast to the introduction of high dependency care, this interaction appeared to be seen more positively. Table 6 lists three examples from the qualitative data on this issue.

One of the effects of inadequate numbers of critical care beds is an increase in transfers between hospitals. The effects of these transfers on intensive care were disruptive. Table 7 lists three examples from the qualitative data that demonstrate this.

One of the features that differentiates units providing critical care is their level of interaction, and so integration, with the rest of the hospital. Table 8 lists three examples from the qualitative data about ICU's insularity and lack of integration.

TABLE 5: QUALITATIVE ANALYSES OF HIGH DEPENDENCY CARE

Theme: Boundary spanning	
Subject: Funding; not enough HDU beds	
Quotes	Interviewee details
'Certainly the nurses that we recruit from the surgical side do say that there are... more seriously ill patients that they have recognised that probably should come to HDU and perhaps only get to HDU as a last resort when they go off and they end up on ICU.'	Sister 1 interview, Trust 1, May 1999
'You feel dreadfully sorry when you go to the wards and you see one trained member of staff and an auxiliary looking after 32 patients - two of whom are bloody sick and ought to be on a High Dependency Unit'	Lead Clinician interview, Trust 4, December 2000
'people are sicker and therefore there are many more people sitting out on wards who actually need extra care or they are critically ill and there aren't enough bed spaces for them'	Directorate Nurse interview, Trust 3, September 2000
Subject: Nurses dislike of working in HDU	
Quotes	Interviewee details
'I like looking after ICU patients because that's what I am trained to do and that's what I came to ICU for'	Sister 6 Interview, Trust 1, June 1999
'The things that attract them to working in intensive care, you get in intensive care and not so much in a high dependency unit.'	Directorate Nurse Interview, Trust 4, December 2000
'there is that little bit of 'Oh, I'm not going in HDU, I'm an ICU nurse' at times. You know, it's a little bit beneath them'	Directorate Nurse interview, Trust 2, July 2000
Subject: Impact on ward; poor relationship between ICU and ward staff	
Quotes	Interviewee details
'Surgical wards not wanting to take patients back... and senior nurses being deliberately obstructive and saying there's no bed, and people who I know coming back and saying "Yes they have got beds".'	Sister 1 interview, Trust 1, May 1999
'I think one of the problems often is that their interaction with us is obviously usually fairly short at a time when they're fairly stressed or we're being pushed… But it's usually not a very good sort of interaction.'	Directorate Nurse (M) Interview, Trust 2, July 2000
'I'm sure in a different way we can be equally, if not busier at times, than the wards are. But I think they think that we just sit around'	Sister 5 interview, Trust 1, June 99

TABLE 6: QUALITATIVE ANALYSES OF DIRECTORATES AND CONTRACTING

Theme: Policy and practice	
Subject: Directorates	
Quotes	Interviewee details
'We are a lot more empathetic towards each other problems…It's a lot more on first name terms than just them in their department and us in our department.'	Sister 1 interview, Trust 1, May 1999
'you interact with people that are generally in your own directorate'	Directorate Nurse Interview, Trust 2, July 2000
'Money affects us in different ways but nevertheless it is something that binds us all together.'	Clinical Director, Meeting, Trust 1, April 1999

TABLE 7: QUALITATIVE ANALYSES OF PATIENT TRANSFERS

Theme: Boundary spanning	
Subject: Transfers	
Quotes	Interviewee details
'If you have to take a nurse out of the unit to transfer, then that'll affect the care and whether you can accept another patient in. There's all sorts of knock-on things that go on.'	Sister 6 Interview, Trust 1, June 1999
'I spend very little time doing clinical work on call, I spend many, many hours on the phone trying to organise and sort out people going to places because we haven't got a bed, or getting people from other places because they haven't got beds.'	Lead Clinician Interview, Trust 4, December 2000
'You're left with poorer staffing levels for more patients and putting a greater number of patients at a bigger risk'	Directorate Nurse 2, Directorate meeting, Trust 1, August 1999

TABLE 8: QUALITATIVE ANALYSES OF ICU INSULARITY

Theme: Integration	
Subject: ICU insularity	
Quotes	Interviewee details
you knew they'd been on an Intensive Care Unit but you'd never actually see the people who would be running the day-to-day business of the Intensive Care Unit.'	Lead Clinician Interview, Trust 4, December 2000
'an ICU with a closed door'	Directorate Nurse Interview, Trust 5, February 2001
'the reticence of staff on the unit to come out of the unit and give their care elsewhere'	Lead Clinician Interview, Trust 5, January 2001

As with the quantitative analyses, these represent a small sample of the results generated by the qualitative analyses, which are fully documented in Kowalczyk [28]. In the next two sections we show how these results can usefully be combined with the quantitative analyses to aid decision making.

Combining the quantitative and qualitative analyses

The results from the quantitative and qualitative analyses can be combined together in various complementary ways. For example, a first step when combining the quantitative and qualitative analyses was to use the four key themes generated from the qualitative analyses to classify the quantitative variables (see Appendix 1). Once this is done various interesting patterns emerge. For example, variables which appear to be linked with an increase in integration into the hospital and a reduction in ICU insularity, (e.g. mixed units or units that are part of a larger contract), have a positive relationship with survival rates (tables 3 & 4) and hence support the view that more integrated units have better survival rates.

Drawing together some of the findings that relate to high dependency care, we see that though units that treat both intensive care and high dependency care patients (mixed units) appear to be more successful in terms of patient survival (tables 3 & 4), the introduction of high dependency care has created additional problems for staff in intensive care and ward areas (table 5). We also see that the introduction of high dependency care could potentially have been much more successful if adequate beds had been provided (table 5).

Like the introduction of high dependency care, the introduction of directorates and contracting reduced ICU insularity by increasing their level of interaction and integration with the rest of the trust (table 6). Units which did not interact more because they remained in their own directorate appear to have lower survival rates, while those units that are part of a larger contract, and so have increased interaction with other parts of the hospital, appear to have better patient survival rates (tables 3 & 4). Unlike the introduction of high dependency care, the introduction of directorates and contracting provided opportunities for interaction that were seen by the staff involved as positive (table 6).

AREAS OF APPLICATION

These kinds of insights can be used in various ways to inform decision makers. They can be used to aid the strategic design of ICU policy at a national level and to support or challenge decisions at operational level, by identifying particular

practices that make a difference to outcomes. Three areas of application are discussed below.

Introduction of high dependency care

Focussing on the introduction of high dependency care, as a previous implementation of ICU policy, when high dependency care was introduced nationally various choices were made at a local level about how closely to intensive care it was situated, the type of patients treated, medical responsibility and nurse staffing. The findings about high dependency care highlighted above suggest that the choices made about high dependency care should promote ICU integration, but that the relationship between staff in ICU and on the wards needs to be considered more closely. However, the funding limitations on high dependency care imply that it is unlikely to be an adequate answer to patient needs.

Comprehensive Critical Care

During the course of this research a new policy for intensive care was introduced, Comprehensive Critical Care[29]. A continuum of care is provided; i.e. patients who need intensive care support, receive it, through the provision of an outreach service if they are situated on the ward. The outreach service also provides education and training for staff on the wards. This policy includes the development at board level of critical care delivery groups and the development of networks between ICUs.

Drawing mainly on the findings shown earlier concerning the introductions of high dependency care, directorates and contracting but also on the fuller findings shown in Kowalczyk [28], the current policy has a lot of potential to improve intensive care. In particular, it addresses the boundaries between intensive care and the wards, and draws intensive care into the hospital trust; and encourages interaction between staff at non-stressful times and for beneficial reasons, e.g. to provide training, rather than only to transfer patients.

Reducing mortality

Two examples of findings relevant at an operational level relate to patient transfers and to medical rotas. (i) Other researchers have found some links between high patient transfers and high mortality[30 31]. This research provides further support for this relationship (see table 3), and also highlights additional problems caused for the units involved (see table 7). (ii) The Audit Commission's survey [32] highlighted

only one quantitative relationship, between survival and the medical staff rota. Our research again clarifies this relationship, showing it to be largely subsumed by the relationship between survival and mixed units (see table 4).

DISCUSSION AND CONCLUSIONS

Fulop et al suggest "a key challenge for research in health service delivery and organisation is that the phenomena under study…are complex and difficult to define"[33] (p9). In addition, the quantitative data available is often quite limited. In this kind of situation, there are limitations on what can be achieved by developing quantitative analyses alone. The decision made in this study was to combine quantitative analyses with qualitative rather than to attempt more sophisticated quantitative analyses.

The greatest benefit gained from this combination was the development of a greater understanding of a particularly complex area of healthcare. This improved understanding can inform decision-makers at both strategic policy level and at operational level, in a way that quantitative analysis alone would not achieve. In some cases this type of analysis can provide support for ideas that they have, while in others it can challenge those ideas by enhancing understanding of why they will or will not work. Whilst neither the quantitative nor the qualitative data analyses alone provide "proof" in a statistical sense, in combination they provide triangulated arguments - a much stronger form of confirmation than the arguments often used in real decision-making.

In addition to the mutual support provided by the triangulation of tentative findings, the research process itself can be much improved when quantitative and qualitative data collection and analysis are performed. In particular ideas generated by the analysis of one type of data can inform collection and analysis of the other, so a more complete picture of the situation is created.

One of the biggest challenges for operational researchers in adopting this kind of research strategy is the need to develop and integrate new skills. Munro et al[6] comment that very few studies which use quantitative and qualitative methods use them equally. They suggested that "choices about which methods to use are affected by the knowledge, experience and skills of the particular practitioner, and to some extent the academic or organisational context, as much as by the nature of the problem itself" (p 378).

One solution is to work more closely with social scientists in multidisciplinary teams as envisaged by operational researchers in the past. This study has also shown that by adding relatively straightforward extensions of the basic interviewing and note-taking skills which many operational researchers already possess, it is possible to dramatically increase the amount of information gained from interviews and to provide a systematic way of recovering qualitative insights and combining them with quantitative analyses. This overall approach should enable operational researchers to contribute to a wider set of decision-making situations than more traditional approaches typically allow.

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APPENDIX 1 – QUANTITATIVE RESULTS

This table shows a summary of the significant (p = 0.1) positive and negative relationships between quantitative variables. The input variables are grouped initially under three key themes: Policy and practice, Boundary spanning activities, Roles & relationships. Those variables which can be classified under the fourth key theme – Integration - as well as another, are shown in column 1.

OUTPUTS / INPUTS	Related to **Integration**	Survival rate	Minimise Difference in Occupancy	Few Transfers out	Relatives' facilities	Follow-up service	Bereavement counseling	Low staff sickness	Low staff turnover	Post-basic nurse training	Intercollegiate recognition
Policy and practice											
Part of a Medical Directorate						-	-				-
Part of a Surgical Directorate		-									-
Part of an Anaesthetic Directorate								+	-		
Own Directorate	Y	-	-			-	-	+			+
Part of an Anaesthetic or Other Directorate			+			+					
Separate contract	Y										+
Cost-based contract						-					
Part of a larger contract	Y	+		-		+					
Inter-collegiate recognition					-						+
Awaiting inter-collegiate recognition				+							
University affiliation					-						+
Boundary spanning											
ICU				+							+
Mixed unit	Y	+	+				+			+	
Nearby HDU		-		+							+
Other unit in the hospital	Y		-							+	+
Patients/bed	Y	+									
% Elective patients	Y	+			-						-
Organ failure		-						+			

Number of specialties served	Y							-			
% Transfers in		-		-			-		-		
Ability to flexibly open beds		+									+
External user involvement	Y								+		
Haemofiltration						+					+
% Refusals		-									
% Re-admissions			-								+
Over-occupied			-			+					+
Under-occupied				-		-					-
Roles & relationships											
Post-basic training		+							+		
Consultant sessions				+		+					+
Nurses / bed				+							
Nurses /occupied bed			+								
Highly-paid nursing staff				-		+	-				
Doctors working a weekly rota			-						-		
Doctors working week blocks		+							-		
Doctors working either a weekly rota or week blocks				+		+					
Staff sickness levels						-					
Staff turnover										-	
Post-basic nurse training		+									
Other factors											
Large Trust		-		+							+
Large unit				+	-	+			-		+
Separate relatives' facilities							-	+		-	
Overnight relatives' facilities								-			-
Bereavement counseling						+					
Follow up service							+				
% Night admissions		-									

+ = positive relationship

- = negative relationship

Y = related to the theme of Integration

APPENDIX 2 – CODING SCHEME

Using a tree structure, this coding scheme shows the four key themes and how they are broken down into sub-themes. Qualitative data is analysed by grouping it together under these themes and sub-themes.

1. Policy and practice

- Purchaser/provider split
- Directorates
- Standardisation
    - Guidelines
    - Intensive care comparison
    - Uses of/responses to
- Centralisation
- Comprehensive Critical Care
    - Outreach
    - Audit/standards
    - Politics
    - Funding
    - Recruitment
    - Trust involvement
    - Networks
    - Flexibility
- Rotation
- Bureaucracy
- Crises
- Stopping care
- Royal Colleges
- Litigation/public involvement
- Hospital effects

2. Boundary-spanning activities

- High dependency care
    - Dependency scoring
    - Staffing
        - Impact on ward
        - Impact on intensive care
            - Workload
            - Nurses dislike of working in HDU
        - Staff rotation
        - Medical responsibility
    - Separate unit
    - Funding
    - Flexibility
- Transfers
    - Effect on ICU
    - Effect on funding

- Networks/joint working
- Standards

3. Roles & relationships

- Roles
  - Medical
  - Nursing
    - Role extension
    - Ward de-skilling
  - Hybrid roles
    - Administration v. clinical
    - Impact on relationships
- Relationships
  - Doctor-doctor
    - Intensive care v. external
    - Clinical Director v. Lead Clinician
  - Doctor-nurse
    - Intensive care doctor v. intensive care nurse
      - Differences
      - Limitations
    - Intensive care doctor v. external nurse
    - Intensive care nurse v. external doctor
    - Lead Clinician v. Directorate Nurse
  - Nurse-nurse
    - Intensive care v. external
  - Doctor-manager
  - Nurse-manager
- Power
  - Medical
    - Use of power
    - Intensive care doctor v. other doctors
    - Attacks on
  - Nursing
  - Management
  - ODA

4. Integration

- Interaction
  - Wards
  - External consultants
  - Trust
  - Outsiders
- ICU insularity
  - Effect of government reforms
    - Directorates
  - Effect of high dependency care
    - Interaction
  - Effect of Comprehensive Critical Care
    - Outreach

        - Trust involvement
- Perceptions of each other
    - Intensive care staff v. ward staff
    - Staff rotation

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