

Anne Miller · Yan Xiao

Multi-level strategies to achieve resilience for an organisation operating at capacity: a case study at a trauma centre

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Abstract Healthcare services are examples of organisations that operate frequently at capacity, as reflected by periods of high demand and hospital overcrowding. Using the safe operating envelope framework (Qual Saf Health Care 14:130–134, 2005), this study identifies the strategies hospital staff use to respond to high patient demand pressures. A surgical unit (SU) in a dedicated trauma hospital provides the context for the study. Results are based on the outcomes of structured, critical decision method and contextual interviews involving six participants selected according to their roles in relation to resource allocation within the SU. The study's central findings are (1) that temporally nested patterns of emergency patient admissions are the dominant influence on three levels of management decision making in the SU and (2) that compensatory buffers are actively planned at multiple levels of work organisation. These results are discussed in terms of their theoretical implications and implications for technological design. The methodological limitations of the research are also discussed.

Keywords Safe operating envelope · Compensation · Temporality · Patient admissions · Resilience

Abbreviations CRNA: Certified registered nurse anaesthetist · RN: Registered nurse · SU: Surgical unit · TRU: Trauma resuscitation unit

1 Introduction

High-risk organisations operate in a confluence of forces such as economic pressures, political pressures and safety requirements that push them towards the limits of their operating capacity (Leveson et al. 2006). Increasing resource capacity by recruiting more workers or expanding physical resources is not always feasible (Duckett 1999), thus there is a growing interest in improving organisations' ability to operate reliably and safely at capacity.

Healthcare services and hospitals in particular are increasingly under intense pressure to operate at capacity. According to recent reports in the United States healthcare is estimated to consume 17% of the gross domestic product by 2010 (Heffler et al. 2002). Ageing populations and new medical technologies have increased patient demand (Locker et al. 2005; Best 2002). In this context, healthcare services are likely to experience more frequent occurrences of emergency department overcrowding and bed gridlock in peak demand times. During bed gridlock patient waiting times increase the risk of complications and a patient's length of hospital stay which further contributes to gridlock in other parts of a hospital (Fatovich et al. 2005; Bell and Reidelmeier 2004; Locker et al. 2005; Molony et al. 2005; Weiss et al. 2004; Fatovich and Hirsch 2003).

One approach to solving demand–capacity mismatches is to develop demand forecasting algorithms. However, their effectiveness may be limited (a) due to inaccuracy given available data (Green 2004), and (b) as a consequence of poor reliability given system modelling issues (Cromwell 2004; Harper and Shahani 2002). Another approach is to improve staff members' ability to better manage resources in high demand periods (Pickard et al. 2004).

Improving staff members' adaptive abilities has been advocated in high-risk industries for many years. Technology is often recommended to support worker flexibility and adaptation. However, new technology can

A. Miller (✉)
ARC Key Centre for Human Factors
and Applied Cognitive Psychology,
The University of Queensland,
McElwain Building (24A), St Lucia Campus,
Brisbane, QLD 4072, Australia
E-mail: amiller@humanfactors.uq.edu.au

Y. Xiao
School of Medicine, University of Maryland,
Baltimore, MD, USA

impose new problems. System brittleness (Smith et al. 1997), for example, may inappropriately restrict behaviour, and inappropriate automation may put workers out of control of situations they are responsible for managing (Nachreiner et al. 2006; Parasuraman 1997).

Compared to other industries healthcare is remarkably devoid of computerised work management technology (Xiao and Seagull 2006). This situation is changing. If we are to avoid the adverse effects of new technology in healthcare it is important that we understand the factors that shape adaptation. Healthcare stands to benefit from the experiences and frameworks developed in other industries, while at the same time providing an increasingly rare opportunity to apply these frameworks in a complex work environment that has few of the confounding effects of technology.

The purpose of the study reported in this paper is to identify the adaptive strategies hospital staff use to respond to high demand pressures. Strategies are defined as the influences, goals and priorities that shape responses to high demand. Strategy identification will be based on a systemic application of Rasmussen's (1997) safe operating envelope model. Applying and further developing this model may also provide insights relevant to emerging ideas such as the role that resilience engineering (Hollnagel et al. 2006) might play in supporting adaptive worker behaviour.

1.1 Theoretical framework

An appropriate framework for studying adaptive behaviour needs to represent the relative states of economic, workload and safety pressures that act on a work system. One framework that has been applied anecdotally and in limited scope to healthcare (Cook and Rasmussen 2005) depicts dynamic socio-technical systems as operating within an envelope enclosed by three boundaries of failure (Rasmussen 1997) (see Fig. 1).

In this framework the overall operating state of a work system changes dynamically in response to eco-

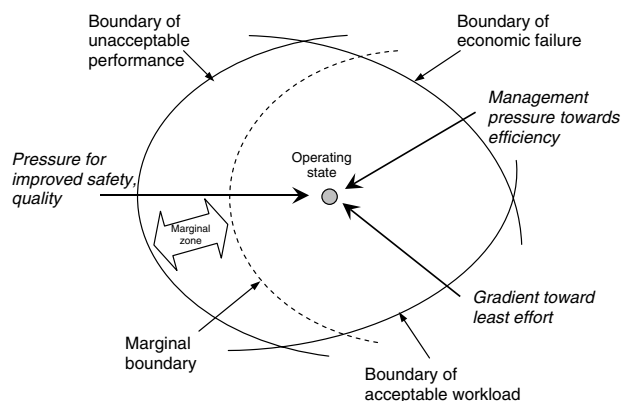


Fig. 1 Rasmussen's modified safe operating envelope (adapted from Cook and Rasmussen 2005)

nomical pressures that push the state away from the economic failure boundary, workload pressures that push the state away from the unacceptable workload boundary, and pressures for improved safety that push the state away from the boundary of unacceptable performance. The system's operating state moves dynamically within this given these relative pressures (Cook and Rasmussen 2005). However, if the system state is pushed beyond economic, workload, performance boundaries then failure is likely to ensue.

In addition to the boundaries of failure, Cook and Rasmussen (2005) define a marginal boundary (see Fig. 1). The marginal boundary is a boundary of acceptable risk. Towards the centre of the envelope the risk of economic, workload and performance failure is minimal, but as the system state is pushed first towards and then over a marginal boundary the risk of failure increases until failure becomes almost inevitable at the boundary of failure.

Cook and Rasmussen (2005) maintain that the marginal boundary is also dynamic, shifting inwards and outwards in response to pressures. The release of the Institute of Medicine's report *To err is human* (Kohn et al. 2000) shifted the marginal boundary inwards increasing the zone between the marginal boundary and the boundary of unacceptable performance (Fig. 1). Conversely, economic pressures such as recession and shortages of skilled healthcare workers shift the marginal boundary out towards the boundary of unacceptable performance. At Bundaberg Hospital, for example, the effects of financial pressures and staff shortages contributed to allowing an incompetent surgeon to undertake procedures that resulted in the deaths of 88 people (Van Der Weyden 2005; see Davies 2005, for the Royal Commission's report).

1.2 Compensation at capacity: a framework

Rasmussen (1997) also refers to the marginal zone as a system's capacity to cope. Thus the wider the zone between the marginal and failure boundary the greater a system's capacity to compensate for or adapt to pressures. In this conceptualisation the marginal zone represents sets of behaviours and resources that can be enacted to keep the system's operating state as close as possible to the area of minimum risk. Cook et al. (Cook and Rasmussen 2005; Cook and Nemeth 2006) illustrate how humans adaptively modify their behaviour when under pressure. In their examples, staff members rearranged operating room schedules and staff rosters to compensate for the effects of intensive care unit bed gridlock. Compensation is understood to involve the adaptive use of back-up or opportunistic processes to manage situations, but tends to mask the overall state of a stressed system (Woods and Cook 2006). Compensatory mechanisms can also become exhausted resulting in decompensation, at which point capacity limits are exceeded and processes for managing particular situations

breakdown (Woods and Cook 2006). These relations are shown in Fig. 2.

In Fig. 2 economic and workload pressures push the operating state from the low-risk zone (Fig. 1) across the marginal boundary and into the marginal zone. In the face of continued pressure, compensatory processes work with diminishing capacity to maintain operating states close to the marginal boundary. However, as the capacity needed for compensation is expended; operating states drift closer to the acceptable performance boundary. If pressure does not decrease, or if capacity is not increased, decompensation occurs with an increased risk of failure.

Resilience refers to a work system's ability to buffer, adapt to, absorb and prevent adverse patient outcomes in the face of disruption (Woods 2006). The sets of back-up behaviours that make up the marginal zone may act as measures of a work system's resilience. We propose to explore this speculation by applying the safe operating envelope model to identifying compensatory mechanisms in a surgical operating unit (SU) in a dedicated trauma hospital.

2 Method

The method outlined in this section is an application of a grounded theory approach to exploratory field research (Charmaz 2000; Strauss and Corbin 1997; Miles and Huberman 1994). In summary, the research process unfolded in three phases represented by three sets of interviews. The structure of subsequent interviews was informed by outcomes from the preceding interviews.

2.1 Setting

The trauma hospital is the primary adult trauma resource centre for a population of over five million. The trauma hospital, one of the busiest in the US (Xiao et al. 2006), received in excess of 7,000 trauma admissions in

the last year. As a hospital it manages the continuum of care from resuscitation to rehabilitation. The six-room SU performs over 3,000 operations per year, with approximately 55% of these being emergency trauma admissions.

2.2 Participants

To better understand the pressures acting on the SU, participants were chosen based on their roles in relation to resource allocation. Six participants were interviewed; one was the SU medical director; two were schedulers (one for anaesthetic staff and one for nursing staff), and three were charge nurses (one each for morning, afternoon and night shifts). Responsibility profiles for the participants are provided in Table 1.

2.3 Procedure

Following a review of organisational charts and SU reports, the interviews began with the SU medical director.

2.3.1 Director's interview

Two interviews were conducted with the director. The first 45-min interview established the managerial scope of the director's role and was divided into two parts. Part 1 included the following question: "Tell me about your role in the SU and the types of decisions you make?" Part 2 included the following questions: "Why do you need to make these decisions?," "What information or artefacts inform them, can you show me examples?," "What kinds of implications or effects do you consider?" and "Who do your decisions most directly affect?" The director's responses to these questions were, given the time allocation, highly general.

The second interview, undertaken 4 days later, took approximately 2 h and was structured according to the critical decision method technique (Blandford and

Fig. 2 The drift to decompensation

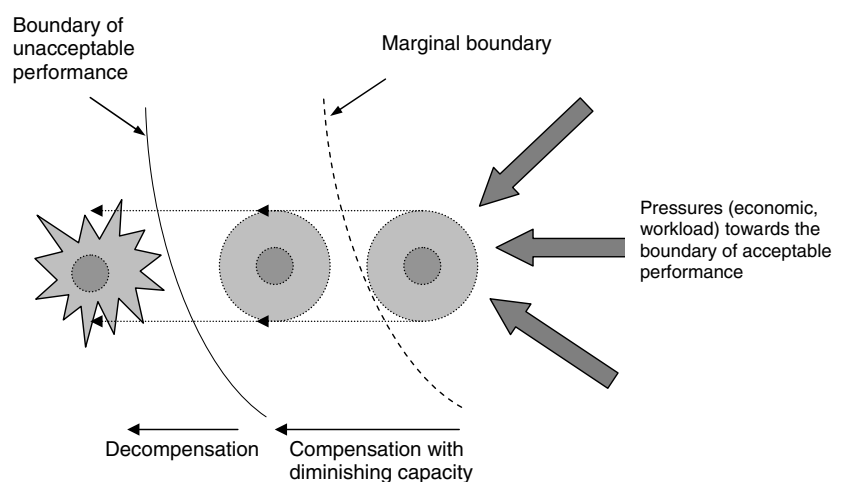


Table 1 Participant responsibility profiles

Participants	Responsibilities in relation to the OR
1. Director	<ul style="list-style-type: none"> • Reports to and represents the SU to the trauma hospital management group (an executive group with decision making responsibility for the hospital as a whole) • Represents the hospital management group in monthly SU management group meetings. The SU management group includes senior anaesthetic, surgical and nursing staff • Is the senior “in-charge” anaesthesiologist supervising other clinicians
2. Schedulers One certified registered nurse anaesthetist (CRNA) One registered nurse (RN)	<ul style="list-style-type: none"> • Respond to SU management group directions about the number of operating rooms to be open and therefore to be staffed each month • Receive schedule preferences from CRNAs and RNs, respectively • Coordinate staff schedules on a daily, weekly and monthly basis • Are scheduled to work in operating rooms as CRNAs or RNs, respectively
3. Charge nurses One each for morning, afternoon and evening shifts	<ul style="list-style-type: none"> • Participate in and report to SU management group meetings • Manage day-to-day OR operations

Wong 2004; Klein et. al. 1989). The purpose of this interview was to further explore the general strategies elicited in the first interview. Consistent with Blandford and Wong’s (2004) application of the method, the director was asked to recall a critical incident in which he had played a role. He was asked to briefly outline the incident’s major stages. Each stage was then explored in detail using questions such as “Is that what you would normally expect?”; “How did you know that?”; “Is that commonly understood?” and “Are there other reasons for that occurring?” Both interviews were audio-recorded for later transcription. All artefacts presented were photographed and where possible samples were collected.

2.3.2 Schedulers’ interviews

The schedulers’ roles were identified during the director’s interview as recipients of decisions made by the SU management group. The schedulers are responsible for scheduling certified registered nurse anaesthetists’ (CRNAs) and registered nurses’ work shifts, respectively. The schedulers were interviewed separately. The same interview process was used as for the director’s first interview. Again the interview was audio-recorded and artefacts photographed and/or collected.

Anaesthesiologists are also scheduled to the SU, however their scheduling is not contained within the SU but influenced by needs across several departments. For this reason anaesthesiologists’ scheduling was considered to be out of the scope of this study and not included. Anaesthesiologists supervise CRNAs’ administration of anaesthesia on a ratio of two CRNAs to one anaesthesiologist.

2.3.3 Charge nurses’ interviews

During the director’s and the schedulers’ interviews, charge nurses were identified as key resource managers during daily operations. Morning, afternoon and night shift charge nurses were interviewed and observed using

the contextual interview technique described by Beyer and Holzblatt (1998). Interviews were conducted during the following times in 1 week: morning shift (Monday from 06:30 to 11:00 h); afternoon shift (Tuesday from 11:00 to 15:00 h) and night shift (Friday from 19:00 to 23:00 h). The choice of times was based on information elicited from the schedulers’ interviews. All interviews were audio-recorded.

2.4 Data collation

Each audio-recorded interview was transcribed. Photographs of artefacts were included in the transcripts with relevant text. Once printed, the transcripts were labelled according to the participants’ role then cut into sections based on the subject themes expressed in the content of each paragraph. Each theme was grouped based on content similarity as in Beyer and Holtzblatt’s (1998) affinity diagramming technique except that Cook and Rasmussen’s (2005) safe operating envelope (Fig. 1) was used to classify the themes. Affinity diagrams are constructed according to perceived similarity between thematic content. The process of thematic grouping occurs by consensus derived during discussion by two or more coders. Thus, for example, a scheduler’s comment that “We don’t want nurses to work more than 40 hours per week—it’s the overtime and it’s the financial cost” was classified with similar themes as a pressure for economic efficiency. Themes were grouped by the first author in consultation with the second. The transcripts for all of the participants were classified in this way to form an aggregated “affinity diagram.”

Following classification, themes associated with the boundary of acceptable performance were further subdivided into three groups as follows: (1) “marginal boundary” which included themes associated with maintaining safe practices; for example “We deal with this in orientation. One of the things they have to learn is...”; (2) “boundary of acceptable performance” which included themes about minimum standards; for example “Staff have to know the rostering rules. You can’t have

someone working 60 hours... you have to be awake” and (3) “compensation” which included themes associated with managing high demand periods; for example, “Another way we cover that time is with the 1500–2300 hr shift, where that person comes in at 1500 hrs and works eight hours.”

3 Results

The following results are reported in two sections: (1) influences associated with the safe operating envelope and (2) factors associated with compensation.

3.1 Influences associated with the safe operating envelope

Table 2 shows the proportion and frequencies of themes reported by the participants related to pressures acting on the safe operating envelope (Cook and Rasmussen 2005). Patient demand for services was separated out from other acceptable workload pressures as will be explained later.

A chi-squared test showed statistically significant differences in the frequencies of themes reported by the participants in each of the safe operating envelope classifications ($\chi^2 = 46.974$; $df = 12$, $p < 0.005$). As shown in Table 2, the director reported the highest proportion of themes in association with patient demand for services. Schedulers reported the highest proportion of themes for acceptable workload pressures other than patient demand and the charge nurses reported highest proportions for marginal zone. Tables 3, 4 and 5 summarise the main themes associated with safe operating envelope pressures, including the artefacts used to assess or work with these pressures. Representative quotations or detailed comments for each of the participants are presented in Appendices 1, 2 and 3.

The dominant pressure affecting decisions made by the director in his role within the SU management group was seasonal variation in patient demand (Tables 2, 3), which is assumed to be related broader social factors, such as peoples’ tendency to engage in higher-risk activities during the summer holiday period. Annual patient admission graphs and statistics showing past seasonal variations in planned and unplanned (emergency) patient admissions were used to inform decisions about the number of

operating rooms to be staffed in the next month. Themes within the remaining categories reflect the director’s day-to-day operational role as an in-charge anaesthesiologist. These are similar to themes presented by the charge nurses and so will be discussed later.

The content of the two schedulers’ interviews were similar to one another and so were aggregated and are summarised in Table 4 (also see Appendix 2). Table 4 shows staff scheduling themes resulting from the SU management group’s decisions about the number of operating rooms to be staffed. Each staffed operating room requires a minimum number and complement of staff to ensure acceptable work performance (i.e. one CRNA, two nurses or a nurse and a technician, and one supervising attending anaesthesiologist for every two operating rooms). Thus the number of open operating rooms determines staffing levels. As suggested in Table 2, the schedulers’ primary objective is to optimise acceptable workloads. Shift work can adversely affect staff lifestyles and is understood by schedulers to be responsible for higher staff attrition rates. Thus a major scheduling priority is to reduce the number of undesirable evening, night and weekend shifts (off-shifts) that staff work. This is achieved using an operating room management strategy involving planned and emergency procedure scheduling and staff scheduling strategies.

Emergency procedures must be attended to, but planned procedures can be delayed or rescheduled. The likelihood of emergency patient arrivals differs across days of the week, and again is assumed to be related to broader social factors, such as increased high-risk leisure activities during the weekend. Thus emergencies are more likely to occur from Friday afternoon and through the weekend and are less likely to occur from Monday to Thursday. Hence, planned procedures were restricted over the weekend to reduce the number of operating rooms that need to be staffed. Instead, planned procedures were undertaken on weekdays when the maximum numbers of operating rooms are staffed, when staff prefer to work, and when emergency patient arrivals are less likely.

Weekly work patterns are also affected by the weekend restriction on planned procedures. Operating rooms are used differently on different days of the week. On Monday four of six operating rooms were allocated to specific surgical specialities (orthopaedics, plastics, etc). The “blocking” or specific allocation of operating rooms to surgical specialities maximises case-handling

Table 2 Proportions (and frequencies) of each participants’ themes classified within the safe operating envelope

	Pressure for acceptable workload	Patient demand	Pressure for efficiency	Marginal zone	Pressure for acceptable performance
Director	0.07 (2)	0.48 (13)	0.11 (3)	0.33 (9)	0
Schedulers	0.44 (25)	0.21 (12)	0.05 (3)	0.09 (5)	0.21 (12)
Charge nurses	0.17 (9)	0.06 (3)	0.10 (5)	0.42 (22)	0.25 (13)

Bold values indicate significant values (χ^2 test)

Table 3 Themes within the safe operating envelope at the Director's level of responsibility

Safe operating envelope	Theme summaries	Associated artefact
Pressure for acceptable workload	<ul style="list-style-type: none"> • Past experience of procedural risk reduces uncertainty and improves efficiency 	–
Patient demand	<ul style="list-style-type: none"> • Patient demand is temporally distributed based on seasonal variations • There are more unplanned cases during the spring and summer than during the winter 	Annual patient admission statistics Monthly admission statistics
Pressure for efficiency	<ul style="list-style-type: none"> • Operating rooms are opened depending on anticipated seasonal demand 	Annual and monthly admission and type of procedure statistics
Maintaining marginal boundary	<ul style="list-style-type: none"> • Managers shift their focus of attention from the state of the OR to specific procedures • Junior staff refer senior staff when problems exceed skill or experience • Quiet times when spare capacity is available are best for complex cases 	–
Boundary of acceptable performance	<ul style="list-style-type: none"> • Responsibility is allocated depending on levels of skill and experience 	–

Table 4 Themes within the safe operating envelope at the Schedulers' level of responsibility

Safe operating envelope	Theme summaries	Associated artefact
Pressure for acceptable workload	<ul style="list-style-type: none"> • Flexible rostering allows staff to accommodate shift work with lifestyles • Per diem staff work night and weekend shifts only, but their availability is uncertain 	Shift request book and holiday schedule. Monthly schedule on-call list
Patient demand	<ul style="list-style-type: none"> • Voluntary on-call is used to cover staff shortages • Annual leave is restricted to two people during the summer but mild winters can be as busy • Monday and Friday are the busiest • Cases held over the weekend are done on Monday • Friday is used to clear cases before the weekend • Weekend trauma is unplanned • Planned cases occur in the middle of the week where they can be prepared for 	Wall calendar for vacations. Monthly schedule (paper chart). Monthly admission statistics. OR white board
Pressure for efficiency	<ul style="list-style-type: none"> • Operating rooms are staffed by either two nurses or a nurse and technician • Nurses work hours are restricted to 40 h per week to reduce overtime 	–
Maintaining the marginal boundary	<ul style="list-style-type: none"> • Per diem and contract staff only work 0.8 full time equivalent • Experienced staff with broad-based skills are central to effective operations • Shift staffing targets are met using on-call and overtime rostering • Cleaning, maintenance, patient assessments or working in related parts of the hospital occupy quite times 	–
Boundary of acceptable performance	<ul style="list-style-type: none"> • Fatigue is managed by controlling the number of hours per week that staff work • There are minimum numbers of appropriately qualified and experienced anaesthesiologists, CRNAs and nurses allocated to each room • If the minimum of staff are not available then operating rooms close affecting planned admissions 	Overtime book

efficiency as specialist expertise and equipment can be prepared and located in particular operating rooms. Blocking also gives surgeons autonomy in prioritising their own case backlogs. Tuesday and Wednesday mornings typically have fewest emergency admissions but are well staffed. Thus long or difficult procedures are scheduled to these days. In contrast to Monday, on Friday, four of six operating rooms were used by any surgeon to clear cases that might need attention over the

weekend. The weekly pattern of allocating planned procedures supports a level of predictability about the nature of work on particular days (i.e. planned procedures of particular types on Monday, difficult procedures on Tuesday and Wednesday and a variable range of procedures on Friday). Decisions about how and to which surgical specialities operating rooms will be blocked are made by the SU management group and may vary across the year.

Table 5 Themes within the safe operating envelope at the Charge Nurses' level of responsibility

Safe operating envelope	Theme	Associated artefact
Demand	<ul style="list-style-type: none"> • Informal communication and “loitering” provides information about the state of emergency patients • Estimated procedure finish times are used to reschedule and reallocate patients • Unplanned, non-emergency procedures are not commenced after 19:00 h 	OR white board
Pressure for efficiency	<ul style="list-style-type: none"> • Patients are called from the wards approximately 30 min before their procedure is expected to start to reduce delays 	OR white board and video monitors
Pressure for acceptable workload	<ul style="list-style-type: none"> • TRU staff alert the OR to impending emergencies allowing the charge nurse to arrange on-call staff as needed 	On-call list
Maintaining the marginal boundary	<ul style="list-style-type: none"> • The next days planned case list arrive between 15:00 and 16:00 h • Cases that are requested after 15:00 h become unscheduled add-on cases • Non-urgent add-ons are the first to be cancelled • The on-coming charge nurse walks through TRU checking each bay and the arrivals notification board • Night staff are responsible for cleaning, maintenance and getting instruments ready for the next day's cases • Equipment and staff are shared across closely related departments 	OR white board
Boundary of acceptable performance	<ul style="list-style-type: none"> • The morning charge nurse focussed on completing the planned cases • The afternoon charge nurse focused on completing any add-on cases • The afternoon charge nurse assessed the need for on-call staff • The night shift charge nurse focused on any emergencies and on preparing for the next morning's cases 	OR white board

The second strategy used to minimise the number of undesirable shifts that staff work involves flexible scheduling policies that give staff opportunities to balance work and lifestyle needs. Thus schedules are written up only 1 month in advance, limited overtime is available especially for part-time staff, on-call schedules are voluntary, per diem staff are restricted to working only undesirable shifts, and staff members willing to work undesirable shifts on a regular basis are rewarded for doing so. Artefacts such as paper-based notebooks that could be easily carried into the operating room assisted the schedulers in negotiating shift schedules through direct interpersonal contact.

As shown in Tables 2 and 5, charge nurses were particularly concerned about maintaining the marginal zone. What it takes to maintain the marginal zone changes across the day depending on the likelihood of emergency patient arrivals. Emergency patients are most likely to arrive in the late afternoon to about midnight. Like weekend shifts, the probability of emergency arrivals corresponds to undesirable shift times; that is, in the evening and overnight.

The likelihood of daily emergency patient arrivals shapes daily work priorities. Planned procedures are scheduled during the morning to take advantage of low probabilities of emergency admissions and higher staff numbers. The morning charge nurse's main priority is to ensure that planned procedures are completed. The

afternoon shift charge nurse has two priorities: to complete any remaining planned and any unplanned, non-urgent (add-on) procedures before the night shift commences at 19:00 h, and to assess the need for and place on stand-by any on-call staff that might be needed during the night. The night shift charge nurse's main priority is to manage any emergencies and to prepare instruments for the next morning's planned procedures based on the list of planned procedures that were made available at 15:00 h.

The OR white board, which is discussed in detail by Xiao et al. (2001), is used exclusively by the charge nurses as a means for representing the dynamic state of particular operating rooms throughout the day. The white board also facilitates projection and negotiation about the effects of procedure reallocation, rescheduling and add-on procedures in relation to available resources.

3.2 Factors affecting compensation

The themes and factors associated with compensation for the schedulers and the charge nurses are shown in Table 6. Few compensatory processes were mentioned in association with the director's role as a member of the OR management group, although monthly decisions about open operating rooms based on seasonal patient demand, may be regarded as attempts to provide

Table 6 Themes and factors facilitating compensation

Theme	Factors
<i>Schedulers</i>	
Variable duration and overlapping shifts	“Shift times vary. CRNAs can work 8, 12 or 16 hour shifts. Nurses can work 4, 8 and 12 hour shifts so you can cover busy times and you don’t drop your numbers as much between the main shifts. So there’s 0700–1900; 1100–1500, 1500–1900, 0700–2300, 1100–2300 hrs and so on”
Role redundancy	“We have one attending for two CRNAs. When we have five rooms going that’s two attending anesthesiologists for four, and one attending for only one CRNA. This attending could start a sixth room” “Sometimes there are OR nurses working in the PACU or the TRU and they can pitch in and help out, and the charge nurse can get things started too. The charge nurse isn’t in the numbers”
Anticipatory planning and action	Daily operations actually begin at 15:00 hours when the SU is given the list of the next day’s planned cases. This list determines the night staff workload. Night nurses are responsible for preparing equipment so that morning staff can begin the scheduled cases. Morning staff work to complete the planned case list by mid-afternoon when emergency cases typically begin to arrive. This frees operating rooms for emergencies as staff numbers decline in the evening
<i>Charge nurses and the in-charge anaesthesiologist</i>	
Role redundancy	“When I’m in-charge I supervise up to 6 attending anesthesiologists. They each supervise 2 CRNAs. So if the CRNA has a problem they go to the attending, if the attending has a problem they come to me. I spend most of my day fire-fighting” “We work as a team, it’s a hierarchical sort of structure” “You can take a scrub nurse off a case that is nearly finished and that nurse can start setting up for the emergency. At that stage the surgeon can help themselves to the instruments
Anticipatory planning and action	Charge nurses typically visit TRU and PACU at the beginning of shifts for informal status reports there. Staff and equipment are routinely shared across these areas and related areas in times of stress, for example an autoclave broke down over night so that equipment for the next day could not be cleaned. Equipment was borrowed from another OR while the autoclave was being fixed
Multiple layers of awareness	“so you walk through the Trauma Resuscitation Unit (TRU) and Post-anesthesia Care Unit (PACU) and loiter by the OR control design and look at where everyone is and what procedures we’re doing” “you walk around the corridors. I’ll see one of my colleagues and mention that there’s an interesting patient that we might be getting or they’ll tell me. When we’re milling around I say ‘where was that admission’” “every other week I do the discharge rounds. So when I’m in charge I talk to the discharge rounds person so I know what the bed status is outside the SU” As the in-charge I’m know what’s going on in the OR and the other Units. Attendings have a more peripheral awareness and CRNAs are aware of the patient—it goes layers up and layers down”
Controlling communication	“I have a beeper and a cell-phone. The other anesthesiologists only have a beeper. My beeper is like a window into every other unit. If there’s no beep everything’s OK” “So I’m in a situation where I can’t answer the beeper I’ll pass it off... I hand the beeper off to one of the others... OK you’re in charge”

sufficient resource capacity to manage patient admission variations. Three themes emerged from the schedulers’ interviews and four from the charge nurses’ interviews.

Shift scheduling involved variable shift lengths and starting times in order to create short periods of overlap when staff numbers increase. According to the schedulers’ shift overlap is used to catch up if there have been delays and to accommodate emergency arrivals. The morning charge nurse, for example, accommodated an emergency patient by opening an unstaffed room in anticipation of nurses starting at 11:00 h (see Appendix 3).

Role redundancy also increases the availability of staff resources that can be recruited during times of high demand. Neither the charge nurses nor the in-charge anaesthesiologists are allocated to work in particular

operating rooms; they are “not included in the numbers.” Similarly, attending anaesthesiologists are responsible for supervising two CRNAs, but not being engaged in the whole procedure they can be recruited as direct anaesthesia care providers. This leaves senior staff members, both nurses and anaesthesiologists, available to manage difficult situations or to temporarily help out as needed in operating rooms or in allied departments (such as resuscitation areas or post-anaesthesia care units). On-call anaesthesia and nursing staff are used in the same way to increase staff numbers during off-shifts (at night and during the weekend).

The schedulers’, the charge nurses and the in-charge anaesthesiologist engage in anticipatory planning and action behaviour. The SU planned procedure list for the next day’s procedure arrives at 15:00 h. On this basis the

afternoon charge nurses is able to assess the night shift workload and may contact scheduled on-call staff so that they are on stand-by. Both the in-charge anaesthesiologist and charge nurses adopt a broad awareness of what is occurring in departments that either admit patients to the SU (especially from the TRU), or that receive patients from the SU. A broad awareness is achieved using informal processes such as walking through and “loitering” in other departments and talking to colleagues in corridors to seek information and to prepare other staff members. Rotating responsibilities in non-operating room clinical processes also allow other staff members to build knowledge about broader hospital processes, constraints and people. Such knowledge can help senior staff to manage emergencies. A broad-based awareness allows in-charge staff members to anticipate and plan for the effects of emergency patient arrivals in the wider context beyond just the SU.

The in-charge staff also address different aspects of high demand situations. The in-charge anaesthesiologist assesses what resources (anaesthetic, surgical, post-surgical care) will be needed. In contrast, the charge nurses assess emergency arrivals in terms of when resources will be needed (how soon will the patient be here) and when resources will be available (e.g. on-call staff or rooms) based on resource availability at different times of the day (day versus night) and day of the week (weekday versus weekend).

4 Discussion

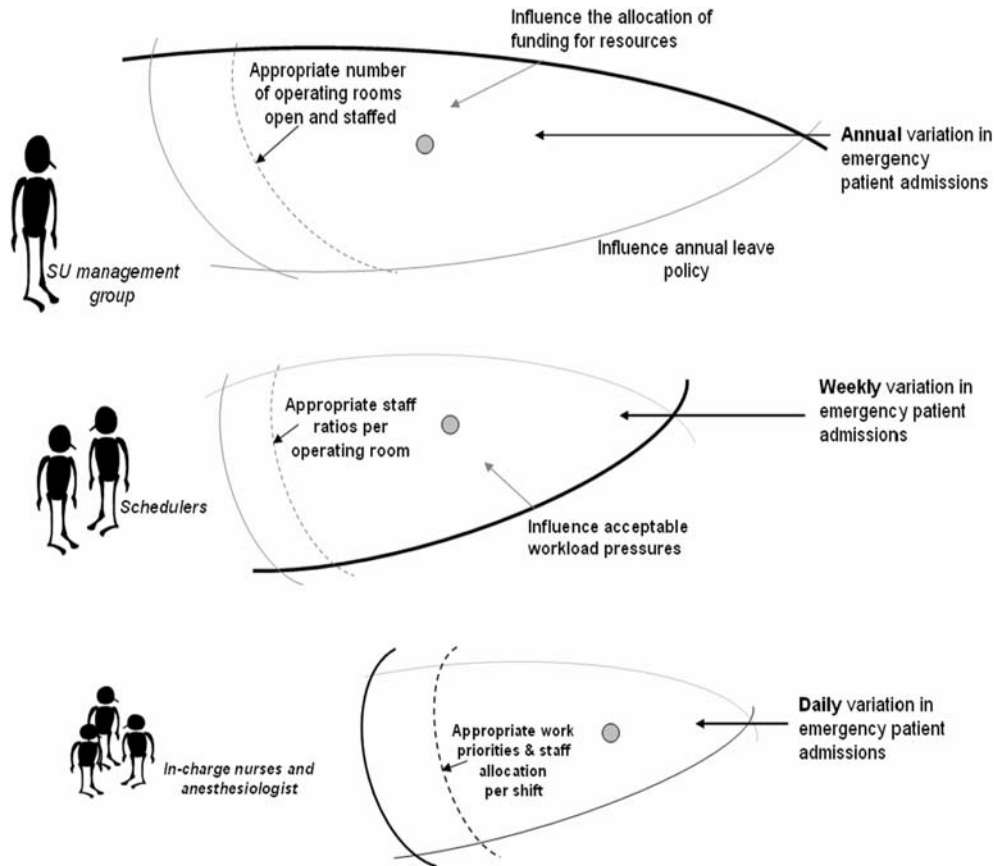
In this section the results presented above are discussed in the following subsections that allow us to (a) integrate and interpret the results; (b) suggest theoretical implications; (c) briefly consider implications for technological design and (d) outline the methodological limitations of this work.

4.1 Temporal nested, proactive management

The results presented above suggest that multiple levels of management, structured around nested annual, weekly and daily patient admission cycles, proactively maintain the marginal boundary by influencing pressures acting on it. The marginal boundary is represented by key indicators at each level. Using the safe operating envelope, Fig. 3 represents the influence exerted by three levels of management.

At the highest level in Fig. 3 the SU management group’s main priority is the overall availability of resources needed to meet annual variation in patient demand. The SU management group, through the Director’s dual role as a representative on broader hospital management committees (see Table 1), influences economic pressures that would otherwise constrain

Fig. 3 The temporally nested structure of emergency patient admissions and the organisation of work in the study SU



the number of operating rooms that can be open and staffed. The marginal boundary at this level is indicated by the number of operating rooms available in relation to emergency admissions throughout the year.

At the second management level, schedulers' influence pressures for acceptable workload by implementing flexible staff scheduling policies around weekly emergency patient admission cycles. The marginal boundary at this level of decision making is indicated by set ratios of suitably experienced personnel to staff open operating rooms. At the lowest level of management, charge nurses and the in-charge anaesthesiologist work at the marginal boundary directly by coordinating daily resource allocation and the distribution of work given daily patient admission cycles.

The three levels of management maintain the marginal boundary to optimise the risk of unacceptable performance which as pointed out by Fatovich et al. (2005) and others is measured by indicators associated with delay. However, as shown in Fig. 4, the three levels of management also affect the strategies that can be enacted to meet or buffer high demand periods. These strategies or buffering capacities and the extent to which they are enacted constitute the marginal zone.

As represented in Fig. 4, at the level of the SU management group the marginal zone involves the ability to open and close operating rooms and to restrict staff annual leave at particular times of the year. Not only does this strategy represent a longer-term (annual) buffering capacity, it also takes considerable time to develop the capacity especially if specialist staff members need to be recruited.

Schedulers have a range of buffering strategies at their disposal. The presence of experienced specialist

staff who can respond effectively and efficiently are critical to effective SU operations and retaining them through flexible scheduling policies is a major priority. Flexible scheduling also includes the preparation of on-call and overtime lists and the use of part-time and per diem staff who create a pool of "stand-by" resources. In addition, overlapping shift schedules expand resources at critical times during the day.

Most high demand periods occur with some forewarning. Role redundancy allows in-charge staff to monitor the state of demand in departments from which they receive patients. This behaviour facilitates preparatory planning: "When is the next shift due to start?", "When will the next procedure be finished?," "What cases can be rescheduled?," "Do we need on-call staff?" Forewarning gives operational managers time to draw on buffers so that available resources match actual patient care demands.

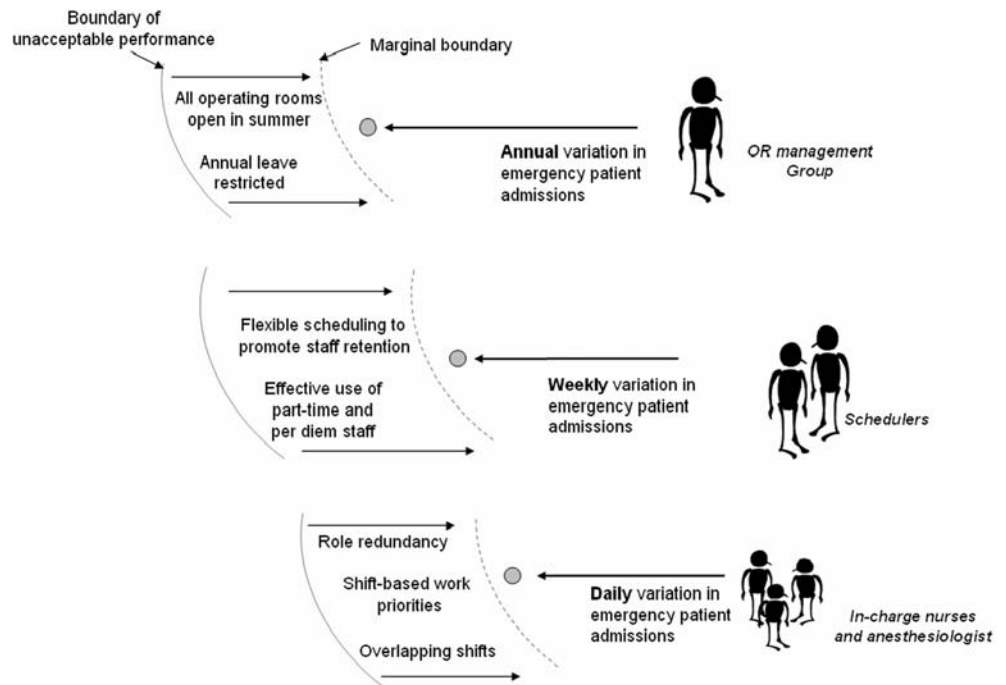
4.2 Theoretical implications

The observations made in the previous section have several theoretical implications. These will be discussed in two subsections: (1) Implications for the safe operating envelope and (2) Implications for compensation, decompensation and resilience.

4.2.1 Implications for the safe operating envelope

The results of this study suggest that the safe operating envelope model is an adequate framework for identifying multi-level strategies for adaptive behaviour. In the

Fig. 4 Temporally nested buffers in the SU work system



SU, three levels management influence different pressures and each level creates buffering capacities over time scales that are aligned with patient admission cycles. The levels of management were represented using three hierarchically related envelopes as shown in Figs. 3 and 4.

The influence of temporally nested variations in patient demand for services was an unexpected outcome of this study. Initially, data coding commenced by categorising patient demand as a workload pressure. However, it quickly became apparent that patient demand was a more complex influencer of organisational behaviour than initially anticipated (see Table 2). Furthermore, themes associated with acceptable workload tended to be associated with staffing levels, scheduling and attrition; themes internal to the SU that are qualitatively different from patient demand. Thus as presented in Tables 2, 3, 4 and 5 and represented in Fig. 3 patient demand was separated from other pressures but was difficult to locate within the safe operating envelope.

In healthcare, patient demand is an uncontrolled variable determined by external social, economic and environmental factors. A hospital's primary purpose is to care for patients as and when they present. Thus the levels of management identified in this study appear to have evolved in response to annual, weekly and daily cycles of patient demand. SU managers may not be able to influence patient admissions but, anticipating patient demand variations, they can influence or control organisational responses.

Rasmussen (1997) maintains that higher levels of management constrain lower levels. This view is supported by the results of this study. The SU management group's decisions about open operating rooms constrain the overall resources that are available to manage demand at any time and weekly on-call and overtime rosters determine the resources that can be called upon on any particular day. However, Rasmussen's (1997) constraint-based framework involves system modelling based on structural decomposition and functional abstraction; the effects of temporal factors are not readily apparent. One simple approach may be to substitute temporal decomposition for structural decomposition given that management structures appear to align with temporal scales. This suggestion warrants further investigation.

4.2.2 Implications for compensation, decompensation and resilience

In this paper's introduction we argued that the marginal zone represents a zone of compensation and further that resilience might be measured.

The first issue in measuring resilience is to identify the marginal boundary. As given previously, each level of management aimed to provide resources appropriate to anticipated cycles of patient demand: appropriate numbers of operating rooms open during the months of

the year and appropriate staff ratios for each operating room during the week and during the day. These indicators represent marginal boundary; when these objectives are met the risk of unacceptable performance is minimised. However, patient demand may increase beyond anticipated levels at which point compensatory strategies are employed.

Compensatory strategies minimise the likelihood of operating state migration across the boundary of unacceptable performance. As shown in Fig. 4 each level of management in the SU developed and maintained compensatory buffers that could be called upon in periods of high demand to keep the system's operating state in the low-risk zone. The states of compensatory mechanisms are measurable: numbers of on-call staff, numbers of staff available for overtime, staff attrition and sick leave, and so on relative to patient demand.

Woods and Cook (2006) maintain that decompensation occurs when buffering mechanisms have been exhausted. Decompensation events were not observed during this study, however, on the basis of Figs. 3 and 4 and past research two types of decompensation can be defined. Fatovich and Hirsch (2003), Fatovich et al. (2005) and Cook and Rasmussen (2005) each describe situations involving bed gridlock where patient demand for services exceeds available resources for relatively short periods of time. As buffer systems are enacted either by redistributing patients to other departments or hospitals (going on bypass) or because on-call staff arrive patient queues reduce and demand-capacity mismatches resolve. Decompensation, the elevated risk of unacceptable performance, is relatively short-lived. Based on a similar concept used in medicine to describe short-term intense illness episodes this form of decompensation may be referred to as *acute decompensation*; defined as the short-term exhaustion of compensatory mechanisms. Referring to Figs. 3 and 4, short-term decompensation is most likely to affect lower levels of management.

Acute decompensation events are contrasted against chronic decompensation events such as those presented by Davies (2005) in his analysis of the deaths of patients at Bundaberg Hospital in regional Australia. In this situation long-term lack of funding resulted in the lack of appropriate staffing resources. This in turn led to poor morale, high staff attrition rates and a culture of tolerance of sub-standard performance at operational levels all of which resulted in patient harm. Chronic decompensation involves the long-term erosion of buffering capabilities at all levels of management and may be measured by the state of buffering capacities relative to patient demand within the management structure as a whole.

On this basis organisational resilience may be assessed first, by evaluating the appropriateness of indicators representing the marginal boundary relative to demand patterns. Patient queues and waiting times, the frequency of bed gridlock, as well as the incidence of

adverse patient events may suggest that the marginal boundary has been set too close to the boundary of unacceptable performance. Second, resilience may also be assessed by the existence and state multi-level buffers.

4.3 Implications for technological design: awareness promoting artefacts

The discussion above suggests two sets of implications for technological design to support work management. First, by representing marginal boundary indicators relative to temporal cycles of patient demand managers may be able to better assess the operational state of work systems such the SU. Such displays should also include or enable the assessment of the state of capacity buffers at all levels of management. This study has also been a first step in determining the types of information and information relationships that need to be displayed. With the targeted capture and display of such information appropriate algorithms may be developed that would better support the anticipatory decision making and projection that is central to resource management.

Second, technological design could be used to better support managerial performance within each level. In this respect several design goals can be articulated as follows:

The temporal life of artefacts was aligned with decision making lifetimes. Each level of management maintained artefacts appropriate to the time scales over which decisions were made. The SU management group used printed graphs covering at least the last 5 years of monthly admission and financial data. The schedulers' artefacts (wall charts and request books) covered weekly to monthly time scales and the charge nurses' artefacts (the whiteboard) covered only 1 day.

Artefacts at each level of management supported different modes of social interaction. The SU management group's decisions were made during monthly face to face meetings and involved longitudinal comparisons among complex data. Schedulers' information representations supported person-to-person interaction and negotiation in informal settings. Artefacts and the schedulers' behaviour reinforced broader social values such as the importance of staff life-style preferences. The central location and visibility of the charge nurses' white board supported this centralised role and as noted by Xiao and Seagull (2006) reduced effort and simplified workflow.

As well as supporting tasks, artefacts supported role-based responsibilities and to this extent represented "artefacts of office." The schedulers and charge nurses, for example, were solely in-charge of creating and making changes to official schedules and the OR whiteboard. Thus clear distinctions need to be made between "official" artefacts that can be changed by specific role holders and artefacts that can be modified by others.

4.4 Methodological limitations

This study represents a first study involving an assessment of managerial decision making using the safe operating envelope as a theoretical basis for exploration. On this basis it is not without its limitations. For example, in the course of the study data collection methods were adopted based on the findings of previous methods. Hence a range of mixed methods were used for data collection. Ideally a standardised data collection approach would have been preferred, however, this may be difficult given variation in the timescales over which management decisions are made. Despite differences in the data collection methods the elements within the safe operating envelope provided a standardised framework for aggregating the thematic content of the interviews.

Affinity diagramming (Beyer and Holtzblatt 1998) was chosen as an appropriate process for grouping themes. This choice of method was based our lack of knowledge about what the operational definitions of the elements of safe operating envelope should be in relation to the SU. To have operationally defined these elements prior to data collation may have imposed preconceived ideas on the data. The discussion between researchers associated with thematic grouping allowed preconceived ideas to be expressed and explored. The difficulty associated with grouping patient demand was identified during such discussion. In order to ensure transparency of process extensive appendices have been provided so that readers may assess the outputs of this process for themselves. In future studies operational definitions may be defined that would serve as a basis for an inter-coder reliability study.

5 Conclusion

In conclusion, the purpose of this study was to identify the strategies that hospital staff use to respond adaptively to high demand pressures. Rasmussen's (1997) safe operating envelope served as a useful basis for exploring adaptive management behaviour and also provided insights related to compensation, decompensation and resilience.

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Appendix 1. Representative quotations: Director's interview

Table 7.

Table 7

Safe operating envelope	Representative comments	Associated artefact
Demand	<p>“Total admissions tend to vary on a seasonal basis with increased admissions during the summer and reduced admissions in the winter”</p> <p>“Higher emergencies in summer mean more cases to the OR”</p> <p>“This patient was building up for a couple of days”</p> <p>“This was complex spinal surgery—it was going to take 5–6 hours”</p> <p>“This procedure required specialist equipment”</p>	<p>Annual patient admission and room utilisation statistics.</p> <p>Monthly admission and type of patient statistics</p>
Pressure for acceptable workload	<p>“Remembering the previous case...the same type of gradual deterioration...recognising the problem early saves a lot of time”</p> <p>“This catheter was put in at another hospital—its shorter and fatter—so we left it in. Ours are much longer but thinner. The shorter one allowed better access, even though it proved to be problematic later”</p>	–
Pressure for efficiency	<p>“We have maximum utilisation of STC capacities over the summer months”</p> <p>“Operating rooms are closed and we need less staff during the winter”</p>	Annual and monthly admission and type of procedure statistics
Maintaining the marginal boundary	<p>“We deal with this in orientation. One of the things they have to learn is to maintain broad attention when exciting events are going on”</p> <p>“You need a broad understanding of what the state of every anaesthesiologist is”</p> <p>“The case starts with the attending anaesthesiologist covering two rooms and the CRNA doing a routine anesthetic”</p> <p>“The CRNA consults the attending who becomes aware of the issues and at that point consults the anaesthesia charge person—that’s me”</p> <p>“This case was expected to be a long case and we needed specialists. We needed time to prepare and so we scheduled it for Tuesday which is a quiet time of the week”</p> <p>“You have to know who else is on: what their skills and experiential base is, what they’re doing”</p> <p>“The CRNA is with the patient the whole time. The anaesthesiologist is only there for critical portions—take offs and landings”</p>	
Pressures on acceptable performance	<p>“OK things aren’t going right. I said to the surgeon time to wrap it up”</p>	

Appendix 2. Representative quotations: Schedulers’ interviews

Table 8.

Table 8

Safe operating envelope	Theme	Associated artefact
Demand	<p>“The SU committee determine how many rooms we need to run during the week, during the weekends, during night and holidays and I guess they use historical data”</p> <p>“Summer months are busier but sometimes there are milder winters when we’ve been just as busy, so its weather dependent as well as seasonal”</p> <p>“In the last two or three weeks of the year we don’t allow anyone to take leave”</p> <p>“We can only have 2 people on leave for June July September and October, [summer], but in the winter months we can have three people on leave”</p> <p>“Monday and Friday are the busiest times. There’s lots of cases on Mondays left over from the weekend and on Friday, the beginning of the weekend you want to get things off the board so they can handle what ever comes in on Saturday and Sunday”</p> <p>“So its April they want to run six rooms from 0700 to 1900 on Monday, Wednesday and Friday and they want five rooms on Tuesday and Thursday from 0700–1900 and then at 1900 they want three rooms until 2300 and from 2300–0700 they want two rooms. On the weekends they want three from 0700–1900 and two rooms from 1900–0700”</p> <p>“A lot depends on the cases you have. Trauma is unplanned and a lot of these people have pre-existing illnesses or injuries. If you were going for a planned procedure they’d work you up find out all about you”</p> <p>“All cases start at the same time but not all procedures finish at the same time. Some take 45 minutes some take 9 hours. So staff are constantly becoming available. The next room finishing will take the emergency”</p>	<p>Wall calendar for vacation. Monthly schedule (paper chart). OR white board</p>

Table 8 (Contd.)

Safe operating envelope	Theme	Associated artefact
Pressure for efficiency	<p>“Here we use a combination of nurses and technicians. You can have two registered nurses or one registered nurse and one technician per room”</p> <p>“Per diem and contract staff only work 0.8 full time equivalent”</p> <p>“We don’t want nurses to work more than 40 hours per week—it’s the overtime and it’s the financial cost. So I have to make sure nobody works more than 40 hours per week”</p>	
Pressure for acceptable workload	<p>“Attrition is a problem. Its 365 days per year plus nights, holidays and weekends. So people who like this like it and they’ll stay versus someone who’ll come for a taste... this is way too hard, I don’t like it and move on”</p> <p>“Flexible rostering. It relates to lifestyles. We have a policy of giving them what [schedules] they want. In seven years I’ve only told two people no. We do deals. If someone wants something they have to give something up. If you have the winter holidays then you work the summer. People have different value propositions, what’s important to me might not be to you. We only roster one month in advance, because people don’t know what they’re doing, and if someone leaves you have to redo it. Some people have military service or you want to go to a wedding and the number of rooms open can change”</p> <p>“Per diem staff only work off-shifts, nights and weekends, not during the week during the day when everyone else wants to work. But I really never know how many shifts these people are going to work these people also prevent us from doing a 3–6 month schedule”</p> <p>“Residents are in training so we don’t include those in the schedule. Our nurse manager is here every week day but she’s not included in the roster”</p> <p>“We also have on-call but it’s voluntary. If the shifts aren’t covered then people will have to be assigned”</p>	<p>Request book</p> <p>Holiday schedule</p> <p>Monthly schedule</p> <p>Monthly schedule</p> <p>On-call list</p>
Maintaining the marginal boundary	<p>“In this SU we’re not service oriented. We don’t have a plastics team or an ortho-team. Everyone does everything so your knowledge base is broad. You have to be able to function”</p> <p>“We never meet the target numbers for all the shifts because we just don’t have the people, hence we have two of three pages of overtime”</p> <p>“There’s always something to do, cleaning or maintenance. Post-ops or pre-ops. You can go up to the floor, help out in TRU”</p> <p>“We always have an experienced anaesthesiologist. On Saturday there might be two residents but you need someone there with experience”</p>	
Boundary of acceptable performance	<p>“Staff have to know what the rostering rules are. You can’t have someone working 60 h and they can’t post overtime before or after a shift. You have to be awake, you can’t afford to be sleepy. We’re not allowed to sleep on night shift”</p> <p>“We have 18 Full-time CRNAs but 5 are in another part of the hospital. About 25% of our current CRNAs are new, straight out of school. So its important to bring them up to speed as soon as possible”</p> <p>“There’s one CRNA per room and you can have one resident and a CRNA but not two residents. And there’s the anaesthesiologist. So on nights we have two CRNAs or one CRNA and a resident and the attending anaesthesiologist. There has to be at least two people to run a room between 2300 and 0700”</p> <p>“For nurses you need two people per operating room, one nurse and one technician or two nurses. Occasionally there are cases where they’ll double team: where one team will work on one part of the body and another team on another part. Here you have one instrument nurse, one circulating, one technician and they’re run off their feet”</p> <p>“We’re two nurses below target so I’ll post overtime. If no-one signs up then we cannot run the rooms. It was four rooms Monday to Friday but they put it up to five and it’s going to six”</p>	Overtime book

Appendix 3. Representative observations and quotations: Charge Nurses' (CN) interviews

Table 9.

Table 9

Safe operating envelope	Theme	Associated artefact
Demand	<p>At 07:35 h a surgeon is coming in to look at an emergency patient with a torn sub-clavian artery. At 07:40 h, CN checks that blood is available for the patient</p> <p>At 14:40 h a surgeon asks about an add-on patient (unplanned, non-emergency); informed that that this won't start for at least another 3 h. Add-ons usually don't go ahead after 19:00 h</p> <p>Calls ward for patient but patient in angiography. Arranges for direct transfer from angiography to SU</p> <p>At 21:50 h resident comes to check if there are any weekend planned patients</p> <p>At 23:30 h OT is notified by TRU that a motor vehicle accident casualty will arrive in the TRU in 15 min</p>	OR white board
Pressure for efficiency	<p>At 08:35 h room 6 is being held for an emergency patient. The room 6 patient is reallocated to room 5 which is about to finish</p> <p>07:30 h The patient for room 4 isn't ready, so the next patient is called</p> <p>Next planned patients are called from the wards approximately 30 min before their procedure is expected to start. Porters are notified to collect the patient</p>	OR white board
Pressure for acceptable workload	<p>At 09:30 h a second patient is added-on and another add-on patient is rescheduled to another SU</p> <p>Using the beeper, TRU staff alert the OR about impending emergency admission allowing the OR CN to warn staff and to arrange on-call staff as needed</p>	On-call list
Maintaining the marginal boundary	<p>At 07:50 h RN sent to find out about the emergency patient returns—surgeon is still coming in and others are discussing doing multiple procedures simultaneously</p> <p>At 10:15 h CN decides to open room 1 which was closed and starts setting it up so that the nurses coming on at 11:00 h can start the emergency patient. Once started, room 6 will close</p> <p>Between 15:00 and 16:00 h SU is given the planned surgical list for the next day. Any cases that are requested after 15:00 h become add-ons unless they are emergencies. Non-urgent add-ons are the first to be cancelled</p> <p>CN walks through TRU checking each bay and the arrivals notification board. Nurses have cleaned and prepared rooms 1 and 2 for night time surgery</p> <p>Night staff are responsible for cleaning, maintenance and getting instruments ready for the next day's cases</p> <p>TRU staff call on attending anaesthesiologist for a minor anaesthetic there</p> <p>Equipment is borrowed from other SUs in the case of breakdown of failure, e.g. autoclave breakdown</p>	OR white board
Boundary of acceptable performance	<p>At 07:30 h CN holds room 6 for the emergency patient. Patients are redistributed to other rooms</p> <p>At 08:15 h, nurse tells CN that water is leaking through room 5. Calls maintenance</p> <p>At 09:45 h, emergency patient is ready but no staff. Patient has waited during tests since 07:30 h and no longer considered that urgent</p> <p>The morning CN focussed on completing the planned cases. The afternoon charge nurse focused on completing any non-scheduled cases as long as these weren't likely to run past 19:00 h. The afternoon charge nurse also assessed the need for on-call staff. The night shift charge nurse focused on preparing for the next morning's cases</p>	

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