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Improving decision making in acute health care through implementation of an ICU intervention: a multi method study

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Manuscripts

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3 **Improving decision making in acute health care through implementation of an ICU**
4 **intervention: a multi method study**
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Abstract

Objective

To evaluate the implementation of an ICU intervention, designed to establish rules for making ICU decisions about post-surgery beds.

Design

Pre/post intervention case study using a multi-method approach, involving two phases of staff interviews, process mapping, and collection of audit data.

Setting

ICU in a 700 bed regional tertiary care hospital in Australia.

Participants

31 interview participants, drawn from three groups of staff: bedside nursing staff in the ICU, ICU specialist doctors, and senior management staff involved in oversight of ICU operations.

Intervention

Implementation of an ICU Escalation Plan, and introduction of a multidisciplinary morning meeting to determine ICU status in accordance with the plan.

Main outcome measures

Interview data consisted of pre-intervention staff perceptions of ICU workplace cohesiveness with bed pressure, and post-intervention staff perceptions of the Escalation Plan and ICU performance. Audit data consisted of bed status (red, amber or green), monthly number of planned elective surgeries requiring an ICU bed, and monthly number of elective surgeries cancelled due to unavailability of ICU beds.

Results

Improved internal communication, decision-making and cohesion within the ICU, and better coordination between ICU and other hospital departments. Significant reduction in elective surgeries cancelled due to unavailability of ICU beds, $X^2_1=24.9$, $P<.0001$.

Limitations

Data from a single ICU case may limit the generalisability of the findings. The chosen methodology, however, facilitates a deeper understanding of why the intervention worked, which may be utilised to translate findings to other hospital environments.

Conclusions

By establishing rules for decision-making around ICU bed allocation, the intervention improved internal professional relationships within the ICU and between the ICU and external departments, and reduced the number of elective surgeries cancelled.

Strengths and limitations of this study

- This is a multi method study, which allows us to understand why the intervention worked in addition to how well it worked

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- Data from a single ICU case may limit the generalisability of the findings
 - Drivers of patient population other than elective surgery that impact ICU bed capacity (such as Emergency Department factors) were not considered as part of our study

For peer review only

Improving decision making in acute health care through implementation of an ICU intervention: a multi method study

Introduction

Targets to reduce elective surgery waiting lists are prevalent in OECD countries,^{1,2} and various interventions have been explored to reduce waiting times.³ In Australia, although the National Elective Surgery Target (NEST) is an important component of hospital performance measurement,⁴ median waiting times for elective surgery have increased by around 2% per year over the five years.⁵ As the population ages, more patients require access to high levels of care following surgery to assist their recovery;⁶ the increasing demand on Intensive Care Unit (ICU) beds places pressure on ICU clinicians and managers, and has been shown to adversely impact patient safety.^{7,8}

In a busy, high-functioning, regional 700 bed tertiary care hospital in Australia, frequent late decisions to cancel elective surgery at short notice, due to lack of ICU beds, resulted in poor interdepartmental relations with Emergency and Surgery departments, and overt conflict between clinicians in the ICU. This conflict between departments called for a positive approach that could improve an already well performing unit, rather than a traditional approach of investigation of failure, such as Root Cause Analysis (RCA). Safety in healthcare remains problematic despite concerted efforts to understand why errors occur and to place protective barriers in place.⁹ A new concept focusing on organisational resilience¹⁰ has the potential to improve patient safety by reversing the focus from being problem centric, to looking at ways to improve functioning through positive measures which enhance system performance under all conditions. A resilient system can allow safety to occur even at 'the edge of chaos', when the system is strained beyond equilibrium.¹⁰ In the ICU, there can be large and unexpected variation in requirement for beds yet the cost of resources required to maintain continuous capacity for peak load are unduly prohibitive. Research conducted internationally has shown potential for improved decision-making and efficiency through planning and fostering resilient behaviour traits.¹¹

Description of the intervention

Resilient thinking principles¹² were used to develop and implement a process to establish rules for making ICU decisions about post-surgery beds, and to improve relationships between the two departments. Prior to the intervention, the ICU had satisfactory performance metrics in comparison with similar hospitals, when measured in terms of Length of Stay (LOS), mortality, bedside handover, Australian and New Zealand Intensive Care Society (ANZICS) Adult Patient Database comparative performance, and trainee performance. The intervention consisted of implementation of an ICU Escalation Plan (overview at Figure 1; detail, including clinician roles and responsibilities, at Appendix 1), and introduction of a multidisciplinary morning meeting to determine ICU status in accordance with the plan.

Figure 1. The ICU Escalation Plan

<insert Fig 1 here>

Method

The aim of the study was to evaluate the implementation of the ICU intervention. The study used a multi-method approach, involving two phases of staff interviews, process mapping, and collection of audit data. Process mapping was completed using the Functional Resonance Analysis Method (FRAM), and is reported elsewhere.¹³

Phase 1 early implementation semi-structured interviews were conducted to collect staff perceptions of ICU workplace cohesiveness with bed pressure. Interview participants were drawn from three groups of staff: bedside nursing staff in the ICU, ICU specialist doctors, and senior management staff involved in oversight of ICU operations. Phase 2 interviews were conducted to collect post-implementation staff perceptions of the plan and ICU performance. Interview participants were drawn from four groups of staff: bedside nursing staff in the ICU, ICU specialist doctors, staff from Surgery and Emergency departments, and senior management staff involved in oversight of ICU operations. Staff members from Surgery and Emergency departments were included in the Phase 2 interviews to provide additional insight into how the Escalation Plan was perceived by those who interfaced regularly with the ICU.

Standard ICU audit data that are currently collected were obtained for the 11 months pre-intervention, and 12 months throughout and post-intervention. Only non-identifiable, aggregate data were obtained. Audit data consisted of monthly number of planned elective surgeries requiring an ICU bed, and monthly number of elective surgeries cancelled due to unavailability of ICU beds. During, and post-intervention, data were also collected on whether the bed status was at 'red', 'amber' or 'green'.

Qualitative Analysis

Inductive interpretive analysis¹⁴ of transcribed interviews was undertaken to identify key themes relating to the implementation of the Escalation Plan. Inductive interpretive analysis does not set out to test an hypothesis, but instead seeks to produce an understanding of a phenomenon including how it is influenced by context and surrounding social constructs. Coding the data allows it to be organised and used to explore connections between data elements and to develop sets of concepts. Once coded, segments of data can be linked in a formal fashion to allow themes to emerge and to determine relationships that may exist between different data sets. This is a way of studying real world complex systems such as healthcare.

Quantitative Analysis

Exploratory statistical analysis was conducted on ICU audit data. On the advice of a biostatistician, chi-square analysis was chosen as the optimum method to compare the percentage of surgeries cancelled each month to the percent of non-cancelled

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3 surgeries by month, before and after implementation of the intervention. Pre and
4 post categories were compared with the data aggregated for all pre and all post
5 months.
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8 **Results**

9 *Qualitative - Phase 1*

10 In phase 1, 12 hospital staff participated in semi-structured interviews approximately
11 two months after the plan commenced operation. Participants consisted of four
12 doctors, four allied health professionals or nurses, and four managers. Interviews
13 were digitally recorded and professionally transcribed. Interview length averaged 26
14 minutes (range 11-50 minutes). Data were coded by two researchers (RC-W, BB) and
15 discrepancies resolved via discussion.
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18 Three themes emerged from inductive analysis: perceptions of the plan, benefits of
19 the plan, and processes associated with the morning meeting. Within each theme
20 were a number of subthemes. Table 1 lists the themes and sub-themes, along with
21 example quotes.
22
23

24 Perceptions of the ICU plan were varied: *"It's a policy that's been written but it's*
25 *more than just a policy ..."* (Phase 1, Doctor 1) Some participants felt that the plan
26 was a behaviour contract, or agreed process that negated the need for micro
27 managing the bed state and resulted in reduced workload and fewer arguments.
28 Others felt that the plan provided consistency and transparency. The ICU response is
29 predictable, and all were aware of the big picture, which facilitated planning. It
30 provided a more structured way of operating that participants felt was likely to
31 improve patient flow.
32
33

34 The plan meant that additional ICU beds were available when on GREEN for
35 emergency or elective surgical admissions. While this was not very helpful to
36 facilitate elective surgery which often required several days notice, some saw the
37 plan as a 'gesture of goodwill', signalling to surgery a willingness to cooperate. The
38 plan also sent a signal to management that ICU are team players, and improvement
39 oriented, and demonstrated willingness to take load off other departments.
40
41

42 Others felt the plan provided them with authority to say 'no'. It was perceived by
43 some as providing a written 'line on the sand', and management endorsement of ICU
44 refusal to accept patients when full. This leveled the power gradient between the
45 ICU and surgery and between ICU and the ED, which was perceived as previously in
46 favour of Surgery and ED both of which had associated external performance targets
47 (National Elective Surgery Targets and National Emergency Access Targets
48 respectively). While not a sure fix, the plan was perceived to provide visibility of the
49 problem, and a common understanding of RED/AMBER/GREEN status. Status colour
50 could be used as a proxy for urgency or 'pay attention to my request' in a crisis.
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53 The plan was also perceived as a 'canary in the coalmine' to identify system
54 pressure. The status could be used as an indicator of proximal system operating
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point,³ and provided a record and trend information on ICU performance in meeting post-surgical needs and capacity.

Table 1. Phase 1 themes and sub-themes

Theme	Sub-theme	Example quotes
Perceptions of the plan	A behaviour contract	. “... it is meant to provide agreement across disciplines ...” (Doctor 1) “... everyone works within this policy ...” (Manager 4) “... there was almost like rules of engagement and people knew how decisions were made.” (Manager 1)
	Provides consistency, predictability & transparency	“... provide[s] guidance that’s consistent so that our response is consistent ...” (Doctor 1) “... so it’s completely clarified our entire process ...” (Manager 4) “... we wanted it to be more transparent how beds get allocated ... if we suddenly had a bus crash ... then we couldn’t do our cardiac surgery that wasn’t because we were badly organised it’s just because we don’t have that many beds.” (Doctor 2)
	Gesture of goodwill	“ I think [the Escalation Plan is] a good attempt at policy for [the] ICU ...” (Manager 3) “[on GREEN] there are [ED, ward] patients that ... might not usually come to ICU that we may admit with a lower threshold.” (Doctor 1)
	An authority to say ‘NO’	“... if we say RED is RED, and we have a ventilated patient down in the ED, and you’ve got the med super saying you need to take it ... well let’s see if this escalation policy actually works.” (AH/Nurse 3) “... it’s kind of solidified. You’ve got it in writing ...” (AH/Nurse 1) “... to have some concrete way of explaining to surgeons and surgical institute that we actually provide a service to the whole community not just post-op patients.” (Doctor 2)

	Not a fix, but provides visibility of the problem	<p>“... flow doesn’t always happen just because of the escalation plan. Unfortunately, there are still bed blocked patients because the wards are so full.” (AH/Nurse 1)</p> <p>“It provides me with evidence if we’re at capacity” (Manager 4)</p> <p>“We say we’re at RED or AMBER but I don’t know if [those outside ICU know exactly what that means] ...” (AH/Nurse 1)</p>
	A canary in the coalmine to identify system pressure	<p>“... [the plan] identifies a way of being able to describe the level of capacity pressure within the ICU ... in terms of how it manages the system and assesses the level of distress the system is under, I think that, ultimately, what you’ve got there is a safer system.” (Manager 1)</p>
Benefits of the plan	Improved teamwork & communication	<p>“I definitely enjoy working in the ICU and I think it’s nice to see a bit more ... multidisciplinary involvement.” (AH/Nurse 4)</p> <p>“The only difference [with the plan] is the [improved] communication.” (AH/Nurse 1)</p> <p>“... everyone knows where we stand.” (AH/Nurse 3)</p>
	New ways of thinking	<p>“I think the success of this ... it was able to give clinicians a different way of looking at things ... the ability to think about your system, and the safety of your system, I think is a real benefit ... What I saw was a shift in terms of the ... problem solving and some of the solution finding.” (Manager 1)</p> <p>“The idea itself is beautiful. It had to happen.” (Manager 4)</p>
Meeting processes	No sub-themes	<p>“...the nurses would go to the bed management meeting and the doctors would not know what they’d asked for, how many beds they had, how many nursing staff were available or how many people we could admit. ...” (Doctor 2)</p>

Participants identified a number of perceived benefits of the intervention, including improved teamwork and communication. These benefits manifested as better information flow, better multidisciplinary team working, and more coherent team mental models. Prior to the intervention, “...[when] we’re full to capacity ... there was no written guideline on who to notify, what order it should be in and what to do ...” (Phase 1, Manager 4). Standardised decision making led to clear ownership of

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3 problems. This resulted in less conflict within the ICU and better rapport with other
4 hospital departments, leading to improved job satisfaction for ICU clinicians.
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6 Participants also felt that the intervention resulted in new ways of thinking, including
7 moving from a 'silos' to a 'systems' viewpoint. Clinicians started to think in terms of
8 the 'system', and how patient flow is about the whole of hospital, not just the ICU or
9 Surgery or ED.
10

11 Creation of a multidisciplinary morning handover meeting at 8:00am appeared to
12 facilitate information flow and improved team cohesion. Pre-intervention, the ICU
13 Nurse Unit Manager (NUM) arrived at 7:00am, checked bed state and advised
14 Surgery prior to first operation at 7:30am. She then departed for the 8:45am hospital
15 bed planning meeting at 8:30am, passing ICU bed state information to the hospital
16 bed planning team. The ICU consultants arrived around 8:30am, and commenced
17 handover ward rounds. Decisions on ICU discharges for that day were determined
18 during the round, which may last several hours. Discharge information often
19 conflicted with the NUM's earlier determination, resulting in short notice
20 cancellation of surgeries and re-planning by the hospital bed planning team (see
21 Figure 2a and 2b). The ultimate decision to cancel a surgical ICU bed flowed from the
22 NUM to the Executive Director of the surgical department, frequently creating
23 hostility and doctor-nurse conflict.
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27 **Figure 2. ICU bed state information flow**

28 <insert Fig 2 here>
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32 Post-intervention, the ICU Nurse Unit Manager (NUM) arrived at the ICU at 7:00am,
33 checked bed state and advised Surgery so that the operating theatre could
34 commence at 7:30am. The ICU consultants arrived for the new meeting at 8:00am,
35 where the multidisciplinary team of doctors, nurses and allied health professionals
36 discussed who would be able to be discharged from the ICU that day. Decisions were
37 agreed in time to postpone any scheduled surgery, and the NUM could present up to
38 date information about ICU bed state to the hospital bed planning meeting at
39 8:30am (see Figure 2c and 2d). Ultimately, ICU bed state was a shared decision by all
40 ICU clinical staff on duty with recommendation, if required, to the Executive Director
41 of Surgery to cancel due to bed shortage.
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44 *Qualitative - Phase 2*

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46 In phase 2, 19 hospital staff participated in post implementation semi-structured
47 interviews approximately seven months after the plan commenced operation.
48 Participants consisted of eight doctors, five allied health professionals or nurses, and
49 six managers. Interviews were digitally recorded and professionally transcribed.
50 Interview length averaged 20 minutes (range 5-52 minutes). Initial coding was
51 completed by one researcher (BB) using NVivo software, themes were then grouped
52 by two researchers (BB, RC-W) and refined via discussion.
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Seven months post implementation the key improvements in cohesion and communication found during Phase 1 were further reinforced. The utility of the implementation of the ICU escalation plan in conjunction with the 8:00am morning meetings can be viewed from two perspectives: internal ICU functioning or management, and external communication with the rest of the hospital, Emergency and Surgery in particular. Table 2 lists the themes and sub-themes, along with example quotes.

Within the ICU and management, perceptions of the sustained utility of the ICU escalation plan varied from neutral to very positive. On a practical level, those who found the ICU escalation plan useful identified a variety of mechanisms for this utility including: making it easier to say 'no' when the ICU was at capacity, providing clear reference points for the concept of 'full' which were universal and not linked to bed numbers, facilitating communication with 'higher ups' about patient load and the need to transfer patients, and as a basis for more constructive conversations. Therefore the plan facilitated improved timing, clarity, unity and positivity in interdepartmental communication. References to current episodes of acute conflict were entirely lacking from the second phase interviews.

Table 2. Phase 2 themes and sub-themes

Theme	Sub-theme	Example quotes
Internal communication	Improved decision-making	<i>"I think by reducing the ad hoc nature of the decisions that makes it clearer. I think any - you know the old good fences make good neighbours. I think it helps from that perspective. I think it probably has improved our workflow. Not so much the morning meeting but the people having an idea about our bed state has improved our workflow to some degree and that helps - then they can say yes we're going to go ahead with all the surgery or we're going to can all the surgery. We had in the past where individual surgeons would come marching up and say well, I want to do my case. That's gone away, which is a very, very good thing."</i> (Doctor 2)

	Increased team cohesion	<p><i>"I think bringing the whole team together and everyone hearing the same thing, and knowing what elective surgery are and knowing what our bed capacity is - I think is a very useful thing. I think it's been good to incorporate nursing and allied health into that, as well. Just so everyone is on the same page, and in terms of a team building exercise."</i> (Doctor 1)</p> <p><i>"So we have lots of people - like the social worker comes, the speech pathologist - I think that's great. Everyone's on the same page. We never used to have that before."</i> (AH/Nurse 3)</p>
	Inbuilt teambuilding practise	<p><i>"I guess it's more of a team environment, multi-disciplinary. I think that's better for the patients we look after. So there's more of a team approach. I think communication's a lot better. Everyone seems to be on the same page more"</i> (AH/Nurse 4)</p> <p><i>"In this unit alone, we have a joint morning meeting at 8 o'clock in the morning. That's probably one of the biggest changes that's come into effect in the last year I'd say within the unit, over the 15 years I've been here. Mainly because everyone's involved, everyone knows what's happening. I think by doing that everyone's more confident with each other. That comes down then if things happen in the unit you can rely on people and you know who they are and you know what their skills and qualities and that are too."</i> (AH/Nurse 5)</p>

	Team mental model	<i>"... overall I'd say that the ICU is working well. I think they're a really cohesive team. I think the steps they've taken to try and manage that uncertainty, that being a positive thing. I think the actual putting something in place that people can own has helped with the relationship in the team, that's great. I think a lot of this is also around the difficulties of you could get the different decision depending on who was there. So having something they could all own and that people recognise this is how we manage and that the other services understand that, that helps. So I think that's certainly, I'd say they were a cohesive, well functioning team. Yes there's pressure but they manage it well."</i> (Manager 1)
General hospital context and patient flow	Improved system understanding of ICU staff	<i>"I guess it's a lot of things. We have departments that have guidelines like ED will have a four hour guideline to get a patient to a ward. So then they want to push a patient to you because that's their guideline. Rightly so, they're trying to do their job"</i> (AH/Nurse 5)
	Need for improved system understanding from other departments	<i>"Then I think the other thing is, not so much transparency because that's what everybody talks about but, more visibility so that we can understand their challenges and constraints. We're not there to fix them, but also so that they can understand ours. Because sometimes it feels like, when you're in the Emergency Department, for example, you're the fish bowl that everybody can look at but we can't see what anybody else is doing, which is a chip on the Emergency guys' shoulders sometimes, which we also need to drop. But I think it's nice to see the other person's pressures as well."</i> (Doctor 7)

	Improved external relationships	<i>“Basically what I can say to you is it's communication between the nursing director and the wards that we transfer to. It's just that network we've built up. We've realised the importance of it. It's the traffic light system that's actually helped us see that. When they see that we're at this and we don't have a lot of room to move, they will support us in taking the patients out, rather than bed blocking.” (Manager 3)</i>
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Those who found the ICU escalation plan of limited use tended to cite bed block as a major concern. Some pointed out that the plan, and the communication of the ICU status, could have little effect on patient flow at the hospital level and the demands and pressures on the ICU if those external to the ICU did nothing to address patient flow issues. Interestingly, this contextual analysis of the plan's effectiveness is in line with the hope from Phase 1, that the plan would be able to foster a more systems level analysis, rather than a 'silo' based perspective. In fact, a major theme of the interviews was hospital wide context and overall patient flow issues. Some participants discussed the pressures they were aware of other teams experiencing, demonstrating an improvement in hospital wide understanding and cohesion. Some skepticism remained in regards to how other departments functioned and the effect of the political environment on their management. While ED and elective surgery targets were often cited as potentially influencing referrals, it was also suggested that visibility of the ICU could be further improved.

In general, those who felt more positive about the plan were more involved with patient flow management rather than delivering clinical care. Some participants also discussed how the plan provided agreement on current status and gave more structure to decision making processes within the ICU. This was seen as going some way to improving the clarity and visibility of the ICU which flowed on to increasing cooperation with other department and hospital management.

One of the most significant aspects of the team meetings was increased team cohesion. One of the main mechanisms of doing so was through the building of a unified mental model through the use of the escalation plan. Interestingly, this process of needing to agree on a bed status each morning could be seen as a team building exercise in itself. The ICU now start every day with a team negotiation which brings everyone together and forces a single point of consensus and reduces potential conflict between roles and individuals. This unified position is then both the foundation for all other conversations and interaction within the team for the rest of the day, and also presents a unified voice for the team when communicating externally. The creation of a single team mental model has influenced interaction externally as well as communicating a sense of clear ownership and accountability.

Quantitative results

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3 Audit data between January 2014 and November 2015 are presented graphically
4 (Figure 3). The ICU Escalation plan commenced operation at the end of November
5 2014 (Figure 3, vertical line). Elements presented are monthly planned surgeries
6 requiring an ICU bed, and the number of surgery cancellations each month due to
7 unavailability of an ICU bed. While the number of planned surgeries varied from
8 month to month, the average number of surgeries planned did not markedly
9 increase or decrease over the data collection period (illustrated by the slope of the
10 regression line in Figure 3 being close to zero). Chi-square comparison of pre- and
11 post-intervention surgery cancellations showed a significant reduction in cancelled
12 surgeries associated with implementation of the intervention, $\chi^2_1=24.9$, $P<.0001$.
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14

15 **Figure 3. Audit data**

16 <insert Figure 3 here>
17

18
19 Data were also collected on whether the bed status was at 'red', 'amber' or 'green'
20 from the time the intervention commenced at the end of November 2014, until the
21 onsite data collection for the study concluded at the end of August 2015 (Figure 4).
22 There were no data for Saturdays or Sundays, as daily meetings did not normally
23 occur, and therefore ICU status was not declared on weekends.
24
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26 **Figure 4. ICU status data**

27 <insert Figure 4 here>
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30 **Discussion**

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32 Pre-intervention, hospital leaders were frustrated with the number of surgeries
33 cancelled by ICU staff, because these surgeries form part of the National Elective
34 Surgery Target (NEST) and are therefore a critical performance target for the
35 hospital. The immediate response to ICU-initiated surgery cancellations was that
36 more ICU beds were required to solve the patient flow problem, and that therefore
37 nothing could be done until more funding was secured. Research in the UK,
38 however, has shown that increasing ICU beds only serves to increase demand.¹⁵
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41 Using a resilience approach to develop and implement the ICU Escalation Plan
42 represented a novel approach to reducing conflict and improving function within
43 existing constraints. Early in implementation, staff within the ICU hoped that the
44 Plan would be able to: 1) increase consistency in decision making; 2) make more
45 visible the pressures within ICU; 3) give greater authority to the unit; 4) increase
46 communication within and external to ICU; 5) provide new perspectives; and 6)
47 show to other departments that the ICU was taking positive measures to reduce
48 conflict. In conjunction with the 8:00am meetings, the Plan was also designed to
49 improve the ICU workflow and communication.
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51

52 These improvements were sustained as the ICU Escalation Plan evolved, with
53 interviews seven months post implementation showing that participants within and
54 external to the ICU still saw the Plan as improving workflow and communication.
55 Even those for whom the plan seemed to have limited effect tended to cite some
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3 benefits and viewed the problems as system wide constraints – demonstrating a
4 higher level of hospital wide cohesion and a reduction in ‘silo’ thinking. This was
5 reflected in the major themes of the second interviews which, after communication,
6 were patient flow and general hospital context.
7

8
9 Although other studies have found that teamwork interventions, including bed
10 planning meetings, result in improved ICU performance,^{16 17} our study is able to
11 provide explanatory detail. Unlike many team building activities, the ICU escalation
12 plan and morning meetings have resulted in a daily reinforcement which likely suits
13 healthcare more than typical team building activities which are once off and often
14 take staff out of the workplace context. In healthcare, shifts, workload, staff
15 availability and job competence are crucial issues. Team building activities which
16 would require staff to be off-site or occurred only once would likely miss many
17 critical members, not evolve with changing staff over time and therefore dissipate.
18 The morning meetings in ICU are able to capture all new staff, occur without fail, are
19 inclusive of all roles and therefore can offer more persistent resilience.
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22 Benefits of the intervention were reflected in the audit data in terms of reduced
23 surgery cancellations due to unavailability of ICU beds, despite monthly average
24 planned surgeries remaining consistent. It interesting to note, however, that the ICU
25 status still reached RED on occasion after the plan was introduced. It appears from
26 the interview data that, although the bed status was declared RED at the morning
27 meeting, rather than cancel surgery, ICU staff worked with the hospital bed planning
28 team to free up ICU beds for when surgery concluded later in the day. It was also
29 rare, particularly by early May 2015, when the plan had been in action for a few
30 months, for the ICU to remain on RED for more than a single day. This may be an
31 indication that the new process facilitated resilience and rapid recovery from
32 unexpected or challenging events. The daily ICU status provides an additional metric
33 that (1) gives an indication of proximity to the safety boundary for the unit, and (2)
34 allows more transparency for when extra bed resources are required.
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38 The new ways of working seem likely to be sustainable: during the post-intervention
39 interviews, it was not recognised as an intervention but rather it is now accepted as
40 ‘how we do things around here’. In some ways, the plan was as much a device to
41 improve cohesion as a plan for improving bed flow. In addition, there is now peer
42 group pressure to attend the 8:00am meeting, as it is a ‘norm’ for the unit.
43 Therefore, although not everyone liked the ICU Escalation Plan and morning
44 meetings, no one interviewed suggested their cessation.
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46

47 *Limitations*

48 While the Phase 1 interviews were completed early in the intervention period, when
49 recollections of pre-intervention behaviours were still fresh, we do not have
50 interview data prior to commencement of the Escalation Plan and it is hence
51 possible that the early interviews were coloured by staff experiences during the
52 implementation process. In addition, other drivers of patient population that impact
53 ICU bed capacity, such as Emergency Department factors, were not considered as
54 part of our study. Data from a single ICU case, particularly where the intervention
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was tailored to address the specific problems encountered by that ICU, may limit the generalisability of the findings. The chosen methodology, however, where behaviour is researched along with quantitative outcome data, facilitates a deeper understanding of why the intervention worked. This understanding may be utilised to translate findings to other hospital environments.

Ethics approval

Ethics approval for the study was obtained from XX Human Research Ethics Committee (HREC/14/QTHS/117).

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Competing interests statement

The authors have no competing interests to declare.

Authors' contributions

RC-W, PL, SS and AJ contributed to the conception and design of the study; RC-W and BB collected, analysed and interpreted the study data; RC-W and BB drafted the manuscript, and PL, SS and AJ revised it critically for intellectual content; all authors approved the final version of the paper.

Data statement

Data available from the corresponding author on request.

References

1. Reddy S, Jones P, Shanthanna H, et al. A Systematic Review of the Impact of Healthcare Reforms on Access to Emergency Department and Elective Surgery Services: 1994–2014. *International Journal of Health Services* 2017:0020731417722089.
2. Siciliani L, Moran V, Borowitz M. Measuring and comparing health care waiting times in OECD countries. *Health Policy* 2014;118(3):292-303.
3. Ballini L, Negro A, Maltoni S, et al. Interventions to reduce waiting times for elective procedures. *The Cochrane Library* 2015
4. New South Wales Agency for Clinical Innovation. National Elective Surgery Targets (NEST) 2014. <https://www.aci.health.nsw.gov.au/resources/surgical-services/delivery/predictable-surgery/10>, accessed 20 June 2018.
5. Australian Institute of Health and Welfare. Australian hospital statistics (2016-2017): elective surgery waiting times 2018. <https://www.aihw.gov.au/reports/hospitals/ahs-2016-17-elective-surgery-waiting-times/contents/table-of-contents> accessed 20 June 2018.

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- 3 6. Etzioni DA, Liu JH, Maggard MA, et al. The aging population and its impact on the
- 4 surgery workforce. *Annals of Surgery* 2003;238(2):170.
- 5 7. Adhikari NK, Fowler RA, Bhagwanjee S, et al. Critical care and the global burden of
- 6 critical illness in adults. *The Lancet* 2010;376(9749):1339-46.
- 7 8. Tarnow-Mordi W, Hau C, Warden A, et al. Hospital mortality in relation to staff
- 8 workload: a 4-year study in an adult intensive-care unit. *The Lancet*
- 9 2000;356(9225):185-89.
- 10 9. Runciman WB, Hunt TD, Hannaford NA, et al. CareTrack: assessing the
- 11 appropriateness of health care delivery in Australia. *Medical Journal of*
- 12 *Australia* 2012;197(10):549.
- 13 10. Cook R, Rasmussen J. "Going solid": a model of system dynamics and
- 14 consequences for patient safety. *Quality & Safety in Health Care*
- 15 2005;14(2):130.
- 16 11. Paries J, Lot N, Rome F, et al. Resilience in Intensive Care Units: the HUG case. In:
- 17 Hollnagel E, Braithwaite J, Wears R, eds. Resilient health care. UK: Ashgate
- 18 Publishing Limited 2013.
- 19 12. Hollnagel E, Braithwaite J, Wears R. Resilient health care. Surrey, UK: Ashgate
- 20 Publishing Limited 2013.
- 21 13. Clay-Williams R, Hounsgaard J, Hollnagel E. Where the rubber meets the road:
- 22 using FRAM to align work-as-imagined with work-as-done when
- 23 implementing clinical guidelines. *Implementation Science* 2015;10(125)
- 24 14. Denzin NK, Lincoln YS. Strategies of qualitative inquiry, 4th Edition. US: Sage
- 25 2013.
- 26 15. Sadique Z. An Examination of the Capacity-Utilisation Relationship in United
- 27 Kingdom (UK) Intensive Care Units (ICUs) Between 2001-2011. B102 Novel
- 28 approaches to understand and improve health outcomes UK: ATS
- 29 Journals:A3700-A00.
- 30 16. Jain M, Miller L, Belt D, et al. Decline in ICU adverse events, nosocomial
- 31 infections and cost through a quality improvement initiative focusing on
- 32 teamwork and culture change. *Quality & Safety in Health Care*
- 33 2006;15(4):235-39.
- 34 17. Ryckman FC, Yelton PA, Anneken AM, et al. Redesigning intensive care unit flow
- 35 using variability management to improve access and safety. *The Joint*
- 36 *Commission Journal on Quality and Patient Safety* 2009;35(11):535-43.
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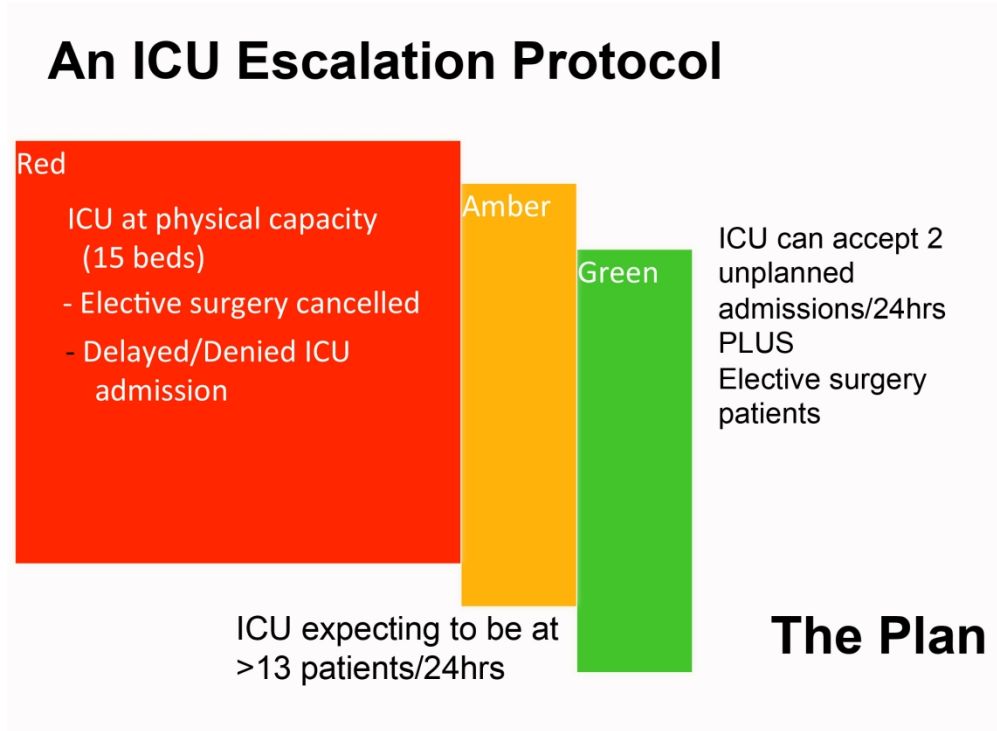


Figure 1. The ICU Escalation Plan
183x134mm (300 x 300 DPI)

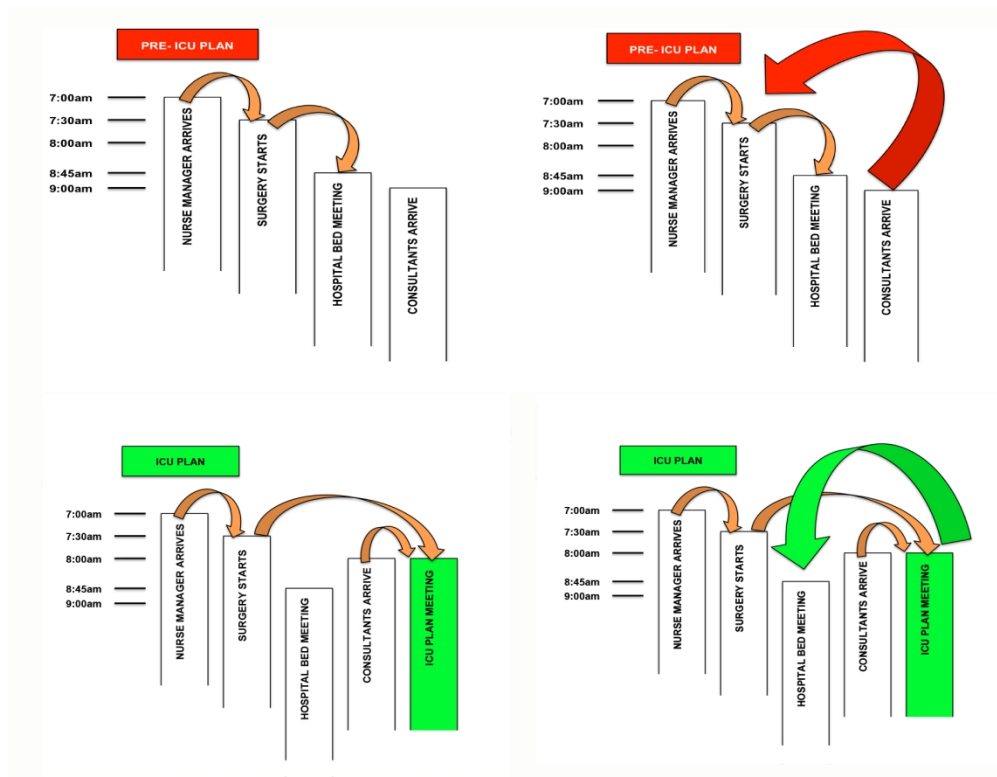


Figure 2. ICU bed state information flow

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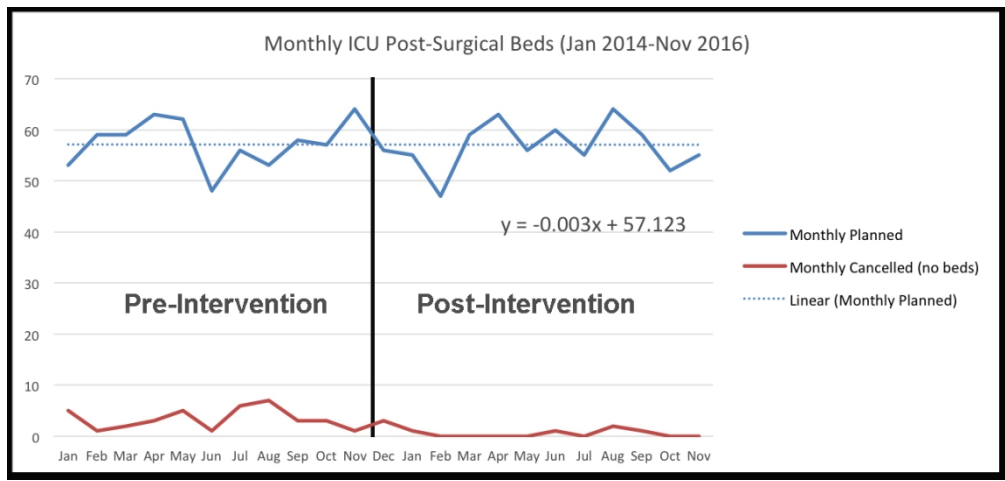


Figure 3. Audit data

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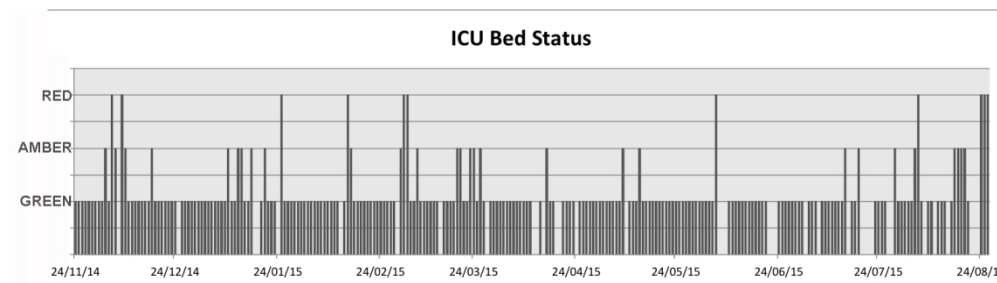


Figure 4. ICU status data

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TTH ICU BED CRISIS ESCALATION PLAN

Condition	Required Actions
<p style="text-align: center;">Green</p> <p>The unit is able to accept 2 unplanned admissions/24 hrs AND elective workload. Nurses are banking hours</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Update ICU bed traffic light system on QHEPS <input type="checkbox"/> Complete refusal forms for patients delayed or cancelled.
<p style="text-align: center;">AMBER</p> <p>>13 patients within next 24 hrs (anticipating 2 unplanned admissions in 24 hrs after taking elective cases)</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Discussion between NUM, PICU consultant & Adult Consultant re: bed plan @ 8 am & 3 pm <input type="checkbox"/> Discuss elective surgery bookings next day & plan on reserve cases with surgeons if cases cancelled. <input type="checkbox"/> Inform Nursing Director of Peri-operative and Critical Care of status. <input type="checkbox"/> ICU to be prioritized for discharge of bed blocked patients <input type="checkbox"/> NUM to commence enhancing capacity using banked hours, establish overtime, shift swap <input type="checkbox"/> NUM & duty consultants to formulate clear plan for next day's actions. <input type="checkbox"/> Get authorization to consider Mater ICU transfer for elective patients that day or next day. <input type="checkbox"/> Update ICU bed traffic light system on QHEPS <input type="checkbox"/> Complete refusal forms for patients delayed or cancelled.
<p style="text-align: center;">RED</p> <p>1. Physical Capacity 2. Nursing Capacity - >6 ventilated patients requiring allocation of 2 Float Nurses</p> <p style="text-align: center;">OR</p> <p>REGARDLESS of the Number of Ventilated patients – Patient acuity and clinical judgement of the Nurse Team Leader & Duty ICU Specialist request 2 floats for the safety of patient care.</p> <p>Can only take in house cardiac arrest / MET call by using a float nurse.</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Inform Nursing Director of status. <input type="checkbox"/> Clinical consultation by Duty Intensivists will recommend to the Service Group cancellation of elective cases until the ICU is able to facilitate de-escalation to Amber <input type="checkbox"/> ICU to be prioritized for discharge of bed blocked patients <input type="checkbox"/> EDMS and Nurse Manager have been contacted by ICU consultant re: bed block & staffing <input type="checkbox"/> Ask retrieval services to divert to another ICU if possible (we can still accept head, heart or child for urgent operative care to hospital) <input type="checkbox"/> ICU Consultants to let ED & Anaes Consultants know of need to keep Patients in their resuscitation areas with ongoing ICU input as required. <input type="checkbox"/> ICU Consultants to contact Mater Intensivist <input type="checkbox"/> Transfer to Mater ICU if any patient deemed suitable with agreement of parent team, Intensivist & family. <input type="checkbox"/> Update ICU bed Traffic light system on QHEPS <input type="checkbox"/> Complete refusal form for patients delayed

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BMJ Open

Improving decision making in acute health care through implementation of an Intensive Care Unit (ICU) intervention in Australia: a multi method study

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Manuscripts

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3 **Improving decision making in acute health care through implementation of an**
4 **Intensive Care Unit (ICU) intervention in Australia: a multi method study**
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Abstract

Objective

To evaluate the implementation of an ICU intervention, designed to establish rules for making ICU decisions about post-surgery beds.

Design

Pre/post intervention case study using a multi-method approach, involving two phases of staff interviews, process mapping, and collection of administrative data.

Setting

ICU in a 700 bed regional tertiary care hospital in Australia.

Participants

31 interview participants. Phase 1 and 2 participants drawn from three groups of staff: bedside nursing staff in the ICU, ICU specialist doctors, and senior management staff involved in oversight of ICU operations. Phase 2 included an additional participant group: staff from Surgery and Emergency departments.

Intervention

Implementation of an ICU Escalation Plan, and introduction of a multidisciplinary morning meeting to determine ICU bed status in accordance with the plan.

Main outcome measures

Interview data consisted of pre-intervention staff perceptions of ICU workplace cohesiveness with bed pressure, and post-intervention staff perceptions of the Escalation Plan and ICU performance. Administrative data consisted of bed status (red, amber or green), monthly number of planned elective surgeries requiring an ICU bed, and monthly number of elective surgeries cancelled due to unavailability of ICU beds.

Results

Improved internal communication, decision-making and cohesion within the ICU, and better coordination between ICU and other hospital departments. Significant reduction in elective surgeries cancelled due to unavailability of ICU beds, $X^2_1=24.9$, $P<.0001$.

Conclusions

By establishing rules for decision-making around ICU bed allocation, the intervention improved internal professional relationships within the ICU as well as between the ICU and external departments, and reduced the number of elective surgeries cancelled.

Strengths and limitations of this study

- This is a multi method study, which allows us to understand why the intervention worked in addition to how well it worked
- Data from a single ICU case may limit the generalisability of the findings

- Drivers of patient population other than elective surgery that impact ICU bed capacity (such as Emergency Department factors) were not considered as part of our study

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Improving decision making in acute health care through implementation of an ICU intervention: a multi method study

Introduction

Targets to reduce elective surgery waiting lists are prevalent in OECD countries,^{1,2} and various interventions have been explored to reduce waiting times.³ In Australia, although the National Elective Surgery Target (NEST) is an important component of hospital performance measurement,⁴ median waiting times for elective surgery have increased by around 2% per year over the five years.⁵ As the population ages, more patients require access to high levels of care following surgery to assist their recovery;⁶ this increasing demand on Intensive Care Unit (ICU) beds places pressure on ICU clinicians and managers, and has been shown to adversely impact patient safety.⁷⁻⁹ Internationally, we know that patients who require acute care following surgery are at higher risk of having their surgery cancelled.^{10,11} Safety in healthcare remains problematic despite concerted efforts to understand why errors occur and to place protective barriers in place.¹²

In the ICU, there can be large and unexpected variation in requirement for beds yet the cost of resources required to maintain continuous capacity for peak load are unduly prohibitive. The presence of uncontrolled variation makes the ICU unsuitable for standard improvement approaches that are based on identifying and fixing individual problems. A new concept focusing on resilience engineering (RE)¹³ has the potential to improve patient safety by reversing the focus from being problem centric, to looking at ways to improve functioning through positive measures which enhance system performance under all conditions. A resilient system can allow safety to occur even at 'the edge of chaos', when the system is strained beyond equilibrium.¹³ Research conducted internationally has shown potential for improved decision-making and efficiency through planning and fostering resilient behaviour traits.¹⁴

The study was set in a busy, high-functioning, 700 bed tertiary care hospital in regional Australia. The ICU consisted of 14 adult beds, and operated as a 'closed' ICU whereby medical and post-surgical patients were admitted under care of intensivists. Frequent late decisions to cancel elective surgery at short notice, due to lack of ICU beds, resulted in poor interdepartmental relations with Emergency and Surgery departments, and overt conflict between clinicians in the ICU. This conflict between departments called for a positive approach that could improve an already well performing unit, rather than a traditional approach of investigation of failure, such as Root Cause Analysis (RCA).

Description of the intervention

RE principles¹⁵ were used to develop and implement a process to establish rules for making ICU decisions about post-surgery beds, and to improve relationships between the Surgery department and the ICU. A small team of influential clinical leaders in the hospital executive team and ICU had been in discussion over a number of years on how to implement RE in the hospital, and concluded that encouraging cohesion, plus 'a few simple rules' to guide behaviour, would provide a starting

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3 point. By the terms 'cohesion' or 'cohesiveness' we mean the degree to which staff
4 respect each other and work together in pursuit of the common goal of patient care.
5 The intervention consisted of implementation of 'a few simple rules' in the form of
6 an ICU Escalation Plan (overview at Figure 1; detail, including clinician roles and
7 responsibilities associated with the colour of the ICU bed status, at Appendix 1), and
8 introduction of a mechanism to improve cohesion in the form of a multidisciplinary
9 morning meeting, led by the senior consultant on duty, to determine ICU status in
10 accordance with the plan. The ICU Escalation Plan and associated morning meeting
11 were developed by senior ICU staff over a number of months, and implemented by
12 the ICU Director with agreement of senior ICU clinicians on a specified date. Prior to
13 the intervention, the ICU had satisfactory performance metrics in comparison with
14 similar hospitals, when measured in terms of Length of Stay (LOS), mortality, bedside
15 handover, Australian and New Zealand Intensive Care Society (ANZICS) Adult Patient
16 Database comparative performance, and trainee performance.

21 **Figure 1. The ICU Escalation Plan**

22 <insert Fig 1 here>

23 **Method**

24 The aim of the study was to evaluate the implementation of the ICU intervention,
25 which was designed to improve decision-making around bed allocation and cohesion
26 in the ICU, and relationships between the ICU and Surgery department. The study
27 used a multi-method approach, involving two phases of staff interviews, process
28 mapping, and collection of administrative data. Process mapping was completed
29 using the Functional Resonance Analysis Method (FRAM), and is reported
30 elsewhere.¹⁶

31 Phase 1 early implementation semi-structured interviews were conducted to collect
32 staff perceptions of ICU workplace cohesiveness with bed pressure. Interview
33 participants were drawn from three groups of staff: bedside nursing staff in the ICU,
34 ICU specialist doctors, and senior management staff involved in oversight of ICU
35 operations. Phase 2 interviews were conducted to collect post-implementation staff
36 perceptions of the plan and ICU performance. Interview participants were drawn
37 from four groups of staff: bedside nursing staff in the ICU, ICU specialist doctors,
38 staff from Surgery and Emergency departments, and senior management staff
39 involved in oversight of ICU operations. Staff members from Surgery and Emergency
40 departments were included in the Phase 2 interviews to provide additional insight
41 into how the Escalation Plan was perceived by those who interfaced regularly with
42 the ICU. Interview Schedule is at Appendix 2.

43 Standard ICU administrative data that are currently collected were obtained for the
44 11 months pre-intervention, and 12 months throughout and post-intervention. Only
45 non-identifiable, aggregate data were obtained. Administrative data consisted of
46 monthly number of planned elective surgeries requiring an ICU bed, and monthly
47 number of elective surgeries cancelled due to unavailability of ICU beds. During, and
48 post-intervention, data were also collected on whether the bed status was at 'red',
49 'amber' or 'green'.
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Qualitative Analysis

Inductive interpretive analysis¹⁷ of transcribed interviews was undertaken to identify key themes relating to the implementation of the Escalation Plan. Inductive interpretive analysis does not set out to test an hypothesis, but instead seeks to produce an understanding of a phenomenon including how it is influenced by context and surrounding social constructs. Coding the data allows it to be organised and used to explore connections between data elements and to develop sets of concepts. Once coded, segments of data can be linked in a formal fashion to allow themes to emerge and to determine relationships that may exist between different data sets. This is a way of studying real world complex systems such as healthcare.

Quantitative Analysis

Exploratory statistical analysis was conducted on ICU administrative data. On the advice of a biostatistician, chi-square analysis was chosen as the optimum method to compare the percentage of surgeries cancelled each month to the percent of non-cancelled surgeries by month, before and after implementation of the intervention. Pre and post categories were compared with the data aggregated for all pre and all post months.

Patient and public involvement

No patients or other members of the public were involved in this study.

Results

Qualitative - Phase 1

In phase 1, 12 hospital staff participated in semi-structured interviews approximately two months after the plan commenced operation. Participants consisted of four doctors, four allied health professionals or nurses, and four managers. Interviews were digitally recorded and professionally transcribed. Interview length averaged 26 minutes (range 11-50 minutes). Data were coded by two researchers (RC-W, BB) and discrepancies resolved via discussion. Data saturation was reached.

Three themes emerged from inductive analysis: perceptions of the plan, benefits of the plan, and processes associated with the morning meeting. Within each theme were a number of subthemes. Table 1 lists the themes and sub-themes, along with example quotes.

Perceptions of the ICU plan were varied: *"It's a policy that's been written but it's more than just a policy ..."* (Phase 1, Doctor 1) Some participants felt that the plan was a behaviour contract, or agreed process that negated the need for micro managing the bed state and resulted in reduced workload and fewer arguments: *"We don't have to fight about beds which is stressful"*. (Phase 1, Doctor 1) Others felt that the plan provided consistency and transparency. The ICU response is predictable, and all were aware of the big picture, which facilitated planning. It provided a more structured way of operating that participants felt was likely to improve patient flow.

The plan meant that additional ICU beds were available when on GREEN for emergency or elective surgical admissions. While this was not very helpful to facilitate elective surgery which often required several days notice, some saw the plan as a 'gesture of goodwill', signalling to surgery a willingness to cooperate. The plan also sent a signal to management that ICU are team players, and improvement oriented, and demonstrated willingness to take load off other departments.

Others felt the plan provided them with authority to say 'no'. It was perceived by some as providing a written 'line on the sand', and management endorsement of ICU refusal to accept patients when full. This leveled the power gradient between the ICU and surgery and between ICU and the ED. Power gradients were perceived to be previously in favour of Surgery and ED, as both of these departments had associated external performance targets (National Elective Surgery Targets and National Emergency Access Targets respectively). While not a sure fix, the plan was perceived to provide visibility of the problem, and a common understanding of RED/AMBER/GREEN status. Status colour could be used as a proxy for urgency or 'pay attention to my request' in a crisis.

The plan was also perceived as a 'canary in the coalmine' to identify system pressure. The status could be used as an indicator of proximal system operating point (see Cook & Rasmussen for further explanation¹³), and provided a record and trend information on ICU performance in meeting post-surgical needs and capacity.

Table 1. Phase 1 themes and sub-themes

Theme	Sub-theme	Example quotes
Perceptions of the plan	A behaviour contract	. "... it is meant to provide agreement across disciplines ..." (Doctor 1) "... everyone works within this policy ..." (Manager 4) "... there was almost like rules of engagement and people knew how decisions were made." (Manager 1)
	Provides consistency, predictability & transparency	"... provide[s] guidance that's consistent so that our response is consistent ..." (Doctor 1) "... so it's completely clarified our entire process ..." (Manager 4) "... we wanted it to be more transparent how beds get allocated ... if we suddenly had a bus crash ... then we couldn't do our cardiac surgery that wasn't because we were badly organised it's just because we don't have that many beds." (Doctor 2)

	Gesture of goodwill	<p><i>" I think [the Escalation Plan is] a good attempt at policy for [the] ICU ..."</i> (Manager 3)</p> <p><i>"[on GREEN] there are [ED, ward] patients that ... might not usually come to ICU that we may admit with a lower threshold."</i></p> <p>(Doctor 1)</p>
	An authority to say 'NO'	<p><i>"... if we say RED is RED, and we have a ventilated patient down in the ED, and you've got the med super saying you need to take it ... well let's see if this escalation policy actually works."</i> (AH/Nurse 3)</p> <p><i>"... it's kind of solidified. You've got it in writing ..."</i> (AH/Nurse 1)</p> <p><i>"... to have some concrete way of explaining to surgeons and surgical institute that we actually provide a service to the whole community not just post-op patients."</i> (Doctor 2)</p>
	Not a fix, but provides visibility of the problem	<p><i>"... flow doesn't always happen just because of the escalation plan. Unfortunately, there are still bed blocked patients because the wards are so full."</i> (AH/Nurse 1)</p> <p><i>"It provides me with evidence if we're at capacity"</i> (Manager 4)</p> <p><i>"We say we're at RED or AMBER but I don't know if [those outside ICU know exactly what that means] ..."</i> (AH/Nurse 1)</p>
	A canary in the coalmine to identify system pressure	<p><i>"... [the plan] identifies a way of being able to describe the level of capacity pressure within the ICU ... in terms of how it manages the system and assesses the level of distress the system is under, I think that, ultimately, what you've got there is a safer system."</i> (Manager 1)</p>
Benefits of the plan	Improved teamwork & communication	<p><i>"I definitely enjoy working in the ICU and I think it's nice to see a bit more ... multidisciplinary involvement."</i> (AH/Nurse 4)</p> <p><i>"The only difference [with the plan] is the [improved] communication."</i> (AH/Nurse 1)</p> <p><i>"... everyone knows where we stand."</i> (AH/Nurse 3)</p>

	New ways of thinking	<p><i>"I think the success of this ... it was able to give clinicians a different way of looking at things ... the ability to think about your system, and the safety of your system, I think is a real benefit ... What I saw was a shift in terms of the ... problem solving and some of the solution finding."</i></p> <p>(Manager 1)</p> <p><i>"The idea itself is beautiful. It had to happen."</i></p> <p>(Manager 4)</p>
Meeting processes	No sub-themes	<p><i>"...the nurses would go to the bed management meeting and the doctors would not know what they'd asked for, how many beds they had, how many nursing staff were available or how many people we could admit. ... "</i> (Doctor 2)</p>

Participants identified a number of perceived benefits of the intervention, including improved teamwork and communication. These benefits manifested as better information flow, better multidisciplinary team working, and more coherent team mental models. Prior to the intervention, *"...[when] we're full to capacity ... there was no written guideline on who to notify, what order it should be in and what to do ..."* (Phase 1, Manager 4). Standardised decision making led to clear ownership of problems. This resulted in less conflict within the ICU and better rapport with other hospital departments, leading to improved job satisfaction for ICU clinicians.

Participants also felt that the intervention resulted in new ways of thinking, including moving from a 'silos' to a 'systems' viewpoint. Clinicians started to think in terms of the 'system', and how patient flow is about the whole of hospital, not just the ICU or Surgery or ED.

Creation of a multidisciplinary morning handover meeting at 8:00am appeared to facilitate information flow and improved team cohesion. Participants described the morning routine in the ICU prior to the intervention, and explained how the new morning handover meeting functioned: Pre-intervention, the ICU Nurse Unit Manager (NUM) arrived at 7:00am, checked bed state and advised Surgery prior to first operation at 7:30am. She then departed for the 8:45am hospital bed planning meeting at 8:30am, passing ICU bed state information to the hospital bed planning team. The ICU consultants arrived around 8:30am, and commenced handover ward rounds. Decisions on ICU discharges for that day were determined during the round, which may last several hours. Discharge information often conflicted with the NUM's earlier determination, resulting in short notice cancellation of surgeries and re-planning by the hospital bed planning team (see Figure 2a and 2b). The ultimate decision to cancel a surgical ICU bed flowed from the NUM to the Executive Director of the surgical department, frequently creating hostility and doctor-nurse conflict.

Figure 2. ICU bed state information flow

<insert Fig 2 here>

Post-intervention, the ICU Nurse Unit Manager (NUM) arrived at the ICU at 7:00am, checked bed state and advised Surgery so that the operating theatre could commence at 7:30am. The ICU consultants arrived for the new meeting at 8:00am, where the multidisciplinary team of doctors, nurses and allied health professionals discussed who would be able to be discharged from the ICU that day. Decisions were agreed in time to postpone any scheduled surgery, and the NUM could present up to date information about ICU bed state to the hospital bed planning meeting at 8:30am (see Figure 2c and 2d). Ultimately, ICU bed state was a shared decision by all ICU clinical staff on duty with recommendation, if required, to the Executive Director of Surgery to cancel due to bed shortage.

Qualitative - Phase 2

In phase 2, 19 hospital staff participated in post implementation semi-structured interviews approximately seven months after the plan commenced operation. Participants consisted of eight doctors, five allied health professionals or nurses, and six managers. Interviews were digitally recorded and professionally transcribed. Interview length averaged 20 minutes (range 5-52 minutes). Initial coding was completed by one researcher (BB) using NVivo software, themes were then grouped by two researchers (BB, RC-W) and refined via discussion. Data saturation was reached.

Seven months post implementation the key improvements in cohesion and communication found during Phase 1 were further reinforced. The utility of the implementation of the ICU escalation plan in conjunction with the 8:00am morning meetings can be viewed from two perspectives: internal ICU functioning or management, and external communication with the rest of the hospital, Emergency and Surgery in particular. Table 2 lists the themes and sub-themes, along with example quotes.

Within the ICU and management, perceptions of the sustained utility of the ICU escalation plan varied from neutral to very positive. On a practical level, those who found the ICU escalation plan useful identified a variety of mechanisms for this utility including: making it easier to say 'no' when the ICU was at capacity, providing clear reference points for the concept of 'full' which were universal and not linked to bed numbers, facilitating communication with 'higher ups' about patient load and the need to transfer patients, and as a basis for more constructive conversations. Therefore the plan facilitated improved timing, clarity, unity and positivity in interdepartmental communication. References to current episodes of acute conflict were entirely lacking from the second phase interviews.

Table 2. Phase 2 themes and sub-themes

Theme	Sub-theme	Example quotes
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Internal communication	Improved decision-making	<p><i>"I think by reducing the ad hoc nature of the decisions that makes it clearer. I think any - you know the old good fences make good neighbours. I think it helps from that perspective. I think it probably has improved our workflow. Not so much the morning meeting but the people having an idea about our bed state has improved our workflow to some degree and that helps - then they can say yes we're going to go ahead with all the surgery or we're going to can all the surgery. We had in the past where individual surgeons would come marching up and say well, I want to do my case. That's gone away, which is a very, very good thing." (Doctor 2)</i></p>
	Increased team cohesion	<p><i>"I think bringing the whole team together and everyone hearing the same thing, and knowing what elective surgery are and knowing what our bed capacity is - I think is a very useful thing. I think it's been good to incorporate nursing and allied health into that, as well. Just so everyone is on the same page, and in terms of a team building exercise." (Doctor 1)</i></p> <p><i>"So we have lots of people - like the social worker comes, the speech pathologist - I think that's great. Everyone's on the same page. We never used to have that before." (AH/Nurse 3)</i></p>

	Inbuilt teambuilding practise	<p><i>"I guess it's more of a team environment, multi-disciplinary. I think that's better for the patients we look after. So there's more of a team approach. I think communication's a lot better. Everyone seems to be on the same page more"</i> (AH/Nurse 4)</p> <p><i>"In this unit alone, we have a joint morning meeting at 8 o'clock in the morning. That's probably one of the biggest changes that's come into effect in the last year I'd say within the unit, over the 15 years I've been here. Mainly because everyone's involved, everyone knows what's happening. I think by doing that everyone's more confident with each other. That comes down then if things happen in the unit you can rely on people and you know who they are and you know what their skills and qualities and that are too."</i> (AH/Nurse 5)</p>
	Team mental model	<p><i>"... overall I'd say that the ICU is working well. I think they're a really cohesive team. I think the steps they've taken to try and manage that uncertainty, that being a positive thing. I think the actual putting something in place that people can own has helped with the relationship in the team, that's great. I think a lot of this is also around the difficulties of you could get the different decision depending on who was there. So having something they could all own and that people recognise this is how we manage and that the other services understand that, that helps. So I think that's certainly, I'd say they were a cohesive, well functioning team. Yes there's pressure but they manage it well."</i> (Manager 1)</p>
General hospital context and patient flow	Improved system understanding of ICU staff	<p><i>"I guess it's a lot of things. We have departments that have guidelines like ED will have a four hour guideline to get a patient to a ward. So then they want to push a patient to you because that's their guideline. Rightly so, they're trying to do their job"</i> (AH/Nurse 5)</p>

	Need for improved system understanding from other departments	<i>“Then I think the other thing is, not so much transparency because that's what everybody talks about but, more visibility so that we can understand their challenges and constraints. We're not there to fix them, but also so that they can understand ours. Because sometimes it feels like, when you're in the Emergency Department, for example, you're the fish bowl that everybody can look at but we can't see what anybody else is doing, which is a chip on the Emergency guys' shoulders sometimes, which we also need to drop. But I think it's nice to see the other person's pressures as well.” (Doctor 7)</i>
	Improved external relationships	<i>“Basically what I can say to you is it's communication between the nursing director and the wards that we transfer to. It's just that network we've built up. We've realised the importance of it. It's the traffic light system that's actually helped us see that. When they see that we're at this and we don't have a lot of room to move, they will support us in taking the patients out, rather than bed blocking.” (Manager 3)</i>

Those who found the ICU escalation plan of limited use tended to cite bed block as a major concern. Some pointed out that the plan, and the communication of the ICU status, could have little effect on patient flow at the hospital level and the demands and pressures on the ICU if those external to the ICU did nothing to address patient flow issues. Interestingly, although this critique was intended to be negative, the participants are now thinking in terms of a systems level analysis, rather than a 'silo' based perspective. In fact, a major theme of the interviews was hospital wide context and overall patient flow issues. Some participants discussed the pressures they were aware of other teams experiencing, demonstrating an improvement in hospital wide understanding and cohesion. Some skepticism remained in regards to how other departments functioned and the effect of the political environment on their management. While ED and elective surgery targets were often cited as potentially influencing referrals, it was also suggested that visibility of the ICU could be further improved.

In general, those who felt more positive about the plan were more involved with patient flow management rather than delivering clinical care. Some participants also discussed how the plan provided agreement on current status and gave more structure to decision making processes within the ICU. This was seen as going some way to improving the clarity and visibility of the ICU which flowed on to increasing cooperation with other department and hospital management.

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3 One of the most significant aspects of the team meetings was increased team
4 cohesion. One of the main mechanisms of doing so was through the building of a
5 unified mental model in the morning meeting through the use of the escalation plan.
6 Interestingly, this process of needing to agree on a bed status each morning could be
7 seen as a team building exercise in itself. The ICU now start every day with a team
8 negotiation which brings everyone together and forges a single point of consensus
9 and reduces potential conflict between roles and individuals. This unified position is
10 then both the foundation for all other conversations and interaction within the team
11 for the rest of the day, and also presents a unified voice for the team when
12 communicating externally. The creation of a single team mental model has
13 influenced interaction externally as well as communicating a sense of clear
14 ownership and accountability.
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19 *Quantitative results*

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21 Administrative data between January 2014 and November 2015 are presented
22 graphically (Figure 3). The ICU Escalation plan commenced operation at the end of
23 November 2014 (Figure 3, vertical line). Elements presented are monthly planned
24 surgeries requiring an ICU bed, and the number of surgery cancellations each month
25 due to unavailability of an ICU bed. While the number of planned surgeries varied
26 from month to month, the average number of surgeries planned did not markedly
27 increase or decrease over the data collection period (illustrated by the slope of the
28 regression line in Figure 3 being close to zero). Chi-square comparison of pre- and
29 post-intervention surgery cancellations showed a significant reduction in cancelled
30 surgeries associated with implementation of the intervention, $X^2_1=24.9$, $P<.0001$.
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35 **Figure 3. Administrative data**

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39 Data were also collected on whether the bed status was at 'red', 'amber' or 'green'
40 from the time the intervention commenced at the end of November 2014, until the
41 onsite data collection for the study concluded at the end of August 2015 (Figure 4).
42 There were no data for Saturdays or Sundays, as daily meetings did not normally
43 occur, and therefore ICU status was not declared on weekends. Additional
44 administrative data are presented graphically in Appendix 3.
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47 **Figure 4. ICU status data**

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51 **Discussion**

52 Pre-intervention, hospital leaders were frustrated with the number of surgeries
53 cancelled by ICU staff, because these surgeries formed part of the National Elective
54 Surgery Target (NEST) and were therefore a critical performance target for the
55 hospital. The immediate response to ICU-initiated surgery cancellations was that
56 more ICU beds were required to solve the patient flow problem, and that therefore
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3 nothing could be done until more funding was secured. Research in the UK,
4 however, has shown that increasing ICU beds only serves to increase demand.¹⁸
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7 Using a resilience approach to develop and implement the ICU Escalation Plan
8 represented a novel approach to reducing conflict and improving function within
9 existing constraints. Early in the implementation, staff within the ICU hoped that the
10 Plan would be able to: 1) increase consistency in decision making; 2) make more
11 visible the pressures within ICU; 3) give greater authority to the unit; 4) increase
12 communication within and external to ICU; 5) provide new perspectives; and 6)
13 demonstrate to other departments that the ICU was taking positive measures to
14 reduce conflict. In conjunction with the 8:00am meetings, the Plan was also designed
15 to improve the ICU workflow and communication.
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18 These improvements were sustained as the ICU Escalation Plan evolved, with
19 interviews seven months post implementation showing that participants within and
20 external to the ICU still saw the Plan as improving workflow and communication. We
21 know from the other studies¹⁹ that successfully negotiating the boundaries between
22 surgery and the ICU through complex social and cultural interactions among
23 surgeons and ICU clinicians produces collaborative, high-quality patient care. In our
24 study, even those for whom the plan seemed to have limited effect tended to cite
25 some benefits and viewed the problems as system wide constraints – demonstrating
26 a higher level of hospital wide cohesion and a reduction in ‘silo’ thinking. This was
27 reflected in the major themes of the second interviews which, after communication,
28 were patient flow and general hospital context.
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32 Although other studies have found that teamwork interventions, including bed
33 planning meetings, resulted in improved ICU performance,^{20 21} our study is able to
34 provide explanatory detail. Unlike many team building activities, the ICU escalation
35 plan and structure of the morning meetings provided a daily opportunity to practice
36 team skills. Studies on team huddles in healthcare confirm that incorporating
37 opportunities for frequent teambuilding into everyday work can enhance workplace
38 relationships and improve patient safety.²² Incorporating teamwork into normal
39 daily activities seems better suited to work as done in healthcare than typical team
40 building activities that can be once off and removed from the workplace context. In
41 healthcare, shifts, workload, staff availability and job competence are crucial issues.
42 Team building activities which would require staff to be off-site or occurred only
43 once would likely miss many critical members, not evolve with changing staff over
44 time and therefore dissipate. The morning meetings in ICU were able to capture all
45 new staff, occur without fail, were inclusive of all roles and were socially reinforced.
46 As teamwork improved, the value of the meetings increased, thereby increasing
47 attendance and contribution.
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54 Benefits of the intervention were reflected in the administrative data in terms of
55 reduced surgery cancellations due to unavailability of ICU beds, despite monthly
56 average planned surgeries remaining consistent. It is interesting to note, however,
57 that the ICU status still reached RED on occasion after the plan was introduced. It
58 appears from the interview data that, although the bed status was declared RED at
59 the morning meeting, rather than cancel surgery, ICU staff worked with the hospital
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3 bed planning team to free up ICU beds for when surgery concluded later in the day.
4 A developing awareness of how individual actions can impact system performance
5 suggested that cross boundary teaming,²³ was developing. In this case, the team did
6 not slavishly follow the plan, but instead worked to adapt fluidly across
7 departmental boundaries to meet a system goal. Resilient performance was hence
8 not about strict adherence to rigid rules, but in the ability to adapt to emerging
9 conditions.
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13 It was also rare, particularly by early May 2015 when the plan had been in action for
14 a few months, for the ICU to remain on RED for more than a single day. This may be
15 an indication that the new process facilitated resilience and rapid recovery from
16 unexpected or challenging events. The daily ICU status provided an additional metric
17 that (1) gave an indication of proximity to the safety boundary for the unit, and (2)
18 allowed more transparency for when extra bed resources were required.
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21 The new ways of working seem likely to be sustainable: during the post-intervention
22 interviews, it was not recognised as an intervention but rather accepted as 'how we
23 do things around here'. In some ways, the plan was as much a device to improve
24 cohesion as a plan for improving bed flow. In addition, there was now peer group
25 pressure to attend the 8:00am meeting, as it was a 'norm' for the unit. Therefore,
26 although not everyone liked the ICU Escalation Plan and morning meetings, no one
27 interviewed suggested their cessation.
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31 By establishing rules for decision-making around how beds were allocated in the ICU,
32 the intervention improved internal professional relationships within the ICU as well
33 as between the ICU and external departments. In addition, there was a reduction in
34 the number of elective surgeries cancelled due to unavailability of ICU beds.
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37 38 *Limitations*

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40 While the Phase 1 interviews were completed early in the intervention period, when
41 recollections of pre-intervention behaviours were still fresh, we do not have
42 interview data prior to commencement of the Escalation Plan and it is hence
43 possible that the early interviews were coloured by staff experiences during the
44 implementation process. Staff attitudes to the intervention may have also influenced
45 their perceptions of its efficacy. In addition, other drivers of patient demand for ICU
46 beds, such as Emergency Department factors, were not considered as part of our
47 study, and we did not include the patient voice. Data from a single ICU case,
48 particularly where the intervention was tailored to address the specific problems
49 encountered by that ICU, may limit the generalisability of the findings. The chosen
50 methodology, however, where behaviour is researched along with quantitative
51 outcome data, facilitates a deeper understanding of why the intervention worked.
52 This understanding may be utilised to translate findings to other hospital
53 environments.
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56 57 *Ethics approval*

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Ethics approval for the study was obtained from XX Human Research Ethics Committee (HREC/14/QTHS/117).

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Competing interests statement

PL, SS and AJ were involved in development of the intervention; however, they were not interviewed as part of the study and were not involved in data collection or analysis. The authors have no other competing interests to declare.

Authors' contributions

RC-W, PL, SS and AJ contributed to the conception and design of the study; RC-W and BB collected, analysed and interpreted the study data; RC-W and BB drafted the manuscript, and PL, SS and AJ revised it critically for intellectual content; all authors approved the final version of the paper.

Data statement

Data available from the corresponding author on request.

References

1. Reddy S, Jones P, Shanthanna H, et al. A Systematic Review of the Impact of Healthcare Reforms on Access to Emergency Department and Elective Surgery Services: 1994–2014. *International Journal of Health Services* 2017;0020731417722089.
2. Siciliani L, Moran V, Borowitz M. Measuring and comparing health care waiting times in OECD countries. *Health Policy* 2014;118(3):292-303.
3. Ballini L, Negro A, Maltoni S, et al. Interventions to reduce waiting times for elective procedures. *The Cochrane Library* 2015
4. New South Wales Agency for Clinical Innovation. National Elective Surgery Targets (NEST) 2014. <https://www.aci.health.nsw.gov.au/resources/surgical-services/delivery/predictable-surgery/10>, accessed 20 June 2018.
5. Australian Institute of Health and Welfare. Australian hospital statistics (2016-2017): elective surgery waiting times 2018. <https://www.aihw.gov.au/reports/hospitals/ahs-2016-17-elective-surgery-waiting-times/contents/table-of-contents> accessed 20 June 2018.
6. Etzioni DA, Liu JH, Maggard MA, et al. The aging population and its impact on the surgery workforce. *Annals of Surgery* 2003;238(2):170.
7. Adhikari NK, Fowler RA, Bhagwanjee S, et al. Critical care and the global burden of critical illness in adults. *The Lancet* 2010;376(9749):1339-46.

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8. Tarnow-Mordi W, Hau C, Warden A, et al. Hospital mortality in relation to staff workload: a 4-year study in an adult intensive-care unit. *The Lancet* 2000;356(9225):185-89.
9. Neuraz A, Guérin C, Payet C, et al. Patient mortality is associated with staff resources and workload in the ICU: a multicenter observational study. *Critical Care Medicine* 2015;43(8):1587-94.
10. Gillies M, Wijeyesundera D, Harrison E. Counting the cost of cancelled surgery: a system wide approach is needed. *British Journal of Anaesthesia* 2018;121(4):691-94.
11. Wong D, Harris S, Moonesinghe S, et al. Cancelled operations: a 7-day cohort study of planned adult inpatient surgery in 245 UK National Health Service hospitals. *British Journal of Anaesthesia* 2018;121(4):730-38.
12. Runciman WB, Hunt TD, Hannaford NA, et al. CareTrack: assessing the appropriateness of health care delivery in Australia. *Medical Journal of Australia* 2012;197(10):549.
13. Cook R, Rasmussen J. "Going solid": a model of system dynamics and consequences for patient safety. *Quality & Safety in Health Care* 2005;14(2):130.
14. Paries J, Lot N, Rome F, et al. Resilience in Intensive Care Units: the HUG case. In: Hollnagel E, Braithwaite J, Wears R, eds. Resilient health care. UK: Ashgate Publishing Limited 2013.
15. Hollnagel E, Braithwaite J, Wears R. Resilient health care. Surrey, UK: Ashgate Publishing Limited 2013.
16. Clay-Williams R, Hounsgaard J, Hollnagel E. Where the rubber meets the road: using FRAM to align work-as-imagined with work-as-done when implementing clinical guidelines. *Implementation Science* 2015;10(125)
17. Denzin NK, Lincoln YS. Strategies of qualitative inquiry, 4th Edition. US: Sage 2013.
18. Sadique Z. An Examination of the Capacity-Utilisation Relationship in United Kingdom (UK) Intensive Care Units (ICUs) Between 2001-2011. B102 Novel approaches to understand and improve health outcomes UK: ATS Journals:A3700-A00.
19. Conn LG, Haas B, Cuthbertson BH, et al. Communication and culture in the surgical intensive care unit: boundary production and the improvement of patient care. *Qualitative Health Research* 2016;26(7):895-906.
20. Jain M, Miller L, Belt D, et al. Decline in ICU adverse events, nosocomial infections and cost through a quality improvement initiative focusing on teamwork and culture change. *Quality & Safety in Health Care* 2006;15(4):235-39.
21. Ryckman FC, Yelton PA, Anneken AM, et al. Redesigning intensive care unit flow using variability management to improve access and safety. *The Joint Commission Journal on Quality and Patient Safety* 2009;35(11):535-43.
22. Provost SM, Lanham HJ, Leykum LK, et al. Health care huddles: Managing complexity to achieve high reliability. *Health Care Management Review* 2015;40(1):2-12.

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3 23. Edmondson AC, Harvey J-F. Cross-boundary teaming for innovation: Integrating
4 research on teams and knowledge in organizations. *Human Resource*
5 *Management Review* 2018;28(4):347-60.
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8 **Figure legends**
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10 **Figure 1. The ICU Escalation Plan**
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12 **Figure 2. ICU bed state information flow**
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14 **Figure 3. Administrative data**
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16 **Figure 4. ICU status data**
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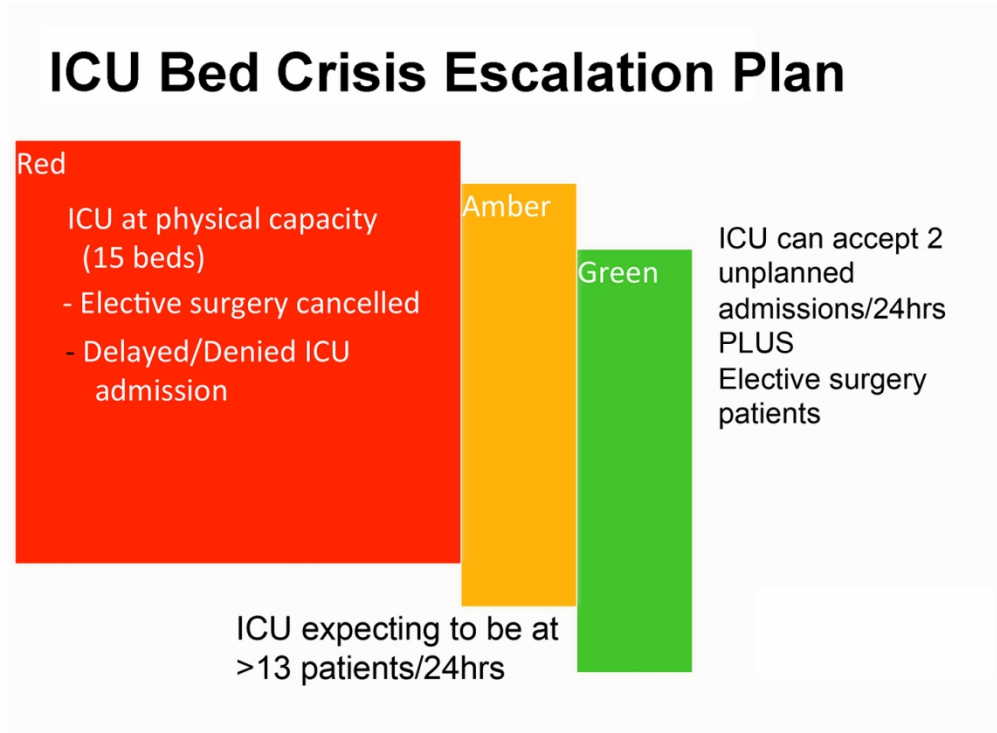


Figure 1. The ICU Escalation Plan

122x90mm (300 x 300 DPI)

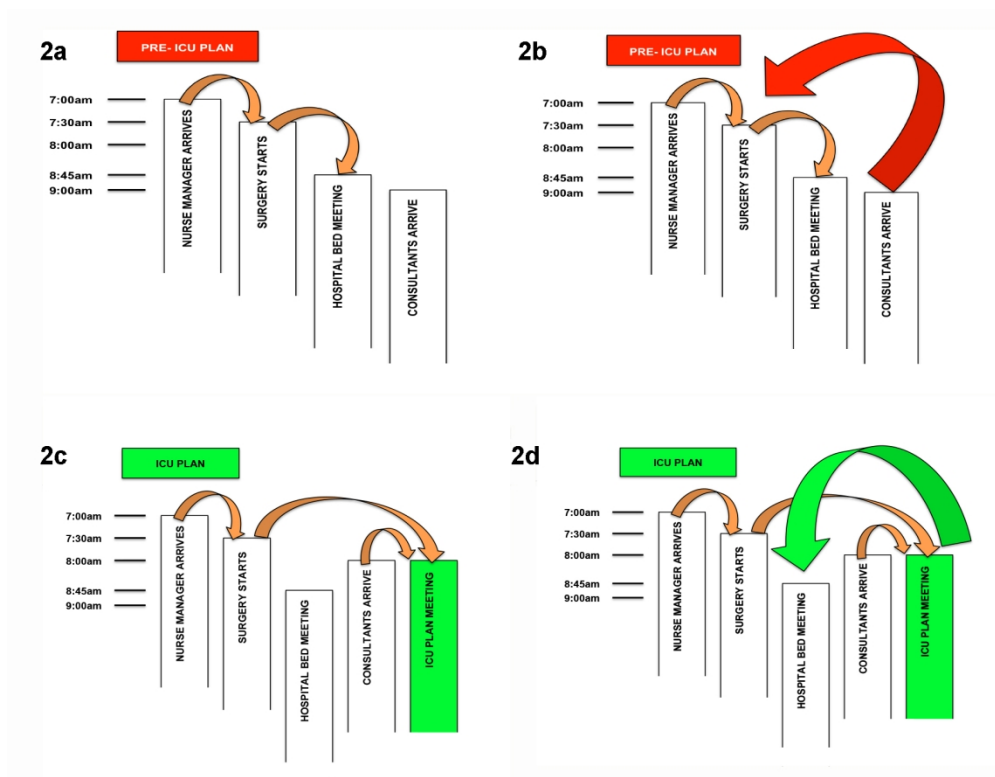


Figure 2. ICU bed state information flow

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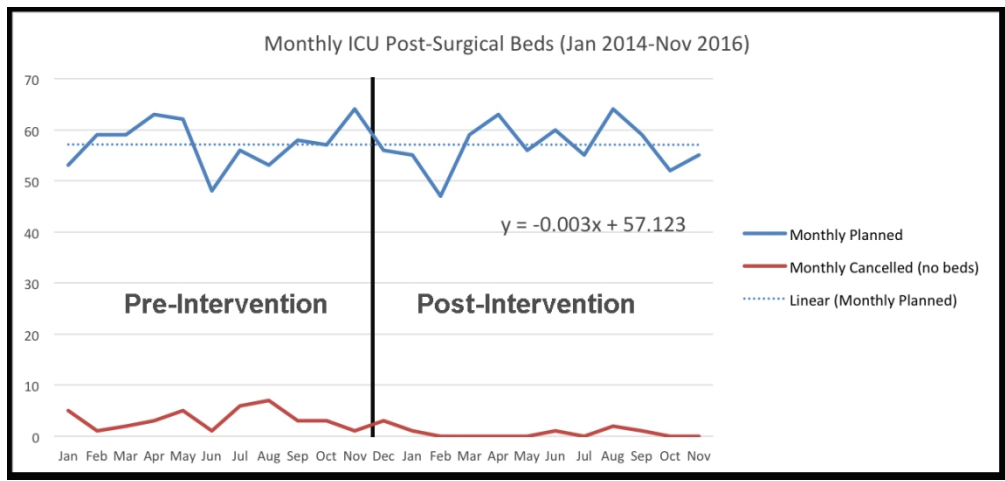


Figure 3. Audit data

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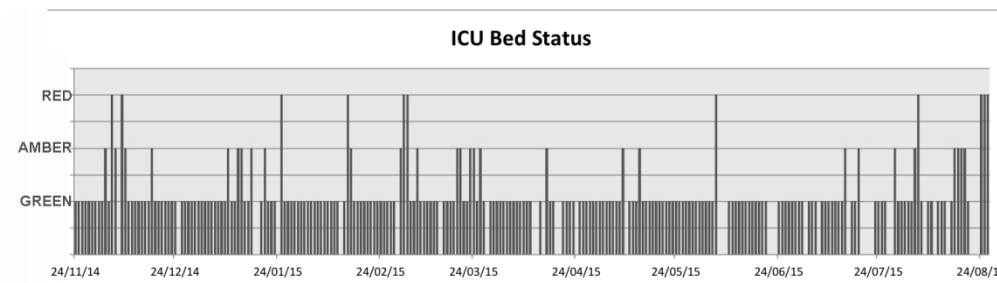


Figure 4. ICU status data

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TTH ICU BED CRISIS ESCALATION PLAN

Condition	Required Actions
<p style="text-align: center;">Green</p> <p>The unit is able to accept 2 unplanned admissions/24 hrs AND elective workload. Nurses are banking hours (accruing positive leave balance)</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Update ICU bed traffic light system on QHEPS <input type="checkbox"/> Complete refusal forms for patients delayed or cancelled.
<p style="text-align: center;">AMBER</p> <p>>13 patients within next 24 hrs (anticipating 2 unplanned admissions in 24 hrs after taking elective cases)</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Discussion between NUM, PICU consultant & Adult Consultant re: bed plan @ 8 am & 3 pm <input type="checkbox"/> Discuss elective surgery bookings next day & plan on reserve cases with surgeons if cases cancelled. <input type="checkbox"/> Inform Nursing Director of Peri-operative and Critical Care of status. <input type="checkbox"/> ICU to be prioritized for discharge of bed blocked patients <input type="checkbox"/> NUM to commence enhancing capacity using banked hours, establish overtime, shift swap <input type="checkbox"/> NUM & duty consultants to formulate clear plan for next day's actions. <input type="checkbox"/> Get authorization to consider Mater ICU transfer for elective patients that day or next day. <input type="checkbox"/> Update ICU bed traffic light system on QHEPS <input type="checkbox"/> Complete refusal forms for patients delayed or cancelled.
<p style="text-align: center;">RED</p> <p>1. Physical Capacity 2. Nursing Capacity - >6 ventilated patients requiring allocation of 2 Float Nurses</p> <p style="text-align: center;">OR</p> <p>REGARDLESS of the Number of Ventilated patients – Patient acuity and clinical judgement of the Nurse Team Leader & Duty ICU Specialist request 2 floats for the safety of patient care.</p> <p>Can only take in house cardiac arrest / MET call by using a float nurse.</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Inform Nursing Director of status. <input type="checkbox"/> Clinical consultation by Duty Intensivists will recommend to the Service Group cancellation of elective cases until the ICU is able to facilitate de-escalation to Amber <input type="checkbox"/> ICU to be prioritized for discharge of bed blocked patients <input type="checkbox"/> EDMS and Nurse Manager have been contacted by ICU consultant re: bed block & staffing <input type="checkbox"/> Ask retrieval services to divert to another ICU if possible (we can still accept head, heart or child for urgent operative care to hospital) <input type="checkbox"/> ICU Consultants to let ED & Anaes Consultants know of need to keep Patients in their resuscitation areas with ongoing ICU input as required. <input type="checkbox"/> ICU Consultants to contact Mater Intensivist <input type="checkbox"/> Transfer to Mater ICU if any patient deemed suitable with agreement of parent team, Intensivist & family. <input type="checkbox"/> Update ICU bed Traffic light system on QHEPS <input type="checkbox"/> Complete refusal form for patients delayed admission.

For peer review only

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Interview Schedule

The information collected will be demographic information and responses to the following questions.

A: ICU Resource allocation processes

Please describe how beds and resources are allocated in the ICU.

What positions have an input into these decisions?

What are the factors involved?

Does the process change as the ICU becomes busier?

B: Experience in the implementation process

Please describe when you became involved in the Escalation WPI that was implemented in the ICU.

If Involved

What was your role?

Why was the WPI developed?

What hopes did you have with the implementation of WPI?

What challenges did you think existed, did you have any concerns

If not involved

What have you heard about the Escalation WPI and Resilient Healthcare?

C: Work practice changes

How does your work at the hospital involve the ICU?

Tell me how the ICU impacts on your daily work routine

Are you aware of any change to your work practice due to the Escalation WPI implementation or Resilient Healthcare Education?

Are you aware of any change to the work practices of other staff as a result of the initiatives?

D: Team functioning

Describe your work team

Is there a clear leader?

What is your role in the team?

What are the challenges for the team?

What is it like for new staff members joining your team?

Did the Escalation WPI influence the way the team worked? How?

Did the Resilient Healthcare education influence the way the team worked? How?

Was there any change in the decision making process with the initiatives? If yes please comment on those periods when ICU resources were stretched.

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4 E: Job satisfaction
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7 How do you feel about coming to work each day, particularly on days with heavy ICU
8 involvement?

9 Was there any impact of the initiatives on your job satisfaction?

10 Did the initiatives make any difference to the days when ICU resources were
11 stretched?

12 Do you feel patient care was improved?
13
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15 F: Patients and Families
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17 What impact do you think the new initiatives will have on patients and families in the
18 ICU?

19 What difference did the Escalation WPI have during these times? Was the
20 performance of the ICU improved with the WPI?

21 Did information regarding Resilient Healthcare and skills required to work 'on the
22 edge of chaos' influence your practice as the ICU workload increased?

23 Did information about Resilient Healthcare alter any other of your work practices?
24

25 What could be changed about the escalation WPI or information on Resilient
26 Healthcare to further improve ICU performance?
27
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29 G: Demographic Information
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31 This information will not be linked to participants name. A number will be given to be
32 used as a code reference for analysis purposes.
33

34 1. Gender

35 2. Profession

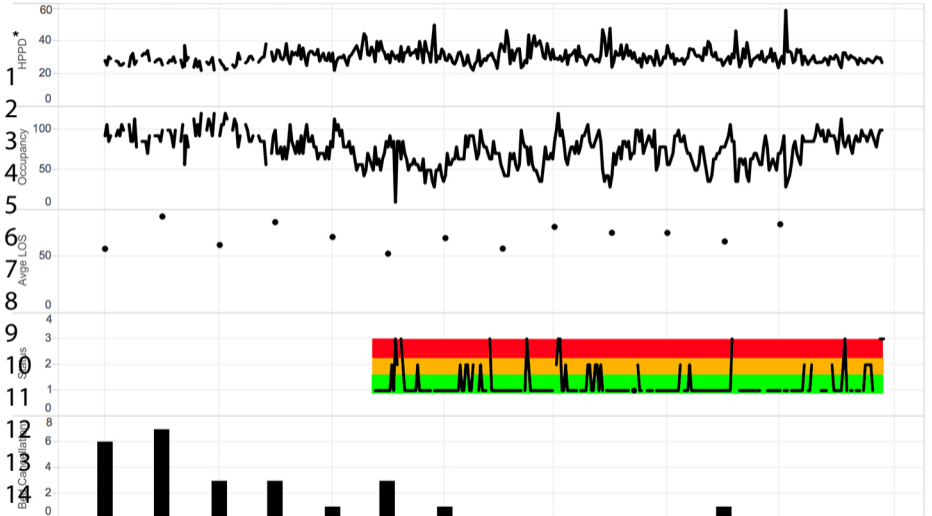
36 3. Role

37 4. Time since qualification to practice his profession

38 5. Time in this organisation

39 6. Time in ICU
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Escalation Plan (Jul 2014 - Aug 2015)



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The trends of HPPD (nursing Hours Per Patient Day), Occupancy, Avg LOS, Status and Bed Cancellation