Interventions to circumvent intensive care access block: a retrospective 2-year study across metropolitan Melbourne

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ABSTRACT

Objectives: To measure the prevalence of interventions used to circumvent intensive care access block and to estimate the attributable mortality and additional hospital bed-days associated with them.

Design and setting: Retrospective observational study of 11 adult public hospital intensive care units (ICUs) in Melbourne, Victoria, July 2004 – June 2006.

Main outcome measures: Prevalence of five interventions in response to access block; attributable fatalities and/or increased length of stay associated with each.

Results: 21 896 ICU admissions and 3039 inhospital deaths (13.9%) were screened. All hospitals reported ICU access block. There were 6787 interventions for access block (mean, 9.3/day) — 4070 (18.6% of admissions) instances of after-hours step-down from an ICU to a low-acuity ward; 1115 (5.1%) delays in an emergency department > 8 hours; 895 (4.1%) postponed major surgeries; 487 (2.2%) interhospital transfers; and 220 (1.0%) instances of premature cessation of intensive care. Based on published risk estimates, these interventions may have resulted in 91.1 (95% CI, 34.7–147.2) attributable deaths and 4368 (95% CI, 333–10 050) additional hospital bed-days each year.

Conclusions: Intensive care access block is frequent, and measures to circumvent it increase mortality and length of stay. Further study of the health and financial implications of access block are warranted.

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Intensive care units (ICUs) in Australian hospitals compare favourably with international benchmarks,[1] but these results mask the outcome of patients who cannot access intensive care services when required. Intensive care access block occurs in all Australian states,[2] but Victoria has a relatively low number of intensive care beds (5.4 beds/100 000 people, compared with the national mean, 6.1/100 000).[3,4] Occupancy rates are high (95%),[4] and for several days each month there is no reserve capacity.[3,5,6]

Intensivists are faced with the competing demands of being gatekeepers,[7] patient advocates, and attending clinicians. When the ICU has no reserve capacity, intensivists must select one of several less suitable options for new patients.[6] Each option has risks, but aims to minimise harm and continue treatment until an intensive care bed becomes available.[8]

Five main interventions are used to deal with access block. Firstly, interhospital transfer may be undertaken if it is safe for the patient.[9,10] Secondly, treatment may be commenced in another high-acuity area, such as the emergency department (ED)[11-14] or the post-anaesthesia care unit,[6] until an intensive care bed is available. These areas do not have the same equipment, expertise and staffing levels as an ICU. Thirdly, in selected cases, a trial of standard care in a low-acuity ward may be considered; up to 25% of such trials fail and require intensive care rescue.[6] Fourthly, major elective surgery for which postoperative intensive care is mandatory (eg, cardiac surgery) may be cancelled or postponed.[3,6] Lastly, triage decisions may lead to increased turnover of intensive care patients — a recovering patient occupying an intensive care bed is transferred to a low-acuity ward sooner than planned to give access to another critically ill patient;[15-18] this can increase risks for both patients.

We aimed to determine the prevalence of these interventions to circumvent intensive care access block in Melbourne, Victoria, and to estimate the attributable mortality and additional hospital bed-days associated with each of them.

METHODS

We categorised interventions according to the Australian and New Zealand Intensive Care Society (ANZICS)[2] and the Australian Council on Healthcare Standards:[19]

1. Interhospital transfer of an intensive care patient due to the absence of an available bed in the ICU of the sending hospital, excluding patients transferred for specialist therapy not normally provided by the sending hospital (Box 1, A).
2. Prolonged stay (> 8 hours) in an ED for a patient awaiting and eventually admitted directly to the ICU, excluding patients included in (1).
3. Cancellation or postponement of elective major surgery due to the absence of an available intensive care bed (Box 1, B).
4. After-hours (between 18:00 and 06:00) step-down of an intensive care patient to a standard care (low-acuity) ward.
5. Premature transfer of an intensive care patient to a low-acuity ward based on the intensivist's clinical judgement, excluding patients included in (4).

From 1 July 2004 to 30 June 2006, adult public hospitals with an ICU in metropolitan Melbourne recorded the frequency of each of these interventions. These data were submitted to the Victorian Government Department of Human Services (DHS). The reported numbers were verified and additional hospital data were extracted from several other reports, including ANZICS[2] and DHS annual reports.[4,20,21]

We excluded paediatric patients (< 17 years of age), readmissions to the ICU during the same hospital stay, requests for intensive care services from other hospitals, postoperative admission delays, and patients initially given a trial of standard care (due to the lack of a reliable definition).

As our study used de-identified patient and hospital data available from several sources, the need for formal ethics committee approval was waived.

Attributable mortality and length of stay

The attributable mortality and excess length of stay (LOS) for each intervention were estimated using a two-stage process.

First, the magnitude of risk (excess LOS and/or mortality) associated with each intervention was estimated using a MEDLINE search (search parameters:

1 Case reports illustrating measures to circumvent access block

A: Access delay from the emergency department and interhospital transfer

A 28-year-old woman with septic shock was admitted to the emergency department (ED) requiring breathing and cardiac life support. That night, there were no public or private hospital intensive care beds available in Melbourne. She remained overnight in the ED while her condition deteriorated to the point that she also required dialysis. Fourteen hours later, she was transferred to another hospital for definitive care and eventually recovered.

B: Postponed major surgery

A 55-year-old man with a slowly expanding abdominal aortic aneurysm waited 4 days for his operation because the hospital's intensive care unit (ICU) was full. During the operation, it was discovered that the aneurysm had extended above the renal arteries, leading to kidney failure. After prolonged treatment in the ICU, he was discharged home. ◆

1966–2008; keywords: intensive care, critical care, access, surgery, after-hours discharge, premature discharge, outcome). Risk estimates derived from Australian data, adjusted for casemix and illness severity, were selected for analysis. If no such data were available, the risk was assumed to be zero. Where necessary, published odds ratios were converted to relative risk estimates using raw data.

Second, each risk estimate was applied to the subgroup that received the relevant intervention. The results of each calculation were summed to determine the total effect of the interventions on mortality rates and LOS.

We assumed that any prolongation of hospital stay only affected survivors. The number of additional bed-days associated with each intervention was calculated according to the formula shown in Box 2, A.

Attributable mortality for each intervention was calculated according to the formula in Box 2, B. We derived a baseline mortality rate for each group from the number of patients, the reported mortality rate, and the relative risk. Attributable mortality was the difference between the observed mortality and the baseline mortality.

Statistical analysis

Unless otherwise specified, prevalence rates are annualised, the mortality results are reported as mean (95% CI), and the LOS data as median (interquartile range [IQR]).

The χ^2 test with Yates correction was used to compare categorical data, and the Mann–Whitney test for continuous data. $P < 0.05$ was considered significant.

Analyses were conducted using Stata, version 9 (StataCorp, College Station, Tex, USA).

RESULTS

Sufficient data for analysis were available from 11/12 eligible public hospitals, and 21 896 intensive care admissions (91% of eligible admissions) were screened. There were 3039 inhospital deaths (13.9%).

The median hospital LOS was 9.5 (IQR, 5.4–18.7) days, including a median of 1.8 (IQR, 0.9–4.0) days of intensive care. The most common referral sources were the operating theatre (48%), the ED (26%) and other hospitals (17%).

The mean number of available (staffed) ICU beds was 118 in 2004–05 and 120 in 2005–06 — equivalent to 81% of the hospitals' declared total physical ICU bed capacity.[2] There were no significant differences in the admission rates (mean, 29.3 v 30.6 per day; $P = 0.3$) or the overall mortality rates (14.0% v 13.8%; $P = 0.7$) between the 2 years.

Prevalence of access block

All hospitals reported access block. The total rate of access block events was significantly higher in the second year (9.8 v 8.9 per day; $P < 0.001$).

There were 6787 interventions for access block. Of these, 4070 (18.6% of admissions) were instances of after-hours step-down from an ICU to a low-acuity ward; 1115 (5.1%) were delays in an ED >8 hours; 895 (4.1%) were postponed major surgeries; 487 (2.2%) were interhospital transfers; and 220 (1.0%) were instances of premature cessation of intensive care. The mean daily rate of interventions for access block was 9.3, equivalent to 31% of the daily admission rate.

The number of interventions for access block was higher during the second year of the study (Box 3). The frequency of interventions and their associated mortality rates are summarised in Box 3. These mortality rates include similar patients not exposed to risk. For example, in 2004–05 there were 2861 admissions from an ED, with a reported inhospital mortality rate of 17.5%, of whom 549 (19.2%) waited for more than 8 hours.

Attributable mortality and length of stay

Risk estimates from the literature search are summarised in Box 4.

The estimated net effect of access block interventions was 91.1 (95% CI, 35–148) additional deaths per year, an average of one death every 4.0 days (Box 5). The estimated net effect on LOS was an additional 4368 (95% CI, 333–10 050) hospital bed-days per year, a mean of 12.0 additional hospital beds per day (Box 5).

DISCUSSION

We found that access block occurred in all hospitals and that interventions to deal with it appeared to increase over the 2 years. The number of interventions for access block was higher than previously reported rates.[6] These interventions amplify risks to patients, resulting in increased patient mortality and LOS. Our results add to the growing body of evidence that access block may lead to patient harm.

Our estimates are a rough approximation, but they are consistent with other

2 Formulae and examples

A: Calculation of attributable length of stay

Excess length of stay = $A \times (1 - D) \times L$ bed-days

where A = number exposed to risk. D = mortality rate. L = relative increase in length of stay.

Example: access delay from the emergency department (ED) in 2004–05

Excess hospital bed-days = $549 \times (1 - 0.18) \times 1.7 = 765.3$

B: Calculation of attributable mortality

Excess fatalities = $(A \times [A + B] \times D \times [R - 1])/(B + [A \times R])$

where A = number exposed to risk. B = number not exposed to risk. D = mortality rate.
R = relative risk.

Example: access delay from the ED in 2004–05, where (A + B) = 2861

Excess fatalities = $549 \times 2861 \times 0.175 \times (1.36 - 1)/(2312 + [549 \times 1.36]) = 32$ ◆

3 Reported frequency of interventions and associated mortality rate used to estimate attributable fatalities

	2004–05		2005–06		
Access block intervention	No. (%)*	Mortality rate†	No. (%)*	Mortality rate†	P‡
Interhospital transfer	283 (2.6%)	13.5%	204 (1.8%)	13.7%	< 0.001
Access delay from ED > 8 hours	549 (5.1%)	17.5%	566 (5.1%)	19.0%	0.98
Premature ICU exit	75 (0.7%)	5.9%	145 (1.3%)	5.5%	< 0.001
After-hours ICU exit	1973 (18.4%)	8.3%	2097 (18.8%)	8.9%	0.50
Postponed major surgery	318 (3.0%)	na	577 (5.2%)	na	< 0.001
Total	**3198 (29.9%)**		**3589 (32.2%)**		**< 0.001**

ED = emergency department. ICU = intensive care unit. na = not applicable.* Per cent of total admissions. † Reported mortality rate used in calculations, as demonstrated in Box 2. ‡ Comparison of frequency for 2004–05 with 2005–06. ◆

4 Published attributable risks of interventions in response to access block

Access block intervention	Attributable mortality, relative risk (95% CI)	Attributable LOS increase, median (IQR)
Interhospital transfer[9,10]	1.38 (0–2.22)	4.0 (1.0–10.0)
Access delay from ED > 8 hours[12-14]	1.36 (0–1.56)	1.7 (1.0–2.5)
Premature ICU exit[15-17]	1.60 (1.37–1.86)	Unknown
After-hours ICU exit[16,18,19]	1.35 (1.28–1.42)	1.0 (0–2.0)
Postponed major surgery[22]	Unknown	2.0 (0–3.0)*

LOS = hospital length of stay (days). IQR = interquartile range. ED = emergency department. ICU = intensive care unit. * Unpublished hospital audits (G J D and D P). ◆

5 Average annual attributable effects of intensive care access block interventions

Access block intervention	Attributable fatalities, mean (95% CI)*	Attributable bed-days, median (IQR)*
Interhospital transfer	12.6 (0–40.0)	838 (210–2096)
Access delay from ED > 8 hours	34.3 (0–53.3)	775 (456–1549)
Premature ICU exit	4.0 (2.3–5.3)	0
After-hours ICU exit	40.5 (32.4–48.6)	1860 (0–3720)
Postponed major surgery	0	895 (0–2685)
Total/year	**91.1 (34.7–147.2)**	**4368 (333–10 050)**
Prevalence per day	0.25	12

IQR = interquartile range. ED = emergency department. ICU = intensive care unit.
* Figures calculated using data in Box 4 and formulae in Box 2. ◆

reports[11,13] and were derived using the best available data. The relative risks were based on Australian data, adjusted for casemix and illness severity, and are comparable with those published in other countries.[6,13,15]

The high rate of after-hours ICU exit is of particular concern. The risk associated with step-down from intensive care to standard care appears to be greatest when it occurs after hours (18:00 to 06:00).[18] Overnight, nurse–patient ratios remain constant in the ICU, but in low-acuity wards they fall to half their daytime levels, and medical staff are even scarcer.

Our research raises questions about the financial implications of access block. These may be considerable, but detailed analysis would be needed to determine their full extent. If improved access to intensive care reduces the total number of patient bed-days, the solution may be partly self-funding. Intensive care is not necessarily expensive when compared with the alternative of suboptimal care resulting in increased mortality and LOS.[23]

Up to 19% of intensive care beds were reported as unavailable[2] during the study period, possibly due to a lack of staff.[6] In response, the DHS has increased funding for intensive care services across Melbourne over the past 2 years (2008–2009), and has indicated a commitment to long-term solutions regarding ICU bed numbers, staffing, and monitoring of access block in Victorian hospitals.[5]

Access block should be routinely monitored and reported by health services as a key performance indicator of resources,[24] as recommended by the Australian Council on Healthcare Standards.[19] Reporting should cover all critically ill patients, not only those who receive intensive care. Those responsible for health service policy and funding decisions need these data.

There were important limitations to our methodology. Data collection was voluntary, the audit was retrospective and observational, and the attributable effects were based on historical estimates (with wide confidence intervals) rather than on actual outcomes.

Our methodology for calculating attributable effects assumed independence between each intervention, assumed a causal link between each intervention and outcome (mortality or LOS), and assumed that these effects were cumulative. These assumptions may have led to an overestimation of attributable effects.

The true rate of access block may be higher than reported here. With the exclusion of one hospital, and incomplete data from four other hospitals, and the exclusion of some intervention categories (such as a trial of standard care), it is likely that we have underestimated the true incidence of access block.

Assessment of the appropriateness of intensive care admission criteria and triage was beyond the scope of this study. This may warrant investigation to ensure that finite resources are used wisely. In Australia, trained and experienced intensivists control access to intensive care services.[7] We believe that inappropriate admission is unlikely.

These preliminary results suggest that access block has a significant impact on survival and resource use, and further study on the topic is warranted. Reporting solely on the quality of care provided to those fortunate enough to receive intensive care ignores the inequality of care to those who are unable to access those services.

COMPETING INTERESTS

None identified.

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REFERENCES

1 Moran JL, Bristow P, Solomon PJ, et al. Mortality and length-of-stay outcomes, 1993–2003, in the binational Australian and New Zealand intensive care adult patient database. *Crit Care Med* 2008; 36: 46-61.
2 Martin J, Anderson T, Turton C, et al. Intensive care resources & activity: Australia & New Zealand 2003–2005. Melbourne: Australian and New Zealand Intensive Care Society, 2007. http://www.anzics.com.au/uploads/ARCCCR_03_05Report_final_2007.pdf (accessed Feb 2009).
3 MA International. Planning for intensive care services in Victoria. June 2001. Melbourne: MA International, 2001. http://www.health.vic.gov.au/criticalcare/icuplan.pdf (accessed Feb 2009).
4 Victorian Government Department of Human Services. Monitoring adult intensive care. Victorian Intensive Care Data Review Committee annual report 2004–05. Melbourne: DHS, 2007.
5 Victorian Government Department of Human Services. Victoria's critical care services: strategic directions 2007–2012. Background paper. Melbourne: DHS, 2008. http://www.health.vic.gov.au/criticalcare/ccare-stratdir.pdf (accessed Feb 2009).
6 Duke GJ. Metropolitan audit of appropriate referrals refused admission to intensive care. *Anaesth Intensive Care* 2004; 32: 702-706.
7 Scheinkestel CD. The evolution of the intensivist: from health care provider to economic rationalist and ethicist [letter]. *Med J Aust* 1996; 164: 758-759.
8 Metcalfe MA, Sloggett A, McPherson K. Mortality among appropriately referred patients refused admission to intensive-care units. *Lancet* 1997; 350: 7-11.
9 Duke GJ, Green JV, Briedis J. Outcome of critically ill patients undergoing interhospital transfer. *Med J Aust* 2001; 174: 122-125.
10 Flabouris A, Hart GK, George C. Observational study of patients admitted to intensive care units in Australia and New Zealand after interhospital transfer. *Crit Care Resusc* 2008; 10: 90-96.
11 Sprivulis PC, DaSilva J, Jacobs IG, et al. The association between hospital overcrowding and mortality among patients admitted via Western Australian emergency departments. *Med J Aust* 2006; 184: 208-212.
12 Duke GJ, Green JV. Survival of critically ill medical patients is time-critical. *Crit Care Resusc* 2004; 6: 261-267.
13 Chalfin DB, Trzeciak S, Likourezos A, et al; DELAY-ED study group. Impact of delayed transfer of critically ill patients from the emergency department to the intensive care unit. *Crit Care Med* 2007; 35: 1477-1483.
14 Parkhe M, Myles PS, Leach DS, Maclean AV. Outcome of emergency department patients with delayed admission to an intensive care unit. *Emerg Med (Fremantle)* 2002; 14: 50-57.
15 Goldfrad C, Rowan K. Consequences of discharges from intensive care at night. *Lancet* 2000; 355: 1138-1142.
16 Duke GJ, Green JV, Briedis JH. Night-shift discharge from the Intensive Care Unit increases the mortality-risk of ICU survivors. *Anaesth Intensive Care* 2004; 32: 697-701.
17 Tobin AE, Santamaria JD. After-hours discharges from intensive care are associated with increased mortality. *Med J Aust* 2006; 184: 334-337.
18 Pilcher DV, Duke GJ, George C, et al. After-hours discharge from intensive care increases the risk of readmission and death. *Anaesth Intensive Care* 2007; 35: 477-485.
19 Australian Council on Healthcare Standards. Intensive care indicators. Clinical indicator users' manual. Version 3 for use in 2006. Canberra: ACHS, 2007. http://www.anzics.com.au/uploads/intensivecareindicatorsver0.4.doc (accessed Feb 2009).
20 Victorian Government Department of Human Services. Monitoring adult intensive care. Victorian Intensive Care Data Review Committee annual report 2005–06. Melbourne: DHS, 2008.
21 Victorian Government Department of Human Services. VAED manual. 15th ed. Melbourne: DHS, 2005.
22 Koomen EM, Hutten BA, Kelder JC, et al. Morbidity and mortality in patients waiting for coronary artery bypass surgery. *Eur J Cardiothorac Surg* 2001; 19: 260-265.
23 Talmor D, Shapiro N, Greenberg D, et al. When is critical care medicine cost-effective? A systematic review of the cost-effectiveness literature. *Crit Care Med* 2006; 34: 2738-2747.
24 Duke G, Santamaria J, Shann F, Stow P. Outcome-based clinical indicators for intensive care medicine. *Anaesth Intensive Care* 2005; 33: 303-310.

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