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REVIEW

Intensive care readmission: A contemporary review of the literature

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Summary ICU readmissions are a commonly used quality measure but despite decades of research, these adverse events continue to occur. Of particular concern is that readmitted patients have much worse prognoses than those not readmitted. In recent years new clinical service roles have evolved to assist ward staff with the care of acutely ill patients, such as those discharged from ICU. Given the recent emergence of these service roles, a review of contemporary ICU readmission studies was warranted to determine their impact on this adverse event.

Reviewed studies indicated the incidence of readmissions and outcomes of these patients have changed little in recent years. Few studies mentioned whether clinical service roles existed to support ward staff caring for patients recently discharged from ICU. Future research needs to focus on identifying modifiable factors in care processes to reduce the incidence and outcomes of this adverse event and to determine how clinical service roles can best help prevent its occurrence.

Introduction

Patients admitted to Intensive Care Units (ICU) are of the highest acuity, requiring management with life support technologies and aggressive interventions to sustain life and progress towards a clinically stable condition (Watts et al., 2007). The demand for intensive care services is escalating worldwide and being driven by increasingly sophisticated technology, increasing numbers of older patients with co-morbidities and increased consumer expectations (Williams et al., 2010a). Due to the costs associated with intensive care provision and the scarcity of these resources, in recent years significant attention has been given to ICU quality measures (de Vos et al., 2007; McMillan and Hyzy, 2007). These measures can be assessed in numerous ways including risk-adjusted outcomes, incident monitoring and access indicators (Hewson and Burrell, 2006).

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Implications for Clinical Practice

- Having survived a critical illness, many post-ICU patients are at risk of readmission to ICU.
- Older patients with co-morbidities are at greater risk of ICU readmission than others.
- The specific factors contributing to or associated with ICU readmission are not clear. Ward staff caring for post-ICU patients should monitor these patients closely to ensure progress towards desired clinical outcomes.

One of the more frequently cited ICU quality measures is readmission to ICU during the same hospitalisation. These events are a significant concern because they carry greater risk for adverse outcomes than other types of ICU admissions (Schorr, 2012). Furthermore as they are considered a marker of ICU and hospital care quality, ICU readmissions may be used for resource allocation or to compare performance between ICUs (Berenholtz et al., 2002; Halpern, 2011).

Two reviews of ICU readmission research were published in the last decade (Elliott, 2006; Rosenberg and Watts, 2000). The reviews found on average 7% of patients are readmitted to ICU and primarily for respiratory and cardiac reasons. Readmitted patients had poorer prognoses, were older and more acute on their first ICU admission than those not readmitted; they also had higher mortality rates than non-readmitted patients. Some of the reviewed studies suggested that abnormal vital signs at the time of ICU discharge may be predictive of readmission but it is unclear if ward staff act upon these. No clear causes or risk factors for readmission were identified in the two reviews and despite three decades of research, the factors leading to unplanned ICU readmission are still not clearly understood (Baker et al., 2009). This may be because risk factors for ICU readmission have not been well studied or are not reproducible (Zimmerman, 2008).

During the period in which the reviews were published, a number of clinical resources evolved to assist ward staff with the care of acutely challenging patients including those recently discharged from ICU. The new resources developed out of necessity as post-ICU patients are a high risk group for adverse events due to their complex care needs (Chaboyer et al., 2008). Ideally, ICU readmission is avoided by monitoring post-ICU discharge progress and promptly recognising when patients are unwell or in a deteriorating condition so as to permit appropriate interventions (Williams et al., 2010b).

The new clinical resources aim to achieve this and include ICU Liaison Nurses, Medical Emergency Teams and Critical Care Outreach Teams (Endacott and Chaboyer, 2006; Green and Edmonds, 2004; MERIT Study Investigators, 2005). A recent study found that ICU Liaison Nurses now exist in 27% of Australian hospitals which have an ICU and that these Nurses have a positive impact on patient outcomes (Athifa et al., 2011; Eliott et al., 2012; Endacott et al., 2010). There is also evidence of the positive impact of Medical Emergency and Critical Care Outreach Teams (Chen et al., 2009; Endacott et al., 2009).

Aim

Given the growing popularity of these new clinical support services and the impact they seem to have on patient outcomes, a review of contemporary ICU readmission research is warranted. The aim of this review is to determine if the nature or characteristics of ICU readmissions have changed in recent years, in light of the new clinical support services. The specific questions addressed by the review are:

I. What is the incidence of ICU readmission?
II. What are the risk factors for ICU readmission?
III. What are the characteristics and outcomes of patients readmitted to ICU?
IV. Is there evidence in the literature of the new clinical support services influencing ICU readmissions?

Methods

A search was conducted of the electronic databases Medline, CINAHL, PubMed and Scopus for publications from 2006 onwards. Key search terms were: intensive or critical care; readmission; recidivism; and discharge. Inclusion criteria were research based publications on adult ICU readmission and published after 2005 in English language peer-reviewed journals. This date was chosen as the most recent review of ICU readmissions was published in 2006 and therefore included studies prior to this date (Elliott, 2006).

Abstracts from intensive care conferences were also searched via professional bodies' websites and publications. These included the Australian College of Critical Care Nurses, British Association of Critical Care Nurses and the Society of Critical Care Medicine. Some of these sites contained links to each organisation's professional journal; these were also searched for relevant publications. Reference lists of identified studies were also reviewed to locate further studies not found by the search strategy. Exclusion criteria were studies on paediatric or cardiac ICU patients and those not published in English.

Literature identified by the search strategy was appraised using guidelines for determining methodological quality; this helped to establish whether to include identified studies in the review (Greenhalgh, 2010; see Table 1). Studies were assessed by a single reviewer. Studies chosen for inclusion were then ranked using national guidelines, to rate their evidence level (NHMRC, 2008; see Table 2).

Findings

After inclusion and exclusion criteria were applied, thirty-five studies were identified for review. The research methods used included case control studies and prospective observational studies. The most popular method was retrospective review of prospectively collected clinical data. Sample sizes ranged from 205 to 263,082 patients (see Table 3). Varying definitions of ICU readmission were used

Table 1 Summary of appraisal guidelines.

Quantitative studies	Qualitative studies
How were subjects recruited?	Was a qualitative approach appropriate for the research question?
Was the study design appropriate to the field of research addressed (e.g. prognosis, causation)?	How were the setting and subjects selected?
Were the inclusion and exclusion criteria appropriate?	What data collection methods were used? Are these described in enough detail?
How were outcomes defined and measured?	What data analysis methods were used?
For a cohort or case—control study, were the controls appropriate?	How was rigour of the research findings established?
Have *p* values been calculated and interpreted appropriately?	Were the conclusions justified by the findings? Has the researcher's perspective been taken into account?
Was the study large enough to make the findings credible?	Are the study findings transferable to other clinical settings?

(see Table 4). A narrative analysis was conducted as heterogeneity of research methods and study samples meant that neither systematic review nor meta-analysis were possible.

Readmission rate

The ICU readmission rate ranged from 1.3% to 13.7% of discharged patients. The lowest rate was in a nested case-control study of 1405 admissions to a 22 bed Australian ICU during a 12-month period (Ho et al., 2006). The purpose of the study was to assess the ability of potential clinical predictors to predict ICU readmission. The highest readmission rate was in a prospective observational cohort study of 546 patients discharged from a general medical-surgical ICU in an 801 bed hospital in Brazil (de Araujo et al., 2013).

Readmission risk factors

Eleven studies identified statistically significant risk factors for ICU readmission. These factors were: patient location before ICU admission; acute physiology score at the time of ICU admission; APACHE II score, older age; co-morbidities; ICU length of stay; physiologic abnormalities at the time of ICU discharge or on the ward; ICU discharge at night or after hours; discharge to another critical care area or hospital; shock index (heart rate/systolic blood pressure), respiratory rate and Glasgow Coma Score; and higher Nursing Activity Score at the time of discharge.

Ten studies reported the disease processes of readmitted patients. The most common involved the cardiac and respiratory systems such as respiratory failure, arrhythmias and myocardial ischaemia. Sepsis was the next most common disease process resulting in ICU readmission. Some disease processes were associated with a statistically greater risk of ICU readmission. These included: ischaemic heart disease, cerebrovascular disease, pneumonia, sepsis, heart failure, chronic liver disease, diabetes mellitus and chronic obstructive pulmonary disease (COPD), viral hepatitis, subarachnoid haemorrhage, non-operative gastrointestinal disorders, haematological conditions, cervical spine injury and hepatic failure.

Table 2 NHMRC Evidence Hierarchy.

Level	Intervention
I	A systematic review of level II studies
II	A randomised controlled trial
III-1	A pseudorandomized controlled trial
III-2	A comparative study with concurrent controls: • non-randomised experimental trial • cohort study • case—control study • interrupted time series with a control group
III-	A comparative study without concurrent controls: • historical control study • two or more single arm study interrupted time series without a parallel control group
IV	Case series with either post-test or pre-test/post-test outcomes

Table 3 ICU readmission studies.

Study	Design	Sample	Evidence level	Key findings
de Araujo et al. (2013). Brazil	Prospective observational cohort study	977 patients discharged from two ICUs	III-2	Readmission rate 13.7% in medical-surgical ICU; 9.3% in trauma/neurosurgical ICU. Readmissions resulted in increased morbidity, length of stay and total costs.
Kramer et al. (2013). North America	Retrospective cohort study	263,082 admissions to 105 ICUs in 46 hospitals	III-2	Readmission rate 6.3%. Readmitted patients had higher post-discharge mortality (21.3% vs 3.6%), longer initial ICU lengths of stay (4.9 vs 3.4 days) and longer hospital stays (13.3 vs 4.5 days); $p < .001$.
Kramer et al. (2012). North America	Retrospective cohort study	229,375 admissions to 97 ICUs in 35 hospitals	III-2	Readmission rate 6.1%. Risk factors included location before ICU admission, age, co-morbidities, diagnosis, ICU length of stay, physiologic abnormalities at time of discharge and discharge to a step-down unit ($p < .001$).
Ouanes et al. (2012). France	Retrospective analysis of prospective database	3462 patients admitted to four ICUs	Not ranked	Post-ICU mortality or readmission rate 7%. Independent risk factors for post-ICU mortality or readmission: age ($p < .002$), SAPS II score at ICU admission ($p < .0001$), use of a central venous catheter ($p < 0.0001$) and discharge at night ($p < .002$).
Laia et al. (2012). Taiwan	Retrospective analysis of prospective database	192,201 patients admitted to ICU	Not ranked	Readmission rate 13%. Risk factors for readmission ($p \leq .05$): age >39 years, female gender, ischaemic heart disease, cerebrovascular disease, pneumonia, sepsis, heart failure, chronic liver disease, diabetes mellitus and COPD.
Brown et al. (2012). North America	Retrospective cohort study	196,202 patients admitted to 156 ICUs	III-2	2% of readmissions occurred within 48 hours of discharge; 3.7% within 120 hours. Median time to readmission was 3 days. Medical patients in tertiary hospitals had higher odds of 48 hour (OR 1.51; 95% CI 1.12—2.02) and 120 (OR 1.63; 95% CI 1.24—2.16) hour readmission than patients in community hospitals.

Table 3 (*Continued*)

Study	Design	Sample	Evidence level	Key findings
Timmers et al. (2012). Netherlands	Prospective observational cohort study	1682 patients discharged from a surgical ICU	III-2	Readmission rate 8%; 20% were readmitted within 48 hours. Main causes of readmission were respiratory failure (48%), cardiac problems (16%) and sepsis (14%). Readmitted patients were older, mostly had vascular disease (39%) or gastrointestinal surgery (25%), had higher initial illness acuity scores ($p = .003$; $p = .007$) and more co-morbidities ($p = .005$). Long-term mortality rate was significantly higher in readmitted patients.
Abu-Awwad and Buran (2012). North America	Retrospective analysis	6194 patients discharged from medical ICU	Not ranked	3.6% of patients were readmitted or died within 72 hours of ICU discharge. Risk factors predicting readmission included heart rate/blood pressure index, temperature, respiratory rate, GCS, haemoglobin and lymphocyte count ($p < .015$ for all factors).
da Silva et al. (2011). Brazil	Longitudinal prospective study	600 patients admitted to ICU in 4 hospitals	III-2	Readmission rate 9.1%. Antecedents related to infectious or parasitic diseases increased the risk of readmission (OR 2.97; 95% CI 1.23—7.22, $p = .016$). Higher Nursing Activity Score at discharge decreased the readmission risk (OR 0.98; 95% CI 0.95—1.0, $p = .036$).
Renton et al. (2011). Australia	Retrospective longitudinal study	247,103 patients discharged from 38 ICUs	III-3	Readmission rate 5.5%. Factors increasing risk of readmission: admission source other than elective surgery; any chronic health issue; tertiary hospital ICU and discharge after hours (OR > 1.05; $p < .001$). Diagnoses associated with a greater risk of readmission: subarachnoid haemorrhage, non-operative gastrointestinal disorders, haematological conditions, isolated cervical spine injury and hepatic failure (OR > 2; $p < .001$). In-hospital mortality rate was nearly 5 times greater for readmitted patients (OR 5.4; 95% CI 5.1—5.7, $p < .001$).

Table 3 (*Continued*)

Study	Design	Sample	Evidence level	Key findings
Lone (2011). Scotland	Retrospective cohort study	8413 patients admitted to ICU	III-2	Readmission rate 9.6%. Independent predictors of readmission: out of hours discharge ($p < .007$); one or more co-morbidities (<.002); and discharge to another critical care area or hospital ($p < .001$).
Elliott et al. (2011). Australia	Qualitative analysis of clinicians' opinions.	21 clinical nurses, educators and managers	Not ranked	Key factors associated with readmission: premature ICU discharge, delayed medical care on the ward, heavy nursing workloads on the wards, lack of adequately qualified staff and clinically challenging patients.
Utzolino et al. (2010). Germany	Retrospective analysis	2558 patients discharged from a surgical ICU	Not ranked	Readmission rate 8.3% in elective discharges and 25.1% in unplanned discharges ($p < .001$). Half of all readmissions were for surgical complications. Half of all readmissions had initially been discharged electively. Hospital mortality rate was 5.8 times higher for readmitted patients ($p < .001$). Readmission for respiratory failure accounted for most of the mortality.
Miller et al. (2010). England.	Retrospective audit	2127 admissions to a medical-surgical ICU	Not ranked	Readmission rate 5.7%. 10.4% of readmitted patients were discharged out of hours. 28.7% of readmissions occurred between days 2 and 7.
Makris et al. (2010). Australia	Retrospective case—control study	205 patients readmitted to a medical-surgical ICU within 72 hours	III-2	Readmission rate 3.1%. Readmitted patients had significantly higher overall mortality (OR 4.7, 95% CI 2.1—10.7). Independent risk factors for readmission: chronic respiratory disease (OR 3.7, 95% CI 1.2—12, $p = .029$), pre-existing anxiety/depression (OR 3.3, 95% CI 1.7—6.6, $p < .001$), immobility (OR 2.3, 95% CI, 1.4—3.6, $p = 0.001$), enteral nutrition (OR 2.0, 95% CI 1.0—4.0, $p = 0.041$) and non-weekend ICU discharge (OR 1.9, 95% CI 1.1—3.5, $p = 0.029$). Physiological derangement on the ward strongly predicted readmission (OR 26, 95% CI 8.0—81, $p < 0.001$), though only 20% of patients meeting MET criteria had a MET call made.

Table 3 (*Continued*)

Study	Design	Sample	Evidence level	Key findings
Frost et al. (2010). Australia.	Inception cohort study	14,952 patients discharged from a single ICU	III-2	Readmission rate 6.6%. Readmitted patients were more likely to have an ICU stay of 7 days or more odds ratio (OR 2.2, 95% CI, 1.85—2.56, $p < .001$), been non-electively admitted initially (OR 1.7, 95% CI, 1.44—2.08, $p < .01$) and have acute renal failure (OR 1.6, 95% CI 0.97—2.47, $p < .001$). Patients initially admitted to ICU from general wards, the emergency department or other hospitals had a higher risk of readmission.
Lee et al. (2009). South Korea	Prospective observational study	25,717 admissions to 8 ICUs	III-3	1.5% of patients were readmitted within 3 days. Respiratory and cardiovascular problems were most common reason for readmission. The risk of readmission increased when the APACHE II score at the time of discharge exceeded 8.5 (OR 1.16, CI 1.03—1.30, $p < .013$). A 1 point increase in the score was associated with a 21% increased risk of readmission (OR 1.21, 95% CI 1.108—1.325, $p < .05$)
Butler et al. (2009). North America	Retrospective cohort study	6511 patients discharged from ICU	III-2	Readmission rate 6%. Readmitted patients had higher APACHE II and SAPS II scores (16 vs 14; $p < 0.001$). Patients with gastrointestinal disorders were most likely to be readmitted, followed for gastrointestinal surgery for neoplasms and congestive cardiac failure.
Japiassul et al. (2009). Brazil	Prospective observational study	577 patients admitted to a mixed ICU	III-3	Readmission rate 10.7%. Average time to readmission was 9 days. Readmitted patients: tended to be older (75 vs 67 years; $p < .01$); were more likely to be admitted with respiratory insufficiency or sepsis (33 vs 13%, $p < .01$); admitted for medical reasons (49 vs 32%, $p < .05$); have first ICU stay longer than 3 days (35 vs 23%, $p < .01$) and have higher SAPS II scores (27 vs 23, $p < .01$). Older age, acute physiology score and admission for respiratory problems or sepsis were independently associated with readmission.

Table 3 (*Continued*)

Study	Design	Sample	Evidence level	Key findings
Ho et al. (2009). Australia	Linked data cohort study	16,926 admissions to a single ICU	III-2	Readmission rate 3.9%. Readmitted patients were older, were more likely to be originally admitted from the ward or operating theatre, had higher acute physiology scores and more co-morbidities. Early readmissions ($\leq$72 hours) were associated with an increased risk of hospital mortality (OR 1.68, 95% CI 1.18—2.39, $p = .004$).
Chrusch et al. (2009). Canada	Prospective cohort study	8693 admissions to 1 medical and 1 surgical ICU	III-2	Readmission rate 5.3%. There was a positive correlation between ICU readmission and average ICU occupancy. Significant risk factors for readmission or post-ICU death: age >35 years (OR 1.46, CI 1.02—2.07, $p < .05$), respiratory diagnosis (OR 1.73, CI 1.11—2.68, $p < .05$), sepsis (OR 1.66, CI 1.08—2.55, $p < .05$), gastroenterology diagnosis (OR 2.55, CI 1.54—4.25, $p < .05$), thoracic surgery (OR 2.79, CI 1.64—4.73, $p < .05$), neurosurgery (OR 1.95, CI 1.14—3.33, $p < .05$), APACHE II score 10—19 (OR 1.5, CI 1.0—2.24, $p < .05$), ICU length of stay 3—10 days (OR 1.72, CI 1.35—2.18, $p < .05$) and ICU discharge at a time of no vacancy (OR 1.56, CI 1.05—2.31, $p < .05$).
Chan et al. (2009). Taiwan	Retrospective medical chart audit	945 discharges from 4 surgical ICUs	Not ranked	Readmission rate 11.6%. Readmitted patients were older, had a longer initial ICU stay (8.05 vs 5.22 days, $p < .001$) were sicker during their initial admission and had higher mortality rates (40% vs 3.6%, $p < .001$). Nearly half of the patients (46.4%) were readmitted with the same diagnosis. Respiratory disease was the most common diagnosis for patients readmitted with a new problem.
Baker et al. (2009). North America	Retrospective comparative analysis	3233 patients discharged from a neuroscience ICU	Not ranked	Readmission rate 3% (39% within 24 hours; 78% within 48 hours). The odds of a patient being readmitted within 72 hours were 2.5 times higher on days when $\geq$9 patients were admitted to ICU (OR 2.43, 95% CI 1.39—4.26, $p < .05$). The odds of readmission were nearly 5 times higher when $\geq$10 patients were admitted (OR 4.99, CI 2.45—10.17, $p < .05$).

Table 3 (*Continued*)

Study	Design	Sample	Evidence level	Key findings
Matsuoka et al. (2008). Japan	Retrospective cohort	1835 patients admitted to a single ICU	III-2	Readmission rate 7.7%. In 14.9% of patients, the reason for readmission was lung oedema or atelectasis.
Kaben et al. (2008). Germany	Logistic regression analysis	2852 patients discharged from a surgical ICU	Not ranked	Readmission rate 13.4%. Readmitted patients had higher SAPS II scores (37 vs 33, $p < .001$) on initial ICU admission, high in-hospital mortality rates (17.1% vs 2.9%, $p < .001$). Higher risk of readmission was associated with: age (OR 1.13; 95% CI 1.03—1.24; $p = .04$), maximum sequential organ failure score (OR 1.04 per point; 95% CI 1.01—1.08; $p = .04$) and C-reactive protein level on the day of discharge (OR 1.02; 95% CI 1.01—1.04; $p = .035$).
Gajic et al. (2008). North America	Prospective cohort study	1131 patients admitted to one medical and one medical-surgical ICU	III-2	Readmission rate 8.8%. Reasons for readmission included respiratory failure, haemorrhage, infection, arrhythmia and myocardial ischaemia. Predictors of readmission: ICU admission source (OR 2.256, 95% CI 1.437—3.540, $p < .01$), ICU length of stay (OR 1.404, 95% CI 1.098—1.795, $p < .01$) and requirement for complex pulmonary management (OR 2.149, 95% CI 1.010—4.576, $p < .05$).
Conlon et al. (2008). Ireland	Retrospective review of prospectively collected data	1061 patients discharged from a medical-surgical ICU	Not ranked	Readmission rate 7.4%. Common diagnoses leading to readmission were categorised as respiratory, cardiovascular and septic shock. The most common cause of readmission was respiratory infection.

Table 3 (*Continued*)

Study	Design	Sample	Evidence level	Key findings
				Readmitted patients were older 66.9 vs 61.7 yrs, $p < .005$), more likely to have been an emergency ICU admission (60% vs 31.7%, $p < .001$) and had higher APACHE II scores (14.4 vs 10.2, $p < .001$). Readmitted patients had double the incidence of death in ICU (19.2% vs 9.1%, $p = .005$).
Campbell et al. (2008). Scotland	Secondary analysis of clinical audit data	475 patients discharged from a medical-surgical ICU	Not ranked	Readmission rate 8.8%.
				Independent risk factors for readmission: surgical admitting specialty (OR 1.27, 95% CI 0.97—1.64, $p < .078$), APACHE II score (OR 1.05, CI 1.03—1.06, $p < .001$) and mean TISS (OR 1.04, CI 1.02—1.05, $p < .001$).
Song et al. (2007). Korea	Retrospective review of prospectively collected data	1087 patients admitted post-operatively to ICU	Not ranked	Readmission rate 8.6%.
				Most common reason for readmission was pulmonary complications such as acute respiratory distress syndrome (60% of patients). Readmission was associated with a higher risk of in-hospital mortality. A third of patients died in ICU after readmission.
Pilcher et al. (2007). Australia	Retrospective analysis of prospectively collected data	76,690 patients discharged from multiple ICUs	Not ranked	Readmission rate 5.3%.
				Patients discharged after hours (>1800 hours) had a higher readmission (6.3% vs 5.1%, $p \leq .0001$) and mortality rates (8% vs 5.3%, $p \leq .0001$).
Klimasauskas and Kekstas (2007). Lithuania	Retrospective cohort study	13,343 patients admitted to 3 ICUs	III-2	Readmission rate 6.4%.
				Patients readmitted within 48 hours had higher mortality than those readmitted later (25.1% vs 20.1%, $p = .045$ and $p = .097$).

Table 3 (*Continued*)

Study	Design	Sample	Evidence level	Key findings
Boudesteijn et al. (2007). Netherlands	Retrospective case—control study	1393 patients admitted to a medical-surgical ICU	III-2	Readmission rate 1.8%. Most common reason for readmission (68%) was respiratory deterioration. 39% of readmitted patients died. In multivariate analysis, significant predictors of readmission were: age (OR 1.1, 95% CI 1.0—.1.3, $p = .03$) ventilator time during first admission (OR 1.1, CI 1.0—1.1, $p = .03$). Readmitted patients had a significantly longer ventilation times (during both admissions) and total ICU length of stay.
Ho et al. (2006). Australia	Nested case—control study	1405 admissions to a single ICU	III-2	Readmission rate 1.3%. C-reactive protein concentration within 24 hours before ICU discharge was associated with a higher risk of readmission ($p < .0001$).
Frankel et al. (2006). North America	Retrospective analysis of prospectively collected routine clinical data	4956 patients admitted to a surgical ICU	Not ranked	Readmission rate 1.8%. Most common reason for readmission was respiratory problems: 46% of readmissions before, 51% during and 80% after implementation of accreditation council staffing guidelines.
Alban et al. (2006). North America	Prospective observational study	10,840 patients admitted to a surgical ICU	III-3	Readmission rate 2.7%. Readmitted patients had higher APACHE II scores on the day of original ICU discharge (15.7 vs 13.8, $p < .001$). Initial ICU length of stay was longer for readmitted patients (4.9 vs 3.2 days, $p < .001$). Readmission significantly increases the risk of mortality independent of the admission severity score.

OR = Odds Ratio; CI = Confidence Interval; APACHE = Acute Physiology and Chronic Health Evaluation; TISS = Therapeutic Intervention Scoring System; MET = Medical Emergency Team; SAPS = Simplified Acute Physiology Score.

Table 4 Definitions of ICU readmission.

Definition	Citing studies	
Returning to ICU during the same hospitalisation	de Araujo et al. (2013) Ouanes et al. (2012) da Silva et al. (2011) Renton et al. (2011) Miller et al. (2010) Frost et al. (2010) Butler et al. (2009) Ho et al. (2009)	Chan et al. (2009) Kaben et al. (2008) Conlon et al. (2008) Campbell et al. (2008) Pilcher et al. (2007) Ho et al. (2006) Alban et al. (2006)
Returning to the same or different ICU after discharge to an area that provided a lower level of care during the same hospitalisation	Kramer et al. (2012, 2013)	
Returning to the same ICU during a single hospitalisation	Brown et al. (2012) Lone (2011)	
More than one admission to ICU during a 12 month period	Laia et al. (2012)	
A return to ICU within 48 hours	Boudesteijn et al. (2007)	
A return to ICU within 72 hours	Makris et al. (2010) Baker et al. (2009)	
A return to ICU within 7 days	Chrusch et al. (2009) Gajic et al., 2008	
A return to ICU within 30 days	Timmers et al. (2012) Matsuoka et al. (2008)	
Returning to ICU during the same hospitalisation or within 3 months of ICU discharge	Japiassul et al. (2009)	
None provided	Abu-Awwad and Buran (2012) Elliott et al. (2011) Utzolino et al. (2010) Lee et al. (2009)	Song et al. (2007) Klimasauskas and Kekstas (2007) Frankel et al. (2006)

Patient characteristics

Many studies described the characteristics of patients readmitted to ICU. Compared with those who were not readmitted, readmitted patients: tended to be older; had more co-morbidities; had more non-surgical diagnoses; had undergone emergency instead of elective surgery; had higher illness severity scores (e.g. APACHE); and had longer initial ICU lengths of stay. In one study of 977 patients, those readmitted had lower Glasgow Coma Scores on the day of ICU discharge than those not readmitted (de Araujo et al., 2013).

Mortality

Five studies reported readmitted patients have much higher mortality rates than those not readmitted. In two studies for example, the in-hospital mortality rate was five times greater for readmitted than non-readmitted patients (Renton et al., 2011; Utzolino et al., 2010). One of these was a retrospective longitudinal study of 247,103 patients discharged alive from 30 Australian ICUs. Similarly, up to a third of readmitted patients died in ICU in a Korean study of post-operative ICU patients (Song et al., 2007).

The highest reported mortality rate for readmitted patients was 41.9% (de Araujo et al., 2013). This was a prospective observational cohort study based on data from a medical-surgical ICU. Of the patients who survived their readmission and were discharged to a ward, another 21% died (de Araujo et al., 2013). The causes of death of readmitted patients were not reported in most reviewed studies.

Discussion

This literature review included studies on ICU readmission published after 2005. The aim was to determine if the nature or characteristics of ICU readmissions have changed in recent years, particularly in light of new clinical support services such as Liaison Nurses. Thirty-five studies were

identified for review, suggesting that ICU readmissions continue to be a substantial clinical problem. This is noteworthy as ICU beds are a significant cost driver for tertiary hospitals (Williams et al., 2010a).

Compared with studies published before 2006, the review found the average ICU readmission rate has changed little in recent years. This is not surprising, as a widely cited study conducted in 10 hospitals in North America found that adverse events such as patient harm continue to occur, despite being highlighted as an acute clinical problem more than a decade ago (Kohn et al., 2000; Landrigan et al., 2010). This may simply be because there are few known effective patient safety interventions or that the gold standard instrument for measuring patient safety problems is too blunt to detect changes with time (Shojania and Thomas, 2013).

There are a number of possible reasons the readmission rate remains unchanged. Firstly the key factors associated with ICU readmission may not be modifiable or amenable to better standards of care. The reviewed studies found for example that readmitted patients tend to be older than those not readmitted. With the ageing process comes an increased incidence of co-morbidities and functional impairment (Mitniski et al., 2007; Song et al., 2007). Elderly patients are therefore less able to meet the physiological demands of critical illness (Vosylius et al., 2005). As age is not a modifiable factor in care processes, there will always be a risk of older post-ICU patients needing further ICU care, thus sustaining the readmission rate.

A second possible reason for the lack of recent change in the readmission rate is that the research methods used may not have been sensitive enough to identify key contributing factors (Zimmerman, 2008). Many of the reviewed studies involved retrospectively collected data and thus represent a weaker form of evidence. There are inherent problems with using retrospectively collected data. For example key data may not have been collected and thus would not appear in research analyses. Alternate methods of data collection and analysis may need to be considered in future research on ICU readmission.

A further reason the readmission rate remains unchanged is the heterogeneity of ICUs in which research was conducted. Local organisational factors which influence care processes may be a significant contributor to ICU readmissions and these factors may differ between hospitals (Maia et al., 2012). For example, a study of 55 ICUs in Switzerland found marked heterogeneity in ICU discharge processes (Heidegger et al., 2005). A recent review also found that only a small number of ICUs used written patient discharge guidelines, a crucial part of the discharge process (Lin et al., 2009).

Factors associated with the transfer of a patient from ICU include limited resources within the health care system, ICU and ward bed availability, ward nursing practices, conflicting objectives of clinical staff and the need for follow-up services (Chaboyer et al., 2012; James et al., 2013; Lin et al., 2013; Wu and Coyer, 2007). Faced with the pressure for an ICU bed, staff may choose to discharge the least acute ICU patient to free a bed for a more acute patient (Chalfin et al., 2007; Chan et al., 2012). The habit of discharging ICU patients to the ward quicker and sicker though is not new (Chaboyer et al., 2002). The increased stress and workload ward staff experience when caring for these complex patients have therefore been described (Whittaker and Ball, 2000).

Post-ICU patients are at particular risk for adverse events because of the severity of their illness and complexity of care required (Williams et al., 2010c). Discharging patients from ICU before they are ready further increases the risk of readmission because wards may not be resourced to provide the higher level of care post-ICU patients still require. The need for ward staff to develop the unique skills needed to care for post-ICU patients has been previously highlighted as an important strategy to help minimise the readmission rate (Russell, 1999). Involving ICU and ward staff in the ICU discharge process may help improve patient outcomes and avoid adverse events such as readmission (Chaboyer et al., 2012; Perren et al., 2008).

The time of ICU discharge has also been found to affect some patients' outcomes. Research has demonstrated that being discharged from ICU after hours increases the risk of readmission and post-ICU mortality (Gopal et al., 2010; Pilcher et al., 2007). Key reasons for this may include lower staffing levels on the wards at night time combined with inadequate clinical handover or poor appraisal of patient needs (Obel et al., 2007; Singh et al., 2010).

Whilst some of the reviewed studies demonstrated a link between after hours discharge and ICU readmission, it was not a common finding. Again this may reflect limitations of the research methods used, rather than this not being the case in clinical practice. It could also be that clinicians today are more aware of the risks associated with the timing of ICU discharge and therefore try to avoid certain discharge times.

The definition of an ICU readmission may also influence data collection and any conclusions reached. Most studies defined readmission as a return to ICU during the same hospitalisation, although six other definitions were also used. The limitations of this popular definition have been highlighted previously (Elliott, 2012). The most significant is that readmissions occurring many days or weeks after first ICU discharge may be due to care processes on the ward unrelated to ICU care or the discharge process. Four studies overcame this limitation by focussing only on readmissions within 72 hours or seven days of discharge. These studies' findings may be the most important for making recommendations about how to modify ICU care to avoid future readmissions.

There is also the challenge of distinguishing between risks and causes of ICU readmission. Most patients are admitted to ICU because of the need for respiratory and/or cardiovascular support. Regardless of whether a patient is admitted two, three or more times to ICU, the need for respiratory or cardiovascular support is the main reason for the admission. Stating this as the cause or reason for readmission fails to identify the actual factors contributing to this adverse event.

Isolating the root causes of ICU readmissions is therefore extremely important for improving future patient outcomes. Stating that a patient was readmitted because of respiratory failure for example does not highlight the true cause of the respiratory failure or the readmission. The respiratory failure for example may have developed because the patient was discharged from ICU prematurely, because of discontinuity of care between ICU and the ward, or because of

inexperienced ward staff not having the knowledge and skills needed to provide essential care. Important questions to ask about readmitted patients therefore include, was there adequate resolution of the primary health problem at the time of discharge or an underestimation of the risk of deterioration after ICU discharge (Russell, 2012). Asking these questions may be a starting point in isolating the root causes of readmissions.

This review found the mortality rates of readmitted patients have also changed little over time compared with previous research. The factors associated with post-ICU mortality have also changed little (Elliott et al., 2013). Given that readmitted patients tend to be older and sicker on first admission, as evidenced by acute physiology scores, it is not surprising contemporary research has found little change in these mortality rates.

A recent meta-analysis demonstrated a relationship between increasing ICU severity of illness scores and the risk of ICU readmission (Frost et al., 2009). This would seem an important point and relationship to consider when caring for these patients. Post-ICU patients who had higher severity of illness scores may therefore be the cohort to benefit the most from the input of clinical support services such as Liaison Nurses and Critical Care Outreach Teams. This is an area requiring further research.

As few studies commented on whether the study hospitals utilised ICU Liaison Nurses, Medical Emergency or Critical Care Outreach Teams, a link between these clinical services and ICU readmissions cannot be established in this review. However, this does not mean these new services do not improve patient outcomes. ICU Liaison Nurses for example have been shown to have a role in preventing major adverse events such as unexpected death, and promoting more efficient ICU discharge such as reducing ICU discharge delay (Chaboyer et al., 2006; Eliott et al., 2008; Endacott et al., 2010). Critical Care Outreach Teams have been demonstrated to decrease the proportion of patients admitted to ICU who received cardiopulmonary resuscitation prior to admission (Harrison et al., 2004). Medical Emergency Teams have been associated with an independent reduction in hospital mortality (Tobin and Santamaria, 2012).

A methodological challenge in trying to establish a relationship between these services and ICU readmissions is that readmission may not be sensitive enough or an appropriate outcome measure to use for service evaluation. It may also be that data currently collected on readmitted patients are not sensitive enough. This may be why some studies were unable to demonstrate a positive impact of ICU Liaison Nurses or Critical Care Outreach Teams (Williams et al., 2010b). The complexities in evaluating the efficacy of Outreach Teams have been noted by others (Esmonde et al., 2006; McGaughey et al., 2007). Alternate data may therefore need to be collected or other data collection methods used.

Recently there has been a call for critical care professional groups to proactively address issues such as ICU discharge processes, enhanced ward coverage of patients at increased risk of ICU readmission and increased use of Medical Emergency Teams (Russell, 2012). Whilst it is likely new clinical services such as Critical Care Outreach Teams and ICU Liaison Nurses positively influence the care of post-ICU patients and their outcomes, more research using appropriate quality measures is needed to determine this.

Recognising and managing patients at high risk of ICU readmission is important for maximising patient outcomes and minimising ICU admission costs (Fialho et al., 2012). This emphasises a key role for clinical support services such as Liaison Nurses. Contemporary research examining ICU readmissions though has not investigated the impact of these services. Research designs such as prospective multi-centre follow-up studies are needed to determine the impact of these services on ICU readmissions.

Limitations

This literature review has a number of limitations. Whilst it reviewed contemporary research on ICU readmission, some of the studies used data that were collected prior to 2005. For example, a study published in 2009 used data collected before the year 2000 (Chrusch et al., 2009). As clinical support services such as ICU Liaison Nurses are relatively new, it is possible they did not exist in some hospitals during the data collection periods.

A further limitation is the validity of comparing studies involving heterogenous populations and those involving single and multiple sites. Whilst the review only included studies on adult patients discharged from non-cardiac ICUs, criteria for admission, discharge and readmission likely varied dramatically between ICUs and between countries (Russell, 2012). Although it is important to apply inclusion and exclusion criteria in a review, such criteria are not able to take into account differing clinical practices such as these.

Finally, heterogeneity of reviewed studies prevented a systematic review or meta-analysis being conducted. Hence most of the studies represent weaker forms of clinical evidence as indicated by the NHMRC criteria. It should be noted though that criteria for evaluating evidence, such as those proposed by the NHMRC, are often biased in favour of quantitative methods and in particular, randomised controlled trials. Studies using qualitative methods receive no ranking. The failure of some of the reviewed studied to be ranked as higher levels of evidence (or to receive any ranking) is also very much due to the nature of the research problem being investigated and that an intervention was not being trialled. All the reviewed studies instead focussed on a clinical outcome.

Conclusion

This review highlighted that despite three decades of research on ICU readmissions and the emergence of new clinical service roles to improve acute patients' outcomes, the readmission rate and outcomes of readmitted patients have changed little over time. Due to limitations of published studies it has not been possible to demonstrate if the new service roles, as important clinical resources, make a difference to ICU readmissions.

Future research needs to focus on identifying modifiable factors in care processes to reduce the incidence and outcomes of this chronic clinical problem. Given the administrative and patient care frustrations associated with ICU

readmissions, clinicians are faced with finding a solution to decrease or prevent these adverse events (Schorr, 2012). Decades of research exist on ICU readmissions but a contemporary solution remains elusive.

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