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Mortality Trends Across Key Diagnostic Groups in Australian and New Zealand ICUs Over the Past 30 Years

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OBJECTIVES: The Australia and New Zealand Intensive Care Society (ANZICS) Adult Patient Database (APD) has been operational for 3 decades. It is important to understand how mortality outcomes have changed across diagnostic groups over time to facilitate the planning of future healthcare resources. We evaluated the trends in risk-adjusted mortality for ICU patients over the last 30 years.

DESIGN: A retrospective cohort study.

SETTING: All ICUs in Australia and New Zealand that contributed data to the ANZICS APD from January 1993 to December 2022.

PATIENTS: Adult patients (≥ 16 yr) admitted to Australian and New Zealand ICUs.

INTERVENTIONS: None.

MEASUREMENTS AND MAIN RESULTS: The final cohort included 2,838,654 patients from 209 ICUs. Compared with the first decade patients admitted during the final decade of the study were older (60.0 yr [18.2 yr] vs. 62.0 yr [17.8 yr]), more often had a least one major comorbidity (23.2% vs. 25.2%), and had higher Acute Physiology and Chronic Health Evaluation III scores (45.6 [28.1] vs. 50.9 [24.1]). The five diagnostic groups with the highest mortality rates were cardiac arrest (53.6%), stroke and intracranial hemorrhage (34.8%), subarachnoid hemorrhage (21.2%), pneumonia (19.2%), and sepsis (19%). Risk-adjusted mortality decreased until 2010 but then plateaued. Cardiac arrest saw the greatest improvement in risk-adjusted mortality between the third vs. first study decades (odds ratio [OR], 0.82 [0.81–0.83]), while pneumonia saw the least (OR, 0.87 [0.87–0.88]). The pattern of improvement for most diagnostic groups were similar; however, mortality from stroke and intracranial hemorrhage continued to improve, whereas mortality from cardiac arrest appears to have increased over the past 10 years.

CONCLUSIONS: There have been substantial improvements in risk-adjusted mortality among ICU patients over the past 30 years; however, this improvement has plateaued recently. The reasons for this plateau warrant further investigation.

KEYWORDS: adults; critical care; mortality

Clinical quality registries provide an opportunity to identify and prioritize the opportunities and need for research to improve patient outcomes (1). Several studies have reported significant improvements in the outcomes of critically ill patients as a whole and among specific diagnostic subgroups (2–6). However, these studies have only considered a limited range of diagnostic groups and present data that is no longer contemporary. To contextualize survival improvements, it is important to compare improvements

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KEY POINTS

Question: How has risk-adjusted mortality changed in patients admitted to Australian and New Zealand ICUs over the past 30 years?

Findings: Overall, risk-adjusted mortality has significantly decreased, particularly for high-risk groups like cardiac arrest patients. However, these gains have plateaued since 2010.

Meaning: Further investigation is required to better understand and address factors limiting continued improvements in ICU mortality outcomes.

between diagnostic groups to identify areas of unmet need. Furthermore, to separate improvements in disease specific survival from those resulting from general quality of care enhancements, it is essential to compare diagnostic groups against the overall temporal trend over an extended period to detect any potential changes. Therefore, the aim of this study was to describe the trends in the outcomes of critically ill patients as a whole over the past 30 years, as well as among individual diagnostics groups with a focus on the five diagnostic groups with the highest mortality rate.

METHODS

A multicenter retrospective cohort study was performed in accordance with the ethical approval obtained from The Alfred Hospital Human Research Ethics Committee (number 298/23, "The Change in Mortality Rate for Key ICU Diagnoses in Australia and New Zealand Over 30 Years," approved April 28, 2023) and the Helsinki Declaration of 1975. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology and REporting of studies Conducted using Observational Routinely collected health Data statements (7, 8).

Setting and Data Sources

The study was conducted using data from all ICUs in Australia and New Zealand that contributed to the Australia and New Zealand Intensive Care Society (ANZICS) Adult Patient Database (APD) from the year 1993 to 2022. The ANZICS APD is a clinical quality registry dataset maintained by the ANZICS Centre for Outcome and Resource Evaluation for benchmarking outcomes of contributing ICUs. In 2022, of the 225 ICUs in Australia and New Zealand, 209 (93%) contributed to the APD (9). Data quality in the registry is supported through the use of a standardized data dictionary, trained data collection personnel and automated validity checks within the data collection software used to submit data to the APD.

Participants

All patients 16 years old and older at the time of admission to a contributing ICU during the study period were included. Patients were excluded if they were admitted for palliative care or organ donation, or if they were missing mortality outcome data. Patients were also excluded if they were admitted with COVID-19 pneumonitis, as this group has a unique clinical trajectory that cannot be compared with patients with other types of pneumonia (10). Only the first episode of ICU care in each hospital admission was included, with subsequent readmissions within the same hospitalization excluded. To avoid double-counting patients who were transferred between ICUs, episodes of care that ended in a transfer to another ICU were also excluded, although the episode of care at the ICU to which they were transferred was included.

Variables and Outcomes

Demographic and clinical characteristics, including age, sex, underlying chronic health conditions, and need for interventions such as mechanical ventilation during the ICU admission were extracted from the ANZICS APD. Causes of admission to ICU were categorized using the ANZICS modification of the Acute Physiology and Chronic Health Evaluation (APACHE) III-J diagnostic coding system and aggregated into 22 clinically relevant groups (**Table s1**, https://links.lww.com/CCM/H778) (11–13). Severity of illness was measured using the APACHE III score. The primary outcome was in-hospital mortality. Secondary outcomes included ICU and hospital length of stay, discharge destination for those who survived the hospital admission, and the relative prevalence of ICU admitting diagnoses, as has been done previously (2, 3).

Statistical Analysis

Descriptive results are reported as percentage of total population (number), median (interquartile range [IQR]), or mean (SD) as appropriate. The study cohort was divided in to three groups according to the decade in which participants were admitted to ICU. The groups characteristics and outcomes were compared using a chi-square test for categorical data and the Kruskal-Wallis test or analysis of variance for continuous data, as appropriate. To assess the relationship between each admission year and hospital mortality, generalized linear mixed-effects regression models were used to calculate the adjusted odds ratio (OR) for mortality in each year of admission. The year of admission was treated as a categorical variable with 2022 as the reference category. Models were adjusted for patient illness severity (APACHE III), sex, hospital type, and site, with the latter treated as a random effect. Given the significant heterogeneity across diagnoses, individual models were fit for each diagnosis. The change in overall risk-adjusted hospital mortality between the first and third decades (1993–2002 vs. 2013–2022) was also assessed using generalized linear mixed-effects regression models; however, for these models, decade of admission was used as the categorical variable, rather than year. We also performed two sensitivity analyses using a derived Sequential Organ Failure Assessment score and the APACHE II score as alternate measures of illness severity. To assess the influence of selection biases, we performed a subgroup analysis that included only participants admitted to sites which contributed to the APD when it began in 1993. All analyses were conducted in R (Version 4.2.1; R Core Team, Vienna, Austria) and a *p* value of less than 0.001 was used to indicate statistical significance.

RESULTS

Over the 30-year study period, the number of sites contributing to the registry increased (39 contributing sites in 1993 vs. 209 in 2022), with a commensurate increase seen in the number of patients included in the registry (329,450 ICU admissions recorded in 1993–2002 vs. 1,597,453 in 2013–2022) (**Fig. 1**). The proportion of patients admitted to ICUs in New Zealand and rural/regional areas consistently increased throughout the study period, as did the number of patients admitted to private ICUs, reflecting the changes in types of ICU which contributed to the APD (**Table 1**). The characteristics of patients admitted to ICU changed over time with patients admitted in the most recent decade being older, more likely to be female, having more comorbidities, and higher severity of illness scores but less likely to receive mechanical ventilation (Table 1; and **Table s4**, https://links.lww.com/CCM/H778). The case-mix in the APD also evolved over time, partially due to changes in which ICUs contributed data, with the greatest proportional decrease seen in patients admitted for nonsurgical cardiac conditions (23.6% of admissions in first decade vs. 5.5% in the most recent decade) and the greatest increase seen in those admitted following nonspinal orthopedic surgery (< 0.1% of admissions in first decade vs. 5.2% in the most recent decade).

Primary Outcome: In-Hospital Mortality

The five diagnostic groups with the highest mortality rates, were cardiac arrest, pneumonia, stroke, subarachnoid hemorrhage, and sepsis (excluding pneumonia). Of these, sepsis was responsible for the highest total number of deaths across the 3 decades (n = 36,357). Overall, in-hospital mortality decreased from 14.5% to 7.5% from the first to last decade of the study (**Table 2**). The crude mortality rates for the five diagnoses with the highest mortality rates followed a similar trend of improvement and are detailed in **Table 3**. Mortality rates over the study period for the remaining diagnoses and rates of missing data can be found in **Tables s2** and **s3** (https://links.lww.com/CCM/H778). When considering the overall trend in the adjusted OR for hospital mortality across all diagnostic groups over the study period, a consistent improvement was observed from 1993 to 2010, beyond which the risk-adjusted mortality plateaued until the end of the study in 2022 (**Fig. 2**). Of the top five diagnostic groups cardiac arrest saw the greatest improvement in risk-adjusted mortality (adjusted OR for mortality in the most recent decade vs. the first decade, 0.82 [0.81–0.83]) while pneumonia saw the smallest improvement (adjusted OR for mortality in the most recent decade vs. the first decade, 0.87

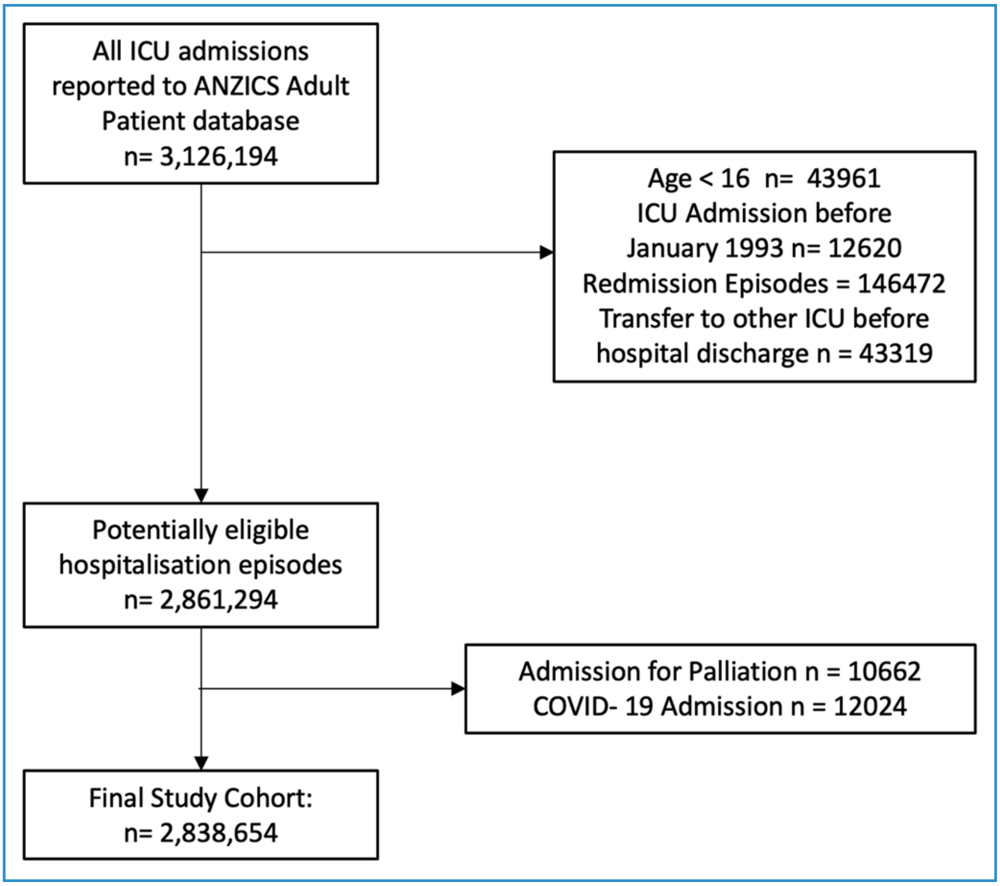

Figure 1. Flow diagram for patient selection and inclusion in the study. ANZICS = Australian and New Zealand Intensive Care Society.

[0.87–0.88]). Of the remaining diagnostic groups, nonspinal orthopedic surgery saw the least improvement (adjusted OR for mortality in the most recent decade vs. the first decade, 0.98 [0.96–1.01]), although relatively few patients were present in this group in the first decade compared with the third (96 vs. 83,103) making this result less reliable than those for other diagnostic groups. Among the top five diagnoses, subarachnoid hemorrhage, pneumonia, and sepsis closely followed the overall trend of improvement. In contrast, while mortality rates for stroke patients have shown a consistent decline over time, mortality for patients with cardiac arrest has increased over the past decade (Fig. 2). These patterns remained consistent across various sensitivity and subgroup analyses (**Tables s5** and **s6** and **Figs. s1–s3**, https://links.lww.com/CCM/H778), although the proportion of out-of-hospital cardiac arrests vs. in-hospital cardiac arrests in the group was also noted to increase (52.7% out-of-hospital in the first decade vs. 64.6% in the most recent decade). Results for the additional diagnostic groups, and for sepsis with and without shock, can be found in **Figures s4–s7** (https://links.lww.com/CCM/H778).

Secondary Outcomes—Length of Stay and Discharge to Long-Term Care

When considering the overall cohort both hospital length of stay and ICU length of stay decreased (Table 2). However, among nonsurvivors, there was a significant increase in the median ICU length of stay from 42 hours (IQR, 14–121 hr) to 58 hours (IQR, 22–136 hr). The same pattern was not seen among patients that survived until hospital discharge. The proportion of patients discharged to long-term care also increased from 4.3% to 5.4% in the last decade although it was highest at 8% in the middle decade. In keeping with this, the proportion of survivors discharged home has decreased from 85% to 79.5%.

DISCUSSION

Key Findings

This study of nearly 3 million patients admitted to over 200 ICUs during a 30-year period in Australia and New Zealand demonstrates that there have been encouraging improvements in the hospital outcomes of ICU patients in Australia and New Zealand. We identified sepsis as the most common cause of mortality in ICU patients and cardiac arrest as the admission diagnosis with the highest mortality rate. We have shown that there have been improvements in mortality across all diagnostic groups even after adjusting for illness severity and organizational factors. Importantly, these improvements occurred mostly up until 2010 and there has been a plateau

TABLE 1.
Patient and Site Characteristics Across Study Decades[a]

Characteristic	1993–2002 (*n* = 329,450)	2003–2012 (*n* = 911,751)	2013–2022 (*n* = 1,597,453)
Number of contributing sites	127	171	209
Age, mean (SD)	60.00 (18.18)	61.39 (18.08)	62.00 (17.75)
Sex, % female (*n*)	39.4 (129,874)	41.3 (376,343)	43.3 (692,148)
Country, % New Zealand (*n*)	3.7 (12,323)	5.8 (52,873)	8.2 (130,883)
Hospital classification, % (*n*)			
Metropolitan	16.4 (53,884)	16.9 (154,114)	15.5 (247,304)
Private	19.1 (62,869)	25.1 (228,993)	30.5 (487,800)
Rural/regional	11.7 (38,530)	13.0 (118,392)	13.3 (211,856)
Tertiary	52.9 (174,167)	45.0 (410,252)	40.7 (650,493)
Elective surgery admission, % (n)	40.7 (133,172)	44.9 (407,177)	41.9 (664,504)
Invasive ventilation, % (*n*)	47.8 (157,610)	42.6 (388,613)	33.4 (534,347)
Acute Physiology and Chronic Health Evaluation III score, mean (SD)	45.58 (28.09)	52.89 (27.43)	50.92 (24.13)
Comorbidities, % (*n*)			
Patients with at least one comorbidity	23.2 (76,399)	26.2 (238,946)	25.2 (403,070)
Patients with more than one comorbidity	6.9 (22,688)	7.7 (69,896)	9.1 (145,809)
Admitting diagnosis, % (*n*)			
Abdominal aortic aneurysm	2.5 (8,088)	2.0 (18,406)	1.5 (23,702)
Cardiac arrest	2.5 (8,228)	2.3 (20,810)	2.0 (31,684)
Cardiac surgery	15.0 (49,285)	14.7 (134,481)	11.2 (178,269)
Chronic obstructive pulmonary disease	1.7 (5,499)	2.2 (20,021)	1.7 (27,854)
Other cardiothoracic or vascular surgery	8.2 (26,993)	7.7 (70,516)	8.9 (142,393)
General surgery	7.9 (25,899)	11.9 (108,737)	12.3 (196,236)
Medical cardiac	23.6 (77,797)	7.4 (67,682)	5.5 (88,509)
Medical gastrointestinal disease	2.7 (9,047)	3.5 (32,096)	3.1 (49,190)
Respiratory disease	4.9 (16,147)	4.5 (41,170)	4.2 (66,306)
Other medical disease	3.4 (11,122)	4.8 (44,170)	5.3 (84,491)
Neurologic disease	3.4 (11,117)	4.9 (44,252)	5.2 (82,821)
Nonspinal orthopedic surgery	0.0 (96)	3.2 (29,028)	5.2 (83,103)
Spinal surgery	0.6 (1,831)	1.9 (17,017)	3.6 (57,391)
Overdose	4.0 (13,123)	3.6 (32,972)	3.7 (58,640)
Pneumonia	3.1 (10,111)	4.1 (37,235)	3.5 (56,682)
Subarachnoid hemorrhage	1.0 (3,294)	1.1 (10,011)	0.9 (14,142)
Seizure	1.0 (3,339)	1.4 (13,114)	1.3 (20,548)
Sepsis excluding pneumonia	3.7 (12,093)	5.9 (53,455)	7.9 (126,176)
Stroke and intracranial hemorrhage	1.1 (3,726)	1.3 (12,302)	1.4 (21,668)
Other surgery	4.1 (13,549)	6.2 (56,758)	7.1 (113,309)
Multitrauma with head injury	2.8 (9,295)	2.3 (20,609)	1.5 (23,887)
Multitrauma without head injury	3.0 (9,771)	3.0 (26,909)	3.2 (50,452)

[a]All baseline variables were found to significantly differ across the three study decades ($p < 0.001$).

TABLE 2.
Unadjusted Outcomes According to Study Period

Outcome	1993–2002 (*n* = 329,450)	2003–2012 (*n* = 911,751)	2013–2022 (*n* = 1,597,453)
Primary outcome			
Hospital mortality, % (*n*)	14.5 (47,884)	10.9 (99,354)	7.5 (119,118)
Secondary outcomes			
ICU mortality, % (*n*)	9.8 (32,020)	7.0 (63,547)	4.7 (75,617)
Hospital length of stay, d, median (IQR)	9.5 (5.4–17.8)	9.0 (5.1–17.0)	7.9 (4.2–14.3)
Survivors	7.0 (2.2–17.2)	7.4 (2.5–17.6)	6.7 (2.6–15.5)
Nonsurvivors	9.7 (5.8–18.0)	9.1 (5.4–16.7)	8.0 (4.4–14.2)
ICU length of stay, hr, median (IQR)	41 (21–77)	43 (22–83)	41 (22–75)
Survivors	41 (22–74)	42 (22–78)	41 (22–73)
Nonsurvivors	42 (14–121)	50 (18–129)	58 (22–136)
Discharged home, % (*n*)[a]	85.0 (239,265)	81.3 (660,272)	79.5 (1,175,325)
Discharge to long-term care, % (*n*)[a]	4.3 (11,993)	8.0 (64,906)	5.4 (79,863)

IQR = interquartile range.
[a]Survivors only.

in the reduction of mortality since that time across nearly all diagnostic groups.

Mortality Changes in Specific Diagnostic Groups

Relative changes in mortality varied across diagnostic groups with stroke, sepsis, and subarachnoid hemorrhage having among the largest relative reduction in unadjusted mortality of around 50%, whereas other key diagnoses such as medical cardiac condition and cardiac arrest have seen smaller improvements. However, after adjustment for illness severity and organizational factors, the odds of in-hospital mortality had improved to a similar degree across the diagnostic groups. Notably, we observed also a recent increase in the adjusted odds of mortality for patients with cardiac arrest, which warrants further independent investigation. Within the cardiac arrest diagnostic category, we also observed an increase in proportion of out-of-hospital cardiac arrests, the outcomes of which are more likely to be influenced by pre-hospital factors such as delays in commencing resuscitation. Future studies investigating diagnosis-specific changes in mortality should also include data on relevant pre-ICU interventions, such as percutaneous coronary intervention or thrombolysis, as these have likely influenced mortality outcomes within the ICU and were not available for the current study.

Comparison With Previous Literature

Our overall findings are consistent with those of previous investigators that have shown improved outcomes for critically ill patients (2, 3, 14). Notably, these studies only examined patients admitted up to 2012. More recent publications have supported the assertion that there has been a plateauing of improvement among certain cohorts. Hurley (15) demonstrated that there has been little improvement in crude mortality in ICU infection prevention studies with improvement only evident after adjustment for illness severity and age. Tan et al (16) found that while adjusted mortality fell slightly between 2016 and 2020, there had been a reversal of the improvements in mortality over previous years during the period of the COVID-19 pandemic. Zimmerman et al (3) noted significant variation in the relative decrease in mortality across different diagnostic groups, and, similar to our findings, found that subarachnoid

TABLE 3.
Mortality Trend Across the Five Diagnostic Groups With Highest Crude Mortality Rates Observed in Decade 3

Diagnosis	Overall Mortality Rate (No. of Deaths), 1993–2022	Decade 1: Mortality Rate (No. of Deaths), 1993–2002	Decade 2: Mortality Rate (No. of Deaths), 2003–2012	Decade 3: Mortality Rate (No. of Deaths), 2013–2022	Adjusted OR[a,b] (95% CI)	Unadjusted Relative Risk[b] (95% CI)
Cardiac arrest	53.6% (32,535)	62.6% (5,151)	55.7% (11,595)	49.8% (15,789)	0.82 (0.81–0.83)	0.80 (0.77–0.82)
Pneumonia	19.2% (19,995)	29% (2,934)	21.6% (8,032)	15.9% (9,029)	0.84 (0.83–0.86)	0.52 (0.49–0.55)
Subarachnoid hemorrhage	21.2% (5,826)	33.6% (1,108)	23.6% (2,361)	16.7% (2,357)	0.87 (0.86–0.88)	0.5 (0.46–0.53)
Sepsis excluding pneumonia	19% (36,357)	35.8% (4,335)	23.4% (12,524)	15.5% (19,498)	0.87 (0.87–0.88)	0.55 (0.53–0.57)
Stroke and intracranial hemorrhage	34.8% (13,128)	52.6% (1,961)	42.8% (5,261)	27.3% (5,906)	0.84 (0.84–0.85)	0.43 (0.42–0.45)

OR = odds ratio.

[a]Adjusted for patient severity (Acute Physiology and Chronic Health Evaluation III), sex, hospital type, and site.

[b]Third decade vs. first decade.

hemorrhage and stroke had seen larger improvements than cardiac arrest patients. Another study describing the changes in outcomes for very elderly patients admitted to an ICU between 2006 and 2018 observed a steady decline in mortality in this cohort throughout their study period (17). However, this was attributed to stricter screening to identify which patients would likely benefit from an ICU admission and an improvement in primary care interventions as opposed to changes in the interventions delivered within the ICU itself. Across the study period the broader Australian population did become older, with an approximate 6 years increase in average life expectancy and growth in the proportion of Australians over 65 years old has increased by almost 5% between 1993 and 2022 (18, 19). However, this potential increase in demand for ICU services due to demographic factors was also offset by a substantial increase in ICU capacity, from 2.3 ICU beds per 100,000 population in 1995 to 9.1 in 2024 (20). This change in population demographics, coupled with an increase in ICU availability, has potentially resulted in an increase in admission of older, more complex patients, for whom ICU interventions may deliver limited benefit, thereby also influencing mortality outcomes.

Implications

Our findings raise important considerations of modifiable and nonmodifiable risks among intensive care patients. The demographics of the ICU cohort have changed, the ICU patients are older with more comorbidity in addition to presenting with a greater severity of physiologic disturbance. As such, it may be that we are reaching a point whereby patient underlying comorbidity and frailty is the determinant of patient outcome rather than the acute pathology (21). It is notable that the relative changes in risk-adjusted in-hospital mortality were quite similar across diagnostic groups. Thus, it is possible that improved processes of care and staff training have contributed to much of the improvement in outcomes rather than to disease specific interventions. Processes of care within the ICU have changed significantly over the past 30 years, with the introduction of care protocols in areas such as infection control, nutrition, and sedation management, which are applicable to the majority of ICU patients regardless of admitting diagnosis (22). It is possible that these more generic improvement measures have reached the limit of their utility, and the development and implementation of interventions that are adapted

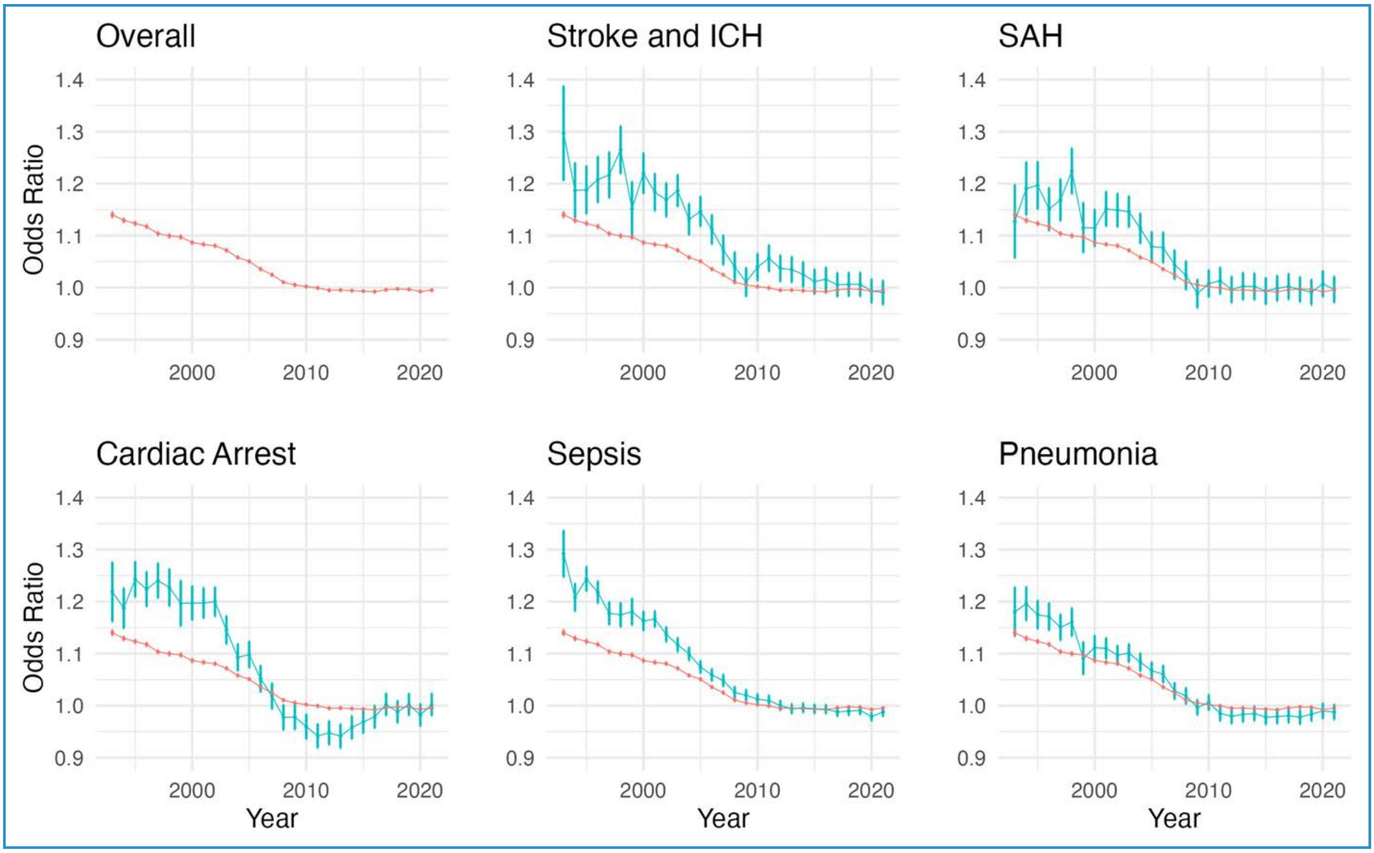

Figure 2. Trends in odds of risk-adjusted mortality over study period for overall cohort (*red*) and five highest mortality diagnostic groups (*green*). Odd Ratios (95% CI) from mixed effect regression adjusted for site type, sex at birth, and Acute Physiology and Chronic Health Evaluation III score. ICH = intracranial hemorrhage, SAH = subarachnoid hemorrhage.

specifically for individual patients or diseases are required to help continue to improve outcomes.

Furthermore, the plateauing of outcomes suggests the need to carefully allocate resources to avoid a situation of diminishing returns whereby increased resource utilization does not translate to improved outcomes. Recent studies of patient-to-intensivist ratios and expenditure on sepsis interventions have not shown that increasing these is associated with improved outcomes (23, 24). However, reductions of resources may also be harmful. A study that investigated the impact of the resourcing constraints that occurred during the COVID-19 pandemic reported an association between a relative reduction in resources, measured as ICU strain, and an increase in patient mortality, which suggests that restricting resources in the ICU may lead to a worsening of patient outcomes (25). The role of intensive care nursing staff is also key; another study that explored the association between the experience and specialist qualifications of ICU nurses and patient mortality found a higher number of specialist critical care nurses was associated with improved patient outcomes across a range of measures, including mortality (26). Interestingly, the proportion of nurses in Australian ICUs with a critical care qualification has remained static over the past decade, in line with the plateauing of mortality reported here, and may represent an opportunity to improve patient outcomes (9, 27).

Strengths and Limitations

Our study has several strengths. First, it encompasses data for nearly 3 million ICU admission episodes covering a 30-year time period with data that now covers the vast majority of ICU admissions in Australia and New Zealand. The findings are representative of the outcomes in these countries and may be generalizable to other countries with similar health systems. However, information to examine for similar trends in other registries would be invaluable. Second, our analyses adjusted for important patient and organizational level factors and the findings were consistent across several sensitivity and subgroup analyses.

There are also important limitations to consider of our study. First, it is a retrospective cohort, and therefore, there is a possibility of residual unmeasured confounding. Second, the number of sites contributing to the registry changed over time, although our subgroup analysis of sites that contributed from the inception of the registry in 1993 was consistent with the primary analysis. Similarly, as discussed previously, the changing population demographics and availability of ICU beds likely influenced the ICU case-mix during the study period and may have interfered with the findings reported here. Third, data was only available for those patients who were admitted to an ICU, and so these findings should not be generalized to patients with similar diagnoses who are managed outside the ICU environment. Finally, some variables that would have been useful to include in risk adjustment such as frailty were only available more recently in the dataset and therefore could not be included in the analysis. Similarly, data relating to mortality outcomes beyond the index hospitalization were also not available in the dataset and the changes over time in long-term outcomes of the ICU cohort should be considered by future studies.

CONCLUSIONS

Sepsis remains the most common cause of death for ICU patients. Risk-adjusted mortality has improved over the past 30 years in Australia and New Zealand but there is heterogeneity in this improvement across some diagnostic groups and the rate of improvement in recent years has declined. Increasing resource utilization alone may be unlikely to continue to improve outcomes further, and more targeted and individualized treatments are needed.

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