Outcomes for very old patients (≥ 80 years) admitted to intensive care units are poor compared with outcomes for younger adults. This group comprises 13% of ICU admissions in Australia and New Zealand, and there are few publications relating to their long-term outcomes. Analysis of the Australian and New Zealand Intensive Care Society (ANZICS) Adult Patient Database showed a 5.6% annual increase in admissions for this age group. The ICU is a finite resource, limited by bed spaces and staffing. Unless there is increased awareness and application of advance care planning, there will be a requirement to increase ICU capacity or apply distributive justice principles to allocate current resources.

Studies evaluating ICU triage for very old patients are hindered by variability in critical care practices between hospitals and countries. Admission policies are also often arbitrary, rather than evidence-based. Published studies about refusal of admission to the ICU show highly variable chronological age. As a result, there are no publications relating to their long-term outcomes. Few publications relating to their long-term outcomes. Studies evaluating ICU triage for very old patients are hindered by variability in critical care practices between hospitals and countries. Admission policies are also often arbitrary, rather than evidence-based. Published studies about refusal of admission to the ICU show highly variable chronological age. As a result, there are no publications relating to their long-term outcomes. Given the international variations in admission practices, we designed our study to evaluate urgent referrals to an Australian tertiary ICU. Our main outcomes were hospital mortality, 12-month mortality and discharge destination for very old patients urgently referred to the ICU.

Methods
We conducted a retrospective, observational review of medical records of all patients aged ≥ 80 years who had been urgently referred (ie, non-electively) to the Canberra Hospital tertiary ICU. The closed-format medical and surgical ICU consisted of 31 mixed intensive care (nurse:patient ratio, 1:1) and high dependency (nurse:patient ratio, 1:2) beds. In addition to recording ICU admissions, the ICU outreach service recorded all urgent referrals, subdivided into outreach reviews and medical emergency team (MET) calls, with referral pathways as shown in Figure 1. Referrals were divided into those who were “too well” for the ICU, admitted to the ICU, and “too sick” for the ICU. Data and main outcome measures: Data were extracted from hospital records, the ICU patient database and the Australian Institute of Health and Welfare National Death Index, and our main outcome measures were health status and destination at hospital discharge, and 12-month mortality rates. Results: Urgent admissions of very old patients accounted for 6.9% of total ICU admissions (443/6415). The hospital mortality rate was 16.0% (93/583) for patients who were too well, 32.1% (142/443) for those admitted to the ICU, and 69.2% (148/214) for those too sick (P < 0.001). Mortality rates 12 months after referral were 40.8% (238/583), 46.0% (204/443) and 88.3% (189/214), respectively (P < 0.001). Conclusion: Very old patients considered too well for the ICU have a significantly lower hospital mortality rate than those admitted to the ICU after urgent referral. However, 12 months after referral, patients considered too well for ICU admission have a mortality rate approaching that of very old patients admitted to the ICU. Over half of very old patients urgently referred to the ICU die within 12 months.

< 80 years or had elective ICU admissions or interhospital referrals not accepted for transfer. Data were only collected during the first referral of the hospital admission, although any subsequent referral or ICU admission was noted. If a patient had a new hospital admission with urgent referral to the ICU, it was treated as a new referral.

Data sources included the ICU computerised medical record and referral system, hospital digital medical record and the Australian Institute of Health and Welfare (AIHW) National Death Index (NDI). The data elements collected are...
summarised in Table 1. The Modified Early Warning Score (MEWS)\textsuperscript{10} quantified the degree of vital sign derangement and was calculated at first review (see Appendix, Table 1, online at cicm.org.au/Resources/Publications/Journal).

Patients were divided into three groups, based on the medical documentation at initial referral:

- patients referred to the ICU but who did not require admission as they were “too well”
- patients admitted to the ICU
- patients “too sick” for the ICU, including patients who would not benefit from the ICU as they were not expected to survive, and those who declined transfer to the ICU because of a pre-existing decision, despite meeting admission criteria.

We defined hospital mortality as death within the tertiary referral centre, documented by death certificates or coronial referral. Twelve-month mortality data were obtained from the AIHW NDI. Patients transferred to the affiliated off-campus hospice for terminal care were considered to have died in the hospital.

The Australian Capital Territory Health Human Research Ethics Committee approved the retrospective study and waived the requirement for consent. The AIHW Ethics Committee approved our use of the NDI.

Statistics
We stored the data in an Excel (Microsoft) spreadsheet and performed analysis using R software (https://www.r-project.org; R Foundation). We compared continuous variables using the Kruskal–Wallis test and report the results with means and SDs. We used medians and interquartile ranges (IQRs) to report lengths of stay, and compared categorical variables using the Fisher exact test. Multivariate logistic regression identified predictors of hospital and 12-month mortality, and we used multinomial logistic regression to identify predictors of admission. We assessed model discrimination with the area under the receiver operator curve, and used the log-rank test to compare survival curves by ICU disposition. We defined statistical significance as $P < 0.05$. We report odds ratios with 95% confidence intervals for ICU admission, hospital mortality and 12-month mortality. We use a Kaplan–Meier curve to show 12-month survival.
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Statistically significant factors associated with being declined ICU admission on multivariate analysis are shown in the Appendix, Table 2. Age was an independent predictor of being declined ICU admission ($P \leq 0.001$).

The median ICU length of stay for ICU admissions was 2 days (IQR, 1–4 days) and mean APACHE III score was 75.7 (SD, 27.7). The mean all-ages APACHE III score from 2011 to 2014 was 55.8 (SD, 27.1). Vasopressor or inotropic support was received by 59.4% of patients (263/443), 44.5% of patients (197/443) were intubated, 14.5% (64/443) received non-invasive ventilation and 5.6% (25/443) received renal replacement therapy. Of the patients admitted to ICU, 18.3% (81/443) did not receive organ support.

Mortality

Overall hospital mortality was 30.9% (383/1240); 16.0% (93/583) for patients who were too well, 32.1% (142/443) for patients admitted to the ICU and 69.2% (148/214) for patients who were too sick ($P \leq 0.001$). Significant odds ratios for factors associated with mortality on multivariate analysis are shown in Table 3.

Table 1. Summary of data elements collected

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Referral information</th>
<th>Comorbid conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>MET call/outreach</td>
<td>Cancer</td>
</tr>
<tr>
<td>Age</td>
<td>Location*</td>
<td>Metastatic cancer*</td>
</tr>
<tr>
<td>Dates</td>
<td>MEWS</td>
<td>Haematological malignancy</td>
</tr>
<tr>
<td>Hospital presentation</td>
<td>Treatment limitations¹</td>
<td>Undergoing chemotherapy or radiotherapy⁶</td>
</tr>
<tr>
<td>ICU referral</td>
<td>In place before ICU referral</td>
<td>Dementia</td>
</tr>
<tr>
<td>ICU discharge</td>
<td>Established in ICU review</td>
<td>Chronic obstructive pulmonary disease⁵</td>
</tr>
<tr>
<td>Hospital discharge</td>
<td>In place after ICU discharge</td>
<td>Cirrhosis</td>
</tr>
<tr>
<td>Date of death</td>
<td>ICU disposition</td>
<td>Heart failure**</td>
</tr>
<tr>
<td>Hospital referral source</td>
<td>Too well</td>
<td>Diabetes mellitus, receiving insulin</td>
</tr>
<tr>
<td>Home</td>
<td>Admitted</td>
<td>Chronic kidney disease, receiving dialysis</td>
</tr>
<tr>
<td>Low-level care</td>
<td>Too sick</td>
<td>Immunosuppression††</td>
</tr>
<tr>
<td>High-level care</td>
<td>ICU intervention</td>
<td>Mortality rate</td>
</tr>
<tr>
<td>Scores</td>
<td></td>
<td>Hospital</td>
</tr>
<tr>
<td>APACHE II</td>
<td></td>
<td>12-month</td>
</tr>
<tr>
<td>APACHE III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of stay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICU referral</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital discharge</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| ICU = intensive care unit. APACHE = Acute Physiological and Chronic Health Evaluation. MET = medical emergency team. MEWS = Modified Early Warning Score. CPR = cardiopulmonary resuscitation. * Emergency department, operating theatre, inpatient ward, other hospital. † Included limitations which would affect ICU management, eg, “not for ICU”, “not for intubation”, “not for CPR”. ‡ Subgroup of cancer group, with radiographic or surgical evidence of metastasis. § Within 6 months before ICU referral. ¶ Severe exercise limitation or receiving home oxygen. ** Symptoms consistent with New York Heart Association III/IV dyspnoea. †† Received prednisolone 10 mg or greater daily, or had HIV or had undergone organ transplantation.
| ICU disposition |                   |                   |

Results

Patient demographic data

During the 40-month study period, 1240 urgent referrals were made for patients aged ≥ 80 years, who were included in the study. Urgent admissions to the ICU for patients ≥ 80 years accounted for 6.9% of total ICU admissions (443/6415). There were 46 patients with separate hospital admissions requiring ICU referral; these were analysed as separate referrals. Two patients had Acute Physiology and Chronic Health Evaluation (APACHE) scores missing from their medical record. Hospital mortality data were not available for one ongoing inpatient, and 12-month mortality data were not available for one international patient. The characteristics of patients by admission status are compared in Table 2.

ICU admissions

The acceptance rates for ICU admission after urgent referral were 58.7% (155/264) from the emergency department, 17.2% (130/755) from inpatient wards and 63.2% (108/171) from the operating theatre ($P \leq 0.001$).
Overall 12-month mortality was 50.9% (631/1240); 40.8% (238/583) for patients who were too well, 46.0% (204/443) for patients admitted to the ICU and 88.3% (189/214) for patients who were too sick (P < 0.001). The mean time until death was 76.7 days in the too-well group, 46.3 days for those admitted to the ICU and 25.2 days in the too-sick group (P < 0.001). Statistically significant odds ratios for 12-month mortality on multivariate analysis are shown in Table 3. A Kaplan–Meier curve for overall survival for the 12 months after referral is shown in Figure 2.

The 12-month mortality rate for hospital survivors was 29.6% (145/490) for patients who were too well, 20.6% (62/301) for patients who were admitted to the ICU and 62.1% (41/66) for patients who were too sick (P < 0.001).
Discharge destination

ICU disposition was a significant predictor of discharge destination ($P = 0.005$). Figure 3 shows a comparison of pre-admission (all patients) and post-discharge residence for patients who survived their hospital stay.

Discussion

Our study describes the characteristics and outcomes of 1240 very old patients referred to a tertiary ICU service over a 40-month period. In addition to obtaining long-term outcome data on patients admitted to the ICU, we also present 12-month mortality outcomes for patients considered too well or too sick for ICU admission. This stratification shows separation of baseline characteristics, hospital and 12-month mortality, and discharge destination, based on ICU disposition. This separation may relate to selection bias, differing baseline health status and treatment variation between groups.

The 12-month mortality data provide insight into the sequelae of critical illness in very old patients. Despite differences between those considered too well and those admitted to the ICU, the 12-month mortality curves trend towards convergence. The 12-month mortality of hospital survivors is lower in patients admitted to the ICU than in patients considered too well for ICU admission.

Our study may help clinicians and patients make decisions relating to ICU admission and advance care planning.

Table 3. Multivariate analysis of factors associated with mortality*

<table>
<thead>
<tr>
<th>Factor</th>
<th>Hospital mortality</th>
<th>12-month mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odds ratio</td>
<td>95% CI</td>
</tr>
<tr>
<td>Too well</td>
<td>0.33</td>
<td>0.20–0.55</td>
</tr>
<tr>
<td>Too sick</td>
<td>2.78</td>
<td>1.52–5.06</td>
</tr>
<tr>
<td>High-care nursing home</td>
<td>0.40</td>
<td>0.21–0.76</td>
</tr>
<tr>
<td>ICU-initiated treatment limitations</td>
<td>0.45</td>
<td>0.26–0.78</td>
</tr>
<tr>
<td>Treatment limitations after discharge from ICU or outreach</td>
<td>17.40</td>
<td>10.70–28.30</td>
</tr>
<tr>
<td>Subsequent referral</td>
<td>4.14</td>
<td>2.62–6.55</td>
</tr>
<tr>
<td>Cancer</td>
<td>0.90</td>
<td>0.54–1.49</td>
</tr>
<tr>
<td>Metastatic cancer</td>
<td>1.13</td>
<td>0.53–2.39</td>
</tr>
<tr>
<td>Chemotherapy or radiotherapy</td>
<td>2.59</td>
<td>1.07–6.26</td>
</tr>
<tr>
<td>Dementia</td>
<td>0.50</td>
<td>0.31–0.80</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>0.59</td>
<td>0.38–0.91</td>
</tr>
<tr>
<td>Heart failure</td>
<td>1.03</td>
<td>0.70–1.53</td>
</tr>
<tr>
<td>Chronic kidney disease, receiving dialysis</td>
<td>0.63</td>
<td>0.17–2.31</td>
</tr>
<tr>
<td>Modified Early Warning Score</td>
<td>1.11</td>
<td>1.05–1.18</td>
</tr>
<tr>
<td>Time from admission to ICU referral</td>
<td>1.07</td>
<td>1.04–1.09</td>
</tr>
</tbody>
</table>

* ICU = intensive care unit. * Area under receiver operator curve = 0.89.

Information such as pre- and post-admission residence indicates functional outcomes and the social implications of acute illness in critically unwell elderly patients. Being sick enough for ICU referral has prognostic implications that are often not completely discussed with patients and families due to the time constraints of critical care treatments.
support and may systematically underestimate ICU admission scores. Irrespective of this, MEWS remained a predictor of hospital mortality for the overall cohort.

Despite our expectation that age would predict being declined ICU admission, consistent with previous publications, it did not predict hospital or 12-month mortality in this cohort. Age predicting mortality is a variable finding, based on the mechanism for cohort selection. There is significant selection bias before ICU referral, and ICU triage includes declining patients deemed unlikely to survive. Age was an independent predictor for discharge to long-term care, consistent with previous publications.

ICU admission was associated with a low rate of discharge to a nursing home, compared with the too-well and too-sick groups, but a high rate of discharge to another hospital or rehabilitation facility. These destinations were combined, because patients often transfer to interstate or private hospitals without a documented reason for ongoing hospitalisation. Due to limitations of accessing data from interstate and private hospitals, our reported hospital mortality only included deaths within the study centre, which perhaps underestimated the overall hospital mortality.

Data for patients in our study who were admitted to the ICU were similar to data previously reported for very old patients in Australia and New Zealand. The ICU mortality was lower than previously reported, despite a higher intubation rate. This is consistent with the observation that treatment intensity and ICU survival rates are increasing in very old patients. The ANZICS database had a lower national mortality rate of 24%, but included 38.2% elective surgical admissions, which we excluded from our current study.

A prospective French study found similar hospital mortality rates in the too-well and too-sick groups (17.6% and 70.8%, respectively), but the mortality rate in patients admitted to the ICU was dramatically higher than in our study (62.5% vs 32.1%). The rate also exceeded those in prior French studies and the predicted mortality rate based on the reported Simplified Acute Physiology Score II. A possible explanation for this difference may be a
higher acceptance rate in our study (35.7% v 26.7%) and shorter ICU stays, suggesting that the patients in our cohort were less sick. The 12-month mortality rate in our cohort was also lower than in previous publications, for all referrals and ICU admissions.2,8,15-19

Strengths and limitations
Strengths of our study include the large number of ICU referrals and the completeness of the dataset. There are limited data published on patients who are declined ICU admission, and a lack of prospective trials. It may take many years to recruit adequate samples for such trials. Correlating hospital outcome with discharge destination and 12-month mortality rates provides insights into the sequelae of acute illness.

Study limitations include the single-centre retrospective design and the possibility of missing referrals from the database. We were unable to correlate ICU disposition decisions with bed availability, although severity of illness is the primary determinant of ICU admission in the study centre. We stratified patients into groups based on their clinical state, and this stratification is inherently subjective and highlights the requirement for more objective classifications in future research.

The literature on intensive care focuses on outcomes of patients admitted to the ICU. Using simple methods, we investigated long-term outcomes in a cohort which had not been described in Australia and New Zealand. Our study provides new insights into patient outcomes and justifies multicentre prospective investigations to optimise resource allocation. Our study also justifies further social and political discussion on allocation of resources to a population with high mortality.9

Conclusion
Very old patients who are considered too well for the ICU have a significantly lower hospital mortality rate than patients admitted to the ICU after urgent referral. However, 12 months after referral, patients considered too well for ICU admission have a mortality rate approaching that of patients admitted to the ICU. Patients considered too sick for ICU admission have high hospital and 12-month mortality, and a low rate of discharge back to the residence category they were in before ICU referral. Over half of very old patients urgently referred to the ICU die within 12 months of referral.

Acknowledgements
We thank Helen Rodgers, Intensive Care Research Co-ordinator and Data Manager, Canberra Hospital, for her help. The Canberra Hospital Intensive Care Research Unit provided funding for the Australian Institute of Health and Welfare National Death Index data linkage.

Competing interests
None declared.

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References


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**TCD MONITORING in INTENSIVE CARE**

**VENUE:** Royal Brisbane and Women’s Hospital  
**DATES:** 10th – 11th OCTOBER 2016  
**TIMING:** 2 days distributed in 4 modules  
2 morning modules + 2 afternoon modules

**10th October – morning (1st module)**
- 08-09.30h: Physics in Ultrasound  
- 09.30h-10.30h: Ultrasound probe and types of ultrasound  
- 10.30h-11h: coffee break  
- 11h-12h: General applications  
- 12h-13h: PFO and emboli detection (This presentation may be re-scheduled as for convenience of the speaker)  
- 13h-14h: Lunch time (supplied)

**10th October – afternoon (2nd module)**
- 14h-17h: 3h non-interrupted hands-on sessions  
  Coffee + snacks supplied

**11th October – morning (3rd module)**
- 08-09h: Subarachnoid haemorrhage and TCD  
- 09-10h: Stroke and TCD  
- 10-10.30h: coffee break  
- 10.30-12h: Simulation  
- 12-12.30h: Demonstration of a complete examination  
- 13h-14h: Lunch time (supplied)

**11th October – afternoon (4th module)**
- 14h-17h: 3h non-interrupted hands-on sessions  
  Coffee + snacks supplied

**MATERIAL:**
A CD will be supplied with the updated reviews of literature on TCD, most relevant articles and power-points presentations of all talks

**WORKSHOPS:**
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**REGISTRATION NUMBERS:**
Maximum of 10 participants per course is ideal to ensure one-to-one tutoring and access to TCD devices.

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- Dr Hayden White (Intensive Care Specialist-Logan Hospital)  
- Ada, lo (Cardiac sonographer: RBWH)  
- Dr Judith Bellapart-Rubio (Intensive Care Specialist RBWH)

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(via credit card on registration)