A microcosting analysis of ICU expenditure in the interval between brain death and organ donation

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ABSTRACT

Objective: The cost of providing care in an intensive care unit (ICU) after brain death to facilitate organ donation is unknown. The objective of this study was to estimate expenditure for the care delivered in the ICU between the diagnosis of brain death and subsequent organ donation.

Design: Cohort study of direct and indirect costs using bottom-up and top-down microcosting techniques.

Setting: Single adult ICU in Australia.

Participants: All patients who met criteria for brain death and proceeded to organ donation during a 13-month period between 1 January 2018 and 31 January 2019.

Main outcome measures: A comprehensive cost estimate for care provided in the ICU from determination of brain death to transfer to theatre for organ donation.

Results: Forty-five patients with brain death became organ donors during the study period. The mean duration of post-death care in the ICU was 37.9 hours (standard deviation [SD], 16.5) at a mean total cost of $7520 (SD, $3136) per donor. ICU staff salaries were the greatest contributor to total costs, accounting for a median proportion of 0.72 of total expenditure (interquartile range, 0.68–0.75).

Conclusions: Substantial costs are incurred in ICU for the provision of patient care in the interval between brain death and organ donation.

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The cost of providing intensive care unit (ICU) care is substantial.[1] Patients who receive ICU care following brain death to facilitate organ donation[2,3] are not currently funded through activity-based funding for the component of their care post death.[4] Support for organ donation is provided via a separate funding stream but, to our knowledge, this funding is not based on a specific detailed cost analysis.[5] The objective of this study was to quantify the cost of caring for patients in an Australian ICU who have died and are awaiting transfer to the operating room.

Methods

Context

A microcosting analysis was conducted to calculate expenses incurred within a 32-bed adult medical–surgical–trauma ICU when caring for patients with brain death who became organ donors. The Royal Melbourne Hospital Research Ethics Committee approved this study (Study QA No. QA2019024).

All patients diagnosed with brain death who subsequently donated one or more organs between 1 January 2018 and 31 January 2019 were included.

All costs were provided in Australian dollars. The primary outcome was the cost incurred in the ICU from diagnosis of brain death to transfer to the operating theatre. A multivariable linear regression analysis explored potential factors associated with greater or lesser costs.

Costing methodology

The total expenditure attributable to ICU care after brain death was calculated using both direct and indirect costs.[6-11] Direct costs are those attributable to the care of a specific donor,[12] with indirect costs attributable to ICU-level costs, such as purchase and maintenance of equipment.[12]

A microcosting methodology was used with a combination of bottom-up and top-down costing techniques.[9,13,14] Microcosting analyses involve enumeration and valuation of all resources accessed in the course of care.[15] Bottom-up costing is performed at the level of the individual patient by recording the cost of each component of care.[12] Top-down techniques assign cost through consideration of total expenditure over a defined period.

Direct costs comprised drugs, imaging, pathology and staff salaries. A bottom-up approach was taken for drugs, fluids and diagnostics,[16,17] with a top-down methodology for salaries.[9,14] All salaries were based on standard hourly rates using mid-level classification of staff. Adjustments were

made to account for penalties, allowances and on-costs, including superannuation, education, and long service and sabbatical leave.

Indirect patient costs were calculated per hour based on the financial ledger for the financial year ending June 2017 adjusted to the consumer price index.

Statistical analyses

Data were extracted from clinical and hospital records and analysed using Stata 16 (StataCorp, College Station, TX, USA). Variables were summarised using descriptive statistics and presented as mean and standard deviation (SD), median and interquartile range (IQR, [range]) or mean and 95% confidence interval (CI). Linear regression models incorporating robust error estimates were used to report selected costs, first without and then with adjustment for the influence of other covariates. Outcomes from these models are presented as increased or decreased mean cost (95% CIs).

Table 1. Demographic data for all included patients, with the details of the donated organs

	Values
Total number of patients	45
Mean age, years (SD)	48.6 (17.4)
Age distribution	
< 40 years	14 (31%)
40 to < 60 years	15 (33%)
≥ 60 years	16 (36%)
Sex	
Female	22 (49%)
Male	23 (51%)
Admission diagnosis	
Non-traumatic intracranial haemorrhage	24 (53.3%)
Traumatic intracranial injury	12 (26.7%)
Cardiac arrest	9 (20.0%)
Post-death duration of admission in ICU	
Mean hours (SD)	37.9 (16.5)
Median hours (IQR) [range]	43.4 (25.7–48.3) [4.3–77.8]
Limitations of medical treatment on admission	
None (ie, for all life sustaining measures)	21 (47%)
Some limitation	24 (53%)
Organs donated, *n*	
Heart	18
Lung	
▸ Single	1
▸ Double	19
Pancreas	14
Cornea	
▸ Single	0
▸ Double	1
Kidney	
▸ Single	1
▸ Double	36
Liver	31

ICU = intensive care unit; IQR = interquartile range; SD = standard deviation.

Results

Forty-five individuals donated at least one organ after brain death (Table 1). The mean duration of care in the ICU after brain death was 37.9 hours (SD, 16.5).

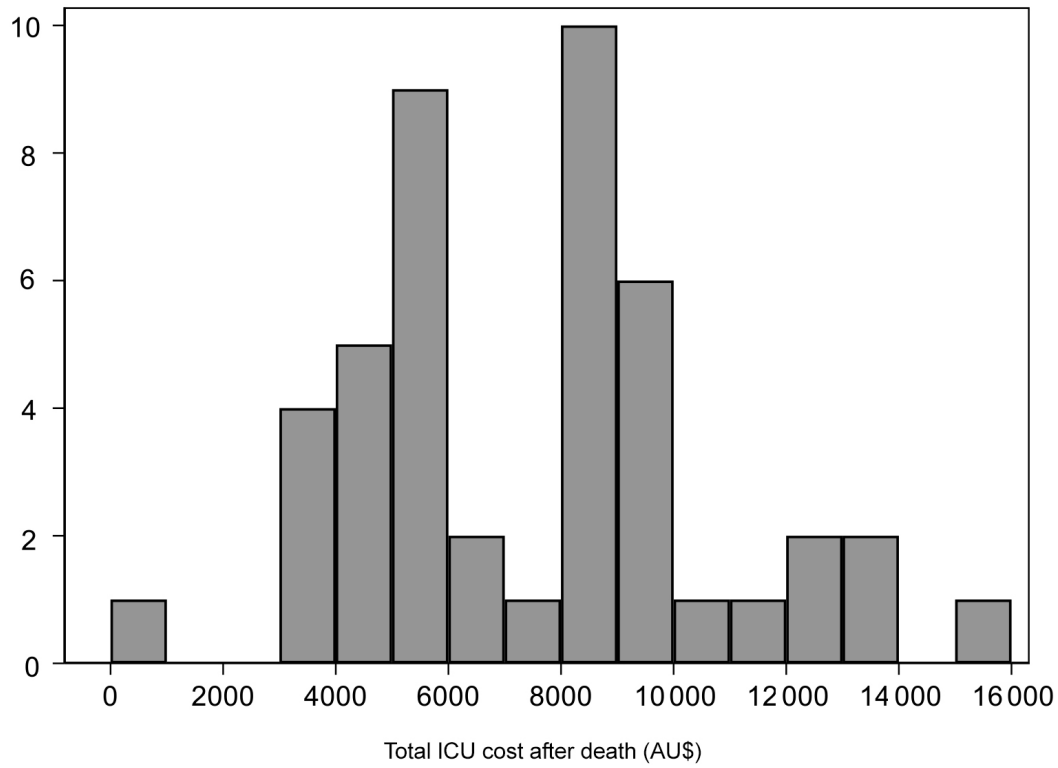
The mean cost of providing ICU care after death was $7520 (SD, $3136) per donor (Figure 1). Staff salaries were the greatest contributor to the cost of care, comprising a median proportion of 0.72 of total expenditure (IQR, 0.68–0.75). The mean cost attributable to drugs and fluids was $478.4 (SD, $680.4). The mean cost of imaging was $288.6 (SD, $281.0) and of pathology was $687.2 (SD, $321.3). The mean cost of other patient expenses was $681.41 (SD, $297.50) and of indirect expenses $113.6 (SD, $49.6). Beyond the major component of staff salary, and thus duration of stay, there were no other identified independent predictors of increased cost on multivariable linear modelling.

Discussion

Organ donation is cost-effective at the community level.[18] Our study estimated that the mean duration of care in ICU after donor death as 37.9 hours (SD, 16.5), accompanied by a mean cost of about $7500, the major component of which was staff salary. In the setting of limited previous Australian data, these updated estimates inform considerations of the adequacy of current hospital funding to provide ICU care to potential organ donor patients after death.

The most comprehensive recently published estimate of cost focused on donation after cardiac death in the United States.[19] The mean cost of donation, including transportation

Figure 1. Histogram of estimated total costs* in intensive care unit (ICU) for patients after brain death and before organ donation



* $1000 cost bracket.

and operating theatre expenses, was US$16 695 per donor. While not reporting ICU-based care as a separate variable, the mean cost was US$8794 per potential donor who did not proceed to theatre.

Microcosting analysis considers costs incurred during management of each patient.[8,20] A major strength of our study lies in the microcosting methodology applied to salaries, radiology, pathology, drug, fluids, and blood products. When using the preferred bottom-up techniques was not possible, top-down microcosting techniques, which retain some accuracy, were applied.[9,14]

Our study has some limitations. The staffing model was minimalist, with no inclusion of time solely dedicated to family donation conversations,[21,22] additional clinicians (eg, senior registrars), and non-clinical roles. Given staff salaries constituted the greatest proportion of cost, such simplifications would underestimate the true cost.

There are further limitations that bias toward conservative cost estimates. Specific costs were not captured that account for after-hours interventions, particularly those that may involve additional payments to specialised staff (eg, transthoracic [*n* = 29] and transoesophageal echocardiograms [*n* = 6] and coronary angiography [*n* = 4]). Moreover, the study did not include potential donors who did not proceed to organ donation, costs incurred before brain death, or costs attributable after ICU, such as theatre costs and surgical procurement team salaries.[23]

Conclusions

Using a conservative microcosting analysis approach there appears to be substantial ICU expenditure in providing care after brain death and before organ donation. These estimates should inform decisions regarding future funding.

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Competing interests

No relevant disclosures.

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