

# Palliative ICU beds for potential organ donors: an effective use of resources based on quality-adjusted life-years gained

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A bed in an intensive care unit is a limited and expensive resource. There is an obligation to consider the net benefit in using that resource responsibly.<sup>1</sup> Organs for transplantation are also a scarce resource, and there is an obligation to maximise opportunities for donation within an ethical framework.

In the ICU, transition to an end-of-life pathway, including consideration of organ donation, often occurs after a period of failed active management of a patient who was initially expected to have a chance of survival. However, some patients arrive at the hospital in a critical condition that is, after resuscitation and investigation have been performed in the emergency department (ED), recognised to be unsurvivable. Treatment choices include end-of-life care delivered in the ICU or withdrawal of life-sustaining treatments in the ED. Palliation in the ICU may provide additional opportunities for end-of-life care to be administered. In the ICU, spiritual and cultural needs can be attended to, and the dying patient's wishes for and expectations of organ donation can be addressed. An alternative view holds that this is an inappropriate use of resources.

We present a focused evaluation of ICU admission when there is consideration of organ donation. We compare the expected gain in adjusted life-years for the wider community when a patient is admitted for end-of-life care (including consideration of organ donation) with an estimate of the adjusted survival benefit expected for ICU patients who are admitted for active care. We ask, from a community perspective, if this is a reasonable use of ICU resources.

An economic evaluation of two strategies compares measures of cost and outcome. To date, monetary comparisons of the relative cost-effectiveness of specific therapies have been published, rather than comparisons between potential uses of a resource such as a single bedspace.<sup>2</sup> In our analysis, we have used one ICU bed-day as the unit of cost, recognising that monetary cost will vary between countries and health care models, but that the unit of bed-day will be generalisable.

Measures of outcome assess effectiveness and utility.<sup>3</sup> Effectiveness is objective, but utility includes the subjective value of the outcome to the beneficiary. A measure of effectiveness such as life-years gained captures duration but not functional quality of survival. Many survivors of

## ABSTRACT

**Objective:** To evaluate whether the admission of a palliative patient to the intensive care unit for end-of-life care and consideration of organ donation provides an equivalent net benefit in quality-adjusted life-years (QALYs) compared with the admission of a non-palliative patient for active management.

**Design:** Relevant publications from the period 1995–2015 were reviewed to estimate the mean QALYs gained from ICU admission of a critically ill patient and mean QALYs gained from transplantation of solid organs from an organ donor. Australian audit data were used to estimate the likelihood of a palliative patient admitted to the ICU progressing to organ donation. We calculated probabilities of each outcome and developed an algorithm to illustrate possible pathways for a patient who may progress to organ donation.

**Results:** A non-palliative ICU admission provides to the patient about 1.0 QALY per ICU bed-day. An ICU bed provided to a patient admitted to the ICU for palliation and consideration of organ donation results in 7.3 QALYs gained for the community per ICU bed-day.

**Conclusion:** The admission of a dying patient to the ICU when organ donation may be possible is of considerable community benefit, yielding an average of over seven times the QALYs per ICU bed-day compared with the average benefit for ICU patients expected to survive. When it is possible to offer end-of-life care in the ICU, it should not be denied on the basis of concerns about lack of benefit or inappropriate use of resources.

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critical illness, and transplant recipients, have a reduced quality of life in comparison with population controls<sup>4,5</sup> and this should be incorporated in the outcome measure. The quality-adjusted life-year (QALY) provides a standardised measure for life-years gained, conditioned by a quality-of-life modifier. One year in full health results in one additional QALY, and a year of life with disability yields less than one QALY. Accumulated future QALYs are often discounted over time, as health consumers attribute greater utility to current gains over future benefits.

**Table 1. Net quality-adjusted life-years (QALYs) gained through solid organ transplantation**

Study lead author, year	QALYs gained per organ					Notes
	Lung (each)	Liver	Kidney (each)	Heart	Pancreas	
Mendonça 2014 <sup>10</sup>	2.7	–	–	–	–	–
Beckwith 2012 <sup>11</sup>	–	–	–	–	1.6	Islet transplantation
Grauhan 2010 <sup>12</sup>	–	–	–	8.0	–	Median provided
Dayton 2006 <sup>13</sup>	–	–	–	11.5	–	Paediatric transplants only
Groen 2004 <sup>14</sup>	2.5	–	–	–	–	–
Whiting 2004 <sup>15</sup>	–	–	2	–	–	–
Yen 2004 <sup>16</sup>	–	–	3.3	–	–	–
Ouwens 2003 <sup>17</sup>	5.2	11.5	–	6.8	–	–
Knoll 2003 <sup>18</sup>	–	–	–	–	2.5	Pancreas + kidney v kidney only
Kalo 2003 <sup>19</sup>	–	–	2.5	–	–	–
Sagmeister 2002 <sup>20</sup>	–	6.2	–	–	–	–
Anyanwu 2002 <sup>21</sup>	2.1/1.7	–	–	–	–	Single, 2.1; double, 3.3
[Schnitzler 2005 <sup>7</sup> ]	[2.1]	[16.9]	[7.2]	[14.5]	[5.7]	[Life-years, not used in analysis]
<i>Mean expected community QALY gain (plausible range)</i>	2.8 (1.7–5.2)	8.9 (6.2–11.5)	2.6 (2.0–3.3)	8.8 (6.8–11.5)	2.1 (1.6–2.5)	–

Our evaluation links five components:

- an estimate of the expected QALY gain to the community with ICU admission of a dying patient when organ donation may be offered
- an estimate of the expected QALY gain to the community with ICU admission for a typical patient
- an algorithm in which the parameters are estimates of the likelihood of progression to relevant outcomes
- a comparison of net outcomes based on likelihood
- a sensitivity analysis.

We do not propose to assign a monetary value to the resources used or the benefits realised.

## Methods

### Organ donation

There are two pathways to cadaveric organ donation. Most donations are through donation after brain death (BDD), and some are through donation after circulatory death (DCD). A greater range and number of organs can be retrieved by BDD than by DCD. Transplantation of the heart, liver, pancreatic tissue, kidneys and lungs can follow BDD. Both lungs and both kidneys will usually be transplanted after DCD. The liver and the heart may be donated after circulatory death, but these are less common donations and we have not considered them in our analysis.

### Literature search

We searched the PubMed database for English-language publications between 1995 and 2015 that addressed the QALY gains associated with patients who benefit from organ transplantation, and patients who are admitted to the ICU. Our search terms for the former were “transplantation” and “QALY”, “utility” or “effectiveness”. Of the 338 transplantation study abstracts we reviewed, we retrieved 33 relevant studies. Twelve studies met all criteria and were included in our analysis.

From the search terms “intensive care” and “QALY” or “cost-effectiveness”, we reviewed 265 studies at abstract level and retrieved 20. We reviewed bibliographies and identified a further three studies. We excluded studies reporting only life-years gained<sup>6,7</sup> and those with follow-up periods of less than 5 years.<sup>8,9</sup> We included seven studies in our analysis.

We developed an algorithm with an iterative Delphi method of consultation with experts from emergency, intensive care and organ donation specialties. De-identified data drawn from the DonateLife audit tool (1/2013–5/2015) provided the parameters of the model. Our analysis, using the de-identified audit data, was approved by the Princess Alexandra Hospital Human Research Ethics Committee.

## Results

### QALY gains from ICU admission for organ donation

To establish the net QALYs gained through a single organ donor, we used studies that reported QALYs gained as a consequence of organ transplantation. These studies reported outcomes for transplantation of a single organ, included failed and successful results in the expected QALY estimate, and reported net QALYs gained rather than QALYs per year. The most comprehensive assessment of multiple organ donation that we found, by Schnitzler and colleagues,<sup>7</sup> reported results as life-years gained rather than QALYs. We show their results for comparison but did not include them in our analysis. We have not included any attribution of QALYs for eye and tissue transplantation. The reports of net incremental QALY gain through organ transplantation are summarised in Table 1.

Based on mean reported figures for BDD when all organs are donated, a net gain of 30.6 QALYs is expected for the community. For DCD when two lungs and two kidneys are donated, a net community benefit of 10.8 QALYs is expected. Therefore, as the reported length of ICU stay of Australian potential organ donors with a palliative diagnosis was 24 hours,<sup>22</sup> the net expected community QALY gain per ICU bed-day, when all possible organs were medically suitable for transplantation, would be 30.6 QALYs for a BDD (plausible range, 22.4–42.5 QALYs) and 10.8 QALYs for a DCD (plausible range, 7.2–17.0 QALYs). We did not account for ICU bed-days incurred by the recipients after transplantation.

**Table 2. Gain in QALYs derived from ICU admission v non-admission**

Study lead author, year	Population	QALY gain	ICU LOS (days)	QALY gain /ICU days
Cuthbertson 2010 <sup>4</sup>	UK medical ICU	1.5*	6.7	0.22
Graf 2008 <sup>26</sup>	European cardiac arrest survivors	5	9	0.56
Cox 2007 <sup>27</sup>	US prolonged ventilation	1.8	21	0.08
Ridley 2007 <sup>24</sup>	International mixed ICU	1.3	5	0.25
Graf 2005 <sup>25</sup>	European medical ICU	11.2	3.7	3.0
Sznajder 2001 <sup>28</sup>	European mixed ICU	3.9	7.9	0.49
Kerridge 1995 <sup>23</sup>	Australian mixed ICU	7.5	3.0	2.5

QALY = quality-adjusted life year. ICU = intensive care unit. LOS = length of stay. UK = United Kingdom. US = United States. \* At 5 years.

### QALY gains from typical admission to the ICU

Estimating a QALY outcome for an average ICU admission is difficult, with varying methodologies in published reports. Casemix is important, with one report identifying an almost fivefold difference in QALY gain between a trauma patient and a patient with pulmonary oedema.<sup>23</sup>

Further, the QALY gain associated with ICU admission must include consideration of the incremental benefit of the admission versus non-admission. There are no randomised controlled trials of the benefit of ICU admission, and studies differ in their approach to the non-admitted population. Ridley and Morris<sup>24</sup> extrapolated an absolute risk reduction associated with ICU admission to modify their QALY estimate. Graf and colleagues<sup>25</sup> assumed that all patients referred but not admitted to the ICU would die, and attributed all post-ICU QALYs to ICU interventions, thus maximally estimating the benefit of the ICU.

Even so, we require an estimate of the remaining life expectancy and quality of life of ICU survivors. The most optimistic estimates assume that ICU survivors have a life expectancy similar to age-matched population peers, defining the upper limit of plausible ICU benefits.<sup>25,26</sup> Other studies applied a modifier to reduce estimated life expectancy after discharge.<sup>23</sup> Discounting, where future QALY gains are given less value than current gains, was variably applied at rates ranging from 0 to 5% per year. The reported quality of life of ICU survivors showed considerable variation, with the highest measured health status index being 0.88.<sup>25</sup> The lowest reported measured health status index was in a large cohort study where, after 5 years, the median accumulated QALYs were just 1.5 per patient.<sup>4</sup>

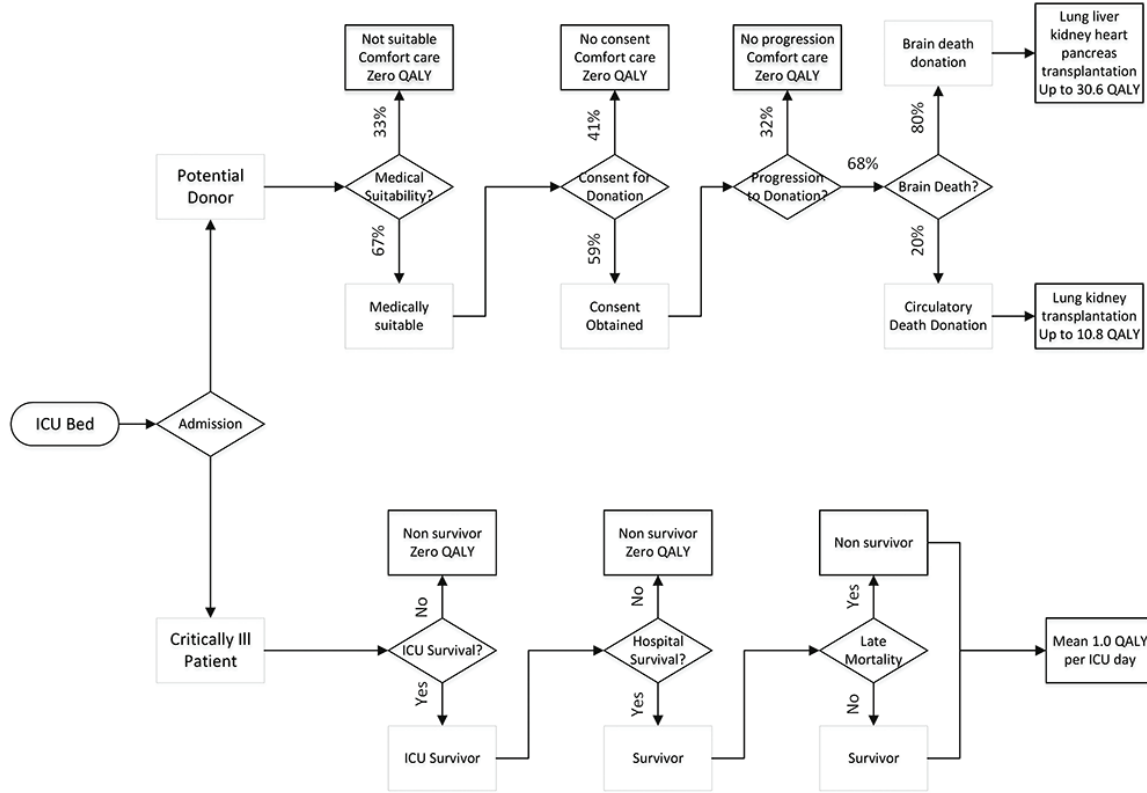
Table 2 summarises the QALY gain and ICU length of stay reported in the relevant studies. In some studies, the reported data required aggregation to arrive at the figures below.

The reported benefits ranged from 0.08 to 3.0 QALYs gained per ICU day. The median figure for QALYs gained per ICU bed-day was 0.49 QALYs, and the mean was 1.0. We chose to use the mean as a representative expected yield of 1.0 QALY gained per ICU bed-day (plausible range, 0.08–3 QALYs).

### Probability of progression to organ donation

Figure 1 maps the possible pathway of an ICU patient admitted for consideration of organ donation, and the possible pathway of a standard critically ill ICU patient. When possible, audit data were used to establish the parameters for these pathways. Of the 55 patients who met the criteria of ICU admission after designation in the ED for palliative care, 67% were deemed medically suitable for consideration of organ donation. Their families consented to donation for 59% of patients. Of the patients deemed medically suitable,

**Figure 1. Possible pathways of a patient admitted to the ICU for consideration of organ donation, and a standard critically ill ICU patient**



ICU = intensive care unit. QALY = quality-adjusted life-year.

when consent was provided, 68% proceeded to organ donation. Of those who proceeded, 80% followed a BDD pathway and 20% followed a DCD pathway.

**Comparison of outcomes**

There are several conditions that must be fulfilled for a patient to progress to organ donation. These conditions and their probabilities are:

- determination of medical suitability (probability, 0.67)
- consent for donation (probability, 0.59)
- progression to donation (probability, 0.68).

Of patients admitted for consideration of donation, the probability of BDD is 0.8 and the probability of DCD is 0.2. Given that the potential net QALY gain from BDD and transplantation is 30.6 QALYs, and gain from DCD is 10.8 QALYs, the net potential QALY gain from admitting a palliative patient to the ICU for consideration of organ donation can be estimated using the following formula:

$$\text{Net QALY} = 0.67 \times 0.59 \times 0.68 \times ((0.2 \times 10.8) + [0.8 \times 30.6])$$

Thus the total potential QALY gain is 7.3 QALYs per ICU bed-day (plausible range, 5.2–10.1 QALYs). This compares favourably (ie, is dominant in economic terms) with

admission of a critically ill patient to an ICU bed, which is estimated at 1.0 QALY per ICU bed-day.

**Sensitivity analysis**

We acknowledge that our figures are estimates only; we combined information from a variety of sources. Nevertheless, the overall conclusion is robust — that admission of a dying patient for end-of-life care which may include consideration of organ donation is a reasonable use of resources in comparison with admission of a non-palliative critically ill patient. Reducing the likelihood of progression to organ donation to half the likelihood on which we based our calculation still results in an estimate of 3.6 QALYs per ICU bed-day for a potential organ donor. Reducing the number of organs per donor to half the number of organs on which we based our calculation leads to a similar estimate. These scenarios are still dominant in comparison with even the most favourable reported estimate of benefit deriving from admission of a critically ill patient, which is 3.0 QALYs per ICU bed-day.<sup>25</sup> Applying both scenarios (half the number of organs from half as many donors) leads to an estimate of 1.8 QALYs per ICU bed-day for a potential donor, which still compares favourably with the mean reported figure of 1.0

QALY per bed-day for a standard critically ill patient. Thus, considering a range of plausible scenarios, the community derives considerable benefit from admitting patients to the ICU for palliative care when there is a possibility of offering organ donation as part of end-of-life care.

## Discussion

A patient with no likelihood of survival who is admitted to the ICU will not gain any individual QALY benefit from that admission, but there are other benefits to the patient and their family. There is also potential benefit to the community if organs are offered for transplantation after a patient's death. The tension between palliation benefits for the individual and the possibility of organ donation has been described as a conflict between intimacy and utility.<sup>29</sup>

Measured on the basis of benefit to the individual patient, end-of-life management has been regarded as a marginally beneficial activity. The American Thoracic Society statement on fair allocation of ICU resources states that:

access for marginally beneficial ICU care (i.e. care providing only minimal or a small incremental benefit) may be restricted on the basis of its limited benefit relative to cost.<sup>30</sup>

An additional perspective is that ICU palliation may provide benefits beyond the possibility of survival and functional recovery of the critically ill patient. Benefits may extend to the family and beyond to the wider community. Access to social and spiritual support, time to carry out religious rituals, and interventions that value the dignity, privacy and autonomy of the patient can be provided in a critical care environment. A period of supported physiological stability during preparation for death can provide a benefit that is not measured with traditional metrics.<sup>31</sup> Additionally, the focus of this discussion is that this period provides the opportunity for organ donation to be offered in this context.

Using the conservative figures of our analysis, we estimate that the benefit to the community of admission of a patient to the ICU when organ donation is part of end-of-life care is potentially very large. For patients who receive palliative care, even without detailed screening for medical suitability for organ donation, the average benefit to the community from ICU admission of that patient is at least as great as the benefit expected for an average ICU patient who is expected to survive.

## Limitations

Limitations of our study include that it does not address the monetary costs associated with the QALY yields, so we cannot comment on how these additional community QALYs rank in value compared with other treatments or public health measures. All studies that informed our analysis were conducted in developed nations, and we caution the application of these findings to the developing

world. We recognise also that patients aged over 80 years and those with known malignancy are excluded from the DonatLife audit, so we cannot extend our findings to dying patients in these groups.

The greatest limitation of our study is the variety of data that have been amalgamated. We do not assert that the estimates of QALY benefit from transplantation or ICU admission are precise values. We do, however, believe that our key finding — that ICU admission for palliation and consideration of donation provides at least as much potential benefit as non-palliative admission — is robust, given the sevenfold difference between the estimated gains in favour of palliative admission.

It is important that this discussion is not misinterpreted as suggesting that dying patients should be preferentially managed in critical care beds ahead of patients who have a prospect of survival. We do not suggest that decisions about patient care in the ICU should be made on the basis that the community could benefit more from the death of an ICU patient than from their survival. Nor should our analysis be used to support the transfer of a dying patient to the ICU for the sole purpose of organ donation without consent. We do propose that it is reasonable to provide end-of-life care and to allow consideration of organ donation in critical care facilities where those resources are available.

## Conclusion

The admission of a dying patient to the ICU when organ donation may be possible is of considerable community benefit, yielding an average of seven times the QALYs per ICU bed-day compared with the expected benefit for ICU patients expected to survive. Therefore, where it is practical to offer end-of-life care in the ICU, it should not be denied because of concerns about lack of benefit or inappropriate use of resources.

## Competing interests

None declared.

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