Rationing critical care beds: a systematic review
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CRD summary
The authors assessed the impact of rationing intensive care unit beds on the process and outcomes of care and concluded that the observational nature, heterogeneity, moderate to poor methodological quality and lack of succinct conclusions of the individual studies precluded strong conclusions. The authors' conclusions reflect the evidence presented and appear reliable.

Authors' objectives
To assess the impact of rationing intensive care unit beds on the process and outcomes of care.

Searching
Six databases (including MEDLINE, EMBASE and The Cochrane Library) were searched to 2003. Search terms were reported. There were no language restrictions. The related articles feature of PubMed was searched. References and meeting abstracts from four societies were handsearched from 1990 to 2003. Personal files were viewed and contact was made with experts and first authors to locate further published or unpublished literature.

Study selection
Retrospective or prospective cohort studies that examined the effect of rationing of intensive care unit beds, based on reduced bed availability or triaging of patients referred for admission, were eligible for inclusion. Eligible study populations were seriously ill adults (>16 years old) considered for admission to intensive care. Any outcome was of interest; examples included severity of illness scores, length of stay and mortality. Studies that reported on cost-effectiveness alone were excluded as were studies of scoring systems or protocols to make rationing/triage decisions and studies of rationing or triaging in coronary care units.

Studies were conducted in Canada, USA, Israel, France, Hong Kong, Sweden and UK; most were single-centre studies conducted between 1979 and 1999. Where reported, just over half of the intensive care units were closed and the number of beds ranged from seven to 22. Hospital intensive care unit bed ratios and nurse-patient ratios varied across the studies (where reported). Half of the studies compared cohorts of patients admitted to intensive care units with those refused admission (triaging studies). Most of the other half compared patients admitted to intensive care units during periods of variable bed availability (rationing studies). Singular studies reported on patients admitted or refused admission to intensive care units during period of bed closure. Reasons for refused admission varied and were related to triage, refusal for inappropriate referrals, futile admission due to patients being too sick to benefit from the intensive care unit and staff and/or bed shortages. Almost half of the studies reported use of official policies to aid decision-making; details of these were reported in the paper. Where reported, mean age of patients ranged from 49 to 65 years and 35% to 60% of the patients were female. Reasons for admission to intensive care units varied and included congestive heart failure, sepsis, acute respiratory failure, trauma and other medical reasons.

Two reviewers independently selected studies for inclusion; any disagreements were resolved by consensus.

Assessment of study quality
A quality assessment tool was developed by the review authors a priori. Criteria included follow-up of more than 90% and adjustment for confounders in their analyses. It appeared that total scores could range from 0 to 5, with a maximum score of 5 indicating higher quality.

Two reviewers independently assessed study quality.

Data extraction
Data on outcomes relating to refusal for intensive care unit admission and hospital mortality were extracted. Study authors were contacted if any key data were unclear or not reported. Data were extracted in a variety of forms (such as proportions and percentages, means and standard deviations/errors, medians and interquartile ranges, odds ratios and 95% confidence intervals). The primary outcome was the effect of rationing or triaging on mortality rate and it
appeared to have been specified post hoc.

Two reviewers independently extracted data; any differences were resolved by consensus.

Methods of synthesis
Studies were classified as type 1 (triaging studies with two group comparisons), type 2 (rationing bed studies with two group comparisons) or type 3 (single cohort studies). Odds ratios (OR) and 95% confidence intervals (CI) demonstrating hospital mortality rates in triaging studies were pooled using a random-effects model; statistical heterogeneity was assessed using the $X^2$ test. Sensitivity analyses were performed for the mortality outcome in relation to study quality, adjustment for confounders in analyses, proportion of surgical patients and study date. A narrative synthesis was presented for data on other outcomes in other types of studies.

Results of the review
Ten observational studies (12,879 patients) were included in the review: six prospective studies and four retrospective studies. The median quality score was 3 (interquartile range 2 to 4). Nine studies followed up more than 90% of their patients. Three studies adjusted for confounders in their mortality analyses.

Triaging studies (patients admitted to intensive care units versus patients who were refused admission, five comparative studies):

From 16% to 51% of the patients were refused intensive care unit admission. The odds of hospital mortality were statistically significantly higher in the group refused admission to intensive care units compared with those who were admitted (OR 3.04, 95% CI 1.49 to 6.17; four studies) although significant heterogeneity was shown ($p<0.001$).

Sensitivity analysis of the studies with a quality score of 3 or more showed greater odds of mortality with refusal of intensive care unit admission (OR 4.07, 95% CI 2.38 to 6.97; three studies) with no significant heterogeneity ($p=0.06$). Heterogeneity was not explained by any of the other sensitivity analyses. Variables associated with increased mortality rates included greater age, higher Acute Physiology and Chronic Health Evaluation II score and medical status.

Rationing beds studies (patient admission to intensive care units during periods of bed shortages, three comparative studies and one single cohort study):

During bed shortages in intensive care units, larger proportions of patients with greater severity of illness were admitted (two studies). Two studies documented a reduced length of stay in intensive care units during bed shortages and one study reported decreases in the length of hospital stay.

Further results were reported in the paper.

Authors’ conclusions
The observational nature, heterogeneity, moderate to poor methodological quality and lack of succinct conclusions of the individual studies precluded strong conclusions.

CRD commentary
The review question was broad and supported by clearly defined inclusion criteria. Relevant databases were searched for publications in any language and attempts were made to locate unpublished literature. Measures were taken throughout the review process to minimise any reviewer error and/or bias. A quality assessment tool was developed by the review authors but very little information was provided in relation to the criteria and it was difficult to assess how valid the assessment was. Study details were presented and revealed some diversity between the studies.

Use of both statistical and narrative methods of synthesis seemed appropriate for the evidence presented. The authors stated that the observational designs of the studies means that the increased risk of mortality with refused admission might not remain following adjustment for confounders. Some of the observational studies were retrospective and this further limited their robustness. Other limitations included restricted generalisability of results, potential for temporal trends (such as through changes in societal values, technology utilisation and intensive care unit workload) and lack of consideration for the influences of families and healthcare professionals. It was also difficult to ascertain the actual conclusion from this review because the conclusive statement in the abstract differed from that provided in the
Conclusion of the review paper.

Overall, this was a well conducted review; the authors' conclusions reflect the evidence presented and appear reliable.

**Implications of the review for practice and research**

**Practice:** The authors stated a need for alternatives to intensive care unit admission for patients who needed stabilisation or whose illnesses were too complex for general wards. They suggested that graded levels of care might help with the optimal utilisation of critical care resources and that the medical community should agree on standardised definitions for rationing and triage.

**Research:** The authors stated that further research was required to evaluate the merit of telephone triage, out-of-intensive care unit consults and intensive care unit admission guidelines. They stated that there was a need for higher quality studies to address how rationing and triaging decisions were made, impacts on morbidity and mortality and the public's perspective on rationing of critical care beds.

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