Effect of a multiple-site intensive care unit telemedicine program on clinical and economic outcomes: an alternative paradigm for intensivist staffing

Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
The study investigated a multiple-site intensive care unit telemedicine programme. This remote care programme used intensivists and physician extenders to provide supplemental monitoring and management of intensive care unit (ICU) patients for 19 hours per day from a centralised, off-site facility. Supporting software, including electronic data display, physician note- and order-writing applications, and a computer-based decision support-tool, were available both in the ICU and at the remote site. This programme was compared to usual the usual standard of care in the ICU.

Type of intervention
Treatment.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised patients receiving ICU care. Patients were excluded if they met the following criteria: admission to the ICU more than 30 days before the start of the study periods, admission to hospital more than 60 days before the start of the study periods, a stay in the ICU of less than 4 hours, and transfer to an ICU that did not participate in the remote monitoring programme within 12 hours of admission to the ICU. However, for study patients who stayed in a non-programme ICU during the same hospitalisation as their programme ICU stay, the days spent in the non-programme ICU were included in ICU length of stay.

Setting
The study setting was tertiary care. The economic study was conducted in the USA.

Dates to which data relate
Effectiveness and resource data were collected in two different time periods, from 1 July 1999 to 30 June 2000, and from 1 January 2001 to 30 June 2001. The price year was 2000.

Source of effectiveness data
The effectiveness data were derived from a single study.

Link between effectiveness and cost data
The costing was undertaken retrospectively on the same patient sample as that used in the effectiveness study. However, the costing in the standard care group was based on 50% of the patients.
Study sample
No sample size calculations appear to have been conducted in the planning phase of the study and no retrospective power calculations were reported. 2,140 patients were included in the analysis: 1,396 in the standard care period and 744 in the intervention period. Four patients were excluded from the intervention group. One because of an ICU admission of more than 30 days before the study start date, and three for an ICU stay of less than 4 hours. The standard care group comprised 782 males, with mean age of 61.3 (+/- 17.7) years. From the 1,396 patients in the standard care period, 631 received care in an ICU that primarily cared for high-acuity medical patients (MICU) and 765 patients received care in an ICU primarily giving care to vascular surgery patients (SICU). The intervention group was composed of 370 males with a mean age of 60.1 (+/- 16.9) years. From the 744 patients in this group, 359 patients received care in the MICU and the remaining 385 in the SICU.

Study design
The study was reported to be a before and after trial conducted in two adult ICUs of a large tertiary care hospital. It would appear that patients were followed-up until they were discharged from hospital. The authors did not report any loss to follow-up.

Analysis of effectiveness
It would appear that all the patients included in the study were accounted for in the analysis. The major clinical outcomes were ICU mortality, hospital mortality, ICU length of stay and hospital length of stay. Patients with an ICU length of stay of 7 days or more were classified as outliers. The percentage of patients who were outliers and their average ICU length of stay were secondary outcome measures. Acute Physiology and Chronic Health Evaluation III (APACHE III) physiology scores were used to evaluate whether severity of illness changed between periods. APACHE physiology scores and predicted mortality and length of stay were determined for all patients during the study period and for 50% of patients from the baseline period. An outside group randomly selected patients for inclusion in the baseline chart abstraction. The authors reported that ICU demographics and patient acuity were similar in the two study periods.

Effectiveness results
ICU mortality for ICU patients was lower during the period of remote ICU care (6.3% versus 8.6%, p<0.05; relative risk (RR) 0.73 with 95% CI: 0.53 - 1.02).

Hospital mortality for ICU patients was lower during the period of remote ICU care (9.4% versus 12.4%, p<0.05; relative risk (RR) 0.73 with 95% CI: 0.55 - 0.95).

Mean ICU length of stay was shorter during the period of remote ICU care (3.63 days versus 4.35 days, p<0.05).

There were no statistically significant differences in hospital length of stay between the two time periods.

The proportion of outliers decreased during the intervention period from 13.9% to 11.6%. However, these differences were not statistically significant. For those receiving SICU care, the proportion of outliers was significantly lower in the intervention period than in the standard care period (5.9% versus 9.4%).

Outlier ICU length of stay was unchanged in the two time periods.

Clinical conclusions
The addition of a supplemental, telemedicine-based, remote intensivist programme was associated with improved clinical outcomes.

Measure of benefits used in the economic analysis
The authors did not derive a measure of health benefit. The analysis was therefore categorised as a cost-consequences
study.

**Direct costs**
Resource quantities and costs were only reported separately for length of stay in hospital and ICU. However, the authors provided a detailed cost breakdown for each level of resource use. The direct costs included in the analysis were those of the hospital and the costs of care in ICU and hospital wards. Hospital costs included the costs of the remote ICU care programme such as the physicians’ fees, fees of the commercial telemedicine provider, equipment costs, installation and ongoing software licensing and support. The costs of ICU and ward care included laboratories, pharmacy, radiology, supplies, and therapies. Average daily ICU and hospital ward costs were determined for each ICU during the two study periods from individual patient charge data. The records of the patients used for the APACHE physiology score analysis were used for this analysis. Costs of care for each day of service were calculated using individual departmental Medicare cost/charge ratios. As all costs were incurred over periods of one year or less, discounting was not relevant, and, appropriately, not performed. The authors reported average case costs (i.e. calculated from average daily ICU and ward costs) and the contribution margin per month (i.e. gross revenue minus variable costs). Costs were converted to 2000 prices using inflation data supplied by the hospital.

**Statistical analysis of costs**
Costs were treated as point estimates (i.e. the data were deterministic).

**Indirect Costs**
The indirect costs were not included in the analysis.

**Currency**
US dollars ($).

**Sensitivity analysis**
No sensitivity analyses were conducted.

**Estimated benefits used in the economic analysis**
Due to the cost-consequences approach, see the "Effectiveness results" section above.

**Cost results**
The average case cost was lower in patients receiving remote care than in those receiving standard care ($7,871 versus $10,444).

The average case contribution margin was higher in the intervention group than in the standard care group ($10,639 versus $6,832). The contribution margin per month was therefore higher in the intervention group than in the standard care group ($1,319,236 versus $795,245).

**Synthesis of costs and benefits**
The costs and benefits were not combined.

**Authors’ conclusions**
The authors concluded that the addition of a supplemental, telemedicine-based, remote intensivist programme was associated with improved clinical outcomes and hospital financial performance.
CRD COMMENTARY - Selection of comparators

A justification was given for the comparator used, namely that only 10 to 15% of US hospitals had a dedicated intensivist staffing model in place. You should decide if this is a widely used health programme in your own setting.

Validity of estimate of measure of effectiveness

The authors described the study as a before-and-after trial, but it seems more appropriately to meet the definition of a prospective study with historical controls (as different patients were assessed in the two time periods). However, the authors pointed out that this study design has several limitations as the use of historical controls raises concerns about possible changes in patient mix and confounding factors such as the introduction of new technology. The shorter duration of the intervention period could have also introduced differences related to seasonal variation in severity of illness. However, the authors reported that the inclusion of the winter months in the intervention period would be expected to bias the results in the opposite direction. Despite this, the authors did not use other external controls to account for the effect that any potential trends, such as medical advances, and better hospital management, occurring over time, could have on health outcomes in the two time periods. The study sample would appear to be representative of the study population, but it should be noted that the authors reported the possibility of sampling error because only 50% of patient charts were abstracted. The authors reported that patient groups were comparable, but they did not report results from statistical tests to support this. However, differences in outcomes between the two groups were tested for statistical significance.

Validity of estimate of measure of benefit

The authors did not derive a measure of health benefit. The analysis was therefore categorised as a cost-consequences study and the comments above under "Validity of estimate of measure of effectiveness" apply.

Validity of estimate of costs

All categories of cost relevant to the perspective adopted were included in the analysis. Furthermore, it would appear that all relevant costs were included in the analysis. Resource quantities and costs were only reported separately for length of stay in hospital and ICU. However, the authors provided a detailed cost breakdown for each level of resource use. Costs were derived from the authors' settings and from Medicare cost/charge ratios. The costing was undertaken by an independent consulting firm, and was focused more on the profits made by the intervention than on the costs of the programme. No sensitivity or statistical analysis of costs was undertaken. Since all costs were incurred over periods of less than one year, discounting was unnecessary. The price year was reported, which will enhance future inflationary exercises. The impact of confounding variables over the two periods (as outlined in the validity of effectiveness comments above) also applies to costs.

Other issues

The authors reported that the magnitude of their results was similar to those reported in studies examining the impact of implementing on-site dedicated intensivist staffing models. The issue of generalisability to other settings was not addressed. The authors do not appear to have presented their results selectively, and their conclusions reflected the scope of the analysis. The authors reported a number of further limitations to their study, namely that multiple different care models existed in the study ICUs during the baseline period, including multiple-consultant care and daytime care by a dedicated intensivist-led team; and individual admitting physicians also varied in the autonomy they granted to the remote intensivist team, which was another potential variable affecting programme efficacy.

Implications of the study

The authors reported that, assuming that the efficacy of this care model was confirmed in subsequent studies, supplementing on-site ICU care with a remote intensivist care programme could represent an option for hospitals that wished to improve ICU clinical and financial performance. A randomised controlled trial would provide a more robust comparison by eliminating the limitations of the present study design.
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