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APACHE System Under-Predicts ICU Length of Stay for Persons with Severe Sepsis

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INTRODUCTION

Severe sepsis is a major worldwide cause of morbidity and mortality. It is:

- An important cause of admission in the intensive care units (ICU);
- The leading cause of death in non coronary intensive care units;
- The 10th leading cause of death overall.

Accurate prediction of length of stay (LOS) of severe sepsis patients in ICUs is critical to ICU outcome assessment, its resource management and floor management.

LOS prediction in ICU is generally carried out using algorithmic tools most of which are proprietary in nature such as:

- Glasgow Coma Scale (GCS);
- Simplified Acute Physiology Score (SAPS);
- Acute Physiology and Chronic Health Evaluation (APACHE);
- Mortality Prediction Model (MPM).

APACHE scoring system (currently in its 4th version – ***APACHE-IV***, is an industry leader among ICU severity scoring systems assessing severity of illness and prognosis of ICU patients. APACHE-IV model is considered to offer the best predictive accuracy in ICU.

The APACHE system incorporates measures of physiologic derangement and co-morbidities. The APACHE system was designed to predict an individual's risk of dying in a hospital. It compares each individual's medical profile against nearly 18,000 cases in its memory before reaching a prognosis that is, on average, 95 percent accurate.

OBJECTIVE:
To assess the ICU-LOS predictability of APACHE-IV system for severe sepsis patients. Does the current LOS prediction tool used in the hospital accurately predict the LOS of ICU-admitted severe sepsis patients?

METHODS

- ICU data [consecutive adult new admission to ICUs: 1st June, 2006 – 31st August, 2008] from AMRI hospitals, Kolkata India.
- Data collected: included demographic data (age, sex), admission category (medical, surgical, trauma), underlying disease(s) and co-morbidities, predicted and actual LOS through chart abstraction. The discharge diagnosis of the patients was used to categorize the organ system involved. Procedures and surgical events during patients' stay at ICU, attending physician information and clinical test data were included.
- Entry criteria: Only severe sepsis ICU patients were included in the study. Patients who stayed in the ICU for < 24 hours for routine post-operative surveillance or those who were discharged alive from ICU within 24 hours without developing sepsis or complications were excluded. Out of these 30 re-admissions were removed
- Patients were followed up till they were discharged from ICU or the study period came to an end. At close of study, their actual ICU-LOS was calculated, which was also a function of their patho-physiological state at baseline.

Methods Contd.

- The main outcome variable: predicted ICU-LOS from APACHE-IV. At the time of entry into the study, all patients had a predicted ICU-LOS score which was a function of their patho-physiological state at baseline.
- APACHE-IV predicted ICU-LOS of severe sepsis patients were compared with observed ICU-LOS, days on mechanical ventilation and other important factors impacting ICU-LOS, employing: tests of suitably transformed variables.
- ***Tests included***: Pearson's product-moment correlation coefficient, t-Tests and Analysis of Variance (ANOVA) as applicable with alpha set at 0.05. Appropriate adjustments for multiple comparisons in ANOVA were made by employing Scheffe's pair-wise comparison test.
- Because each patient acted as his/ her own control for the main outcome variable, expected and actual ICU-LOS were deemed correlated. Therefore, paired t-Test was conducted to test the differences between mean expected ICU-LOS and actual ICU-LOS. Other sub-group comparisons used unpaired tests after testing for equality of variances - ICU-LOS differences between groups (sex, age groups, de-identified treating physician, type of admission source, and different procedures during ICU stay) were tested using Pearson's correlation coefficient, independent t-Tests and ANOVA.
- All analyses were done using a "clean" data set in SAS® software program for windows (V9.2, SAS institute, Cary, NC).

Institutional ethical committee clearance from AMRI hospitals, Kolkata India (AMRI Ethics Committee approval for Epidemiology of Severe Sepsis Study).

RESULTS

- Out of 3949 ICU admissions, 218 severe sepsis admissions were identified [*168 unique admissions*] where 134 patients [80%] had complete usable data.
- 59% men; median age: 63 Years [IQR:24].
- 42% had dialysis; 84% had mechanical ventilation [MV].
- Mean observed ICU-LOS [9.3 $\pm$ 6.7 days] was significantly greater than APACHE-IV predicted ICU-LOS [6.3 $\pm$ 4.3 days; paired t-test; p=0.0017].
- The difference between mean observed ICU-LOS and mean expected ICU-LOS was ~ 3 days [2.98 days].
- ICU-LOS was under-predicted in 83% cases.
- ICU-LOS was very strongly correlated with days on MV [r=0.9].
- Mean ICU-LOS was significantly greater for those receiving blood transfusion [p<0.0001]; on MV [p=0.0018]; having surgery [p<0.0001].
- For other factors, the differences were not statistically significant (e.g. time of admission). Although mean ICU-LOS was greater for men compared to women (p = 0.09); admissions from surgery and emergency departments compared to others; for some attending physicians compared to others; and for those having a source of payment other than their own personal source (such as insurance, employer covered plans, or other third party payment sources) (p = 0.2), these differences did not reach statistical significance after adjusting for multiple comparison where needed.

DISCUSSION

- Improving the quality of care in ICUs has been shown to reduce costs.
- In general, for patients who require admission to ICUs, the average LOS is significantly longer than for admissions that do not require ICU stays. Therefore, it becomes imperative for the hospital running the ICU to put policies in place that not only plan and use ICU budgets judiciously, but also maximize the efficiency of ICU utilization to maximize effectiveness and benefits for the monies spent. Key factors determining such policy initiatives is a prediction of individual and average LOS in ICUs for patients.
- Increasing ICU beds appears to have shortened emergency department LOS for ICU patients but has less effect on other admitted patients and apparently no effect on patients discharged home (McConnell, 2005).
- In emergency care a perfect balance between given resources and demand is much more difficult to achieve and maintain. In reality, certain key resources, e.g. ICU beds, are often over-utilized (Örtenwallet al., 2009).
- Under-estimation of LOS may lead to poor bed-strength of ICUs .

CONCLUSIONS

- On an average, APACHE-IV under-predicted the actual length of stay in ICUs by about 3-days.
- This underestimation is about 33% of the actual LOS and may impact hospital readiness for accommodating and managing patients in ICUs.
- Underestimation occurred in most cases. Correct prediction of length of stay in ICUs impacts clinical as well financial outcomes of the ICUs and the hospital because ICUs are considered major revenue generators for hospitals.

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