

Resource use and optimization in intensive care units

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Background and Rationale

The proposed study is part of the executive MBA work by Philipp Venetz at the University of St. Gallen, St. Gallen, Switzerland, an attending specialist in intensive care medicine at the Department of Intensive Care Medicine, Bern University Hospital (Inselspital), Bern, University of Bern Switzerland. The proposed study is also aimed at establishing the methodology and platform for future studies on intensive care unit (ICU) economics within the Consortium and locally.

Given both the realities of an aging population and advances in medicine, concomitant economic pressures are becoming evident worldwide. Competitive private insurance companies and/or restricted national health budgets will urge intensive care physicians to analyze costs and the use of resources efficiently, considering the resource availability and patient-oriented outcomes. Benchmarking with other institutions is a well-established method, and the Finnish Intensive Care Consortium (FICC) has a unique position for more in-depth resource use analysis than any other large ICU data base worldwide.

Projecting the upcoming demographic shift towards an older and sicker population, costs occurring from intensive care will increase in the upcoming years, and, more than ever before, we will need hard facts to justify costs. Ethical dilemmas deriving from economic pressures will additionally be an important concern in any intensive care specialist's daily routine. Literature suggests that today in U.S., 10-30% of hospital care derived costs are related to intensive care as are 0.5-1.0% of the USA's gross domestic product (1). Corresponding numbers have not been well established for European countries. International benchmarking remains difficult due to such complex factors as different compensations schemes, poor data quality and different managerial settings. Current literature (2-4) suggests various methods for benchmarking, but there is no consensus on the approach so far.

Previous studies indicate that there is considerable variation in standardized mortality rate (SMR) and standardized resource use (SRU) (5-8). This has also been shown in the FICC data, by one-off analysis of the SRU's in 2008. The variation of SMRs is still the case today but current SRU's are not known. We suggest that the FICC data base provides a unique opportunity for an in-depth analysis of the components of the differences in SRU, and may help the participating ICU's to optimize their resource use in the future.

Hypothesis

We hypothesize, that SMRs and SRUs still have considerable variability and that the components of resource use, such as staff salary costs, materials and medications contribute to different degree to the SRUs between the individual ICUs (specific aim 1). We furthermore want to assess, whether outcome and resource use are related to related to ICU structure and process and to explore factors associated with efficient resource use (specific aim 2).

Specific aims, methodology and expected results

Specific aim 1: Determine the variability in outcome and resource use between participating ICUs.

- **Methodology:** With data derived from benchmarking analyses we aim to define standardized resource utilization by comparing the severity adjusted resource use to produce hospital survivors in patients requiring intensive care. We will employ methods as described before by Rothen et al (Figure 1). In addition to the original method, calculating SRU by using "length of stay"(LOS) as a surrogate of costs, we will assess the true direct costs by using the data on salaries, medication and material costs. Since LOS is frequently used as a variable in current literature (9, 10), an additional analysis will be performed to enable comparison with existing evidence. To assess different structures concerning physician staffing, especially of smaller ICUs, we will use the number of full time equivalents as a surrogate for physician staffing in ICUs with physicians working only part time

in the ICU. To differentiate between university and non-university hospitals concerning case mix (especially elective cardiac surgery and neurosurgery patients), we will compare the two categories separately. Concerning units including ICU and intermediate care (IMC) on the same campus, we will calculate the resources used in IMC separately. In addition, discharge location (other hospital, IMC, ordinary ward) will be considered for explanatory modeling. For the comparison of all participating ICUs, we will eliminate the effect of the aforementioned elective patients by discounting Therapeutic Intervention Scoring System (TISS)-points of these interventions. To verify the model, we plan to analyze data acquired over a 10 year's time frame (2005-2014). The data will be collected in yearly instead of monthly bins to minimize outliers deriving from long term patients. Since all cost components are not available for each year, different models are created based on the cost availability. We also plan to collect further data on the structure and processes of the participating ICUs using structured questionnaires – this is the only additional effort for the participating units. Additionally, the SRU will be adjusted for the purchasing power (Big Mac Index) of the currencies of the studied economies.

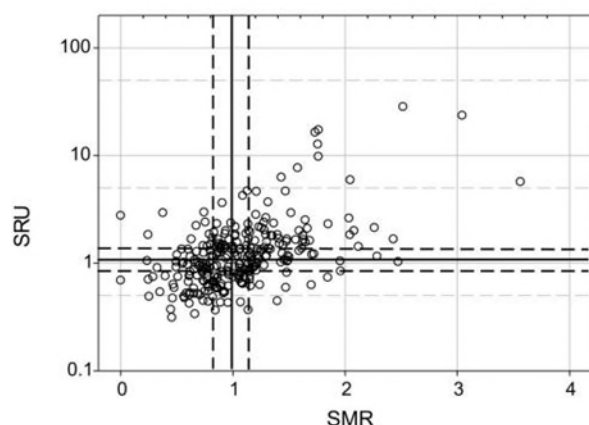


Figure 1: Rothen H.U., Intensive Care Med (2007)

Specific aim 2: To explore factors associated with efficient resource use, we will analyse how factors related to structure and process impact the performance of the ICU.

- Factors related to structure:
 - o Academic vs. non-academic setting: we hypothesize resource use in academic centers to be higher, influenced by teaching activities and research
 - o Number of ICU beds
 - o On site availability of an attending physician in intensive care during night shift (after 8 pm to 7 am), as night time intensivist staffing is questioned
 - o Number of full-time equivalent (FTE) physicians (specialists in intensive care medicine) per occupied per bed, alternative: number of FTE physicians per 10,000 TISS points
 - o Total number of FTE nurses (including nurse aids) per occupied bed, alternative: number of FTE nurses per 10,000 TISS points
 - o Existence of an IMC unit / step down unit on same campus
- Factors related to process:
 - o Number of patients admitted per year; as we hypothesize that the process of care may be more efficient if the case volume is high and we expect economies of scale
 - o Re-admissions (patients readmitted within 48h after discharge from ICU)
 - o Relative number of different age groups (<60y, 60-75y, >75y) in percentage (%) of total admissions

Analysis by multiple linear regression and multiple logistic regression models (11, 12). Details of the statistical analysis are to be discussed with statistician, and a full statistical analysis plan will be completed once the details of data availability in the data base have been verified. We assume 80% of the costs being fixed costs, independent of the number of treated patients (1, 13-16). We assume that both the fixed costs and the variable costs should be modifiable, based on the structure and processes as

well as on the strategy of variable costs allocation. Furthermore, we plan to analyse the economic impact. The relative influence of the five aforementioned factors on the final performance will be quantified to enable a relative weighting.

Data acquisition, anonymization and ethical considerations

Data will be acquired from the FICC database. The FICC's board has already granted permission to use the database. In the data acquisition phase, we will make sure not to collect data that can be traced back to the individual patient. All patient names and social security numbers will be left out. Furthermore, we will leave out detailed information regarding hospital admission and discharge dates (hospital length of stay in days will be acquired). Thus, the acquired material will be completely anonymised. Due to the nature of this project (retrospective observational, anonymised data, no patient contact, does not affect patient care in any way) we consider the project ethical justifiable.

Collaborators

This project will be performed in collaboration with Prof. Jukka Takala, head of Department of Intensive Care Medicine, University Hospital Bern and Prof. Ville Pettilä from Helsinki University Hospital, Department of Anesthesiology, Intensive Care, Emergency Medicine and Pain Medicine. Docent Rahul Raj (MD, PhD) is the Finnish national coordinator. Other members of the research group are docent Matti Reinikainen (MD, PhD, North Karelia Central Hospital, head in intensive care), docent Tero Varpula (MD, PhD, Helsinki University Hospital), Philipp Venetz (MD, PhD, Bern University Hospital) and Prof. Stephan Jakob (MD, PhD, Bern University Hospital). All statistical analyses (completely anonymised data) will be supervised by Prof. Takala in collaboration with the institute of Mathematical Statistics at the University of Bern.

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