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Direct Cost Analysis of Intensive Care Unit Stay in Four European Countries: Applying a Standardized Costing Methodology

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A B S T R A C T

Objectives: The objective of the present study was to measure and compare the direct costs of intensive care unit (ICU) days at seven ICU departments in Germany, Italy, the Netherlands, and the United Kingdom by means of a standardized costing methodology. **Methods:** A retrospective cost analysis of ICU patients was performed from the hospital's perspective. The standardized costing methodology was developed on the basis of the availability of data at the seven ICU departments. It entailed the application of the bottom–up approach for "hotel and nutrition" and the top–down approach for "diagnostics," "consumables," and "labor." **Results:** Direct costs per ICU day ranged from €1168 to €2025. Even though the distribution of costs varied by cost component, labor was the most important cost driver at all departments. The costs for "labor" amounted to €1629 at department G but were fairly similar at the other departments (€711 ± 115). **Conclusions:** Direct costs of ICU days vary widely between the seven departments. Our standardized costing methodology could serve as a valuable instrument to compare *actual* cost differences, such as those resulting from differences in patient case-mix.

Keywords: comparative study, cost analysis, costing methodology, Europe, intensive care.

Introduction

Although intensive care unit (ICU) beds comprise less than 10% of hospital beds, ICU departments consume 22% of total hospital costs in the United States [1]. Also, the costs of ICU departments in the Netherlands have been estimated to represent approximately 20% of the total hospital budget, with the costs per day between three- and fivefold greater in ICU departments than in general wards [2,3]. Therefore, several studies have assessed the costs of ICU services. Cost estimations of ICU stay vary extensively. From a multicenter German study, Moerer et al. [4] reported the total costs per ICU day to be €855 (inflated to 2008). At the other extreme, the total costs per day at ICU departments in the United States were found to be €3221 (inflated to 2008) [5].

A number of studies have tried to explain *actual* cost differences between ICU departments [2,6,7]. The patient case-mix is considered to have an important effect on the actual costs of ICU days. Other potential factors influencing actual cost differences include variations in study setting (e.g., bed occupancy rate, density of acute care beds, and staff composition), variations in medical practice (emergency retrievals, referral pattern, and use of mechanical ventilation), the availability of health-care resources (e.g., the presence of a High Dependency Unit), the hospital payment system (e.g., public/private-mix and insurance payment), and relative and absolute prices between countries [2,6]. It has been argued, however, that some of the observed cost differences are as a result of the methodologies used to estimate the costs rather than being as a result of *actual* differences [7,8].

The application of a standardized costing methodology enables a meaningful comparison of *actual* cost differences between health-care services [9,10]. This way cost differences can be attributed to the health-care services under consideration, rather than to differences in the costing methodology [11,12]. Yet, standardized costing methodologies are often restricted by the availability and quality of data. Resource quantities for individual patients are generally not available with the same level of precision, even within a single health-care provider's clinical costing system and systems vary markedly between health-care providers [13].

Several studies have made recommendations on the application of standardized costing methodologies and potential bias for the comparability between health-care services at different health-care providers [13–15]. For example, Ritzwoller et al. [15]

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attempted to identify comparable measures from the hospital information systems of seven health-care providers in the United States to compare the health-care utilization of smokers, former smokers, and never smokers. They found a substantial variation in both the content and the capture of data across all health-care providers and across all cost components.

Recommendations on the application of standardized costing methodologies have also extensively been made in the field of ICU stay [2,6,16]. A systematic literature review by Elliot [7] demonstrated that the costing methodologies employed to calculate costs of ICU stay are diverse and make comparative analyses between studies difficult. In their narrative review, Pines et al. [8] have argued that despite considerable progress in costing methodologies, critical care studies have not adequately implemented these techniques.

The objective of the present study was to measure and compare the direct costs of ICU days at seven ICU departments in Germany, Italy, the Netherlands, and the United Kingdom by means of a standardized costing methodology. Only one study in the field of ICU stay has earlier applied a standardized costing methodology across jurisdictions. Negrini et al. [17] developed a standardized costing methodology and tested its feasibility at ICU departments in France, Germany, Hungary, and the United Kingdom. A recognized limitation of their study was that estimates of costs were permitted for some cost components, because cost data were not always available at the ICU departments under consideration. To overcome this limitation, the present study used a standardized costing methodology that was based on the availability of data at the ICU departments under consideration.

Methods

The countries providing data to populate the study were Germany, Italy, the Netherlands, and the United Kingdom. These countries have participated in the center-randomized "real-life" study ULTISAFE (see among others [18]). The aim was to select ICU departments that were representative of the overall setting and treatment patterns in the respective countries. Recruitment, however, was restricted by both hospitals' willingness to participate and time constraints. Hence, a retrospective cost analysis of ICU patients was performed at seven ICU departments from the hospital's perspective. Department A involved the anesthesiological adult ICU (12 beds) of the German focused-care (level III) hospital "Klinik am Eichert" in Göppingen, at which all patients admitted between January and October 2006 were recruited. In Italy, data were collected at the medical-surgical adult ICU departments of the "San Paolo Hospital" in Milan (department B; 6 beds) and of the "Azienda Ospedaliera" in Padova (department C; 18 beds), at which departments all patients admitted from January 2006 to January 2007 were included. In the Netherlands, costing studies were performed at the medical-surgical adult ICU departments of the "Erasmus MC University Medical Center" in Rotterdam (department D; 32 beds; April–July 2006), the general university-affiliated hospital "Gelre Hospitals" in Apeldoorn (department E; 10 beds; January–July 2003), and the general university-affiliated hospital "Isala clinics" in Zwolle (department F; 22 beds; November 2006). With respect to department E, it was decided to retrospectively collect data for a period of 6 months in 2003 owing to capacity problems in the summers of 2006, 2005, and 2004. Department G concerned the medical-surgical adult ICU (9 beds) of the British "Royal Berkshire NHS Trust Hospital" in Reading, at which all patients admitted from April 2006 to April 2007 were recruited. The patient samples of the recruited ICU departments showed some *actual* differences at baseline that reflect the daily clinical practice.

A standardized costing methodology was employed to ensure that the identified cost differences would reflect only *actual* cost differences. A recognized limitation of the study of Negrini et al. [17] was that estimates of costs were permitted for some cost components, because cost data were not always available at the ICU departments under consideration. To overcome this limitation, the present study used a standardized costing methodology that was based on the availability of data at the ICU departments under consideration. Data concerned the four cost components: "diagnostics" (medical imaging and laboratory services), "consumables" (drugs, fluids, and disposables), "hotel and nutrition," and "labor" (ICU specialists, ICU nurses, and consulted specialists such as medical specialists, pharmacists, physiotherapists, laboratory technicians, and nutrition specialists). Overheads were explicitly excluded from the cost analyses, because they are assumed to vary widely between jurisdictions; that is, different parties may be responsible for the same cost item. For instance, where most capital costs of public hospitals are paid for by the state in Germany and do not represent any costs to the hospital, this was not the case in Italy, the Netherlands, or the United Kingdom.

For each of the cost components, either the bottom–up approach or the top–down approach was considered. The bottom–up approach is generally believed to be the preferred methodology because it values each cost component for *individual* patients. This enables statistical analyses to be made for the detection of cost differences between patients and between cost components [19–22]. The main drawback of the approach, however, is that it requires data at the patient level, which makes the data collection lengthy and expensive, especially when differences in coding systems exist [20,21]. The top–down approach is more feasible compared with the bottom–up approach, because it requires data at the department level. Consequently, the top–down approach values each cost component for *average* patients; statistical analyses of costs cannot be performed and differences between patients cannot be detected [9,14].

The crucial criterion for the choice between both approaches was the level of aggregation in which resource-use data are available (patient vs. department level). Table 1 depicts the level of aggregation in which data are available at the seven departments. For "diagnostics," the level of aggregation varied between the patient level (departments A, D, E, and F) and the department level (departments B, C, and G). Even though resource quantities of "consumables" were generally deductable to the patient level, the application of the bottom–up approach was impeded by the dif-

Table 1 – Availability of data: Level of aggregation of the cost components per department.

	Department A		Department B		Department C		Department D		Department E		Department F		Department G	
	BU/PL	TD/DL	BU/PL	TD/DL	BU/PL	TD/DL	BU/PL	TD/DL	BU/PL	TD/DL	BU/PL	TD/DL	BU/PL	TD/DL
Diagnostics	x	x		x		x	x	x	x	x	x	x		x
Consumables	x	x	x	x	x	x	x	x	x	x	x	x		x
Hotel and nutrition	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Labor		x		x		x		x		x		x		x

BU/PL, bottom–up approach/patient level; TD/DL, top–down approach/department level.