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Results and costs of intensive care in a tertiary university hospital from 1996–2000

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Background: Costs of intensive care may be 20% of all hospital costs. Population aging likely increases the demand for intensive care services, while health care has financial limitations. Therefore data about outcome and costs of intensive care are needed. We studied changes in patient characteristics, outcome, intensity of care and costs of intensive care in a tertiary university hospital in Finland.

Methods: We analyzed retrospectively data of patients admitted to the ICU between 1 January 1996 and 31 December 2000 using the patient data management system. Postoperative and ICU patients were analyzed separately. Data included age, Apache II score, cause of intensive care admission, length and intensity of ICU care. ICU, hospital and 6-month mortality were analyzed. Intensity of care was assessed by TISS points and the annual costs of intensive care were evaluated.

Results: The number of ICU admissions from 1996–2000 was 11,323. The proportions of ICU and postoperative patients were 39% and 61%, respectively. The mean age of the patients did not change. The mean Apache II score increased over time both in the ICU and postoperative patients. There was no change in crude hospital mortality. Total ICU costs decreased from 8,660,000€ (in 1997) to 7,480,000€ (in 2000). In the ICU patients, the costs of hospital survival decreased towards the end of the study period.

Conclusions: We treated more severely ill patients with unchanged outcome but at lower costs towards the end of the study period. Costs of intensive care are not necessarily increasing.

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Key words: Costs; intensive care; outcome.

Intensive care offers specialized care around the clock to patients with life-threatening illnesses. The cost per day in such wards is between 4- and 6-fold more than in general hospital wards (1). In the US, costs of intensive care are about 20% of all hospital costs (1). Most of the costs are due to care of the small number of patients who receive intensive care for longer than 5–7 days. On the other hand, with population aging the demand for intensive care services is increasing (2) and at the same time health care has financial limitations and hospital administrators are requesting a demonstration of cost-effective care. Therefore, there is a need for more data about the costs and outcome of care provided in intensive care units (ICUs). Outcome is mainly determined by the severity of acute illness, but it is not known whether more intensive monitoring or treatment leads to better outcome (3, 4). Part of the variation in mortality is due to case mix but it may be related also to differences in ICU structure and care processes (5). In our hospital, the quality assurance project was carried out from 1995 to the end of 1998 (6). The quality system was mainly developed by the hospital's own staff. External auditing, a process that lasted 12 months, was performed by SFS-Certification Ltd (SFS-Certification Ltd, Helsinki, Finland) and our hospital gained SFS-EN ISO 9002 certification in March 1999. Certification covers all patient care services of the hospital but excludes education and research.

The primary aims of our study were to evaluate changes of the patient characteristics and costs of intensive care over 5 years. We retrospectively studied temporal changes in patient characteristics, outcome, intensity of care and costs of intensive care over 5 years in a tertiary university hospital.

Patients and methods

We analyzed the data of patients admitted to the ICU of Kuopio University Hospital between 1 January 1996 and 31 December 2000. The unit provides ICU services to all patients aged >1 year in a population of 256,000 people (primary referral population).

Additional admissions for neurosurgery and cardiac surgery occur from an area of 870,000 inhabitants. The ICU is a medical-surgical unit with 23 beds in a tertiary university hospital with 900 beds. The department has 24-h access 7 days a week to an intensivist working full-time in the ICU.

A computerized patient data management system (CIMS®, Deio, Kuopio, Finland) was used for data collection. Data included age, Apache II score, cause of intensive care admission, and length and intensity of ICU care. ICU, hospital and 6-month mortality were analyzed. The severity of illness was assessed by the Apache II score based on data collected during the first 24 h in the ICU. The underlying diagnosis and cause of admission were classified into eight admission diagnosis-related categories: cardiac surgery, neurology or neurosurgery, major surgery, gastroenterology, trauma, acute respiratory failure, acute circulatory failure and other (7). The intensity of care during the ICU stay was assessed by the Therapeutic Intervention Scoring System (TISS) for each patient (8). Readmission was defined as an admission within 2 days from primary discharge. Mortality data at 6 months was obtained from the National Population Register, which registers all births and deaths occurring in Finland. The cost of one TISS point was calculated by dividing the yearly total costs of the department by the total number of TISS scores accumulated, and the cost per patient calculated by multiplying the cost of the TISS point by the individual patient's total TISS score. The cost accounting covered all salaries, materials, full allocation of step-down costs (e.g. administration, depreciation, rents) and all secondary costs (laboratory, imaging, consultations, etc.). In addition, we shared total costs over four different cost blocks and evaluated the changes of cost blocks during the study (9). The cost-block staff included both medical and nursing staff. Consumables included drugs, fluids and nutrition, blood and blood products and disposables. Clinical support services represented physiotherapy, laboratory services, radiology and consultations from other departments. Other included equipment, estates and nonclinical support. Costs of the use of the operation theatre was not included in the ICU costs. Yearly inflation accounted in the costs according to the guidelines of the Association of Finnish Local and Regional Authorities.

Because a major part of all admissions consists of postoperative cardiac and neurosurgical patients whose ICU stay is short and mortality is low, we divided patients into postoperative and ICU patients. The data of the ICU patients were analyzed also according to

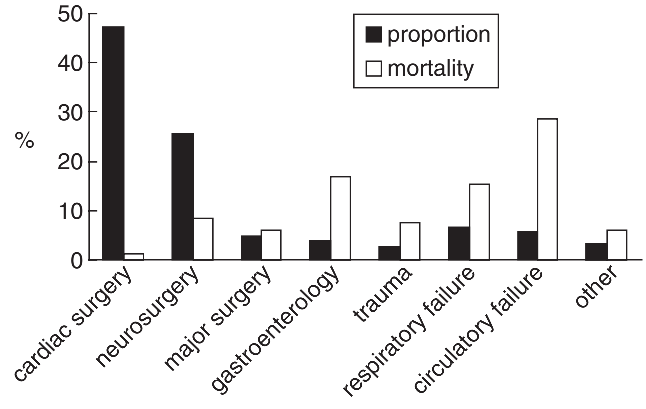

Fig. 1. Proportion and hospital mortality of the patients in different admission diagnosis-related categories.

Apache II scores 1–10, 11–20, 21–30 and >30. Admission Apache II score was missing in 146 ICU patients. These admissions were excluded from the mortality data in different Apache II score groups. In statistical analyses a statistical software package for Windows (SPSS 9.0 for Windows, SPSS, Chicago, IL, USA) was used. Analysis of variance (ANOVA) and Chi-square tests were used to analyze temporal changes over 5 years. The Kruskall-Wallis test was used in the analysis of the ICU and hospital stays. Results are presented both as means with standard deviations and as medians with interquartile ranges. Statistical significance was defined as a P-value less than 0.05.

Results

The number of admissions from 1996–2000 was 11,323, including 6877 (61%) postoperative admissions and 4446 (39%) ICU admissions, respectively. Cardiac surgery and neurosurgical patients accounted for 73% of admissions (Fig. 1). ICU patients consumed 65% of total care days and produced 54% of TISS points. Only 7.7% of patients were treated for more than 5 days in the ICU but they used 47% of total care days and produced 36% of total TISS scores. Readmission rate did not change; there were 66–69 readmissions annually.

Patient characteristics and mortality

ICU patients

Mean Apache II score increased during the study period (Table 1). ICU and hospital stay remained stable and mortality did not change over time (Table 2). In secondary analysis, length of ICU stay decreased in Apache II scores 0–10 and 11–20 (Table 3). In secondary analysis, hospital mortality also decreased in

Table 1

Age, Apache II score (mean ± SD), and intensive care unit and hospital length of stay [median (IQ-range)].

	1996	1997	1998	1999	2000	*P*-value
ICU patients (n)	833	854	905	925	929	
Age (years)	54 ± 19	54 ± 19	55 ± 18	55 ± 18	53 ± 19	0.053
Apache II	14 ± 6	14 ± 7	17 ± 6	17 ± 6	18 ± 7	<0.001
ICU LOS (days)	1.7 (0.8 – 3.1)	1.6 (0.8 – 3.5)	1.7 (0.9 – 3.8)	1.6 (0.9 – 2.9)	1.5 (0.8 – 2.9)	0.163
Hospital LOS (days)	10 (5 – 17)	10 (5 – 16)	10 (6 – 17)	9 (5 – 15)	9 (5 – 15)	0.100
Postoperative patients (n)	1412	1412	1401	1288	1364	
Age (years)	59 ± 14	59 ± 13	60 ± 14	60 ± 14	60 ± 14	0.493
Apache II	8 ± 4	9 ± 4	13 ± 4	13 ± 5	14 ± 5	<0.001
ICU LOS (days)	0.9 (0.9 – 1.0)	0.9 (0.8 – 1.0)	0.9 (0.8 – 1.0)	0.9 (0.9 – 1.0)	0.9 (0.8 – 1.0)	<0.001
Hospital LOS (days)	7 (6 – 8)	6 (6 – 8)	7 (6 – 8)	6 (6 – 8)	6 (6 – 8)	<0.001

ICU = intensive care unit; LOS = length of stay.

Table 2

Annual mortality of patients.

	1996	1997	1998	1999	2000	*P*-value
ICU patients (n)	833	854	905	925	929	
ICU mortality percentage (n)	8.3 (69)	7.7 (66)	7.2 (65)	7.2 (67)	6.9 (64)	0.825
Hospital mortality percentage (n)	17.0 (142)	14.6 (125)	12.6 (114)	15.7 (145)	14.2 (132)	0.105
6-month mortality percentage (n)	26.2 (218)	26.0 (222)	24.3 (220)	24.5 (227)	21.4 (199)	0.132
Postoperative patients (n)	1412	1412	1401	1288	1364	
ICU mortality percentage (n)	0.9 (13)	0.6 (8)	0.4 (5)	0.5 (6)	0.3 (4)	0.162
Hospital mortality percentage (n)	2.1 (29)	1.0 (14)	0.7 (10)	1.4 (18)	1.5 (21)	0.023
6-month mortality percentage (n)	5.1 (72)	4.1 (58)	2.6 (37)	4.3 (56)	4.4 (60)	0.02

ICU = intensive care unit.

Table 3

Length of intensive care unit stay, hospital stay and hospital mortality in different Apache II scores in intensive care patients (n = number of patients in each Apache II score).

Apache II score	1996	1997	1998	1999	2000	*P*-value
0–10	n = 258	n = 251	n = 137	n = 143	n = 111	
ICU LOS (d)	1.3 (0.7 – 2.5)	1.2 (0.7 – 2.8)	0.9 (0.6 – 1.9)	0.9 (0.7 – 2.1)	0.8 (0.6 – 1.6)	<0.001
Hospital LOS (d)	10 (6 – 17)	10 (6 – 16)	8 (5 – 13)	9 (5 – 15)	9 (5 – 12)	0.004
Hospital mortality percentage (n)	7.4 (19)	5.6 (14)	4.4 (6)	3.5 (5)	0.9 (1)	0.094
11 – 20	n = 407	n = 414	n = 484	n = 487	n = 479	
ICU LOS (d)	1.8 (0.9 – 3.8)	1.7 (0.9 – 3.7)	1.7 (0.9 – 3.7)	1.6 (0.8 – 2.8)	1.5 (0.8 – 2.7)	0.033
Hospital LOS (d)	10 (5 – 18)	10 (5 – 16)	10 (6 – 18)	10 (6 – 15)	10 (5 – 16)	0.068
Hospital mortality percentage (n)	16.2 (66)	13.0 (54)	8.3 (40)	6.6 (32)	8.4 (40)	<0.001
21 – 30	n = 108	n = 130	n = 240	n = 253	n = 286	
ICU LOS (d)	1.9 (0.9 – 3.9)	1.9 (0.9 – 4.7)	2.3 (1,1 – 4,8)	2.1 (1.2 – 5.0)	2.0 (1.0 – 3.6)	0.054
Hospital LOS (d)	7.5 (3 – 15)	8 (3 – 17)	10 (5 – 18)	10 (5 – 16)	10 (5 – 17)	0.052
Hospital mortality percentage (n)	44.4 (48)	35.4 (46)	21.7 (52)	33.6 (85)	22.0 (63)	<0.001
>30	n = 11	n = 8	n = 31	n = 31	n = 44	
ICU LOS (d)	2.0 (1.8–5.5)	0.9 (0.8 – 2.4)	2.2 (1.2 – 4.3)	1.2 (0.9 – 1.9)	1.8 (1.2 – 3.3)	0.061
Hospital LOS (d)	7 (2 – 13.5)	7 (1 – 14)	5 (2 – 13.5)	3 (1 – 9.5)	8.5 (2 – 14.5)	0.632
Hospital mortality percentage (n)	54.5 (6)	62.5 (5)	48.4 (15)	61.3 (19)	61.4 (27)	0.804

ICU = intensive care unit; LOS = length of stay.

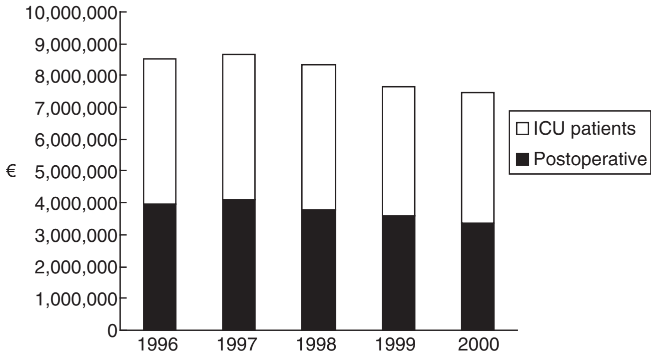

Fig. 2. *Annual ICU costs of patients.*

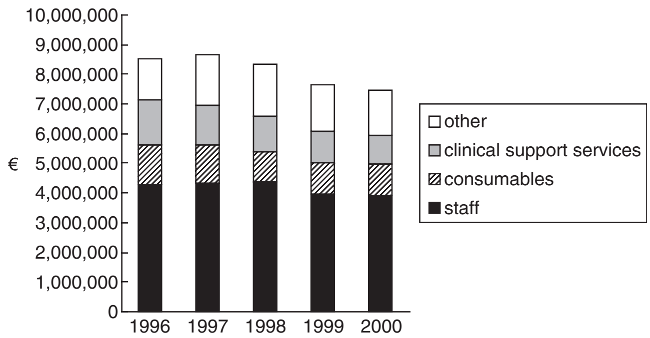

Fig. 3. *Total annual costs of care and costs of different costs blocks.*

Apache II scores 11–20 and 21–30. Hospital mortality of the ICU patients without Apache II score was 10.3%.

Postoperative patients

The mean Apache II score increased over time (Table 1). There was statistical change in ICU and hospital stay, even if the medians and interquartile ranges did not differ. There were variations both in hospital and 6-month mortality during the study period (Table 2).

Costs and intensity of care

Total ICU costs were highest (8,660,000€) in 1997 and lowest (7,480,000€) in 2000 (Fig. 2). The proportion of intensive care costs decreased from 4.4% to 3.7% of the annual hospital costs (Table 4). The cost of TISS points varied between 34 and 37€ yearly. The proportions of each cost block did not change over time (Fig. 3).

ICU patients

The proportion of the costs of the ICU patients varied between 52.7 and 55.1% of total costs (Fig. 2). The costs of care day remained stable but the costs per hospital survivor decreased from 6580€ to 5170€ during these 5 years. TISS points per admission and daily TISS points divided by Apache II score decreased (Table 5). Nonsurvivors consumed about 20% of both care days and TISS points.

Postoperative patients

Neither costs of care day nor costs of survival changed markedly over time. Costs of non-survivors varied markedly between study years. TISS points per admission and daily TISS points divided by Apache II score both decreased.

Discussion

Intensive care represents 5–10% of all hospital beds but may consume up to 30% of hospital budgets in the US (1). Demand for intensive care services is likely increasing owing to population aging. However, in view of the high cost of health care delivery, increasing attention has been devoted to minimizing costs while maintaining quality. Our study revealed that during 1996–2000 total ICU costs, costs of a saved ICU patient and intensity of care decreased despite increased Apache II scores. If taken together, our results suggest that we treated more severely ill patients with unchanged outcome but at lower costs towards the end of the study period. In our hospital, intensive care represents about 2.5% of all hospital beds and costs allocated to intensive care were less than 5% of total hospital costs. Resources of intensive care are markedly less than reported in the US (1).

Even if the mean age of our patients did not increase over time, the proportion of patients aged >70 years increased from 21.7% to 25.3%. This increase in the proportion of older patients has been demonstrated in some European ICUs (10, 11). Mean age of our patients is comparable with the study of Iapichino in 89 European ICUs (12). Severity of disease, assessed by Apache II score, increased annually, which is reflected by a decrease of the proportion of patients with an Apache II score <10 over time. Patients with an Apache II score <10 have low expected mortality and treatment of these patients in an ICU may be questionable, but a proportion of these patients are scheduled cardiac and neurosurgery patients requiring monitoring in an ICU. The proportion of ICU patients with an Apache II score of 10–30 increased markedly during the study period. This suggests that treatment has improved over time for patients that are more likely to benefit from intensive care.

Costs of care can be calculated by several different ways and comparison of costs between units is complex. However, the cost of TISS points 34–37€ in our study is comparable to the costs of several other units. TISS-based cost calculation in two German ICUs

Table 4

Costs of care.

	1996	1997	1998	1999	2000
Total hospital costs (€)	195,917,350	199,308,340	204,756,950	195,898,660	199,750,010
Costs of intensive care (€)	8,527,330	8,663,830	8,351,830	7,634,050	7,478,850
Costs of intensive care of total hospital costs (%)	4.4	4.3	4.1	3.9	3.7
Cost of TISS point (€)	34	37	36	36	35
Cost day^{-1} (€)					
ICU patients	1425	1425	1405	1395	1410
Postoperative patients	2075	2220	2335	2255	2080
Costs of survivor (€)					
ICU patients	6580	6265	5795	5185	5170
Postoperative patients	2880	2930	2710	2825	2500
Costs of non-survivor (€)					
ICU patients	6910	7500	8450	6050	6365
Postoperative patients	8425	15 445	8300	5685	2975

reported costs of 35–38€ per TISS point (13, 14). In a recent Norwegian study, mean cost of an ICU day was 2601€, which is markedly more than the cost of an ICU day patient in our study (15). In Norway, the costs of staff were 63% of total costs, which were significantly greater than the costs of 50–53% in our department. In our study, the cost of a TISS point did not change during the study period. Total costs of intensive care were lower during the last 2 years of the study period. Edbrooke et al. introduced the cost-block method to measure the annual costs of intensive care (9). The method measures six blocks describing non-patient-specific and patient-specific costs. We have not shared non-patient-specific costs to different blocks. Patient-specific costs are generated by providing patient care and are therefore dependent on it. The slightly decreased ICU LOS and workload reflects the costs of staff, clinical support services and consumables, which were lower in 1999–2000. The costs of staff were 50–53%, consumables 13–16% and clinical support services 13–18% of the total annual costs. The proportion of clinical support services decreased from 18% to 13% of the total costs, which possibly reflects a slightly shortened ICU LOS. These three cost blocks accounted for approximately 80% of the total costs. In 11 ICUs in the UK, the proportion of these blocks accounted for 85% of the total costs (9). The costs of staff for more than 50% of the total costs are comparable to the costs in ICUs in the UK.

Our department is a closed ICU directed by a full-time intensivist and the department has access to a full-time intensivist 24 h a day, 7 days a week. In a closed ICU, patients are accepted to the unit only after they have been evaluated by an intensivist. Multz et al. showed that duration of mechanical ventilation, and length of hospital and ICU stay were lower in closed than in open ICUs (16). In addition, the care directed by the intensivist has been demonstrated to reduce both intensive care unit and hospital mortality in several studies (17). However, in our study, the organization of the ICU did not change over the

Table 5

Number of accumulated therapeutic intervention scoring system (TISS)-points during intensive care unit stay, number of TISS points divided by care day and Apache II score (mean ± SD). Percentage of care days and total TISS points of non-survivors.

	1996	1997	1998	1999	2000	*P*-value
TISS points/admission						
ICU patients	160 ± 280	145 ± 210	140 ± 190	120 ± 175	125 ± 175	0.001
Postoperative patients	80 ± 100	80 ± 105	75 ± 65	75 ± 65	70 ± 60	0.001
TISS points/day/APACHE						
ICU patients	4.1 ± 3.3	3.8 ± 3.3	2.7 ± 1.5	2.6 ± 1.5	2.6 ± 1.7	<0.001
Postoperative patients	9.0 ± 6.3	8.4 ± 6.0	5.6 ± 3.0	5.3 ± 3.0	4.4 ± 2.0	<0.001
Nonsurvivors						
% of care days						
ICU patients	20.2%	19.8%	21.1%	20.2%	19.9%	
Postoperative patients	7.9%	9.0%	3.1%	3.9%	2.1%	
% of TISS points						
ICU patients	21.9%	20.6%	21.3%	22.0%	20.8%	
Postoperative patients	6.2%	5.3%	2.2%	2.9%	1.9%	

TISS = therapeutic intervention scoring system.

5 years and does not explain our results. Why have the costs reduced? Our study does not answer this question. However, a quality system was adopted in our hospital. One of the requirements was the regular reporting of quality criteria in patient care. Therefore, follow up of ICU stay, prolonged care (>5 days) and ICU and hospital outcome were reported every 3 months. As a result of the project, several guidelines, such as guidelines for sedation, were implemented into the clinical practice. From the beginning of 1999, we started systematically monitoring the sedation level using the Ramsay score, and continuous infusions of midazolam were interrupted every 12 h. As a main sedative agent, propofol was adopted during 1999. Recently, protocol-driven sedation was shown to shorten ventilator time and length of ICU stay and to decrease health care costs (18, 19). There are also studies reporting protocol-based ventilation management (20–22). A lung-protective ventilator strategy was shown to reduce mortality in patients with acute respiratory distress syndrome (22, 23). Likely, our quality assurance project and new effective treatment modalities affected our results and costs.

Our study was retrospective and the study period rather short. The study included patients of one ICU only and comparison of the results with other studies is difficult. However, our results suggest that the costs of intensive care are not necessarily increasing. While improving the quality of care, it is even possible to reduce costs.

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