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The Effect on Overall Cost and Health-Related Quality of Life by Inpatient Trajectories 3 Years Before and After Critical Illness

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Abstract

Background: Pre-existing disease is the most important factor in the prediction of health-related quality of life (HRQoL) after intensive care. We hypothesised that the "inpatient care trajectories" in the years before admission to the ICU is a stronger predictor of HRQoL and mortality after intensive care than pre-existing disease, and that it has significant effects on overall costs.

Method: A retrospective investigation in two combined medical and surgical ICUs in Sweden. Inpatient care was assessed from the County administrative registry. HRQoL (SF-36) was measured at 6, 12, 24, and 36 months after discharge.

Results: Of 1092 patients, 459 (73%) had pre-existing diseases, and among them 360 (57%) had at least one inpatient episode less than 3 years before the ICU period, during which the group used significantly more hospital resources than the combined cost for all ICU care during the same time. The addition of episodes of inpatient care to the regression model strongly reduced the effect of pre-existing disease on HRQoL and was also a strong predictor for early mortality after ICU.

Conclusions: Episodes of inpatient care before admission to ICU uses considerable hospital resources, affects mortality and is a better predictor of HRQoL than diagnoses of pre-existing disease.

Keywords: Long-term survival; Health-related quality of life; Hospital inpatient care episodes; Intensive Care; Mortality; Pre-existing diseases

Abbreviations: HRQoL: Health-Related Quality of Life; ICU: Intensive care unit; DRG: Diagnosis Related Groups; ICD: International Classification of Diseases; SF-36: Short Form 36; PF: Physical Functioning; RP: Role limited by Physical problems; BP: Bodily Pain; GH: General Health; VT: Vitality: SF; Social Functioning; RE: Role limited by Emotional problems; MH: Mental Health

Introduction

Intensive care (IC) uses substantial resources for few patients [1]. In a recent study we showed that patients who require IC have a high rate (73%) of pre-existing diseases, and that these pre-existing diseases had a considerable impact on the patients' perceived health-related quality of life (HRQoL) after critical illness [2,3]. We still do not know, however, how much the pre-existing diseases influenced the patterns of episodes of inpatient care several years before admission to the Intensive Care Unit (ICU) and after. If such a pattern exists it may be a better estimate of the previous burden of disease than the diagnoses per se, and so improve the prediction of HRQoL and mortality after discharge from the ICU. The economic aspects of such periods are also of interest as the cost of care during the year in which time is spent in the ICU is substantial, and an economic burden on society. A special characteristic for Sweden is that all inpatient events are centrally recorded, and each individual can be traced by the matchless social security number. This provides a unique chance to trace all inpatient events.

The objectives of this study were to describe the extent of the episodes of inpatient care recorded during the three years before admission to the ICU and to assess if there is any

association between this proxy of pre-existing disease on HRQoL and mortality after IC. We hypothesised that the number of inpatient care episodes before admission to ICU was a better estimate of the burden of disease before that admission than separate diagnoses, and that it could further explain HRQoL and effects on mortality recorded after admission to the ICU. We also hypothesised that given the rate of pre-existing diseases reported among patients in the ICU, the corresponding cost of inpatient care before and after admission to the ICU is appreciable (inpatient care was also recorded for up to three years after ICU care), and an important factor in the examination of ICU-related costs.

Materials and Methods

Design and patients

The group studied was part of a larger group that had previously been examined from several different perspectives, [2-7] described in detail elsewhere [3].

From that study we extracted the participating patients from two of the three ICUs. All patients were 18 years or over; were consecutively admitted to the intensive care unit at the university hospital between 1 August 2000 and 30 June 2004, or the intensive care unit of the general hospital between 1March 2002 and 30 June 2004; remained in the ICU for more than 24 hours; and were alive 6 months after discharge from hospital.

Both ICUs admit roughly 600-750 patients each year. Patients with primary coronary disease, those recovering after heart surgery and neurosurgery, neonates, and patients with burns are treated at other specialist units, and were excluded.

Nearly all the admissions to the study ICUs were emergencies, and the primary admission diagnoses usually disturbances of the respiratory or the circulatory systems, gastrointestinal problems, and multiple trauma or sepsis.

We studied patients who were; 18 years or over; consecutively admitted to the ICUs between 2000 and 2004; remained in the ICU for more than 24 hours; were alive 6 months after discharge from hospital; and consented to participate in the study.

The clinical databases in each hospital were used to extract data on age, sex, diagnosis on admission, APACHE II score, duration of stay in ICU and in hospital, time spent on a ventilator, and outcome.

The study was approved by the Committee for Ethical Research at the University of Health in Linköping. Written informed consent was waived by the ERB.

Previous episode(s) of inpatient care

The episodes of inpatient care were recorded prospectively from the hospitals' central databases, but data were missing for 18 patients. For the patients included in the study the episodes were extracted for years three, two, and one before the year of admission to the ICU. For the year of admission to the ICU, including the period in the ICU and the care in the ward afterwards, we extracted the episodes of inpatient care during and after discharge from hospital. We also extracted the data for years one, two, and three after discharge.

Economy

To calculate the costs involved, the calculation was based on the codes for Diagnosis Related Groups (DRG) [8]. DRG is a system by which patients admitted to hospital are classified by their medical diagnosis together with information about the cost. A special medical statement is economically-weighted based on diagnoses from the International Classification of Diseases (ICD), age, sex, condition at discharge, and the presence of complications or coexisting diseases. This means that patients within each DRG category are similar clinically, and are expected to use the same amount of resources.

Questionnaires and Instruments

Structured questionnaires were mailed to the study population 6, 12, 24, and 36 months after discharge from hospital [2,3]. The questionnaires contained questions about the patients' background (civil state, children living at home, born in Sweden or not, education, employment before and after admission to the ICU, sick leave before and 6 months after discharge from the ICU and hospital, and pre-existing diagnosis). The questionnaire also asked, "Have you had any illness, reduced bodily function or other medical problem for more than 6 months before the ICU period" with the answer "yes" or "no". This question also gave the pre-specified choices of illness: "cancer, diabetes, heart failure, asthma/allergy, rheumatic, gastrointestinal, blood, kidney, psychiatric, neurological disease, thyroid or any other metabolic disturbance, or any other long-term illness". The last option was an open question with a slot for free text. The open question was used in less than 3% of cases.

Health-related Quality of Life

The Swedish version of the Medical Outcome Short Form version 1 (SF-36) [9,10] was chosen to evaluate HRQoL. The instrument is internationally known and has often been used [11]. It has previously been applied in IC [2,3,12,13] and has been recommended as the best instrument for measuring HRQoL in trials in critical care [14].

SF-36 has been validated in a representative Swedish sample [15]. It has 36 questions and generates a health profile of 8 subscale scores: physical functioning (PF), role limited by physical problems (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role limited by emotional problems (RE), and mental health (MH) [9,15]. The scores of all the subscales are transformed to a scale ranging from 0 (worst) to 100 (best). To maximise the statistical power, the six-month

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follow-up data was used for this purpose (n=631).

Statistical methods

Data are presented as descriptive statistics. Unadjusted two-sample comparisons (the chi square test and Student's *t* test) were used to assess differences in background characteristics between the groups as appropriate. In the comparison of HRQoL (SF-36) between the groups (no episodes of inpatient care, 1 and >1 episodes of inpatient care) we used ANOVA.

To model the impact of in-patient care episodes one, two and three years before on HRQoL, a linear regression model was used with each dimension of SF-36 as dependent variable and sex, age and the hospital in-patient care episodes one, two and three years before as independent variables. From the model, the coefficients for the hospital in-patient care episodes together with their 95% confidence interval were plotted.

Data are presented as two-tailed values and 95 % CI, and were analysed with the help of SPSS (version 20.0, SPSS Inc. Chicago, USA).

Results

Clinical and personal characteristics of the patients

A total of 1092 patients met the inclusion criteria. After two reminders 631 patients (58%) answered the mailed questionnaire. The patients who did not respond in the study differed from the group who responded in that they had shorter length of stay in the ICU (P<0.001), and shorter time on ventilator (P=0.02). There were no significant differences between the non-responders and responders in gender, age, APACHE II score or length of stay in hospital. The clinical characteristics of the ICU patients in the study group are shown in Table 1, and the socio-economic characteristics are shown in Table 2. The patients from the university hospital ICU were younger (56 vs 61 years (p=0.001)), had higher disability or Apache II scores (16.2 vs 14.7 (p=0.019), and more admissions with a diagnosis of multiple trauma and sepsis (n=53, 14.3% vs n=22, 8.4% and n=38, 10.2% vs n=15, 5.7% (p=<0.001)) respectively. There were no significant differences between the two hospital groups in sex, duration of stay in ICU or in hospital, time on ventilator, or pre-existing disease (data not shown).

Table 1: Clinical characteristics on admission of the ICU patients in the study group (n=631).

	Mean	%	Median	Range	95% CI
Age (years)	57.6		60	78	56 - 59
Sex (male %)		57.7			54 - 62
APACHE II Score	15.6		15	43.00	15 - 16
Duration of stay in ICU (hours)	114.4		56	1821.00	102 - 127
Duration of stay in hospital (days)	14.6		8	200.00	13 - 16
Time on ventilator (hour)	54.9		0	1753	43 - 67
Diagnose on admission (%)					
Multiple trauma		11.9			9 - 14
Sepsis		8.2			6 - 10
Gastrointestinal		23.1			20 - 26
Respiratory		20.6			17 - 24
Miscellaneous		36.1			32 - 40
Pre - existing diseases (%),		72.6			69 - 76
Cancer		18.2			15 - 22
Diabetes		19.9			16 - 24
Cardiovascular		29.4			25 - 34
Gastrointestinal		19.3			16 - 23
Miscellaneousa		64.1			60 - 69

No. of diseases (%)	
0	173 (27)
1	252 (40)
>1	206 (33)

a i.e. asthma/allergy, rheumatic- blood, kidney, psychiatric, neurological disease, thyroid or any other metabolic disturbance, each diagnose group too small for comparisons.

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Table 2: Socio-economic characteristics of patients in the study group.

	n (%)
Marital status (n=625)	
Married	379 (61)
Single	174 (28)
Widow/widower	72 (12)
Children at home >19y (n=627)	115 (18)
Born in Sweden (n=629)	579 (92)
Education (n=629)	
Compulsory school	236 (38)
University/college	146 (23)
Employment	
Before ICU (n=602)	
Employed	239 (40)
Retired	307 (51)
Student	20 (3)
Other	36 (6)
6 months after ICU (n=575)	
Employed	186 (32)
Retired	330 (57)
Student	21 (4)
Other	38 (7)
Sick leave (n=631)	
Before ICU	69 (11)
Reported sick leave < 100%	22 (3)
Reported sick leave 100%	47 (7)
6 months after ICU	132 (21)
Reported sick leave < 100%	31 (5)
Reported sick leave 100%	101 (16)

Episodes of inpatient care

Of the patients included, 360 (57%) had at least one episode of inpatient care within the 3 years before the admission to ICU. The ICU patients with pre-existing diseases used significantly more hospital resources 3, 2, and 1 year before admission to the ICU (p= 0.008, <0.001, and <0.001), and up to 3 years after discharge regarding amount of care (number of visits) (p= 0.003), duration of stay (p=0.001), and costs (p=0.002), but there were no differences during the ICU period in that pre-existing disease did not increase the cost of the stay in ICU. Most importantly, there was a significant increase in the number of episodes of inpatient care for the 3 years before admission to ICU (p<0.001).

A total of 3669 inpatient care episodes were recorded: 939 occasions during the 3 years before the year of the admission to the ICU, 953 during the year of IC, and a total of 1777 from years 1-3 after discharge from the ICU by all the 631 patients included in the study. The episodes of inpatient care increased from month 30 before the IC period, and 145 (23%) of the study group had at least one inpatient care episode three years before the IC period; 158 (25%) two years before; and 278 (44%) one year before the IC period. After IC the number of inpatient care slowly decreased and 334 (53%), 208 (33%), and 170 (27%) of the study group had at least one inpatient care episode 1, 2, and 3 years, respectively, after the period in IC (Figure 1). The number after IC also includes those patients who died during this period.

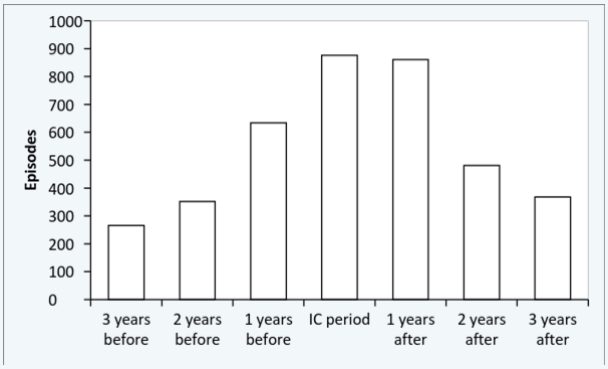

Figure 1: Episodes of inpatient care during the years before admission and after discharge from intensive care. (IC) Intensive Care.

A total of 461 (73%) of the former IC patients had pre-existing disease which was present at least 6 months before admission to the ICU. One year before their admission (p=0.003), and one (p=0.001), two (p=0.002), and three years (p=0.046) after their admission to IC the patients with pre-existing diseases had significantly more inpatient episodes than the previously healthy patients in the ICU.

The diagnoses on admission had no significant effect on the episodes of inpatient care apart from gastrointestinal and respiratory diseases one year before (p<0.001) and one year after (p=0.001) the time spent in IC.

Table 3: Costs per year for the ICU-patients in the study (n=631) based on DRG.

	Mean	SD
3 years before the ICU period	17654.3	73216.5
2 years before the ICU period	19974.7	56863.5
1 year before the ICU period	43437.6	90565.1
ICU period	151166.9	187078.8
1 year after the ICU period	60758.2	115278.6
2 years after the ICU period	29938.8	70410.8
3 years after the ICU period	23161.3	74510.3

DRG: Diagnosis Related Group; ICU: Intensive Care Units

The costs in DRG/year for the episodes of inpatient care are shown in Table 3. The peak is during the period in IC and one month after, to be in total at nearly the same level before as after

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the time spent in IC. When all care during the 3 years before and after the ICU stay is added for those patients who had episodes of inpatient care, the total DRG cost was roughly 50% higher than the total cost of ICU for all the patients.

When we examined the effect of episodes of inpatient care before the ICU period we found that patients who had previously been an inpatient were older (p<0.02) and had more pre-existing diseases (p< 0.007).

Health-related quality of life

Six months after discharge the results for HRQoL (age and sex adjusted) between the three groups being compared were as follows. From three years before the IC period they had 0, 1, and >1, episode of inpatient care compared with the group with no episodes of inpatient care. The group with >1 episode of inpatient care one year before the period spent in the ICU had significantly reduced HRQoL in all 8 SF-36 dimensions, and for 1 episode of inpatient care 5/8 dimensions were significantly affected (all except role limitation by physical problems, bodily pain, and social function). Episodes of inpatient care two years before the admission to ICU had minor effects. For >1 episode of inpatient care there were significantly reduced effects on HRQoL for physical function. For 1 episode of inpatient care, there were effects on general health. Episodes of inpatient care three years before the admission to the ICU had, for those with >1 episode of inpatient care, an effect on limitations of role by physical problems and emotional problems, whereas those with 1 episode of inpatient care had effects on bodily pain, general health, and mental health (Figure 2 & Table 4). When we examined the effect of pre-existing disease and the episodes of inpatient care in the same linear regression (n=609), the effect of pre-existing disease was eliminated (β=0.584; p=0.09) when the episodes of inpatient care were introduced (β=0.014; p=0.003).

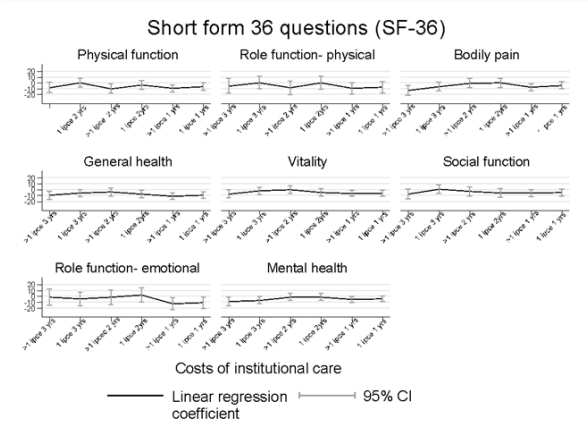

Figure 2: Health-related quality of life (SF-36) 6 months after discharge from hospital comparing the patients with 1, and >1 episodes of inpatient care with those with none (reference group) 3, 2 and 1 years before the intensive care period. The upper levels of the confidence interval are the levels of significance (from zero and down). (ipce) in patient care episode.

Table 4: Descriptive values for health related quality of life (SF-36) at 6 months after discharge for the ICU patients in the study. (n=613)

	Mean	Median	Range	95% CI for mean
No episodes of inpatient care (n=484)				
Physical function	62.5	70.0	100	59,6 to 65.5
Role function-physical	43.8	25.0	100	39.6 to 48.0
Bodily pain	62.8	62.0	100	60.0 to 65.6
General helath	56.0	57.0	100	53.7 to 58.4
Vitality	54.1	55.0	100	51.8 to 56.4
Social function	71.8	75.0	100	69.2 to 74.5
Role function-emotional	61.7	100	100	57.5 to 65.9
Mental health	71.8	76.0	96	69.6 to 73.9
1 episode of inpatient care (n=71)				
Physical function	56.1	55.0	100	48.8 to 63.4
Role function-physical	39.0	25.0	100	28.5 to 49.4
Bodily pain	54.7	51.0	100	47.6 to 61.8

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General helath	46.9	40.0	95	41.1 to 52.7
Vitality	49.8	50.0	90	43.8 to 55.8
Social function	70.8	75.0	100	63.4 to 78.2
Role function-emotional	53.8	66.7	100	42.4 to 65.3
Mental health	63.9	68.0	96	57.5 to 70.2
>1 episodes of inpatient care (n=58)				
Physical function	45.6	42.5	100	36.3 to 54.8
Role function-physical	32.3	25.0	100	21.0 to 43.6
Bodily pain	45.4	36.5	100	36.3 to 54.5
General helath	39.7	40.0	87	33.1 to 46.3
Vitality	43.5	45.0	90	36.9 to 50.1
Social function	57.8	62.5	100	49.5 to 66.1
Role function-emotional	56.2	66.7	100	43.4 to 69.1
Mental health	60.2	60.0	100	53.7 to 66.7

SF-36: Short Form 36 questions; ICU; Intensive Care Unit

Table 5: Clinical characteristics of the ICU-patients in the study group (n=631) and divided in those with episodes of inpatient care or not. Word file containing descriptive data for all the study patients divided in those with no inpatient care episodes, 1 inpatient care episode, and >1 inpatient care episodes, for each study year (3,2 and 1 year before the ICU period, and 1,2, and 3 years after the ICU period.

	No inpatient care episodes	**1 inpatient care episode**	**>1 inpatient care episodes**	**p-value**	**p-value**	**p-value**
	Group a	Group b	Group c	a vs b	a vs c	all groups
3 years before the ICU period	n=484	n=71	n=58			
Age (years)	56.8 (19.1)	62.2 (17.2)	59.9 (15.3)	0.07	0.22	
Sex male/female (%)	56.8/43.2	62.0/38.0	55.2/44.8			0.68
APACHE II score mean (SD)	15.5 (7.7)	16.5 (7.4)	15.1 (8.4)	0.31	0.66	
Duration of stay in ICU (hours) mean (SD)	111.7 (145.6)	149.3 (256.7)	97.4 (164.6)	0.07	0.49	
Duration of stay in hospital (days) mean (SD)	15.5 (20.5)	11.9 (16.4)	10.8 (12.1)	0.16	0.09	
Time on ventilator mean (SD)	54.4 (138.7)	75.2 (230.0)	43.8 (160.6)	0.29	0.59	
Pre-existing disease, n (%)	340 (70.2)	53 (74.6)	52 (89.7)			0.007
Mortality during the studyperiod, n (%)	63 (13)	15 (21.1)	8 (13.8)			0.18
2 years before the ICU period	n=472	n=69	n=72			
Age (years)	56.4 (19.1)	62.1 (17.3)	61.6 (15.2)	0.020	0.03	
Sex male/female (%)	55.5/44.5	71/29.0	55.6/44.4			0.05
APACHE II score mean (SD)	15.2 (7.5)	17.4 (8.6)	16.3 (7.6)	0.024	0.25	
Duration of stay in ICU (hours) mean (SD)	119.5 (170.6)	99.3 (148.8)	97.7 (132.6)	0.35	0.30	
Duration of stay in hospital (days) mean (SD)	14.5 (20.0)	14.2 (15.9)	15.6 (19.8)	0.90	0.66	
Time on ventilator mean (SD)	62.0 (166.2)	26.8 (79.3)	42.8 (118.6)	0.08	0.34	
Pre-existing disease, n (%)	327 (69.3)	56 (81.2)	62 (86.1)			0.003
Mortality during the studyperiod, n (%)	60 (12.7)	12 (17.4)	14 (19.4)			0.25
1 year before the ICU period	n=356	n=116	n=141			
Age (years)	53.6 (19.3)	62.6 (16.6)	63.9 (15.7)	<0.001	<0.001	
Sex male/female (%)	57/45.3	58.6/41.4	56.7/43.3			0.95
APACHE II score mean (SD)	14.7 (7.6)	17.5 (8.1)	15.9 (7.3)	0.002	0.19	
Duration of stay in ICU (hours) mean (SD)	126.9 (179.9)	100.8 (158.1)	95.2 (119.9)	0.16	0.05	

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Duration of stay in hospital (days) mean (SD)	13.8 (20.6)	15.3 (17.5)	16.1 (18.0)	0.49	0.25	
Time on ventilator mean (SD)	67.9 (174.0)	45.8 (139.7)	33.3 (100.1)	0.21	0.027	
Pre-existing disease, n (%)	235 (66.0)	89 (76.7)	121 (85.8)			<0.001
Mortality during the studyperiod, n (%)	28 (7.9)	20 (17.2)	38 (27.0)			<0.001
1 year after the ICU period	n=299	n=125	n=189			
Age (years)	54.0 (19.6)	62.8 (18.3)	60.1 (16.0)	<0.001	<0.001	
Sex male/female (%)	56.2/43.8	56.8/43.2	59.3/40.7			0.80
APACHE II score mean (SD)	13.9 (7.3)	16.8 (8.1)	17.5 (7.5)	<0.001	<0.001	
Duration of stay in ICU (hours) mean (SD)	110.4 (168.3)	107.0 (136.0)	126.5 (174.6)	0.84	0.31	
Duration of stay in hospital (days) mean (SD)	13.6 (19.8)	13.5 (17.4)	16.9 (20.2)	0.96	0.08	
Time on ventilator mean (SD)	54.9 (163.4)	59.4 (145.0)	54.7 (145.29	0.79	0.99	
Pre-existing disease, n (%)	187 (62.5)	96 (76.8)	162 (85.7)			<0.001
Mortality during the studyperiod, n (%)	22 (7.4)	15 (12.0)	49 (25.9)			<0.001
2 years after the ICU period	n=420	n=86	n=107			
Age (years)	56.0 (19.3)	61.0 (16.2)	61.7 (17.0)	0.026	0.006	
Sex male/female (%)	56.9/43.1	61.6/38.4	55.1/44.9			0.64
APACHE II score mean (SD)	15.0 (7.6)	16.7 (7.3)	17.0 (8.2)	0.05	0.015	
Duration of stay in ICU (hours) mean (SD)	110.3 (142.6)	136.3 (247.0)	114.6 (161.2)	0.18	0.79	
Duration of stay in hospital (days) mean (SD)	13.5 (17.9)	20.0 (27.7)	15.0 (16.0)	0.006	0.43	
Time on ventilator mean (SD)	55.1 (141.6)	76.4 (237.2)	41.5 (110.5)	0.26	0.35	
Pre-existing disease, n (%)	283 (67.4)	70 (81.4)	92 (86.0)			<0.001
Mortality during the studyperiod, n (%)	40 (9.5)	10 (11.6)	36 (33.6)			<0.001
3 years after the ICU period	n=459	n=77	n=77			
Age (years)	56.5 (19.2)	61.0 (16.5)	61.3 (16.1)	0.06	0.038	
Sex male/female (%)	57.1/42.9	58.4/41.6	57.1/42.9			0.98
APACHE II score mean (SD)	15.4 (7.8)	15.6 (6.9)	16.5 (7.9)	0.92	0.29	
Duration of stay in ICU (hours) mean (SD)	116.2 (166.0)	126.4 (189.29	93.6 (121.1)	0.63	0.25	
Duration of stay in hospital (days) mean (SD)	14.3 (20.0)	14.7 (15.9)	16.4 (20.0)	0.88	0.39	
Time on ventilator mean (SD)	60.2 (162.2)	57.6 (161.1)	27.4 (76.0)	0.89	0.08	
Pre-existing disease, n (%)	317 (69.1)	62 (80.5)	66 (85.7)			0.003
Mortality during the studyperiod, n (%)	64 (13.9)	5 (6.5)	17 (22.1)			0.020

13 patients have missing data of inpatient care episodes.

Mortality

We found that mortality after ICU increases ($p<0.001$) if the episodes of inpatient care are in the year before the admission to ICU. If 1 episode of inpatient care is recorded the mortality increases twofold, whereas if there are >1, the mortality is quadrupled (Table 5).

Discussion

We have made four new and important observations. First, our results suggest that episodes of inpatient care are a good measure of the amount of pre-existing illness, and may be a better proxy for it than diagnoses themselves, particularly for HRQoL. The episodes before and after the admission to IC were also closely related to the patient's pre-existing state of health.

Secondly, episodes of inpatient care before the admission to ICU had a significantly decreasing effect on HRQoL recorded after the period in ICU. This was seen particularly if there was more than 1 episode, and if the episode was in the year before the admission to IC. The results suggest that 1 or >1 episode of inpatient care during the year before the admission to ICU is significant for all dimensions of HRQoL. This was the most important effect recorded on HRQoL.

Thirdly, a large proportion of the patients who will later be admitted to the ICU had important episodes of inpatient care during the period from three years before admission to the ICU. Most of these inpatient events happened near to the time of admission to the ICU, and 57% of the patients had least 1 episode as early as three years before the admission to IC. For these patients the DRG costs were 50% higher during the three

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years before and after admission to the ICU than for the entire aggregated cost of IC for all the patients in ICU. The costs for the inpatient episodes increased linearly from year three to year one before admission to the ICU. There is an inverse pattern for the years after admission to the ICU, with many episodes of inpatient care during the first year after admission to ICU. After three years this effect disappeared.

Fourthly, and importantly, mortality after admission to the ICU increased significantly if the episodes of inpatient care were in the year preceding admission to the ICU. If 1 episode of inpatient care increases the mortality twofold, then if there is >1 the mortality is quadrupled. Our study has extended previous research that showed that pre-existing diseases had an impact on mortality, [16-18] and is the first study to our knowledge to show that the number of episodes of inpatient care also have a major impact on mortality after admission to the ICU.

We think that the results presented are of general value as was suggested in previous studies [2,3]. The characteristics of the population that we studied match western European data well. The unique circumstance that provided the data for this study is that the Swedish inpatient registry can provide data about episodes of inpatient care for all patients cared for in the Swedish health care system.

The patients who were admitted to hospital for inpatient care were older and had more pre-existing conditions than those who were not, and this was the trend from year two before admission to the ICU to year two afterwards. This indicates that an unhealthy state that leads to an admission to hospital for older patients can predict the future need for IC, reduced HRQoL, and early mortality.

In previous studies we have shown that pre-existing diseases are of significant importance for perceived HRQoL after ICU care [2,3,19] and this study emphasises in a different way the need for assessment of pre-existing diseases in patients in the ICU because they are common, they increase the risk of ICU admission, and have an impact on both HRQoL and mortality. It is possible that the patients with pre-existing diseases have reduced HRQoL as long as three years before admission to the ICU. Similarly, analyses from other studies show that the incidences of pre-existing conditions before admission range between 48% and 77% of the patients in ICU [16,20,21].

Consequently, the incidence in the present study is not unique, and indicates that the data would be generalizable at least in Western Europe. The most common pre-existing disease in our study was cardiovascular disease (29%, n=134). This is in line with a previously study from Denmark, in which the authors had analysed pre-admission morbidity in 28,172 patients in ICU using the Charlson Comorbidity Index and found that one of the most common pre-existing conditions was cardiovascular disease [16].

This work has some limitations. First, the use of only two centers has limited the selection of patients. However, at the time of data collection not all hospitals in Sweden had provided data to the registry. Secondly, we have included only data about inpatients. A wide field of health care is provided to outpatients, such as for diabetes, for example. Unfortunately data on outpatients was not at the time available from the Swedish patient registry database. Thirdly, criteria for inpatient care may vary between patients and hospital and also due to other subjective measures. However, inpatient care beds are usually in shortage why patients must often need to present a significant disease pattern to be admitted. We consider this factor less important for the conclusions. Fourthly, the pre-existing diseases were self-reported and did not take into account the seriousness and the burden of each disease [22]. This has been previously discussed [3]. Fifth, the present study does not take into account the costs for the withdrawal of drugs. In Sweden, at the time of the study period, we did not have prescription drugs recorded centrally. With that in mind the total costs can be altered, possibly increasing the costs for both periods before and after admission to the ICU. However, it would not change the effect of pre-existing diseases on the episodes of inpatient care. Sixth, it is important for the strengths of the conclusions made in the present paper to note that there is a significant loss to follow-up. The low response rate, however, is in the range commonly seen in similar studies. Lastly, the last data samples are from 2008, and the final manuscript has been delayed due to the complexity of data collection. However, we think the large and congruent changes observed and the treatment pattern changes in these respects (co-morbidity and costs) are not altered to the extent over time that it will affect the major conclusions drawn.

Conclusions

Episodes of inpatient care 3 years before and after an admission to ICU take a large amount of hospital resources and exceed the total cost of IC. It, inpatient care before ICU, is a better predictor of HRQoL after IC than pre-existing clinical diagnoses and a strong predictor for IC and after ICU mortality. This finding further strengthens the importance of the effect of pre-existing state of health on outcome after critical illness.

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