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Differences in critical care practice between an industrialized and a developing country

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Unterschiede in der intensivmedizinischen Praxis zwischen einem Industrie- und einem Entwicklungsland

Zusammenfassung. *Hintergrund:* Es stehen nur wenige Daten über die Patientenpopulationen und intensivmedizinischen Behandlungspraktiken in Entwicklungsländern zur Verfügung.

Methodik: In dieser prospektiven Studie wurden Unterschiede in Patientencharakteristika, intensivmedizinischer Praxis und Outcome zwischen einer Intensivstation in einem mongolischen Universitätskrankenhaus mit 400 Betten (MonICU) und einer Intensivstation in einem österreichischen Schwerpunktkrankenhaus mit 429 Betten (AutICU) untersucht. Demographische Daten, Vorerkrankungen, klinische Parameter, Behandlungs- und Erkrankungsschweregradscores sowie die Sterblichkeit wurden bei allen Patienten, die an der MonICU bzw. AutICU aufgenommen wurden, während fünfeinhalb Monaten erfasst. Standardtests und eine multiple Regressionsanalyse wurden zur statistischen Auswertung herangezogen.

Ergebnisse: Zweihundertdrei kritisch kranke Patienten wurden an der MonICU aufgenommen, 257 an der AutICU. MonICU Patienten wiesen weniger Vorerkrankungen als AutICU Patienten auf (0.9 ± 0.8 *vs.* 2.7 ± 1.5, $p < 0.001$), aber litten öfters an Tuberkulose (2.5 *vs.* 0%, $p = 0.01$) und waren häufiger vor ihrer Aufnahme auf die Intensivstation nie medizinisch untersucht worden (10.8 *vs.* 0%, $p < 0.001$). Die Aufnahmediagnosen unterschieden sich zwischen den beiden Intensivstationen sowohl in Art als auch relativer Häufigkeit ($p < 0.001$). MonICU Patienten wurden häufiger ungeplant aufgenommen (69 *vs.* 50.2%, $p < 0.001$) und waren schwerer erkrankt, erhielten aber weniger therapeutische Interventionen als AutICU Patienten. Die Gesamtsterblichkeit war in der MonICU höher als in der AutICU (19.7 *vs.* 6.2%, $p < 0.001$).

Zusammenfassung: Patientencharakteristika und intensivmedizinische Praktiken unterschieden sich signifikant zwischen den beiden Intensivstationen. Die Sterblichkeit auf der Intensivstation war bei in der MonICU behandelten Patienten deutlich höher, besonders dann wenn die Patienten an einem Multiorgandysfunktionssyndrom litten. Strategien zur Verbesserung der Behandlung von kritisch kranken Patienten in der MonICU sollten sich auf system- und personalbezogene Probleme, eine Erhöhung der Akzeptanz der Intensivmedizin bei Ärzten anderer Disziplinen sowie auf eine verbesserte Ausbildung des Personals der Intensivstation konzentrieren.

Summary. *Background*: Few data are available on intensive care unit (ICU) patient populations and critical care medicine practices in developing countries.

Methods: This prospective study evaluated differences in patient characteristics, ICU practice, and outcome between the ICUs of a Mongolian 400-bed tertiary university hospital (MonICU) and an Austrian 429-bed secondary hospital (AutICU). Demographics, chronic health status, clinical parameters, disease and therapeutic severity scores, and outcome were documented for all patients admitted to the two ICUs during a period of four and a half months. Standard tests and multiple regression analysis were used for statistical analysis.

Results: A total of 203 critically ill patients were admitted to MonICU and 257 to AutICU. MonICU patients had fewer chronic diseases than AutICU patients (0.9 ± 0.8 *vs.* 2.7 ± 1.5, $P < 0.001$) but more frequently suffered from tuberculosis (2.5% *vs.* 0%, $P = 0.01$) and more fre-

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quently had never been medically examined before ICU admission (10.8% *vs.* 0%, $P < 0.001$). Admission diagnoses differed both in type and relative proportions in the two ICUs ($P < 0.001$). Admission of MonICU patients was more frequently unplanned (69% *vs.* 50.2%, $P < 0.001$), and although disease was more severe in these patients they received fewer therapeutic interventions than the AutICU patients. Overall mortality was higher in the MonICU patients (19.7 *vs.* 6.2%, $P < 0.001$).

Conclusions: Patient characteristics and ICU practices varied significantly between the two ICUs. Mortality was substantially greater at MonICU, particularly among patients suffering from multiple-organ dysfunction. Strategies to improve the care of critically ill patients at MonICU should address both system- and staff-related problems, improve acceptance of the ICU service among physicians of other disciplines and upgrade the training of ICU staff.

Key words: Intensive care medicine, less developed countries, mortality, Mongolia, Austria.

Introduction

High-end critical care medicine as taught in contemporary textbooks and updated in international journals occurs almost exclusively in the industrialized nations [1, 2], where stable healthcare systems can cover the cost [3]. Since only one-quarter of the world's population lives in industrialized countries [4], it can be assumed that most critically ill patients worldwide receive insufficient or no adequate care. Recent reports have revealed that intensive care units (ICUs) in the medium- and least developed countries, as defined according to the Human Development Index of the United Nations [4], face serious staff- and education-related problems as well as alarming deficits in medical equipment, drugs and disposables [3, 5–7]. Very few details on patients and practices in critical care medicine in these countries have been published; such information, together with knowledge of local needs, could help facilitate improvement of critical care medicine by local healthcare practitioners and optimize the efforts of medical aid organizations.

Mongolia is a Central Asian country that is home to ~2.6 million people and ranks 114th in the 2007/2008 Human Development Report [4]. Following its release from communist rule in 1990 and despite an ongoing economic boom, Mongolia faces substantial political, social and healthcare problems. In 2005, average life expectancy at birth was 65 years, with cardiovascular disease, liver cancer and ischemic heart disease being the main causes of death [8]. The maternal mortality rate in 2000 was 0.1%; the under-five mortality rate in 2005 was 3.9% [8]. Further healthcare-related data and the comparative standards of living in Mongolia and Austria are shown in Table 1.

This prospective study evaluated the differences in patient characteristics, ICU practice and outcome between a Mongolian (MonICU) and an Austrian (AutICU) ICU. We also attempted to identify determinants of patient outcome in both ICUs.

Methods

This prospective study was conducted at the ICU of the Central State University Hospital in Ulaanbaatar, Mongolia, and the ICU of the Krankenhaus der Barmherzigen Schwestern in Ried im Innkreis, Austria, during the period July 1 to November 15, 2007. The study protocol was approved by the institutional review board for each hospital. Written informed consent was waived since all data were handled anonymously and did not exceed routine data documentation.

Table 1. Standards of living in Mongolia and Austria

		Mongolia	Austria
Total annual expenditure on healthcare	% of GNP	6	10.3
Government expenditure on healthcare	% of total expenditure	66.6	75.6
Private expenditure on healthcare	% of total expenditure	33.4	24.4
Social security expenditure on healthcare	% of total expenditure	38.6	61
Annual per capita total expenditure on healthcare	Average dollar rate	37.3	3683
Physicians	Density per 1000 inhabitants	2.63	3.38
Nurses	Density per 1000 inhabitants	3.21	9.38
Tuberculosis burden	Cases/100,000 inhabitants/year	188	13
HIV prevalence among adults >15 years	Cases/100,000 inhabitants	<100	173
Average monthly wage physician*	€	140	2300
Average monthly wage nurse*	€	60	1600
Price one loaf of bread	€	0.3	1.5
Price 1 kg of rice	€	0.7	2
Price 1 kg of meat	€	1.4	5
Monthly rent medium-class apartment	€	120	450

GNP gross national product; approximate prices Ulaanbaatar/Ried im Innkreis November 2007; * including night shifts.

Table 2. Details of the Mongolian and Austrian ICUs

			Mongolian ICU	Austrian ICU
Beds		n	8	8
ICU type			multidisciplinary	multidisciplinary
Specialty of physcians			anesthesiologists	anesthesiologists
Physicians during daytime		n	2	2
Physicians during the night		n	1	1
Shift characteristics for physicians		hours	24	24
Nurse-to-patient ratio	n	day	1:2.6	1:2
		night	1:4	1:2
Shift characteristics for nurses	hours	day	8	12
		night	16	12
Availability of a physiotherapy service			no	yes
Duration of postgraduate physician training		years	1.5	6
Duration of nurse training		years	3	3
Nurses with special ICU training		%	0	66.7

ICU details

The characteristics of the two ICUs are shown in Table 2. MonICU, a multidisciplinary ICU, is one of twelve Mongolian tertiary university teaching hospitals and is located in Ulaanbaatar, the capital. The hospital has 400 beds, primarily serves adult patients from the countryside and other Mongolian states, and is the only hemodialysis center in Mongolia. Its surgical department performs most procedures except for neurological, cardiac and transplant surgery.

MonICU is equipped with patient monitors for all the beds and mechanical ventilators for 50% of them, but the unit faces serious problems caused by the variable and inconsistent supply of drugs and disposables. Support is deficient from backup disciplines such as radiology (computed tomography and magnetic resonance tomography are available only to patients who can cover the high costs), laboratory medicine (small and inconsistent spectrum of laboratory tests), blood bank (shortage of blood products), cardiology (no intravenous thrombolytics available or percutaneous coronary interventions possible) and endoscopy (no interventional procedures possible). The ICU has been supported since 2002 by a Swiss medical aid organization and since 2004 by an Austrian organization also. Support has included modernization and new construction of the ICU, donation of medical equipment and supply materials, and regular periods of staff training from one to six months. During the study, one intensivist and one nurse from the Austrian team were present at the ICU for purposes of staff training and data documentation.

AutICU is located in a 429-bed secondary hospital which does not offer neurological, cardiac or transplant surgery, or percutaneous coronary interventions. The ICU is equipped according to the latest recommendations and faces no limitations in meeting up-to-date standards of intensive care.

Data documentation

During the period of observation, data documentation was conducted identically at the two ICUs. At ICU admission, data on sex, age, chronic disease status, origin and type (planned *vs.* unplanned) of admission and diagnosis were documented for all patients . If patients had never been examined by a medical doctor before ICU admission, this was reported as "not medically examined at all". The simplified acute physiology score (SAPS) II [9] and the therapeutic intervention severity score (TISS) 28 [10] were calculated within the first 24 h. On discharge from the ICU, the following data were recorded: incidence of systemic inflammatory response syndrome, sepsis or septic shock as defined according to the ACCP/SCCM criteria [11], focus of sepsis (when applicable), need for mechanical ventilation, renal replacement therapy, massive transfusion, tracheotomy, surgical revision and ICU re-admission (all "needs" documented in binary fashion); incidence of acute delirium (binary), critical illness polyneuropathy (binary), and new-onset arrhythmias (binary and type of arrhythmia); length of ICU stay; patient outcome; and frequency of withdrawal of life-sustaining therapy. The highest daily score for multiple-organ dysfunction syndrome (MODS) [12] during the ICU stay was also documented and used to define the presence of single-organ failures as follows: pulmonary failure, ratio of arterial oxygen tension/inspiratory oxygen concentration <250; renal failure, need for renal replacement therapy; liver failure, total bilirubin levels > 5 mg/dl or ASAT/ALAT plasma levels > three times the normal limit; blood/coagulation failure, disseminated intravascular coagulation or need for massive transfusion (> 5 blood products/h or >10 blood products/24 h); cardiovascular failure, need for dobutamine > 10 µg/kg per min or epinephrine, norepinephrine or arginine vasopressin any dosage; gastrointestinal failure, gastrointestinal hemorrhage requiring > 6 blood products/24 h; central nervous system failure, Glasgow coma scale ≤ 8 points [12].

Data on how many patients died unexpectedly on wards other than the ICU during the observation period were retrieved from the databases at the two hospitals.

Study objectives

The primary objective was to assess differences in patient characteristics, ICU care and outcome between the two ICUs studied. Evaluation of independent determinants of outcome was the secondary study objective.

Statistical analysis

Variables that could not be documented in binary fashion (e.g. admission diagnoses) were converted to a uniform numerical code to allow statistical comparison. SPSS 12.0.1 software (SPSS Inc, Chicago, IL) was used for statistical analysis. Kolm-

ogorov–Smirnov tests were used to test for normality of distribution of continuous study variables. An unpaired Student's *t*-test and Fisher's exact test were used to compare continuous and categorical data between the study groups, as appropriate. In order to identify determinants of ICU outcome in both groups, relevant study parameters were entered in a bivariate correlation model. Variables significantly associated with ICU mortality at $\alpha = 0.05$ were then introduced into a multiple logistic regression analysis. For all tests, a significance level of 0.05 was assumed. Data are presented as mean values ± SD, if not otherwise indicated.

Results

During the period studied, 203 patients were admitted to MonICU and 257 to AutICU; all were enrolled in the study protocol. Table 3 summarizes the demographics and chronic disease status of the two ICU populations. Except for liver cirrhosis and immune defects, chronic diseases were more frequent in patients admitted to AutICU. Critically ill patients at MonICU suffered more frequently from chronic tuberculosis and more often had never been medically examined.

ICU admission diagnoses differed both in type and in relative proportions at the two ICUs ($P < 0.001$) (Table 4). Table 5 shows ICU treatment practices at both centers. Type and origin of ICU admission were different. Significantly fewer patients received mechanical ventilation, renal replacement therapy or tracheotomy at MonICU. SAPS II, TISS 28 and MODS scores, as well as the incidence of abdominal sepsis, systemic inflamma-

Table 3. Demographic and comorbid status of the Mongolian and Austrian ICU populations

		Mongolian ICU	Austrian ICU	P
Patients admitted	n	203	257	
Male sex	n (%)	98 (48.3)	147 (57.2)	0.06
Age	years	50 ± 18	66 ± 16	<0.001*
Number of chronic illnesses	n	0.9 ± 0.8	2.7 ± 1.5	<0.001*
Chronic obstructive pulmonary disease/asthma	n (%)	11 (5.4)	45 (17.5)	<0.001*
Heart disease	n (%)	14 (6.9)	99 (38.5)	<0.001*
Arterial hypertension	n (%)	20 (9.9)	144 (56)	<0.001*
Chronic renal insufficiency	n (%)	8 (3.9)	63 (24.5)	<0.001*
Liver cirrhosis	n (%)	16 (7.9)	13 (5.1)	0.174
Diabetes mellitus	n (%)	7 (3.4)	46 (17.9)	<0.001*
Thyroid disease	n (%)	1 (0.5)	33 (12.8)	<0.001*
Malignant disease	n (%)	25 (12.3)	80 (31.1)	<0.001*
Adipositas	n (%)	3 (1.5)	41 (16)	<0.001*
Neurologic or psychiatric disease	n (%)	21 (10.3)	71 (27.6)	<0.001*
Immunologic disease	n (%)	6 (3)	13 (5.1)	0.48
Chronic tuberculosis infection	n (%)	5 (2.5)	0 (0)	0.01*
No health status evaluation before ICU admission	n (%)	22 (10.8)	0 (0)	<0.001*

Chronic renal insufficiency defined as elevated baseline creatinine levels (>1.3 mg/dl or >115 µmol/l) before onset of the acute disease process which led to ICU admission. *Significant difference between groups. Data are given as mean values ± SD unless indicated otherwise.

Table 4. The 10 most common ICU admission diagnoses

Mongolian ICU		Austrian ICU	
Elective gastrointestinal surgery	29 (14.2)	Elective gastrointestinal surgery	34 (13.2)
Surgery for intraabdominal infection	23 (11.3)	Trauma surgery extremities/pelvis	22 (8.6)
Acute neurologic diseases	20 (9.9)	Acute abdomen	17 (6.6)
Gastrointestinal hemorrhage	15 (7.4)	Surgery for intraabdominal infection	17 (6.6)
Acute respiratory failure	13 (6.4)	Radical prostatectomy	15 (5.8)
Pulmonary surgery	12 (5.9)	Post-cardiopulmonary resuscitation	11 (4.3)
Acute abdomen	10 (4.9)	Orthopedic surgery	11 (4.3)
Acute heart failure	10 (4.9)	Vascular surgery	10 (3.9)
Acute renal failure	10 (4.9)	Nephrectomy	10 (3.9)
Sepsis	7 (3.4)	Acute respiratory failure	9 (3.5)

Data are given as n (%).

Table 5. Overview of practices in the Mongolian and Austrian ICUs

		Mongolian ICU	Austrian ICU	P
n		203	257	
Unplanned ICU admission	n (%)	140 (69)	129 (50.2)	<0.001*
Source of ICU admission				<0.001*
Operation room	n (%)	104 (51.2)	181 (70.4)	
Emergency department	n (%)	72 (35.5)	20 (7.8)	
Hospital ward	n (%)	19 (9.4)	39 (15.2)	
Other ICU	n (%)	8 (3.9)	10 (3.9)	
Recovery room	n (%)	0 (0)	7 (2.7)	
Focus of infection	n (%)	78 (38.4)	72 (28)	
Abdomen	n (%)**	38 (48.7)	27 (37.5)	0.006*
Lungs	n (%)**	22 (28.2)	28 (38.9)	0.17
Urinary tract	n (%)**	3 (3.8)	4 (5.6)	0.71
Thorax excluding lungs	n (%)**	2 (2.6)	0 (0)	0.18
Catheter	n (%)**	0 (0)	4 (5.6)	0.14
Others	n (%)**	13 (16.7)	9 (12.5)	0.12
Incidence of syndromes				
SIRS	n (%)	53 (26.1)	21 (8.2)	<0.001*
Sepsis	n (%)	44 (21.7)	27 (10.5)	0.001*
Septic shock	n (%)	15 (7.4)	33 (12.8)	0.07
SAPS II	points	34 ± 22	30 ± 16	0.04*
SAPS II corrected for age	points	27 ± 21	18 ± 16	<0.001*
MODS	points	4.5 ± 3.6	3.2 ± 3.3	<0.001*
Acute delirium	n (%)	33 (16.3)	19 (7.4)	0.001*
Critical illness polyneuropathy	n (%)	20 (9.9)	4 (1.6)	<0.001*
New-onset arrhythmias	n (%)	10 (4.9)	23 (8.9)	0.2
TISS 28	points	21 ± 8	31 ± 9	<0.001*
Mechanical ventilation	n (%)	71 (35)	167 (65)	<0.001*
Duration of mechanical ventilation	days	0.9 ± 2.9	2.5 ± 5.2	<0.001*
Renal replacement therapy	n (%)	12 (5.9)	48 (18.7)	<0.001*
Massive transfusion	n (%)	2 (1)	12 (4.7)	0.05
Tracheotomy	n (%)	3 (1.5)	17 (6.6)	0.011*

SAPS simplified acute physiology score; *MODS* multiple organ dysfunction syndrome; *TISS* therapeutic intervention severity score. * Significant difference between groups; ** patients with infection. Data are given as mean values ± SD unless indicated otherwise.

tory response syndrome, sepsis, acute delirium and critical illness polyneuropathy were higher at MonICU. Significantly more patients were admitted to MonICU with a SAPS II > 50, predicted mortality rate > 46% (42 [20.7%] *vs.* 35 [13.6%], $P = 0.02$). Although the two groups had a similar incidence of new-onset arrhythmias, their type differed significantly (MonICU: atrial fibrillation 30%, supraventricular tachycardia 20%, ventricular tachycardia 20%, bradycardia 30%; AutICU: atrial fibrillation 89.5%, ventricular tachycardia 10.6%; $P = 0.01$).

Table 6 shows the outcome variables for the two ICUs. Both overall mortality and mortality for specific patient groups were higher at MonICU than at AutICU. Life-sustaining therapy was less frequently withdrawn at MonICU. Patients admitted to MonICU immediately after surgery had a trend towards lower ICU mortality than those admitted only after postoperative complications had occurred (8 [8.4%] *vs.* 3 [33%], $P = 0.05$). At both ICUs, length of stay was similar for non-survivors and survivors (MonICU, 4.6 ± 3.2 *vs.* 5.3 ± 6.5 days, $P = 0.45$; AutICU, 4.7 ± 5.7 *vs.* 5.4 ± 6.3 days, $P = 0.66$), and non-survivors had significantly higher MODS scores (MonICU, 3.3 ± 2.6 *vs.* 9.5 ± 2.7 points, $P < 0.001$; AutICU, 2.9 ± 3 *vs.* 7.8 ± 2.8 points, $P < 0.001$). During the observation period, significantly more patients died unexpectedly on wards other than the ICU in the Mongolian hospital (30/6475 *vs.* 7/12118, $P < 0.001$).

At MonICU, SAPS II (OR per point, 1.1; CI 95%, 1.07–1.12; $P = 0.04$) and MODS scores (OR per point, 2.2; CI 95%, 1.2–3.6; $P = 0.001$) were independent determinants of ICU outcome; at AutICU, SAPS II (OR per point, 1.08; CI 95%, 1.08–1.16; $P = 0.04$) and the abdomen as the

Table 6. Parameters of outcome in the Mongolian and Austrian ICUs

		Mongolian ICU	Austrian ICU	P
Length of ICU stay	days	4.8 ± 4.1	4.7 ± 5.8	0.89
Need for surgical revision	n (%)**	8 (7.7)	12 (6.7)	0.81
ICU re-admission	n (%)	4 (2)	10 (3.9)	0.41
SAPS II prediced overall mortality	n (%)	31 (15.3)	17 (10.6)	0.17
Observed overall mortality	n (%)	40 (19.7)	16 (6.2)	<0.001*
Mortality of patients on MV	n (%)	29 (40.8)	16 (9.6)	<0.001*
Mortality of patients with SIRS	n (%)	13 (24.5)	2 (9.5)	0.21
Mortality of patients with sepsis	n (%)	5 (20.8)	0 (0)	0.15
Mortality of patients with septic shock	n (%)	12 (80)	7 (21.2)	<0.001*
Mortality of patients on RRT	n (%)	2 (16.7)	10 (20.8)	1
Mortality of surgical patients	n (%)	11 (10.6)	6 (3.3)	0.02*
Mortality of planned surgical patients	n (%)	1 (2.2)	0 (0)	0.28
Withdrawal of life-sustaining therapy	n (%)***	11 (27.5)	11 (68.8)	0.014*

SAPS simplified acute physiology score; *MV* mechanical ventilation; *SIRS* systemic inflammatory response syndrome; *RRT* renal replacement therapy.
* Significant difference between groups; ** surgical patients; *** patients dying in the ICU. Data are given as mean values ± SD unless indicated otherwise.

focus of sepsis (OR, 52.8; CI 95%, 13.41–87.63; $P < 0.001$) were the determinants. Figure 1 shows ICU mortality rates associated with organ failure and the number of failing organs at both ICUs: mortality in patients with cardiovascular, central nervous system, pulmonary and coagulatory failure, and in patients with three or more failing organs, was higher at MonICU.

Discussion

In this prospective study the characteristics of patients in the ICU in an industrialized country, Austria, differed significantly from those of patients in a medium-developed country, Mongolia. Admission of the Mongolian patients was more frequently unplanned, and even though disease severity in these patients was greater, they received fewer therapeutic interventions. Overall mortality was higher at the Mongolian ICU, particularly when cardiovascular, cerebral, pulmonary and/or coagulatory failure was present.

Chronic diseases and both the type and the relative proportion of admission diagnoses differed between the two ICUs. Some chronic diseases were seen only at the Mongolian ICU, *e.g.* chronic tuberculosis infection, a growing problem in many less developed countries such as Mongolia [13, 14]. Similarly, in subtropical and tropical regions, diseases leading to critical illness are different from those in industrialized nations [3, 5, 15]. The strikingly lower incidence of comorbid factors in the Mongolian patients may be due to their lower age but could also reflect inadequate previous examination of their general health status.

Admission of half the patients to the Austrian ICU was unplanned, whereas in the Mongolian ICU population this figure was two-thirds. Taken together with the larger number of unexpected deaths in patients hospitalized outside the Mongolian ICU, these findings suggest a comparatively low acceptance of the ICU service among physicians of other medical disciplines at the Mongolian hospital. The high portion of unplanned admissions of critically ill patients may partly explain the greater disease severity, as assessed by SAPS II and the MODS score, as well as the higher incidence of systemic inflammatory response syndrome, sepsis, acute delirium and critical illness polyneuropathy at the Mongolian ICU [16, 17]. Other authors have suggested that the number of unplanned ICU admissions in surgical patients can be used as an indicator of the quality of perioperative patient management [18]. Another possible factor contributing to the greater disease severity in the Mongolian patients is that, in contrast to Austria, no refusal criteria apparently exist at the Mongolian ICU although this was not prospectively documented in the study) and thus dying patients are also admitted to the unit.

Overall mortality was strikingly higher at the Mongolian ICU. The difference was all the more pronounced in light of the exceptionally low mortality of patients with septic shock and MODS at the Austrian unit [19]. The fact that no interventional cardiologic procedures are available at the Austrian hospital could further explain why only a few patients with cardiogenic shock, usually known to have a grave prognosis [20], were admitted to that ICU and only few cardiovascular deaths occurred. On the other hand, the comparatively high mortality rate in Austrian ICU patients suffering from systemic inflammatory response syndrome results from the inclusion of patients after primarily successful cardiopulmonary resuscitation. Although the smaller percentage of scheduled admissions to the Mongolian ICU may also have contributed to the considerable difference in patient mortality between the two units [16, 17], multiple regression analysis clearly suggests that disease severity and dysfunction of multiple organs were

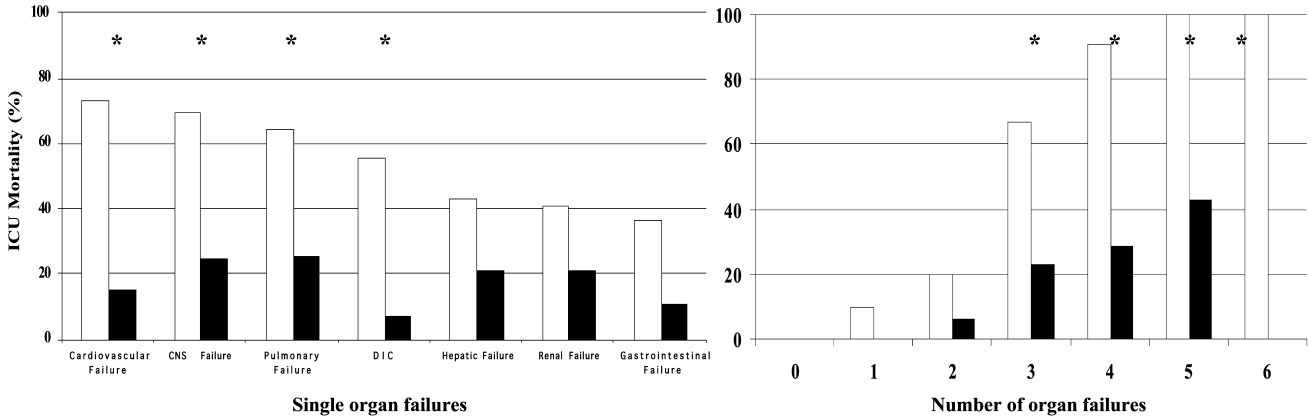

Fig. 1. Intensive care unit (ICU) mortality associated with single-organ failures (left panel) and the number of organ failures (right panel) at the Mongolian (white bars) and Austrian (black bars) ICUs. *CNS* central nervous system; *DIC* disseminated intravascular coagulation. *Significant difference between the two ICUs

the main determinants of patient outcome at the Mongolian ICU. Organ failures associated with particularly high mortality were cardiovascular, cerebral, pulmonary and coagulatory failure. Together with the therapeutic complexity of critically ill patients with MODS, cardiovascular and pulmonary failure reflects organ dysfunctions that require strict care by a well trained and experienced ICU team [21]. It is therefore likely that the shorter training period undergone by the staff at the Mongolian ICU and the smaller number of available staff nurses contributed relevantly to the excess ICU mortality; in addition, the lower frequency of therapeutic interventions may have resulted in poorer patient outcome.

Another major difference in the practices observed at the two ICUs was the frequency of withdrawing life-sustaining therapy. Similarly to most ICUs in industrialized nations [22], therapeutic measures were limited or withdrawn in over two-thirds of dying patients in the Austrian ICU. In contrast, Mongolian intensivists withdrew life-sustaining therapy in only one-quarter of their non-surviving ICU patients. Although the findings of this study cannot elucidate this difference, the personal experience of the authors suggests two reasons for the infrequent withdrawal of life-sustaining therapy at the Mongolian ICU: on the one hand, it may be due to the Mongolian people's belief that every disease can be healed with modern, apparatus-based intensive care medicine; on the other hand, it could be due to the doctors' frequent anxiety about having possibly administered insufficient diagnostic or therapeutic measures.

Only one study has previously evaluated differences in ICU care between an industrialized and a developing country. Nouria et al compared the variations in ICU outcome in relation to resource utilization and costs between a Tunisian and a French ICU. Similarly to our results, the Tunisian patients were younger and in better health before ICU admission than were the French ICU patients, but in contrast to our results the Tunisian patients were less severely ill at the time of ICU admission. Also similar to our data, the French patients had a lower overall mortality and received more therapeutic interventions. Although outcome and resource utilization at the two ICUs were similar in patients with low disease severity, treatment costs were lower at the Tunisian ICU. Mortality rates in severely ill patients were equal in the two units. Particular differences in treatment were observed only in patients with chronic obstructive pulmonary disease [23].

When interpreting the results of our study important limitations need to be considered. Firstly, in comparison with other ICU facilities in Mongolia, the ICU that was studied is well equipped and its physicians have had repeated training by foreign intensivists. This may not have affected patient characteristics, but practice and outcome at the study ICU must be assumed to be better than at other Mongolian ICUs. Secondly, although Mongolia is a typical medium-developed country, the results of our study cannot be extrapolated to other less developed countries. ICU patient characteristics are likely to be different in other countries, particularly in subtropical and tropical regions [3, 5, 7].

In conclusion, patient characteristics and ICU practices differed significantly between the two ICUs. Mortality was substantially greater at the Mongolian ICU, particularly in patients suffering from multiple-organ dysfunction. Strategies to improve the care of critically ill patients at the Mongolian ICU should address system- and staff-related problems, improve the acceptance of the ICU service among physicians of other disciplines and upgrade the training of ICU staff.

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