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Intensive Care Units in Croatia: 2001 Survey

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Aim. To establish a framework for the Intensive Care Units (ICU) Register in Croatia, and examine the relation between their present organization and medical practices and their outcome performances.

Methods. The survey of a total of 123 ICUs in Croatia was conducted between February 1 and October 31, 2001. Census questionnaires were filled out by ICU chiefs of staff. Demographic data, data on hospital and ICU structure and organization, disposable equipment, admission and discharge decision-making, outcome, and patient demographic data were collected for February 1, 2001. Descriptive statistics was used for data analysis.

Results. On February 1, 2001, there were 123 ICUs in Croatia. The questionnaire was filled out by 117 ICU chiefs of staff (95% response rate). The total number of ICUs beds was 900, comprising 3.3% of all hospital beds. Croatian ICUs were divided into 13 subtypes; 89% of them were adjoined to hospital departments of various subspecialties and only 13 (11%) were freestanding. The number of ICUs per hospital, number of ICU beds, quantity of disposable equipment, and number of permanently employed medical and nursing staff within hospitals and individual units increased as hospitals enlarged. Also, the number of mixed surgical/medical and coronary care/medical units decreased, and specialized units became prevalent. The mortality data in Croatian ICUs were similar to those reported elsewhere in the world: the lowest mortality was found in psychiatric ICUs (3%) and the highest in an ICU for infective diseases (30%), followed by neurological (19%), medical (17%), and respiratory (16%) ICUs.

Conclusion. Establishing a database on intensive care medicine and assessing the performance of ICUs in Croatia could serve as a model for improvement of ICU service in other transition countries.

Key words: *data collection; databases; Croatia; intensive care units, survey*

Organizational practices of intensive care units (ICUs) "are related to a patient-centered culture, strong medical and nursing leadership, effective communications and coordination and collaborative approaches to solving problems and managing conflicts" (1). ICUs greatly contribute to the rising health care costs. In the United States, they account for almost 20% of health care expenditures (2). Provision of an appropriate type and mix of ICUs in university and general hospitals throughout the country, the number of ICUs and step-down beds, admission, discharge and transfer practices, employment of subspecialized medical and nursing staff can significantly reduce the use of intensive care resources. Hospitals in all systems have to deal with rising expectations and a need to contain the costs of health care. Almost all developed countries have made substantial reductions in hospital beds; on the other side, Eastern European and former Soviet Union countries have an overdeveloped hospital sector (3). The European Prevalence of Infection in Intensive Care study revealed important differences between northern and southern European countries in the structure of ICUs and patient demography (4). In 1995, Mose (5) stressed that "the time has come for establishing a national database concerning the organization of ICU size, structure, technology capacity, staff, type and number of patients, mortality, length of stay, bed occupation, criteria for admission and discharge, interventions, and procedures". Collected and published 1991/1992 data on Croatian ICUs were the results of the survey of 30 ICUs, which represented 50% of the existing ICUs at that time (6).

The major task of the Croatian Society of Intensive Care Medicine is to create a more uniform system of intensive care. The first step is to make a framework for the Register of ICUs in Croatia and examine their present organizational and medical practices as related to outcome performances. To achieve this goal, demographic, hospital, ICU structure and organization, patient demographic, disposable equipment, admission and discharge decision-making, and outcome data were collected by a census questionnaire. We present an initial analysis of the data obtained

from 117 ICUs evaluating hospital and ICU's structure and organization, disposable equipment, staffing, admission, discharge, and outcome.

Method

Sample

The Croatian Institute for Health Insurance, Croatian Health Service Yearbook 2000, and all hospitals in the Republic of Croatia that stated they had an ICU were used as a sampling frame to create an ICU database (7). According to those three sources, there were 123 ICUs in Croatia in 2001. All were included in the voluntary survey conducted between February 1 and October 31, 2001. That ICU really exists was confirmed in personal contact with medical directors of the 67 hospitals. The questionnaire was mailed to the chiefs of medical staff of each ICU. The response rate was 95% by the end of October 2001, with all collected data referring to February 1, 2001.

Questionnaire

Data collected by the census questionnaire included the following: data on the type of hospital, type of ICU, bed capacities, organizational structure, ICU management, staffing, administrative policies, disposable equipment, patient demographic data, admission and discharge decision making, bed occupancy, where from the patients were admitted, length of ICU stay, and outcome. Intensive care units were subdivided into 13 subtypes, as follows: medical, surgical, surgical/medical, coronary care, coronary care/medical, pediatric, neonatal, respiratory, neurological, burns, trauma, psychiatric, and others (8,9). Nine ICUs (all in Zagreb) defined themselves as pediatric/surgical, gynecological, three urology ICUs, orthopedic, neurosurgical, otorhinolaryngological (ENT) postoperative ICU, and ICU for infective diseases. Eight of them were classified as surgical subtype and one as ICU for infective diseases.

Statistics

Descriptive statistics was used to present the data. The statistical software package SAS System for Windows Release 6.12 (SAS Institute Inc., Cary, NC, USA) was used for data analysis.

Results

Demographic and Hospital Data

According to the Croatian Institute for Health Insurance and the Croatian National Institute of Public Health, on February 1, 2001, there were 2 university hospital centers, 12 university hospitals, 23 general hospitals, 30 specialized hospitals, 5 health resorts, 4 emergency medical aid institutions, 154 health centers, a National Institute of Public Health, 20 regional institutes of public health, and 6 other state health institutes in Croatia (7). These medical institutions served a total population of 4,437,460 inhabitants in Croatia, as attested by the population census 2001. Croatian Institute for Health Insurance data showed that out of 16,819 hospital beds in 2001, 679 were ICUs beds, which accounted for 3% of beds in general (non-teaching) hospitals, and 5% of beds in university (teaching) hospitals. In 2000, there were 26,955 hospital beds (7), but no data on the number of ICU beds existed, except for 232 beds in the category of "anesthesiology and reanimation," with an occupancy rate of 63.5% per year and a mean length of patient stay of 5.3 days (10).

Before sending the questionnaire to the ICU chiefs of staff, we had contacted medical directors of each of 67 hospitals to confirm the number of ICUs in their hospital. Out of a total of 123 ICUs in Croatia, we received responses from 117 (95% response rate). ICUs were located in all 20 Croatian counties, in 42

Figure 1. Number and distribution of intensive care units in Croatian counties, 2001. Data for the city of Zagreb (Grad Zagreb) and the Zagreb County were pooled.

hospitals (62.6% of the total number of hospitals), in 30 cities (Fig. 1). There were 46 (39.3%) ICUs located in Zagreb, the capital of Croatia. Cities of Osijek, Rijeka, and Split had 6 (5.1%) ICUs each; cities of Bjelovar and Šibenik had 4 (3.3%) ICUs each, and cities of Koprivnica, Pula, Varaždin, and Virovitica, had 3 (2.6%) ICUs each. Thirteen cities had 2 (22.1%) ICUs each, whereas 7 cities (Gospić, Klenovnik, Knin, Lovran, Ogulin, Pakrac, and Popovača) had only one ICU (6.3%) per hospital each.

Hospitals covering a population of 100,000-500,000 had the largest number of ICUs (a total of 97 ICUs, or 82.9%). There were 14 (12.0%) ICUs located in hospitals covering a population of 50,000-100,000, and 6 (5.1%) in hospitals covering 20,000-50,000 inhabitants. Fifty-four ICUs (46.2%) were located in general hospitals, 36 (30.7%) in university hospitals, 19 (16.3%) in 2 university hospital centers of Zagreb and Rijeka, and 8 (6.8%) in special hospitals. Croatian hospitals with 200-500 hospital beds had the largest number of ICUs (Table 1). As many as 110 (94%) ICUs were in hospitals with emergency rooms operating around the clock, and only 7 (6.0%) were in special hospitals with no emergency admissions.

Table 1. Distribution of intensive care units (ICUs, n = 117) in Croatian hospitals according to the total number of hospital beds

No. of hospital beds	No. (%) of ICUs
50-100	4 (3.4)
100-200	16 (13.7)
200-500	37 (31.6)
500-700	20 (17.1)
700-1,000	14 (12.0)
> 1,000	26 (22.2)

ICU Structure and Organization

The total number of ICU beds in Croatia was 900 (Table 2). There was almost an equal number of large

Table 2. Subtypes of intensive care units (ICUs) and the number of beds in each ICU subtype in Croatia, 2001

Type of ICU	No. (%) of ICUs	No. of ICU beds		
		total (%)	mean ± SD	median (range)
Surgical[a]	27 (23.0)	223 (24.7)	8.2 ± 2.0	7 (4-11)
Mixed (surgical/medical)	18 (15.4)	141 (15.6)	7.8 ± 2.6	7 (4-11)
Mixed (coronary care/medical)	15 (12.8)	104 (11.5)	6.9 ± 2.1	7 (4-11)
Coronary care	14 (12.0)	81 (9.0)	5.8 ± 1.5	6 (4-10)
Neurological	10 (8.5)	80 (8.8)	8.0 ± 2.7	7 (4-11)
Medical	9 (7.7)	68 (7.5)	7.5 ± 2.6	7 (4-11)
Neonatal	7 (6.0)	66 (7.3)	9.4 ± 1.7	10 (7-11)
Psychiatric	6 (5.1)	57 (6.3)	9.5 ± 2.0	10 (6-11)
Respiratory	4 (3.4)	24 (2.6)	6.0 ± 2.1	5 (4-9)
Pediatric	3 (2.6)	26 (2.8)	8.7 ± 2.5	9 (6-11)
Trauma	2 (1.7)	15 (1.6)	7.5 ± 4.9	10 (4-11)
Burns	1 (0.9)	4 (0.4)	4	4
Infective diseases	1 (0.9)	11 (1.2)	11	11

[a]Surgical subtype included 8 ICUs from Zagreb, which defined themselves as pediatric/surgical, gynecological, urology ICU (three), orthopedic, neurosurgical, and otorhinolaryngological postoperative ICU.

ICUs (21.4% had ≥11 beds, and 11.1% had 10 beds) and small ICUs (19.7% had 6 beds, and 11.1% had 4 beds), accounting for 63.3% of all ICUs. The rest of units (36.7%) were medium-sized, with 6-8 beds (Table 3). Sixty-four (54.7%) ICUs had adjoining post-intensive care units, and 53 (45.3%) ICUs transferred patients to the other wards. Out of all ICUs responding to the survey, only 13 (11.1%) were freestanding, ie, had no departmental affiliation. Thirty-eight ICUs (32.5%) were located within departments of medicine, 31 (26.5%) within departments of anesthesiology, 10 (8.5%) within departments of neurology, 8 (6.8%) within the departments of surgery (general, cardiac surgery, trauma, burns, or neurosurgery), 5 (4.3%) within departments of psychiatry, and 5 (4.3%) within departments of gynecology. There were 4 (3.4%) ICUs within pediatric departments, and 3 (2.6%) were within departments of urology.

Table 3. Number of intensive care units (ICUs) according to the number of beds, permanently employed specialists, and nurses per shift

Parameter	No. (%) of ICUs
No. of ICU beds:	
4	13 (11.1)
5	12 (10.2)
6	23 (19.7)
7	9 (7.7)
8	16 (13.7)
9	6 (5.1)
10	13 (11.1)
≥11	25 (21.4)
No. of permanently employed ICU specialists:	
2	39 (33.3)
3	15 (12.8)
4	18 (15.4)
5	14 (12.0)
6	11 (9.4)
≥7	20 (17.1)
No. of nurses per shift:	
2	37 (31.6)
3	38 (32.5)
4	22 (18.7)
5	0 (0.0)
6	6 (5.2)
≥7	14 (12.0)

Medical and Nursing Staff

ICU chiefs of staff were mostly anesthesiologists (48 or 41%), usually working in surgical units; followed by internists (39 or 33.3%), predominating in medical, coronary care, mixed coronary care/medical, and respiratory units; neurologists (10 or 8.5%); pediatricians (9 or 7.7%), predominantly in pediatric and neonatal units; and psychiatrists (6 or 5.1%). There were one gynecologist, one specialist for infective diseases, and one urologist among ICU chiefs (4.4%). Largest number of ICUs had only 2 or 3 permanently employed specialists and nurses per shift (Table 3). Permanently employed specialists covered all shifts in 82 (70.1%) ICUs, whereas in 35 (29.9%) units shifts were partly covered by the physicians employed on other wards.

Head nurses were employed in 114 (97.4%) ICUs, and only 3 (2.6%) units were headed by a nurse from another ward. In 82 (70.1%) ICUs nursing shifts lasted 12 h, and in 35 ICUs (29.9%) shifts lasted 8 h. There were 14 ICUs with 7 or more nurses per shift; all were surgical and had 11 or more beds. Psychotherapist was present on a day-to-day basis in 9 (7.7%) units, out of which 6 were psychiatric and 3 neurological ICUs (Table 4).

Table 4. Number of intensive care units (ICUs) with everyday work of physiotherapist, psychotherapist, clinical pharmacologist, and clinical microbiologist

Specialist profile	No. (%) of ICUs	
	with	without
Physiotherapist	81 (69.2)	36 (30.8)
Psychotherapist	9 (7.7)	108 (92.3)
Clinical pharmacologist	16 (13.7)	101 (86.3)
Clinical microbiologist	37 (31.6)	80 (68.4)

Disposable Equipment

Heart rate monitors for each bed were available in 88 (75.2%) ICUs; 23 (19.7%) ICUs had monitors for every two or three beds, and none of the 6 (5.1%) psychiatric ICUs had heart rate monitors. A portable electrocardiograph was available in 93 (79.5%) ICUs; 64 (54.7%) ICUs had their own portable X-ray equipment, and 38 (32.5%) ICUs could implant and control the position of temporary pacemaker, introduce a central venous catheter or pulmonary artery catheter under X-ray control. Thirty-six ICUs out of eighty-three in subtypes: surgical, mixed (surgical/medical, coronary care/medical), coronary care and medical used X-ray equipment for insertion and control of position for temporary pacemaker in the critically ill patients (Table5). As many as 26 (31.3%) of them – 16 in

Zagreb, 3 in Osijek, 2 in Karlovac, 2 in Rijeka, one in Zadar, one in Krapinske Toplice, and one in Split – were located in hospitals where implantation of permanent pacemaker could be done.

Forty-five (38.5%) ICUs had the equipment for pulmonary artery catheterization, and 88 (75.2%) had equipment for mechanical ventilation (Table 6). There were as many as 29 (24.8%) ICUs that did not have equipment for mechanical ventilation, with psychiatric and neurological ICUs faring the worst (Table 7). Equipment for mechanical ventilation for each bed existed in all ICUs of the following subtype: surgical and mixed surgical/medical, trauma, burns, and infective diseases. As many as 91 (77.8%) ICUs had portable pulse oximetry monitoring system, only 28 (23.9%) ICUs had their own bronchoscopy equipment and personnel trained to perform the procedure.

Ultrasound equipment was available in 48 (41%) ICUs, and only 28 (23.9%) ICUs had their own blood-gas analyzers for determining acid-base status, blood sugar concentration, and serum electrolytes. Twenty-two (18.8%) ICUs had the equipment for acute hemodialysis, and only 18 of them, or 15.4% of all ICUs, had equipment for acute continuous veno-venous hemodialysis or hemodiafiltration. All of these ICUs were surgical and medical, and 13 of them were located in Zagreb university hospitals. An infusion pump for each bed was available in 80 (68.4%) ICUs, compared with 37 (31.6%) units that had an infusion pump for every two or three beds. The number of perfusors was even smaller: only 51 ICUs (43.6%) had a perfusor pump for each bed. One pump for enteral nutrition for every two beds existed only in 39 ICUs (33.3%). The possibility of isolating patients existed in 73 ICUs (62.4%) (Table 8). Sixty-seven (57.3%) ICUs had a computer for daily processing of patient data, 95 (81.2%) ICUs had their own uniform papers for patient data, and 90 (76.9%) ICUs had their own therapy protocols for critically ill patients.

Table 5. Number and subtypes of intensive care units (ICUs) that use X-ray equipment for insertion and control of the position of temporary pacemaker in critically ill patients

Type of ICU	No. (%) of ICUs	No. (%) of ICUs using X-ray control of insertion and position of temporary pacemaker
Surgical[a]	27 (23.0)	8/27 (29.6)
Mixed (surgical/medical)	18 (15.4)	5/18 (27.7)
Mixed (coronary care/medical)	15 (12.8)	7/15 (46.6)
Coronary care	14 (12.0)	10/14 (71.4)
Medical	9 (7.7)	6/9 (66.6)

[a]Surgical subtype included 8 ICUs from Zagreb, which defined themselves as pediatric/surgical, gynecological, urology ICU (three), orthopedic, neurosurgical, and otorhinolaryngological postoperative ICU.

Table 6. Intensive care units (ICUs) that use pulmonary artery (PA) catheter and the number of ICUs with equipment for mechanical ventilation according to ICU subtype

		No. (%) of ICUs using	
Type of ICU	No. (%) of ICUs	PA catheter	mechanical ventilators
Surgical[a]	27 (23.0)	11/27 (40.7)	27/27 (100.0)
Mixed (surgical/medical)	18 (15.4)	9/18 (50.0)	18/18 (100.0)
Mixed (coronary care/medical)	15 (12.8)	2/15 (13.3)	7/15 (46.6)
Coronary care	14 (12.0)	10/14 (71.4)	9/14 (64.2)
Neurological	10 (8.5)	1/10 (10.0)	4/10 (40.0)
Medical	9 (7.7)	7/9 (77.7)	7/9 (77.7)
Neonatal	7 (6.0)	0/7 (0)	6/7 (85.7)
Psychiatric	6 (5.1)	0/6 (0)	1/6 (16.6)
Respiratory	4 (3.4)	1/4 (25.0)	3/4 (75.0)
Pediatric	3 (2.6)	0/3 (0)	2/3 (66.6)
Trauma	2 (1.7)	2/2 (100.0)	2/2 (100.0)
Burns	1 (0.9)	1/1 (100.0)	1/1 (100.0)
Infective diseases	1 (0.9)	1/1 (100.0)	1/1 (100.0)

[a]The surgical subtype included 8 ICUs from Zagreb, which defined themselves as pediatric/surgical, gynecological, urology ICU (three), orthopedic, neurosurgical, and otorhinolaryngological postoperative ICU.

Table 7. Number and distribution of ICU subtypes without equipment for mechanical ventilation

Type of ICU	No. (%) of ICU subtype without equipment for mechanical ventilation	City/Town
Surgical[a]	0/27 (0.0)	-
Mixed (surgical/medical)	0/18 (0.0)	-
Mixed (coronary care/medical)	8/15 (53.3)	Bjelovar, Čakovec, Koprivnica, Našice, Nova Gradiška, Sisak, Vukovar, Zabok
Coronary care	5/14 (35.7)	Dubrovnik, Osijek, Požega, Split, Split
Neurological	6/10 (60.0)	Bjelovar, Koprivnica, Osijek, Pula, Split, Šibenik
Medical	2/9 (22.2)	Osijek, Osijek
Neonatal	1/7 (14.2)	Rijeka
Psychiatric	5/6 (83.3)	Bjelovar, Zagreb
Respiratory	1/4 (25.0)	Rijeka
Pediatric	1/3 (33.3)	Šibenik
Trauma	0/2 (0.0)	-
Burns	0/1 (0.0)	-
Infective diseases	0/1 (0.0)	-

[a]The surgical subtype included 8 ICUs from Zagreb, which defined themselves as pediatric/surgical, gynecological, urology ICU (three), orthopedic, neurosurgical, and otorhinolaryngological postoperative ICU.

Table 8. Number of intensive care unit (ICU) subtypes with possibility of patient isolation, and availability of one infusion and perfusor pump per each bed and enteral nutrition pump per every two beds

Type of ICU	No. (%) of ICUs	No. (%) of ICUs with			
		isolation	infusion pump/bed[b]	perfusor pump/bed[c]	enteral pump/2 beds[d]
Surgical[a]	27 (23.0)	18 (66.6)	18 (66.6)	13 (48.1)	12 (44.4)
Mixed (surgical/medical)	18 (15.4)	11 (61.1)	13 (72.2)	10 (55.5)	9 (50.0)
Mixed (coronary care/medical)	15 (12.8)	6 (40.0)	9 (60.0)	4 (26.6)	0 (0)
Coronary care	14 (12.0)	9 (64.2)	12 (85.7)	5 (35.7)	0 (0)
Neurological	10 (8.5)	6 (60.0)	6 (60.0)	3 (30.0)	3 (30.0)
Medical	9 (7.7)	3 (33.3)	7 (77.7)	4 (44.4)	4 (44.4)
Neonatal	7 (6.0)	7 (100.0)	5 (71.4)	5 (71.4)	2 (28.5)
Psychiatric	6 (5.1)	6 (100.0)	0 (0)	0 (0)	0 (0)
Respiratory	4 (3.4)	1 (25.0)	3 (75.0)	1 (25.0)	1 (25.0)
Pediatric	3 (2.6)	3 (100.0)	3 (100.0)	3 (100.0)	3 (100.0)
Trauma	2 (1.7)	2 (100.0)	2 (100.0)	2 (100.0)	2 (100.0)
Burns	1 (0.9)	1 (100.0)	1 (100.0)	1 (100.0)	1 (100.0)
Infective diseases	1 (0.9)	1 (100.0)	1 (100.0)	1 (100.0)	1 (100.0)

[a]The surgical subtype included 8 ICUs from Zagreb, which defined themselves as pediatric/surgical, gynecological, urology ICU (three), orthopedic, neurosurgical, and otorhinolaryngological postoperative ICU.
[b]One infusion pump per bed.
[c]One perfusor pump per bed.
[d]One enteral nutrition pump per every two beds.

Table 9. The distribution of intensive care units (ICUs, n = 117) according to the number of admissions per year

No. of ICU admissions/year	No. (%) of ICUs
> 900	18 (15.3)
200-300	16 (13.6)
400-500	14 (12.0)
500-600	12 (10.3)
600-700	12 (10.3)
700-800	12 (10.3)
800-900	11 (9.4)
300-400	11 (9.4)
< 200	11 (9.4)

Admission, Discharge, and Outcome Data

There were <200 admissions per year in the following ICUs, which are all strictly specialized: burns, spine trauma, cardiac surgery, ENT surgery, 3 neonatal units, and 2 neurological and 2 mixed coronary care/medical ICUs in small general hospitals (20,000-50,000 inhabitants) (Table 9). An ICU specialist permanently employed at ICU approved ICU admission in 91 (77.8%) units and discharge in 113 (96.6%) units, whereas in 26 (22.2%) ICUs admission was ap-

Table 10. Admissions to intensive care units (ICUs) in Croatia in 2001 according to their subtypes

Subtype of ICU	No. (%) of ICUs	Admissions (%, range) from					
		home	another ward	operating room	surgical ward	another ICU	another hospital
Surgical[a]	27 (23.0)	5.6 (0-37)	5.2 (0-40)	76.5 (30-100)	5.0 (0-30)	1.4 (0-10)	6.3 (0-19)
Mixed (surgical/medical)	18 (15.4)	17.9 (0-50)	15.4 (0-36)	51.3 (12-95)	11.5 (0-34)	2.3 (0-24)	1.6 (0-10)
Mixed (coronary care/medical)	15 (12.8)	87.4 (65-99)	8.8 (1-33)	0.1 (0-1)	1.4 (0-5)	1.3 (0-5)	1.1 (0-5)
Coronary care	14 (12.0)	87.1 (76-100)	8.0 (0-20)	0.7 (0-2)	0.8 (0-4)	0.7 (0-5)	2.7 (0-10)
Neurological	10 (8.5)	82.3 (70-90)	8.4 (0-20)	0.3 (0-3)	1.4 (0-6)	3.1 (0-8)	4.5 (0-10)
Medical	9 (7.7)	73.9 (60-100)	13.8 (0-25)	0.3 (0-3)	2.6 (0-10)	4.4 (0-10)	5.0 (0-10)
Neonatal	7 (6.0)	0.0	0.0	99.6[b] (98-100)	0.0	0.4 (0-2)	0.0
Psychiatric	6 (5.1)	80.8 (65-95)	5.8 (0-10)	0.0	0.8 (0-5)	2.5 (0-10)	10 (0-20)
Respiratory	4 (3.4)	66.4 (58-80)	21.2 (15-30)	0.7 (0-3)	4.0 (0-13)	3.5 (0-10)	4.2 (0-10)
Pediatric	3 (2.6)	13 (9-20)	1.6 (0-5)	2.0 (0-5)	0.0	0.0	83.4 (80-90)
Trauma	2 (1.7)	12 (0-24)	0.0	53.0 (50-56)	5.0 (0-10)	30.0 (10-50)	0.0
Burns	1 (0.9)	60.0	0.0	0.0	0.0	0.0	40.0
Infective diseases	1 (0.9)	50.0	10.0	0.0	0.0	0.0	40.0

[a]The surgical subtype included 8 ICUs from Zagreb, which defined themselves as pediatric/surgical, gynecological, urology ICU (three), orthopedic, neurosurgical, and otorhinolaryngological postoperative ICU.
[b]Delivery room was considered as an operating room.

Table 11. Bed occupancy rate, length of stay (days), percentage of ICU patients with length of stay shorter than 24 h and longer than 14 days, and mortality rate at intensive care units (ICUs) according to their subtypes

Type of ICU	No. (%) of ICUs	Bed occupancy (%, range)	Length of stay (days)	Length of stay < 24 h (%, range)	Length of stay > 14 days (%, range)	Mortality rate (%, range)
Surgical[a]	27 (23.0)	86.2 (60-96)	3-4	8.1 (0-55)	14.2 (0-92)	7.8 (0.5-45)
Mixed (surgical/medical)	18 (15.4)	82.6 (60-96)	3-4	11.3 (1-49)	10.2 (1-20)	10.7 (0.5-23)
Mixed (coronary care/medical)	15 (12.8)	84.9 (70-96)	3-4	13.4 (1-35)	5.3 (1-10)	10.7 (5-23)
Coronary care	14 (12.0)	83 (60-96)	3-4	11.5 (1-20)	4.0 (0-20)	10.2 (6-18)
Neurological	10 (8.5)	91.0 (70-96)	5-7	7.2 (3-15)	44.1 (10-90)	18.8 (9-25)
Medical	9 (7.7)	90.2 (80-96)	< 3	13.2 (5-28)	12.5 (4.5-40)	16.7 (10-36)
Neonatal	7 (6.0)	81.5 (60-96)	> 7	8.0 (0-20)	46.7 (5-80)	5.6 (1-17)
Psychiatric	6 (5.1)	87.3 (60-96)	3-4	7.0 (2-10)	11.6 (0-50)	3.1 (0-10)
Respiratory	4 (3.4)	89.0 (80-96)	> 7	11.2 (5-25)	14.7 (4-25)	16.5 (10-21)
Pediatric	3 (2.6)	82.0 (60-96)	> 7	7.3 (2-15)	55.0 (5-80)	14.3 (5-20)
Trauma	2 (1.7)	75.0 (60-90)	> 7	0.0	90.0	15 (10-20)
Burns	1 (0.9)	96.0	> 7	0.0	90.0	10.0
Infective diseases	1 (0.9)	80.0	> 7	10.0	70.0	30.0

[a]The surgical subtype included 8 ICUs from Zagreb, which defined themselves as pediatric and surgical, gynecological, urology ICU (three), orthopedic, neurosurgical, and otorhinolaryngological postoperative ICU.

proved by a non-ICU physician and discharge in 4 (3.4%) surgical ICUs by a surgeon. The majority of surgical patients were admitted to the surgical ICUs from an operating room, whereas the majority of medical and neurological patients were admitted to ICUs from their homes (Table 10). Data on bed occupancy rate, length of stay in days, percentage of patients with a length of stay less than 24 h and more than 14 days, and mortality rate are presented in Table 11.

Discussion

Although our survey revealed many similarities among Croatian ICUs, there were also large differences among them, especially between teaching and non-teaching hospitals. Our survey had an excellent response rate of 95%, implying that intensive medicine specialists in Croatia are highly motivated of to help setting up the national Register of ICUs. Groeger et al (9,10) performed a similar study in the United States in 1991, but they had a response rate of only 38.7%.

The cost of intensive care medicine is increasing more than the overall health care cost, which makes it an important issue in health care policies. In transition countries, such as Croatia, which face limited financial resources, aging population, and social and ethical concerns about which patient will benefit from ICU the most, the first step is to make a framework for the ICU Register and examine their present organizational and medical practices associated with outcome performances.

Demographic and Hospital Data

Out of 67 hospitals in Croatia, 42 (62.6%) had ICUs of different types and each Croatian county had a hospital with ICU beds. ICUs were located in 30 cities, mostly in Zagreb (39.3%). In 2001, there were a total of 900 ICU beds, accounting for 3.3% of all beds in Croatian hospitals. In Wales, for example, average daily number of required adult intensive care beds per 500,000 inhabitants was 21, and 43 in high dependency beds in a single ICU (11). A quantitative study with the Therapeutic Intervention Scoring System (TISS) (12-14) in five hospitals in Hessen, Germany, revealed that on average 6.1% of the total number of hospital beds had been required for intensive care patients (15). A comparison of hospital admissions, outpatient attendances, and intensive care activity by Ridley et al (16) showed that the increase in the rate of activity in hospitals and ICUs was similar, but that the workload in ICUs increased at a faster rate. The authors suggested that the demand for critical care might have been generated from within hospitals (16). It is obvious that, in comparison with European standards, Croatia lacks ICU beds. However, the number and distribution of ICUs in Croatia according to the types of hospitals (46.2% of ICUs were in general hospitals), size of geographic areas, and number of inhabitants they cover (82.9% of ICUs are located in hospitals covering areas with 100,000-500,000 inhabitants) as well as emergency admission they provide on a 24-hour-a-day basis (94% of Croatian ICUs) emphasize good distribution and organization of hospitals.

ICU Structure and Organization

The number of ICUs per hospital increased as hospitals enlarged. Also, the number of mixed surgical/medical and coronary care/medical units decreased, and specialized units became prevalent. Kelly et al (17) showed that with an increase in the number of medical ICU beds and the construction of a separate coronary care unit in a teaching hospital with 700 beds, the number of medical ICU patients increased by 51%. Types of admission diagnosis remained the same as well as Acute Physiology And Chronic Health Evaluation (APACHE) II severity of illness score (18,19), bed occupancy rate, length of stay, hospital or medical ICU mortality, and medical ICU readmission rate. The increase resulted from the transfer of patients from other hospitals and other ICUs within the hospital (17) – a finding that correlates with data and conclusions of Ridley et al (16).

In most hospitals, medical patients in critical condition continue to be cared for in the medical wards due to the limited accessibility of mixed intensive care units. Such patients can be treated in medical ICUs, as a cost-effective option, without impairing their chances of survival (20). Byrick et al (21) showed that ICU admission and discharge decision-making altered after closure of the institution's intermediate care area. The non-emergency ICU admissions and the proportion of patients with APACHE II severity of illness score (18,19) $<$ 15 (or less than 15) significantly increase, whereas mean APACHE II score 24 hours upon admission and nursing workload (12-14) at time of discharge from ICU significantly decreased. Parameter determining the patient load in an ICU was the availability of facilities outside the unit (21).

In the Recommendations on Intensive Care Department (ICD) Minimum Requirements, the Task Force of the European Society of Intensive Care Medicine (22) stated: "The objectives of an ICD are the monitoring and support of failing vital functions in critically ill patients in order to perform adequate diagnostic measures with medical and/or surgical therapies to improve outcome. Successful intensive care medicine depends on a meticulous interaction between human, technological, and spatial resources." European Society of Intensive Care Medicine recommends a functional unit of 6 beds minimum and 8 beds maximum for all three levels of care (22). To avoid any misunderstanding regarding intermediate care and subtypes of ICUs, Croatian Society of Intensive Care Medicine should define levels of care (III, II, and I) in terms of matching resources, for example, nurse/patient ratio 1/1, 1/1.6 or 1/3, rather than give descriptions, such as high, medium, and low. An intermediate care unit in a university hospital might be at a higher level than an ICU in a small general hospital. The balance of subtype-based vs general ICU beds, ICUs location, and their county distribution depend directly on the activities of a hospital and indirectly on the surrounding population (23). Various organizational arrangements within hospitals determine the position of each ICU. Only 13 Croatian

ICUs (11.1%) were freestanding. Most of the surgical and mixed surgical/medical units were located within surgical departments and headed by anesthesiologists, in contrast with findings by Groeger et al (9) where most units of this type were headed by surgeons. In our survey, 10 neurological ICUs were headed by neurologists, whereas Groeger's survey found that surgeons were the decision-making persons and heads of neurological units (9).

Medical and Nursing Staff

A permanently employed ICU specialist was in charge of admission in 91 ICUs (77.8%), and of discharge in 113 (96.6%) ICUs. Powner (24) showed on the group of 500 hospitals with fewer than 300 beds in the United States that intensive care specialists were present in only 57% of them, and their presence only slightly influenced the ICU credentialing process of other selected specialists. One of the conclusions of EURICUS I study (25) that included 89 ICUs in the European Community was that "medical skills might become relatively more important than organizational criteria when patient is sicker."

There is a perception that nursing shortage significantly affects care in the ICU, and Therapeutic Intervention Scoring System for measuring the burden of nurse work is highly debated (12-14). European Society of Intensive Care Medicine suggested that the workload per ICU nurse should not exceed 40-50 TISS points (22). The number of nurse full-time equivalents for running a single ICU bed are 6 for level of care III, 4 for level of care II, and 2 for level of care I. It is also suggested that nursing shifts should be 8 hours. As compared with Recommendations of European Society of Intensive Care Medicine Task Force, our data show a lack in the number and training of medical and nursing staff in all three levels of care. Even worse, medical work in almost one-third of Croatian ICUs was covered by specialists from other wards. Additional work in shifts may be done by senior residents in intensive care medicine capable of handling emergency situations, provided that an attending physician is on call and available within 20 minutes (22). In our study, the number of both ICU beds and permanently employed medical and nursing staff within hospitals and individual units increase as the hospital enlarges.

Disposable Equipment

The amount of technical equipment should be adjusted to the type and size of ICU. Generally, our data showed a lack of equipment in all ICUs but surgical (general, cardiac surgery, pediatric/surgical, trauma, burns, and neurosurgery) in university hospitals in Zagreb, Rijeka, and Split, in Magdalena cardiac surgery hospital in Krapinske Toplice, and in the ICU for infective diseases. The quantity of disposable technical equipment and its use within hospitals and individual ICUs increased as hospital enlarged; it was higher in teaching hospitals and increased with the subspecialization of ICUs (for example, the highest percentage of X-ray control of pacemaker users (71.4%) was in the group of coronary care units). Mixed coronary care/medical units in general hospitals had the lowest number of mechanical ventilators and the lowest rate of pulmonary artery catheter use (13.3%) compared with coronary care units (71.4%). Only 45 ICUs (38.5%) performed pulmonary artery catheterization, and among them only 40.7% were surgical units. The highest number of critically ill patients who needed mechanical ventilation and/or pulmonary artery catheterization were in surgical units. Only 13-20% of critically ill patients in medical and similar units needed mechanical ventilation or pulmonary artery catheterization (17,20). The availability of all technology listed in the survey was confirmed by only 10.2% of the ICUs. Most ICUs in Croatia lacked expensive technical equipment (mechanical ventilators, sophisticated monitors, ultrasound set, or bronchoscope set). Unfortunately, there was also a lack of essential equipment for everyday routine work, such as infusion pumps, perfusors, enteral nutrition pumps, and computers for medical and administrative work. Almost half of the ICUs did not have a computer.

Admission, Discharge, and Outcome Data

The majority of surgical patients were admitted to the surgical ICUs from operating rooms, whereas the majority of medical and neurological patients were admitted to ICUs from their homes. The rate of admission of patients from other hospitals was higher in three pediatric units (83.4%) and ICU for infective diseases (40%) in teaching hospitals, due to their subspecialization. The mean bed occupancy rate of 85.2% in Croatian ICUs was similar as elsewhere (9,10): ICU bed occupancy rate increased with hospital enlargement and ICU specialization. In EURICUS I study (25), the occupancy rates of European ICUs ranged from 56% to 85% (median, 70.1%). Medical, surgical, coronary care, and mixed surgical/medical and coronary care/medical units had a shorter mean length of stay (3-4 days) than neurological, neonatal, pediatric, respiratory, burns, trauma, and ICU for infective diseases (>7 days). Surprisingly, psychiatric ICUs had a mean length of stay of 3-4 days.

Chronic ICU patients (patients with ICU length of stay of more than 14 days) are an important category in every type of ICU. Neurological ICUs had 44.1% of chronic patients, neonatal 46.7%, pediatric 55.0%, ICU for infective diseases 70%, and ICUs for trauma and burns 90% of such patients. Such a high proportion of these patients is a reflection of a lack in step-down units. In the study of Groeger et al (10), 17% of patients had been in the ICUs for 14 or more days. Mixed coronary care/ medical and surgical/medical, medical, coronary care, and respiratory units had 11.2-13.4% of patients with short stay (less than 24 h), whereas all other ICUs had less than 10% of such patients. A short ICU stay may be a mark of bed admission criteria. Measuring complexity and level of care in ICUs in 23 Italian mixed ICUs, Iapichino et al (26) showed that most of the ICUs (69.9%) used a large proportion of their high facility beds for patients who did not need a high-level care. Rosenthal et al (27) analyzed the use of the ICUs for patients with a low severity of illness in 44 ICUs (medical, surgical, neurological, and mixed) in the

USA from 1991 to 1995. They found that as many as 19.6% admissions were categorized as low severity (52.3%of postoperative patients underwent laminectomy and carotid endarterectomy, and 40.2% of non-operative were cases of alcohol and drug overdose). Mortality among those patients was 0.3%, and as many as 28.6% received no ICU-specific intervention during the first ICU day. If a large proportion of patients admitted to the ICU has a low probability of death and do not receive ICU-specific interventions, the question is how we use ICUs resources. In EURICUS I study, the price of ICU treatment ranged from US$24 to US$3,551 per day (26). On the other hand, short ICU stay might be the result of shortage of ICU beds, which could be the reason for inadequate early ICU discharge. Daly and Chang (28) developed a triage model for the identification of patients at risk from death on the ward after ICU discharge. By using this model, the discharge mortality of patients at risk may be reduced by 39% if they remain in an ICU for another 48 hours. Goldfrad and Rowan (29) reported a 1.4-fold increase in ultimate hospital mortality among patients discharged from ICU at night. Parameters related to higher mortality rate were age, end-stage disease, length of ICU stay, cardiothoracic surgery, and physiology. More than a quarter of all deaths occurred after the discharge from the ICU (30); this may be decreased by less inappropriate early discharge to the ward by providing high-dependency and step-down units, and by continuing advice and follow-up by ICU medical and nursing team.

ICU mortality data in Croatian ICUs are similar to other study data (30): mortality was the lowest in psychiatric units (3.1%) and the highest in ICU for infective diseases (30%), followed by neurological (18.8%), medical (16.7%) and respiratory (16.5%) units. High mortality rate in neonatal (5.6%) and pediatric units (14.3%) represents the greatest concern. Patients admitted from wards or other ICUs had higher mortality than patients admitted directly from the operating room or emergency department, because patients transferred from wards were more severe cases. We must be aware of the importance of interventions and support before ICU admission, since patients admitted to ICUs after cardiopulmonary resuscitation constituted 30% of all deaths (30).

In conclusion, this survey is the first step in building up a national database for ICU Register, which will include information on organizational, managerial, medical, and outcome performances of ICUs in Croatia. We believe that creating such a database, which would allow detailed assessment the performance of ICUs in Croatia, could serve as a model for improvement of ICU services in other transition countries. Furthermore, it will help achieve uniformity with regard to the definitions of ICU type, levels of care (22), objective severity of illness scoring systems (18,19), and workload recording (12-14). Admission and discharge criteria for each type of ICU should also be developed to ease identification of patients who would benefit the most from ICU treatment (31). To achieve this, close professional links between different types of ICUs are needed. Such initiative should come from the hospitals and Croatian Society of Intensive Care Medicine in collaboration with health authorities. Next step of the Croatian Society of Intensive Care Medicine should be to conduct a prospective multicenter study, with periodical surveys of ICUs structure and organization, on-site organizational analysis, interviews, and direct observations by a team of clinical and organizational researchers.

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