



The Austrian ICU survey

A questionnaire-based evaluation of intensive care medicine in Austria

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Summary

Background While structures of intensive care medicine in Austria are well defined, data on organisational and medical practice in intensive care units (ICUs) have not been systematically evaluated.

Methods In this explorative survey, organisational and medical details of ICUs in Austria were collected using an online questionnaire consisting of 147 questions.

Results Out of 249 registered ICUs 73 (29.3%) responded, 60 were adult, 10 pediatric/neonatal ICUs and 19, 25 and 16 ICUs were located in level I, II and III hospitals, respectively. Of the respondents 89% reported that the ICU director was board-certified in intensive care medicine. Consultants were constantly present in 78% of ICUs during routine working hours and in 45% during nights and weekends. The

nurse:bed ratio varied between 1:1 and 1:2 in 74% during day shifts and 60% during night shifts. Routine physiotherapist rounds were reported to take place daily except weekends in 67% of ICUs. Common monitoring techniques were reported to be in routine or occasional use in 85% and 83% of ICUs, respectively. The majority of ICUs provided daily visiting hours ranging between 2–12 h. Waiting rooms for relatives were available in 66% and an electronic documentation system in 66% of ICUs. Written protocols were available in 70% of ICUs.

Conclusion The Austrian ICU survey suggests that ICUs in Austria are clearly structured, well-organized and well-equipped and have a high nurse:bed ratio. In view of the relatively low return rate we cannot exclude that a selection bias has led to overestimation of the survey findings.

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Introduction

Intensive care medicine is a specialized field in medicine and practised by representatives of different medical specialties in Austria. Internationally, Austria ranks high in terms of availability of intensive care unit (ICU) beds [1] as well as the quality of intensive care treatment [2]. Structures of intensive care medicine in Austria are well defined. Before the coronavirus disease 2019 (COVID-19) pandemic, approximately 2500 ICU beds were available in 177 Austrian hospitals [3]. Adult ICUs in Austria are categorized into four levels (intermediate care units, levels 1–3 ICUs) for which clear requirements regarding staffing as well as availability of monitoring and therapeutic equipment have been outlined [4]. Pediatric and neonatal ICUs are dedicated to the care of critically ill

children < 15 years and during the first 28 days of life, respectively. Similar to adult ICUs, specific requirements for staffing and equipment of pediatric ICUs have been issued [4]. Financial reimbursement of intensive care services is performed according to the Performance-oriented Hospital Financing (leistungsorientierte Krankenanstaltenfinanzierung) and the Austrian Health Care Structure Plan (Österreichischer Strukturplan Gesundheit); however, these plans lack clearly defined requirements for each ICU category and intermediate care, i.e. minimum nurse:bed ratio [5]. Despite the availability of these and other structural information on the Austrian ICU landscape, data on organizational and medical practice in Austrian ICUs (e.g., shift patterns, inclusion of other medical specialties and allied healthcare specialists into ICU rounds, frequency of equipment use, availability of special organ support therapy and standard operating procedures, quality indicators, patient and family care) have not yet been systematically evaluated.

In this explorative, questionnaire-based survey, we sought to collect organizational and medical details of daily practice in Austrian ICUs and separately report these for adult ICUs, as per their location in different hospital levels, and pediatric ICUs.

Material and methods

This study was designed as an explorative web-based, prospective, cross-sectional, self-reported questionnaire-based survey among Austrian ICUs and was conducted under the auspices of the Federation of the Austrian Societies of Intensive Care Medicine (FASIM). Data acquisition took place from 16 January until 12 March 2020, when the survey was prematurely terminated due to the escalating COVID-19 pandemic in Austria. Since the survey was based on voluntary participation and information disclosure, the study protocol did not undergo review by an ethics committee.

Surveyed ICUs

All units registered as adult ICUs of the levels 1–3 (as defined by the Austrian Health Care Structure Plan (Österreichischer Strukturplan Gesundheit [4]): level 1 ICUs provide basic intensive care whereas level 3 ICUs have equipment available to provide all evidence-based organ support techniques) as well as all pediatric including neonatal ICUs were eligible for participation in this survey. We did not include intermediate care units in our survey. Electronic letters of invitation were sent through the FASIM office to the chair of each department running an ICU. Each letter of invitation included a link to the web-based questionnaire at www.surveymonkey.com. In case two or more ICUs were affiliated with one department, the department chair was asked that one questionnaire

was completed per ICU. One reminding note was sent.

Study questionnaire and data processing

The study questionnaire consisted of 147 questions, was grouped into 5 sections and could be downloaded from the electronic repository. The study questionnaire was available in German, the official language of Austria. It underwent pilot testing by the study investigators with respect to flow, salience, acceptability and administrative ease. Open-ended questions were reduced to a minimum and multiple answers were only allowed for those questions where this was considered absolutely necessary. Based on the results of the pilot testing, the questionnaire was modified and finally approved by all investigators.

The first section of the questionnaire retrieved general information on characteristics and staffing patterns of the surveyed ICU and hospital. In detail, the level of hospital care was recorded. According to the Austrian Health Care Structure Plan [4], level I hospitals correspond to primary care hospitals (e.g. regional hospitals), level II hospitals to secondary care hospitals (e.g. referral hospitals) and level III hospitals to tertiary care hospitals (e.g. university teaching hospital). In order to guarantee anonymity of the respondents, we did not collect information on the level of care of the ICU. Section two collected data on the availability and frequency of use of monitoring techniques and diagnostic equipment. Section three included questions on the spectrum and frequency of use of therapeutic options available in the ICU and hospital of the respondent. While section four focused on quality indicators in the surveyed ICUs, the last section of the questionnaire recorded information on patient and family care.

After online completion of the questionnaire, data were saved and automatically transferred into a spreadsheet. At the end of the survey period, questionnaire accessibility through the study homepage was blocked and raw data were manually and independently checked by two authors for plausibility and quality control. Open-ended questions in the database were numerically coded.

Study objectives and statistical analysis

The primary objective of this study was to explore organizational and medical details of daily practice in Austrian ICUs. The secondary study objective was to separately report primary objectives for ICUs located in different levels of hospitals as well as pediatric/neonatal ICUs.

The SPSS software program was used for data analysis (SPSS 15.0; SPSS Inc, Chicago, IL, USA). Descriptive methods were used to report absolute numbers with percentages for binary study variables and me-

Table 1 Characteristics of the surveyed ICUs

		All					Pediatric ICUs
		Adult ICUs					
			Level I hospitals	Level II hospitals	Level III hospitals		
<i>N</i>	–	73	19	25	16	10	
<i>Type of ICU</i>	<i>N (%)</i>	–	–	–	–	–	
Anesthesiology	–	30 (41.1)	8 (42.1)	12 (48)	10 (62.5)	0	
Internal medicine	–	14 (19.2)	4 (21.1)	9 (36)	1 (6.3)	0	
Multidisciplinary	–	13 (17.8)	7 (36.8)	3 (12)	3 (18.8)	0	
Neurology/neurosurgery	–	3 (4.1)	0	1 (4)	2 (12.5)	0	
Pediatrics	–	2 (2.7)	0	0	0	2 (2.7)	
Neonatal	–	8 (11)	0	0	0	8 (11.1)	
Missing	–	3 (4.1)	–	–	–	0	
<i>Number of ICU beds</i>	<i>N</i>	8 (6–12)	7 (6–9)	7 (6–10)	9 (7–12)	12 (5–16)	
<i>Level of hospital</i>	<i>N (%)</i>	–	–	–	–	–	
Primary care	–	20 (27.4)	19 (100)	0	0	1 (10)	
Secondary care	–	30 (41.1)	0	25 (100)	0	5 (50)	
Tertiary care	–	20 (27.4)	0	0	16 (100)	4 (40)	
Missing	–	3 (4.1)	–	–	–	0	
<i>Bed number hospital</i>	<i>N (%)</i>	–	–	–	–	–	
< 500 beds	–	31 (42.5)	18 (94.7)	5 (20)	2 (12.5)	3 (30)	
500–1000 beds	–	19 (26)	1 (5.3)	15 (60)	1 (6.3)	2 (20)	
> 1000 beds	–	23 (31.5)	0	5 (20)	13 (81.3)	5 (50)	
<i>ICU architecture</i>	<i>N (%)</i>	–	–	–	–	–	
Single bed rooms	–	15 (20.5)	4 (21.1)	6 (24)	4 (25)	1 (10)	
Multiple bed rooms	–	40 (54.8)	13 (68.4)	15 (60)	6 (37.5)	6 (60)	
Open ICU	–	14 (19.2)	2 (10.5)	4 (16)	6 (37.5)	2 (20)	
Missing	–	4 (5.5)	–	–	–	1 (10)	
<i>Isolation rooms</i>	<i>N (%)</i>	57 (78.1)	16 (84.2)	23 (92)	10 (62.5)	8 (80)	
<i>Isolation with anteroom</i>	<i>N (%)</i>	24 (32.9)	4 (21.1)	12 (48)	3 (18.8)	5 (50)	
<i>Isolation with air pressure regulation</i>	<i>N (%)</i>	22 (30.1)	6 (31.6)	10 (40)	2 (12.5)	4 (40)	
<i>IMCU adjacent to ICU</i>	<i>N (%)</i>	39 (53.4)	9 (47.4)	16 (64)	6 (37.5)	8 (80)	
<i>Admission of children < 16 yrs</i>	<i>N (%)</i>	–	–	–	–	–	
Regularly	–	11 (15.1)	0	1 (4)	1 (6.3)	9 (90)	
Occasionally	–	32 (43.8)	15 (78.9)	10 (40)	7 (43.8)	0	
Never	–	26 (35.6)	4 (21.1)	14 (56)	8 (50)	0	
Missing	–	4 (5.5)	–	–	–	1 (10)	

ICU intensive care unit, IMCU intermediate care unit, yrs years

dian values with interquartile ranges for continuous variables.

Results

Of 249 ICUs invited to participate in this survey, 73 questionnaires were completed (return rate of 29.3%) and included into the statistical analysis. Of these, 60 were reported as adult ICUs and 10 as pediatric including neonatal ICUs. In three questionnaires, the type of ICU and level of hospital the ICU was located in were not reported. Of the remaining adult ICUs, 19, 25 and 16 were located in level I, II and III hospitals, respectively. Table 1 presents characteristics of all surveyed ICUs with data separately reported for adults (categorized according to their location in level I, II and III hospitals) and pediatric ICUs. Of the respondents 78% reported having

isolation rooms available in the ICU with one third stating that room air in isolation rooms can be pressure regulated. Approximately half of the respondents declared that an intermediate care unit was adjacent to the ICU. Staffing characteristics in the surveyed ICUs are detailed in Table 2 and Table 1 of the Electronic Supplementary Material. Of the respondents 89% reported that the director of their ICU was board-certified in intensive care medicine. Consultants were given to be constantly present 78% of ICUs during routine working hours and in 45% during nights and weekends. The reported nurse:bed ratio varied between 1:1 and 1:2 in 74% during day shifts and 60% during night shifts. Routine physiotherapist rounds were reported daily except weekends in 67% of ICUs. The frequency with which certain monitoring techniques are in use is summarized in Table 3 and Table 2 of the Electronic Supplementary Material. Commonly

Table 2 Staff characteristics of the surveyed ICUs

		All		Adult ICUs			Pediatric ICUs
				Level I hospital	Level II hospital	Level III hospital	
<i>N</i>	–	73	19	25	16	10	
<i>ICU director with board-certification in intensive care medicine</i>	<i>N</i> (%)	65 (89)	19 (100)	24 (96)	14 (87.5)	8 (80)	
<i>ICU director > 75% of work time dedicated to ICU</i>	<i>N</i> (%)	44 (60.3)	12 (63.2)	15 (60)	13 (81.3)	4 (40)	
<i>ICU consultant constantly present on ICU</i>	<i>N</i> (%)	–	–	–	–	–	
Regular working hours	–	57 (78.1)	12 (63.2)	23 (92.0)	14 (87.5)	8 (80)	
Nights/weekends	–	33 (45.2)	9 (47.4)	12 (48)	11 (68.8)	1 (10)	
<i>Physician shift patterns</i>	<i>N</i> (%)	–	–	–	–	–	
25 h shifts	–	63 (86.3)	19 (100)	23 (92)	13 (81.3)	8 (80)	
13 h shifts	–	3 (4.1)	0	2 (8)	1 (6.3)	0	
Missing	–	7 (9.6)	0	0	2 (12.5)	2 (20)	
<i>Nurse:bed ratio daytime</i>	<i>N</i> (%)	–	–	–	–	–	
1:1	–	2 (2.7)	0	1 (4)	1 (6.3)	0	
1:1–2	–	30 (41.1)	6 (31.6)	12 (48)	6 (37.5)	6 (60)	
1:2	–	24 (32.9)	10 (52.6)	8 (32)	5 (31.3)	1 (10)	
1:2–3	–	5 (6.8)	2 (10.5)	1 (4)	1 (6.3)	1 (10)	
1:3	–	3 (4.1)	1 (5.3)	1 (4)	1 (6.3)	0	
Missing	–	9 (12.3)	0	2 (8)	2 (12.5)	2 (20)	
<i>Nurse:bed ratio nighttime</i>	<i>N</i> (%)	–	–	–	–	–	
1:1	–	0	–	–	–	0	
1:1–2	–	9 (12.3)	1 (5.3)	2 (8)	3 (18.8)	3 (30)	
1:2	–	21 (28.8)	4 (21.1)	11 (44)	6 (37.5)	0	
1:2–3	–	23 (31.5)	8 (42.1)	8 (32)	3 (18.8)	4 (40)	
1:3	–	9 (12.3)	6 (31.6)	1 (4)	2 (12.5)	0	
1:3–4	–	2 (2.7)	0	1 (4)	0	1 (10)	
Missing	–	9 (12.3)	0	2 (8)	2 (12.5)	2 (20)	
<i>Nurse shift patterns</i>	<i>N</i> (%)	–	–	–	–	–	
25 h shifts	–	2 (2.7)	0	0	2 (12.5)	0	
13 h shifts	–	64 (87.7)	19 (100)	25 (100)	12 (75)	8 (80)	
Missing	–	7 (9.6)	0	0	2 (12.5)	2 (20)	
<i>Physiotherapist rounds</i>	<i>N</i> (%)	–	–	–	–	–	
Daily	–	14 (19.2)	4 (21.1)	6 (24)	2 (12.5)	2 (20)	
Daily except weekends	–	49 (67.1)	13 (68.4)	18 (72)	12 (75)	6 (60)	
When needed	–	3 (4.1)	2 (10.5)	1 (4)	0	0	
Missing	–	7 (9.6)	0	0	2 (12.5)	2 (20)	

ICU intensive care unit

used ICU monitoring techniques, such as invasive blood pressure or end-tidal carbon dioxide measurement were reported to be in routine or occasional use in 85% and 83% of the ICUs, respectively. Table 4 and Table 3 of the Electronic Supplementary Material display the frequency with which certain therapeutic techniques were used. Patient and family care practices in as well as quality indicators of the surveyed ICUs are summarized in Table 5 and Table 6 as well as Table 4 of the Electronic Supplementary Material, respectively. The majority of ICUs provided a daily visiting time for relatives ranging between 2 and 12 h. Waiting rooms for relatives were available in 68% of surveyed ICUs. In 66% of the ICUs, an electronic documentation system was established. Written therapy protocols were available in 70% of participating ICUs.

Discussion

This was the first nationwide survey on the structure, organization as well as monitoring and therapeutic capacities of ICUs in Austria. As we could obtain completed questionnaires from only 73 out of 249 invited ICUs, our results cannot be regarded as reflective of the entire cohort of Austrian ICUs but more as a cross-sectional overview on the functioning and organizational structures of ICUs in Austria. One reason for the fairly low return rate of 29.3% might have been that the study period overlapped with the emerging COVID-19 pandemic leading to a premature end of the data collection process. Except for a likely underrepresentation of ICUs located in primary level hospitals, the cohort of ICUs included in our survey ap-

Table 3 Monitoring techniques available in the surveyed ICUs

		Adult ICUs				Pediatric ICUs
		All	Level I hospital	Level II hospital	Level III hospital	
<i>N</i>	–	73	19	25	16	10
<i>Invasive blood pressure measurement</i>	<i>N</i> (%)	–	–	–	–	–
Regularly used	–	60 (82.2)	18 (94.7)	24 (96)	14 (87.5)	4 (40)
Occasionally used	–	2 (2.7)	0	0	0	2 (20)
Rarely used	–	2 (2.7)	0	0	0	2 (20)
Never used	–	0	0	0	0	0
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)
<i>End-tidal CO₂ measurement</i>	<i>N</i> (%)	–	–	–	–	–
Available at each bed	–	56 (76.7)	17 (89.5)	22 (88)	13 (81.3)	4 (40)
Available at some beds	–	5 (6.8)	0	1 (4)	1 (6.3)	3 (30)
Used on demand	–	3 (4.1)	1 (5.3)	1 (4)	0	1 (10)
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)
<i>Pulse contour analysis use</i>	<i>N</i> (%)	–	–	–	–	–
Regularly used	–	25 (34.2)	10 (52.6)	13 (52)	2 (12.5)	0
Occasionally used	–	12 (16.4)	3 (15.8)	3 (12)	4 (25)	2 (20)
Rarely used	–	10 (13.7)	3 (15.8)	5 (20)	2 (12.5)	0
Never used	–	17 (23.3)	2 (10.5)	3 (12)	6 (37.5)	6 (60)
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)
<i>Transpulmonary thermodilution use</i>	<i>N</i> (%)	–	–	–	–	–
Regularly used	–	26 (35.6)	8 (42.1)	14 (56)	4 (25)	0
Occasionally used	–	21 (28.8)	6 (31.6)	8 (32)	5 (31.3)	2 (20)
Rarely used	–	8 (11)	4 (21.1)	1 (4)	3 (18.8)	0
Never used	–	9 (12.3)	0	1 (4)	2 (12.5)	6 (60)
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)
<i>Pulmonary artery catheter use</i>	<i>N</i> (%)	–	–	–	–	–
Regularly used	–	7 (9.6)	0	1 (4)	5 (31.3)	1 (10)
Occasionally used	–	20 (27.4)	7 (36.8)	8 (32)	3 (18.8)	2 (20)
Rarely used	–	10 (13.7)	2 (10.5)	6 (24)	2 (12.5)	0
Never used	–	27 (37)	9 (47.4)	9 (36)	4 (25)	5 (50)
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)
<i>EEG use in the ICU</i>	<i>N</i> (%)	–	–	–	–	–
Regularly used	–	29 (39.7)	2 (10.5)	15 (60)	6 (37.5)	6 (60)
Occasionally used	–	24 (32.9)	11 (57.9)	5 (20)	6 (37.5)	2 (20)
Rarely used	–	6 (8.2)	2 (10.5)	2 (8)	2 (12.5)	0
Never used	–	5 (6.8)	3 (15.8)	2 (8)	0	0
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)
<i>Intracranial pressure measurement</i>	<i>N</i> (%)	–	–	–	–	–
Regularly used	–	15 (20.5)	0	9 (36)	6 (37.5)	0
Occasionally used	–	15 (20.5)	6 (31.6)	2 (8)	5 (31.3)	2 (20)
Rarely used	–	4 (5.5)	0	1 (4)	2 (12.5)	1 (10)
Never used	–	30 (41.1)	12 (63.2)	12 (48)	1 (6.3)	5 (50)
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)
<i>Mobile X-ray available</i>	<i>N</i> (%)	64 (87.7)	18 (94.7)	24 (96)	14 (87.5)	8 (80)
<i>Sonography available</i>	<i>N</i> (%)	64 (87.7)	18 (94.7)	24 (96)	14 (87.5)	8 (80)
<i>Transthoracic echocardiography use</i>	<i>N</i> (%)	–	–	–	–	–
Regularly used	–	59 (80.8)	16 (84.2)	23 (92)	12 (75)	8 (80)
Occasionally used	–	2 (2.7)	1 (5.3)	0	1 (6.3)	0
Rarely used	–	3 (4.1)	1 (5.3)	1 (4)	1 (6.3)	0
Never used	–	0	0	0	0	0

Table 3 (Continued)

		All	Adult ICUs			Pediatric ICUs
			Level I hospital	Level II hospital	Level III hospital	
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)
<i>Transesophageal echocardiography use</i>	<i>N (%)</i>	–	–	–	–	–
Regularly used	–	38 (52.1)	10 (52.6)	18 (72)	10 (62.5)	0
Occasionally used	–	13 (17.8)	4 (21.1)	4 (16)	3 (18.8)	2 (20)
Rarely used	–	7 (9.6)	4 (21.1)	2 (8)	1 (6.3)	0
Never used	–	6 (8.2)	0	0	0	6 (60)
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)
<i>Blood gas analyzer use</i>	<i>N (%)</i>	–	–	–	–	–
Regularly used	–	64 (87.7)	18 (94.7)	24 (96)	14 (87.5)	8 (80)
Occasionally used	–	0	0	0	0	0
Rarely used	–	0	0	0	0	0
Never used	–	0	0	0	0	0
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)
<i>Thromboelastometry use</i>	<i>N (%)</i>	–	–	–	–	–
Regularly used	–	32 (43.8)	11 (57.9)	16 (64)	5 (31.3)	0
Occasionally used	–	10 (13.7)	3 (15.8)	1 (4)	5 (31.3)	1 (10)
Rarely used	–	8 (11)	2 (10.5)	2 (8)	3 (18.8)	1 (10)
Never used	–	14 (19.2)	2 (10.5)	5 (20)	1 (6.3)	6 (60)
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)

*CO*₂ carbon dioxide, *EEG* electroencephalography, *ICU* intensive care unit

pears well balanced between adult and pediatric ICUs as well as ICUs located in secondary and tertiary level hospitals. As mentioned before, this survey did not aim at evaluating details of ICUs that are regulated and determined by the Austrian Health Care Structure Plan (Österreichischer Strukturplan Gesundheit [4]). Accordingly, instead of evaluating whether certain diagnostic or therapeutic equipment was available, we sought to determine how frequently these techniques were in use in order to gain insights into the current practice of ICU care in Austria. This is also the reason why the results of this survey neither intended to nor can evaluate whether regulatory requirements were met by the surveyed ICUs.

The median number of beds in the ICUs included in our survey was eight. Over three quarters of the responding ICU directors stated that their ICUs were architectonically arranged in multiple bed rooms or open ICUs (i.e., ICU halls). This is in contrast to modern ICU design which currently focuses on single rooms to optimize patient privacy and allow for undisturbed patient-family interaction [6]. Isolation rooms were reported to be available in 78.1% of surveyed ICUs. This number appears remarkably high but could be the result of a lacking uniform definition of what an isolation room is (e.g. some respondents may have referred to single patient rooms as isolation rooms); however, only one third of the ICUs enrolled in this analysis had an isolation room with an anteroom and/or the possibility to regulate air pressure in the isolation room. In view of the current SARS-CoV-2 pandemic and preparedness for upcoming care

of critically ill patients suffering from highly contagious infectious diseases, it appears advisable that isolation facilities should routinely be included into the planning of future ICUs in Austria.

Both the number of consultant-led ICU services as well as the nurse:bed ratio among the survey ICUs were high compared to reports from other countries [7, 8]. Staffing patterns of ICU physicians and nurses have been associated with survival of critically ill patients [8, 9]. Multidisciplinary structures are a key feature of today's intensive care medicine. This is also reflected by the results of our survey. Physiotherapists and psychologists were found to be the medical partners most frequently involved in the care of critically ill patients in addition to the ICU team. In contrast to ICU practice in other regions of the world, particularly in Anglo-American countries, other medical specialists (e.g., radiologists, infectious disease specialists, palliative care teams) and professions (e.g., pharmacists, dieticians) were not reported to be routinely involved in patient care in the surveyed ICUs. These partners were consulted in an on-demand fashion. Published evidence suggests that involvement of other medical specialists and professions has the potential to improve patient care, safety and outcomes in the ICU [10–12].

Our results on the frequency of use of diagnostic and therapeutic techniques clearly highlight that echocardiography is a regularly used diagnostic technique in the vast majority of surveyed ICUs. This finding is in line with guidelines underlining the rapid and high diagnostic yield of bedside echocardiogra-

Table 4 Therapeutic techniques available in the surveyed ICUs

		Adult ICUs				Pediatric ICUs
		All	Level I hospital	Level II hospital	Level III hospital	
<i>N</i>	–	73	19	25	16	10
<i>High-flow nasal oxygen therapy</i>	<i>N</i> (%)	–	–	–	–	–
Regularly used	–	58 (79.5)	15 (78.9)	21 (84)	14 (87.5)	8 (80)
Occasionally used	–	3 (4.1)	2 (10.5)	1 (4)	0	0
Rarely used	–	2 (2.7)	1 (5.3)	1 (4)	0	0
Never used	–	1 (1.4)	0	1 (4)	0	0
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)
<i>Noninvasive ventilation</i>	<i>N</i> (%)	–	–	–	–	–
Regularly used	–	61 (83.6)	17 (89.5)	23 (92)	13 (81.3)	8 (80)
Occasionally used	–	1 (1.4)	0	1 (4)	0	0
Rarely used	–	2 (2.7)	1 (5.3)	0	1 (6.3)	0
Never used	–	0	0	0	0	0
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)
<i>Invasive ventilation</i>	<i>N</i> (%)	–	–	–	–	–
Regularly used	–	61 (83.6)	17 (89.5)	24 (96)	14 (87.5)	6 (60)
Occasionally used	–	1 (1.4)	0	0	0	1 (10)
Rarely used	–	2 (2.7)	1 (5.3)	0	0	1 (10)
Never used	–	0	0	0	0	0
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)
<i>Percutaneous tracheostomy</i>	<i>N</i> (%)	–	–	–	–	–
Regularly used	–	28 (38.4)	7 (36.8)	11 (44)	10 (62.5)	0
Occasionally used	–	14 (19.2)	6 (31.6)	3 (12)	1 (6.3)	4 (40)
Rarely used	–	12 (16.4)	3 (15.8)	6 (24)	3 (18.8)	0
Never used	–	10 (13.7)	2 (10.5)	4 (16)	0	4 (40)
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)
<i>CVVHDF/CVVHF</i>	<i>N</i> (%)	–	–	–	–	–
Regularly used	–	46 (63)	15 (78.9)	20 (80)	11 (68.8)	0
Occasionally used	–	3 (4.1)	0	3 (12)	0	0
Rarely used	–	4 (5.5)	2 (10.5)	1 (4)	0	1 (10)
Never used	–	11 (15.1)	1 (5.3)	0	3 (18.8)	7 (70)
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)
<i>Hemodialysis</i>	<i>N</i> (%)	–	–	–	–	–
Regularly used	–	21 (28.8)	6 (31.6)	11 (44)	4 (25)	0
Occasionally used	–	6 (8.2)	1 (5.3)	4 (16)	1 (6.3)	0
Rarely used	–	7 (9.6)	2 (10.5)	3 (12)	2 (12.5)	0
Never used	–	30 (41.1)	9 (47.4)	6 (24)	7 (43.8)	8 (80)
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)
<i>Veno-venous ECMO</i>	<i>N</i> (%)	–	–	–	–	–
Regularly used	–	11 (15.1)	0	5 (20)	6 (37.5)	0
Occasionally used	–	6 (8.2)	0	6 (24)	0	0
Rarely used	–	1 (1.4)	1 (5.3)	0	0	0
Never used	–	46 (63)	17 (89.5)	13 (52)	8 (50)	8 (80)
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)
<i>Veno-arterial ECMO</i>	<i>N</i> (%)	–	–	–	–	–
Regularly used	–	10 (13.7)	0	4 (16)	6 (37.5)	0
Occasionally used	–	1 (1.4)	0	1 (4)	0	0
Rarely used	–	1 (1.4)	0	1 (4)	0	0
Never used	–	52 (71.2)	18 (94.7)	18 (72)	8 (50)	8 (80)
Missing	–	9 (12.3)	1 (5.3)	1 (4)	2 (12.5)	2 (20)

*CO*₂ carbon dioxide, *CVVHDF/CVVHF* continuous veno-venous hemodiafiltration/hemofiltration, *ECMO* extracorporeal membrane oxygenation, *ICU* intensive care unit

Table 5 Patient and family care practices in the surveyed ICUs

		All		Adult ICUs			Pediatric ICUs
				Level I hospital	Level II hospital	Level III hospital	
<i>N</i>	–	73	19	25	16	10	
<i>Visiting hours</i>	<i>N</i> (%)	–	–	–	–	–	
< 2	–	2 (2.7)	0	2 (8)	0	0	
2–4	–	21 (28.8)	3 (15.8)	9 (36)	9 (56.3)	0	
4–6	–	16 (21.9)	6 (31.6)	5 (20)	4 (25)	1 (10)	
6–12	–	10 (13.7)	6 (31.6)	3 (12)	1 (6.3)	0	
12–24	–	6 (8.2)	0	2 (8)	0	4 (40)	
24	–	8 (11)	3 (15.8)	2 (8)	0	3 (30)	
Missing	–	10 (13.7)	1 (5.3)	2 (8)	2 (12.5)	2 (20)	
<i>Waiting room for relatives</i>	<i>N</i> (%)	50 (68.5)	15 (78.9)	18 (72)	9 (56.3)	8 (80)	
<i>Separate room for family discussions</i>	<i>N</i> (%)	44 (60.3)	11 (57.9)	18 (72)	8 (50)	7 (70)	
<i>Psychologist support</i>	<i>N</i> (%)	–	–	–	–	–	
Daily	–	28 (38.4)	9 (47.4)	10 (40)	5 (31.3)	4 (40)	
Daily except weekends	–	19 (26)	5 (26.3)	9 (36)	2 (12.5)	3 (30)	
Some days	–	5 (6.8)	1 (5.3)	1 (4)	3 (18.8)	0	
When needed	–	11 (15.1)	3 (15.8)	3 (12)	4 (25)	1 (10)	
Never	–	0	0	0	0	0	
Missing	–	10 (13.7)	1 (5.3)	2 (8)	2 (12.5)	2 (20)	
<i>Information brochure for families</i>	<i>N</i> (%)	–	–	–	–	–	
In German and other languages	–	27 (37)	4 (21.1)	8 (32)	9 (56.3)	6 (60)	
Only in German	–	28 (38.4)	12 (63.2)	11 (44)	3 (18.8)	2 (20)	
Unavailable	–	8 (11)	2 (10.5)	4 (16)	2 (12.5)	0	
Missing	–	10 (13.7)	1 (5.3)	2 (8)	2 (12.5)	2 (20)	
<i>ICU diary for long-term patients</i>	<i>N</i> (%)	16 (21.9)	2 (10.5)	7 (28)	3 (18.8)	4 (40)	
<i>Post-ICU follow-up care of long-term patients</i>	<i>N</i> (%)	14 (19.2)	3 (15.8)	3 (12)	1 (6.3)	7 (70)	

ICU intensive care unit

phy and ultrasound in the ICU [13, 14]. Similarly, electroencephalography was regularly or occasionally used in approximately three quarters of the surveyed ICUs. This likely mirrors the usefulness of electroencephalography to predict neurological outcome and the evolving understanding that nonconvulsive status epilepticus may mimic hypoactive delirium in ICU patients [15]. While extracorporeal life support appears to be used on a regular base in selected centers, artificial liver support was found to be used in only one of the ICUs included in this survey (Table 3 of the Electronic Supplementary Material). It is also noteworthy that some therapeutic (e.g., nitric oxide inhalation, high-frequency oscillatory ventilation, extracorporeal blood purification techniques, intra-aortic balloon counterpulsation) or diagnostic (e.g., near infrared spectroscopy) techniques, for which only limited evidence or even evidence against its standard use exists [16–21], were found to be regularly used in up to one quarter of ICUs in this cohort (Table 3 of the Electronic Supplementary Material).

Our survey also evaluated selected quality indicators of critical care in Austrian ICUs. Some of these quality indicators (e.g., goals of therapy, sedation depth, pain scale, conversations with relatives and therapy limitations) were reported to be systemati-

cally documented in most ICUs. On the other hand, some quality indicators, such as those recommended by the European Society of Intensive Care Medicine [22] and the German Interdisciplinary Association of Intensive and Emergency Medicine [23], were found to be documented in only half of the surveyed ICUs. Similarly, only half of the respondents reported that written management protocols were available for certain procedures or selected pathologies. While less than half of the respondents stated that the ICU participated in a national or international benchmarking project, more than two thirds of respondents expressed interest in taking part in such a benchmarking project.

Many of the differences between adult and pediatric ICUs observed in our survey (e.g., differences in the use of monitoring techniques and treatment) can be explained by the dissimilar patient populations cared for in adult and pediatric ICUs. On the other hand, we also identified differences uninfluenced by the age of ICU patients. For example, respondents from pediatric ICUs reported more liberal visiting hours than those from adult ICUs. Several publications have indicated that more liberal or even open visiting hours, where family members or selected support persons have unrestricted access to the critically

Table 6 Quality indicators of the surveyed ICUs

	N	All	Adult ICUs			Pediatric ICUs
			Level I hospitals	Level II hospitals	Level III hospitals	
	–	73	19	25	16	10
<i>Hospital-wide ICU bed coordination</i>	N (%)	25 (34.2)	2 (10.5)	12 (48)	6 (37.5)	5 (50)
<i>SOP defining ICU admission</i>	N (%)	24 (32.9)	8 (42.1)	10 (40)	2 (12.5)	4 (40)
<i>SOP defining ICU discharge</i>	N (%)	26 (35.6)	9 (47.4)	9 (36)	4 (25)	4 (40)
<i>Hospital-wide cardiac arrest team</i>	N (%)	59 (80.8)	16 (84.2)	22 (88)	14 (87.5)	7 (70)
<i>Hospital-wide medical emergency team</i>	N (%)	28 (38.4)	7 (36.8)	11 (44)	4 (25)	6 (60)
<i>Electronic documentation in ICU (PDMS)</i>	N (%)	48 (65.8)	9 (47.4)	20 (80)	13 (81.3)	6 (60)
<i>Documentation of goals of therapy</i>	N (%)	56 (76.7)	16 (84.2)	21 (84)	13 (81.3)	6 (60)
<i>Daily documentation of depth of sedation</i>	N (%)	55 (75.3)	17 (89.5)	22 (88)	13 (81.3)	3 (30)
<i>Daily documentation of pain scale</i>	N (%)	59 (80.8)	18 (94.7)	22 (88)	13 (81.3)	6 (60)
<i>Daily screening for delirium</i>	N (%)	41 (56.2)	16 (84.2)	12 (48)	12 (75)	1 (10)
<i>Documentation of conversations with relatives</i>	N (%)	47 (64.4)	16 (84.2)	16 (64)	8 (50)	7 (70)
<i>Documentation of therapy limitations</i>	N (%)	63 (86.3)	18 (94.7)	23 (92)	14 (87.5)	8 (80)
<i>Hospital-wide availability of a critical incident reporting system</i>	N (%)	56 (76.7)	16 (84.2)	21 (84)	13 (81.3)	6 (60)
<i>Regular M&M conferences</i>	N (%)	42 (57.5)	12 (63.2)	14 (56)	9 (56.3)	7 (70)
<i>DIN/DIVI-based color coding of drugs</i>	N (%)	46 (63)	15 (78.9)	18 (72)	8 (50)	5 (50)
<i>Participation in national/international benchmarking projects</i>	N (%)	35 (47.9)	8 (42.1)	16 (64)	6 (37.5)	5 (50)
<i>Interested to participate in national benchmarking projects</i>	N (%)	51 (69.9)	13 (68.4)	20 (80)	13 (81.3)	5 (50)
<i>Availability of written therapy protocols</i>	N (%)	51 (69.9)	14 (73.7)	22 (88)	8 (50)	7 (70)

DIN German Institute for Standardization (deutsches Institut für Normung), *DIVI* German Interdisciplinary Association for Intensive Care and Emergency Medicine (deutsche interdisziplinäre Vereinigung für Notfall- und Intensivmedizin), *ICU* intensive care unit, *M&M* morbidity and mortality, *PDMS* patient data management system, *SOP* standard operating procedure

ill patient, do not only support the concept of patient-centered care but have also been associated with improved family satisfaction and patient outcomes in adult ICUs [24]. Another interesting finding was that respondents from pediatric ICUs more often reported that an intermediate care unit was adjacent to their ICU than respondents from adult ICUs (80% vs. 51.7%). Intermediate care units not only avoid ICU admission but also facilitate a safe step-down from the ICU to the general ward in high-risk patients [25, 26]. Furthermore, while 70% of respondents from pediatric ICUs reported to follow-up long-term patients after ICU discharge, only a minority (11.7%) of respondents from adult ICUs did so. Although to date the longitudinal care model of outpatient follow-up after ICU discharge is not yet evidence-based, positive effects on patient and family experiences as well as improvement of ICU quality have been reported [27].

Certain limitations need to be considered when interpreting the results of this survey. First, we cannot exclude that a selection bias has occurred and influenced our survey results. Furthermore, it is a distinctive limitation of questionnaire-based surveys that opinions rather than the true clinical practice are collected [28]. Therefore, although our survey mostly focused on structural and objective data, we cannot verify that the information provided by the respondents reflects the actual situation in the surveyed ICUs.

In conclusion, the Austrian ICU survey suggests that ICUs in Austria are clearly structured, well-organized and well-equipped and have a high nurse:bed ratio. In view of the relatively low return rate, we cannot exclude that a selection bias has led to overestimation of the survey findings.

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