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INTENS CRIT CARE NUR 72 (2022) 103276

Contents lists available at ScienceDirect

Intensive & Critical Care Nursing

journal homepage: www.sciencedirect.com/journal/intensive-and-critical-care-nursing

Research Article

Missed nursing care in the critical care unit, before and during the COVID-19 pandemic: A comparative cross-sectional study

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ARTICLE INFO

Keywords:
Cross-sectional studies
Critical care
Missed nursing care
Nursing
Quality of care
Workforce

ABSTRACT

Objectives: To describe and evaluate reported missed nursing care in the critical care context during different phases of the COVID-19 pandemic in Sweden.
Research methodology: A comparative cross-sectional design was used, comparing missed nursing care in three samples: before the COVID-19 pandemic in 2019, during the second wave of the pandemic in spring 2020, and during the third wave of the pandemic in fall 2021.
Setting: The study was conducted at critical care units at a university hospital, Sweden.
Main outcome measures: The MISSCARE Survey-Swedish version was used to collect data along with two study-specific questions concerning perception of patient safety and quality of care.
Results: Significantly more overtime hours and number of days absent due to illness were reported during the pandemic. The nurse/patient ratio was above the recommended level at all data collection time points. Most missed nursing care was reported in items concerning basic care. The most reported reasons for missed nursing care in all samples concerned inadequate staffing, urgent situations, and a rise in patient volume. Most nurses in all samples perceived the level of patient safety and quality of care as good, and the majority had no intention to leave their current position.
Conclusion: The pandemic had a great impact on the critical care workforce but few elements of missed nursing care were affected. To measure and use missed nursing care as a quality indicator could be valuable for nursing managers, to inform them and improve their ability to meet changes in patient needs with different workforce approaches in critical care settings.

Implications for clinical practice

- Most missed nursing care in the critical care units was reported in items concerning basic care. Bedside critical care nurses need to be aware that missed nursing care impacts both patient outcomes and nurses' work environment.
- Bedside nurses should take part in the development of quality indicators in critical care to address the reasons for missed nursing care, such as inadequate staffing in urgent situations.
- To regularly measure and use the results concerning missed nursing care as a quality indicator could be a valuable approach for nursing managers when planning the optimal workforce.

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https://doi.org/10.1016/j.iccn.2022.103276
Received 3 January 2022; Received in revised form 28 May 2022; Accepted 30 May 2022
Available online 1 June 2022

Introduction

During recent years, research has focused on missed nursing care (MNC) as part of the patient safety movement (Kalisch, 2015), where MNC is defined as any aspect of required nursing care that is omitted (in part or in whole) or delayed (Kalisch et al., 2009). Research shows that consequences of MNC have an impact on both patients (lower perceived quality of care, increased occurrence of urinary infections, pressure ulcers, nosocomial infections, increased mortality rates) and on nurses (decreased job satisfaction, burnout, and increased intention to leave) (Recio-Saucedo et al., 2018; Cho et al., 2009; Cho et al., 2020).

The literature describes several factors that contribute to the variation of MNC, including the nurse/patient ratio (Ball et al., 2018) and nursing skill mix (Griffiths et al., 2018). Kalisch and Williams (2009) result showed that less MNC was found in critical care units (nurse/patient ratio 1:1–1:2) in comparison to rehabilitation units (nurse/patient ratio 1:5–1:8), interpreted as due to differences in the nurse/patient ratio. The amount of reported MNC has also been shown to differ between nursing groups; registered nurses (RNs) report more missed nursing activities in comparison to nursing assistants (NAs) (Kalisch, 2009, Bragadottir and Kalisch, 2018), and the reported reasons for MNC also differ significantly (Kalisch, 2009; Bragadottir and Kalisch, 2018).

Furthermore, a higher educational level (i.e. bachelor's degree) among nurses has been shown to result in fewer health injuries for surgical patients (Aiken et al., 2014) and reduced mortality in critical care (Kelly et al., 2014). RNs may therefore have a more comprehensive picture of patient situations and needs (Bragadottir and Kalisch, 2018).

Internationally, as well as in Sweden, a general shortage of registered RNs and specialised nurses throughout the healthcare system, including critical care units, has been reported (International council of nurses, 2020; The Swedish National Board of Health and Welfare, 2018; WHO, 2021). The need for healthcare is met differently in European countries, both concerning education for nurses as well as organisations of care. In Sweden, nursing education became part of the higher education in 1977 and since 1993, to become a RN requires a bachelor level degree and for employment in critical care, a second cycle level degree is needed (one-year master's) (Swedish Ministry of Education and Research, 1993).

Among European countries, Sweden has one of the lowest numbers of intensive care beds (five beds per 100,000 inhabitants) compared to Germany with the highest number of beds (35.3 per 100,000 inhabitants) (Bauer et al., 2020). However, it is unclear if these differences in proportions are part of a strategic planning process, developing from patient needs in different healthcare organisations, or due to shortages of RNs and specialised nurses.

In March 2020 the World Health Organization (WHO) characterised COVID-19 as a pandemic (WHO, 2020). At the beginning of the first COVID-19 wave, which reached Sweden in April 2020 (The Swedish National Board of Health and Welfare, 2021), the need to expand the capacity for treating patients in critical care units was identified. To meet the demand for critical care in the initial phase, the university hospital where this study was conducted increased the critical care bed capacity by 500% (from 38 to 126 beds) (Ahlsson, 2020). The increase was possible due to the emergent need to put competence first, and was executed by transferring healthcare personnel (RNs, NAs, specialised nurses, physicians, and physiotherapists) from non-critical care areas within the hospital to the critical care setting as well as by temporarily employing RNs and specialised nurses from both private and non-private hospitals. The second wave reached Sweden in November 2020 and the third wave in April 2021 (The Swedish National Board of Health and Welfare, 2021).

MNC has been reported to have occurred to a low extent in in-hospital care during the COVID-19 pandemic (Labrague et al., 2021; von Vogelsang et al., 2021). However, nurses working in critical care during the COVID-19 pandemic have described an increased workload, leading to compromised patient safety and quality of care (Bergman et al., 2021), but studies on MNC in a critical care context during the pandemic are lacking. Nurses' perceptions regarding MNC in a critical care context during the COVID-19 pandemic are valuable to highlight nursing care and identify areas for further development during different prerequisites of care.

Therefore, the aim of this study was to describe reported MNC in the critical care context and to evaluate MNC during different phases of the COVID-19 pandemic in Sweden.

Methods

This cross-sectional study had a comparative approach, comparing the findings from data collections during two of the COVID-19 pandemic waves with a reference sample from the same university hospital providing level I critical care before the Covid-19 outbreak. This study was reported in adherence to the consolidated criteria for reporting observational studies (STROBE) (von Elm et al. 2014).

Setting

The study was conducted at a university hospital in Stockholm, Sweden, that normally has a total of 980 hospital beds, of which 38 are critical care beds for adult patients.

Ethical approval

The study was approved by the National Ethical Review Authority (reference number 2019-04080) and followed the principles outlined in the 'Declaration of Helsinki' (1964). Written information about the study was given as an introductory text to the survey, where voluntariness was emphasised, and confidentiality guaranteed. By answering the questionnaire, the participants consented to participation. The researchers had access only to unidentified data.

Participants

To enhance the possibility to obtain a more comprehensive picture of MNC, only RNs were included in this study. The samples consist of RNs at four critical care units (thoracic, neurosurgical and two general critical care units), which are Level III critical care units that provide advanced respiratory support or monitoring and support for several organ systems (SIR). The number of employed RNs at the units during the data collection periods were as follows: 2019: n = 221, 2020: n = 242, and 2021: n = 198.

Data collection

The three data collections were conducted at the following time points: before the pandemic in October 2019 (n = 59, response rate 26.7%); in November 2020, during the second wave (n = 38, response rate 15.7%); and in May 2021, during the third wave (n = 37, response rate 18.7%). The participants were permanently employed RNs at the critical care units who received an email at their work email address in which they were asked to participate if they had been working in direct patient care during the weeks before the data collection. No temporarily employed nursing staff were invited. The email had an individual link to the web-survey *MISSCARE Survey-Swedish version* and included study information and contact information for the investigators. Each data collection period continued for two weeks. A reminder email was sent to non-responders after about one week after the first email and then after two weeks.

The *MISSCARE Survey-Swedish version* was used (Nymark et al., 2020). The survey has three sections; a background section which includes questions on demographic data such as age and sex, educational level, experience in role and at current unit. Furthermore, there are questions on workload: number of patients cared for on the last shift, number of hours usually worked, hours of overtime, number of absent

shifts due to illness in the past three months, perception of adequate staffing, teamwork and whether they had any intention to leave their current position. For sections A (elements of MNC) and B (reasons for MNC), the participants were instructed to complete the questionnaire as a reflection of their ward's practice environment, that is, the frequency of care omissions by nursing staff (including themselves) on their ward during the last month. Section A comprised 24 questions on elements of MNC, answered using a five-point Likert scale: 'always missed', 'frequently missed', 'occasionally missed', 'rarely missed' and 'never missed'. Section B comprised 17 questions on reasons for MNC answered with a four-point Likert scale: 'significant reason', 'moderate reason', 'minor reason' and 'not a reason for missed care' (Bragadottir and Kalisch, 2018).

Two study-specific questions were included: "How do you perceive the quality of care on the ward?" and "How do you perceive patient safety on the ward?" to be answered using a five-point Likert scale, with the answering options 'very good', 'good', 'neutral', 'poor' and 'very poor'.

Table 1
Characteristics of participants.

Characteristic	Baseline, fall 2019, n = 59		2nd wave, fall 2020, n = 38		3rd wave, spring 2021, n = 37		*P*
	n	(%)	n	(%)	n	(%)	
Age (years)							0.104
Median (IQR)	43.5	(34–53)	41.0	(34–56)	50.0	(40–55)	
Range	24–63		25–67		27–65		
Sex							0.319
Male	9	(15.3)	2	(5.3)	5	(13.5)	
Female	49	(83.1)	34	(89.5)	32	(86.5)	
Missing	1	(1.7)	2	(5.3)	0	(0.0)	
Academic degree							0.210
Nursing diploma	4	(6.8)	5	(13.2)	6	(16.2)	
Bachelor's degree	11	(18.6)	8	(21.0)	12	(34.4)	
Master's degree or higher	44	(74.6)	22	(57.9)	19	(51.4)	
Missing	0	(0.0)	3	(7.9)	0	(0.0)	
Experience in role							0.862
≤6 months	1	(1.7)	0	(0.0)	0	(0.0)	
6–24 months	0	(0.0)	1	(2.6)	1	(2.7)	
2–5 years	7	(11.9)	5	(13.2)	3	(8.1)	
6–10 years	11	(18.6)	9	(23.7)	9	(24.3)	
>10 years	40	(67.8)	23	(60.5)	24	(64.9)	
Experience at current unit							0.762
≤6 months	8	(13.6)	2	(5.3)	2	(5.4)	
6–24 months	7	(11.9)	7	(18.4)	7	(18.9)	
2–5 years	12	(20.3)	6	(15.8)	6	(16.2)	
6–10 years	9	(15.3)	4	(10.5)	4	(10.8)	
>10 years	23	(39.0)	18	(47.4)	18	(48.6)	
Missing	0	(0.0)	1	(2.6)	0	(0.0)	
Patients cared for on the current or last shift							<0.001
None	2	(3.4)	7	(18.4)	7	(18.9)	
1 patient	22	(37.3)	10	(26.3)	6	(16.2)	
2 patients	33	(55.9)	18	(47.4)	15	(40.5)	
3 patients	0	(0.0)	0	(0.0)	4	(10.8)	
4 patients	0	(0.0)	0	(0.0)	2	(5.4)	
5 patients	0	(0.0)	0	(0.0)	1	(2.7)	
6 patients	0	(0.0)	0	(0.0)	1	(2.7)	
7 Patients	0	(0.0)	0	(0.0)	1	(2.7)	
Missing	2	(3.4)	1	(2.6)	0	(0.0)	
Number of hours usually worked per week							
Less than 30 h per week	4	(6.8)	5	(13.2)	2	(5.4)	0.419
30 h or more per week	54	(93.1)	33	(86.8)	35	(94.6)	
Missing	1	(1.7)	0	(0.0)	0	(0.0)	
Hours of overtime the past 3 months							0.033
None	7	(11.9)	6	(15.8)	5	(13.5)	
1–12 h	31	(52.5)	9	(23.7)	10	(27.0)	
More than 12 h	21	(35.6)	23	(60.5)	21	(56.8)	
Missing	0	(0.0)	0	(0.0)	1	(2.7)	
Number of absent days or shifts due to illness, injury etc. past 3 months							0.022
None	41	(69.5)	13	(34.2)	19	(51.4)	
1 day or shift	4	(6.8)	5	(13.2)	1	(2.7)	
2–3 days or shifts	11	(18.6)	9	(23.7)	9	(24.3)	
3–6 days or shifts	2	(3.4)	4	(10.5)	3	(8.1)	
Over 6 days or shifts	1	(1.7)	7	(18.4)	5	(13.5)	

Data analysis

The researchers received only unidentified data; thus, the data was not considered to be longitudinal in the analyses. In accordance with how Kalisch and colleagues (Kalisch et al., 2011) defined MNC and answering options, we defined MNC in section A when reported 'occasionally', 'frequently' or 'always' as missed. Reported 'significant' and 'moderate' reasons in section B were considered reasons for missed nursing care. All variables in sections A and B were subsequently treated dichotomously. Satisfaction with the level of teamwork was categorised into three categories: satisfied (including answering options 'very satisfied' and 'satisfied'), neutral, and dissatisfied (including 'dissatisfied' and 'very dissatisfied').

For the study-specific questions on perception of quality of care and patient safety, the answering options were categorised into three categories: good, poor, and neutral.

Chi-square tests were used to explore differences in background characteristics, satisfaction with the level of teamwork, perception of quality of care, and perception of patient safety. The continuous variables age and number of patients cared for were not normally distributed and an independent samples median test was used to examine differences between samples. Furthermore, Chi-square tests were used to examine differences between samples concerning missed elements of care (section A) and reasons for MNC (section B). No imputation of missing data was conducted. The results on sections A and B are presented in the order they appear in the survey, with numbers and valid percentages. The internal consistency for section B was assessed with Cronbach's Alpha. The internal consistency for section B of the instrument was good for all three samples, with alpha values of 0.846 (fall 2019), 0.773 (spring 2020) and 0.827 (fall 2021) respectively. A two-tailed significance level was set at 0.05. The statistical software used was IBM SPSS Statistics version 25.

Results

The results showed no differences in the general background characteristics such as age, gender, academic degree, number of hours usually worked and experience in role among the participants. However, significant differences between the samples were found in; number of patients cared for (md = 2 in all samples, although the range varied significantly between the samples), overtime hours and number of days absent from work due to illness. Participants' characteristics are shown in Table 1.

The most reported numbers of missing items in the MNC were found in 'ambulation three times a day or as ordered', 'turning patients every two hours', 'feeding patients when the food is still warm' and 'setting up meals for patients who feed themselves' (Table 2).

Less MNC was reported during the pandemic in the items: 'ambulation three times a day or as ordered' ($p = 0.004$), 'vital signs assessed as ordered' ($p = 0.007$), and 'assist with toilet needs within five minutes of request' ($p = 0.036$). 'Mouth care' was the only item with a significant difference that showed an increase in missed care between the data collections.

In all samples, the most reported reasons for MNC were 'inadequate number of staff', 'urgent patient situations' and 'unexpected rise in patient volume and/or acuity in the unit'(Table 3).

Significant differences between the samples were found in the following reported reasons for MNC: 'medications were not available when needed' ($p = 0.033$) and 'supplies/equipment not available when needed' ($p = 0.001$). Both reasons for MNC were decreased during the pandemic compared to before COVID-19.

In all samples, RNs were satisfied with the level of teamwork and perceived that the staffing was adequate for 50% of the time or more. The participants perceived the quality of care and patient safety to be good. No significant differences were found between the samples concerning intention to leave (Table 4).

Discussion

This study aimed to describe reported MNC in the critical care context in relation to the COVID-19 pandemic. Our results show significant differences in overtime hours, and number of days absent from work due to illness, and a greater variation in nurse/patient ratio in the later sample and the reasons for MNC, indicating the pandemic's impact on the critical care workforce.

Basic care needs according to MNC, i.e. turning patients every two hours, feeding patients while food is still warm, setting up meals for patients who feed themselves and ambulation, were the items that were

Table 2
MNC by numbers and valid percentages and data collection periods.

Items in section A	Baseline, fall 2019 n = 59			2nd wave, fall 2020 n = 38			3rd wave, spring 2021 n = 37			*P*
	n	(%)	Missing	n	(%)	Missing	n	(%)	Missing	
Ambulation 3 times per day or as ordered	52	(88.1)	0	26	(68.4)	0	22	(59.5)	0	0.004
Turning patient every 2 h	46	(78.0)	0	27	(71.1)	0	29	(78.4)	0	0.687
Feeding patient when the food is still warm	40	(80.0)	9	25	(71.4)	3	27	(79.4)	3	0.612
Setting up meals for patient who feeds themselves	40	(80.0)	9	28	(75.7)	1	26	(74.3)	2	0.804
Medications administered within 30 min before or after scheduled time	14	(24.1)	1	10	(26.3)	0	9	(25.7)	2	0.968
Vital signs assessed as ordered	9	(16.1)	3	1	(2.6)	0	0	(0.0)	0	0.007
Monitoring intake/output	3	(5.1)	0	1	(2.6)	0	1	(2.7)	0	0.764
Full documentation of all necessary data	5	(8.8)	2	1	(2.7)	1	6	(16.2)	0	0.130
Patient teaching about procedures, tests and other diagnostic studies	19	(32.8)	1	14	(36.8)	0	8	(21.6)	0	0.330
Emotional support to patient and/or family	8	(13.8)	1	13	(34.2)	0	7	(18.9)	0	0.052
Patient bathing/skin care	6	(10.2)	0	4	(10.5)	0	6	(16.2)	0	0.640
Mouth care	14	(23.7)	0	2	(5.6)	2	10	(27.0)	0	0.040
Nursing staffs' hand washing	9	(15.3)	0	2	(5.3)	0	3	(8.1)	0	0.251
Patient discharge planning and teaching	42	(80.8)	7	25	(67.6)	1	22	(62.9)	2	0.152
Bedside glucose monitoring as ordered	3	(5.3)	2	3	(8.3)	2	1	(2.8)	1	0.580
Patient assessments performed each shift	2	(3.4)	0	1	(2.7)	1	0	(0.0)	1	0.549
Focused reassessments according to patient condition	8	(13.6)	0	6	(15.8)	0	2	(5.4)	1	0.335
IV/central line site care and assessments according to hospital policy	12	(20.3)	0	5	(13.2)	0	6	(16.2)	0	0.647
Response to call light is initiated within 5 min	15	(28.8)	7	10	(32.3)	7	5	(13.9)	1	0.163
PRN medication requests acted on within 15 min	1	(1.8)	4	4	(10.5)	0	2	(5.4)	0	0.188
Assess effectiveness of medications	4	(6.9)	1	4	(10.5)	0	2	(5.4)	0	0.682
Attend interdisciplinary care conference whenever held	36	(64.3)	3	23	(63.9)	2	20	(57.1)	2	0.768
Assist with toileting needs within 5 min of request	30	(56.6)	6	15	(40.5)	1	11	(29.7)	0	0.036
Wound care	14	(24.6)	2	4	(10.8)	1	10	(27.0)	0	0.173

Table 3
Significant and moderate reasons for missed nursing care by data collection periods, numbers and valid percentages.

Items in section B	Baseline, fall 2019 n = 59			2nd wave, fall 2020 n = 38			3rd wave, spring 2021 n = 37			*P*
	n	(%)	Missing	n	(%)	Missing	n	(%)	Missing	
Inadequate number of staff	55	(94.8)	1	37	(97.4)	0	31	(93.2)	1	0.127
Urgent patient situations (e.g. a patient's condition worsening)	50	(86.2)	1	30	(78.9)	0	28	(81.2)	0	0.403
Unexpected rise in patient volume and/or acuity on the unit	51	(89.5)	2	35	(92.1)	0	33	(89.2)	0	0.891
Inadequate number of assistive personnel (e.g. nursing assistants, techs etc.)	19	(33.9)	3	18	(47.4)	0	11	(29.7)	0	0.244
Unbalanced patient assignments	41	(70.7)	1	21	(55.3)	0	23	(62.2)	0	0.296
Medications were not available when needed	25	(43.1)	1	10	(26.3)	0	7	(18.9)	0	0.033
Inadequate hand-off from previous shift or sending unit	9	(15.8)	2	5	(13.2)	0	7	(19.4)	1	0.761
Other departments did not provide the care needed	10	(17.5)	2	5	(13.2)	0	9	(24.3)	0	0.450
Supplies/ equipment not available when needed	15	(26.3)	2	2	(5.3)	0	1	(2.9)	2	0.001
Supplies/ equipment not functioning properly when needed	4	(7.0)	2	4	(10.5)	0	1	(2.7)	0	0.404
Lack of back up support from team members	23	(40.4)	2	11	(28.9)	0	11	(29.7)	0	0.416
Tension or communication breakdowns with other support departments	17	(30.4)	3	10	(26.3)	0	5	(14.3)	2	0.218
Tension or communication breakdowns within the nursing team	19	(33.3)	2	10	(26.3)	0	9	(24.3)	0	0.592
Tension or communication breakdowns with the medical staff	14	(25.0)	3	8	(21.1)	0	10	(27.0)	0	0.827
Nursing staff did not communicate that care was not provided	14	(24.6)	2	10	(26.3)	0	10	(27.0)	0	0.961
Caregiver off unit or unavailable	22	(40.0)	4	13	(35.1)	1	14	(37.8)	0	0.895
Heavy admission and discharge activity	33	(58.9)	3	18	(47.4)	0	18	(48.6)	0	0.461

Table 4
Satisfaction with teamwork, perceptions of staffing, quality of care and patient safety, and intention to leave.

Item	Baseline, fall 2019, n = 59		2nd wave, fall 2020, n = 38		3rd wave, spring 2021, n = 37		*P*
	n	(%)	n	(%)	n	(%)	
Satisfaction with the level of teamwork on the unit							0.719
Satisfied	40	(67.8)	26	(68.4)	29	(78.4)	
Neutral	10	(16.9)	8	(21.1)	5	(13.5)	
Dissatisfied	9	(15.3)	4	(10.5)	3	(8.1)	
Perception of adequate staffing on the unit							0.172
100% of the time	1	(1.7)	0	(0.0)	1	(2.7)	
75% of the time	17	(28.8)	11	(29.0)	18	(48.6)	
50% of the time	29	(49.2)	12	(31.6)	11	(29.7)	
25% of the time	7	(11.9)	11	(29.0)	5	(13.5)	
0% of the time	5	(8.5)	3	(7.9)	2	(5.4)	
Missing	0	(0.0)	1	(2.6)	0	(0.0)	
Perception of quality of care on the unit							0.751
Good	40	(67.8)	30	(78.9)	26	(70.3)	
Neutral	9	(15.3)	4	(10.5)	4	(10.8)	
Poor	10	(16.9)	4	(10.5)	7	(18.9)	
Perception of patient safety on the unit							0.066
Good	24	(40.7)	21	(55.3)	25	(67.6)	
Neutral	13	(22.0)	9	(23.7)	3	(8.1)	
Poor	22	(37.3)	8	(21.1)	9	(24.3)	
Intention to leave							0.728
Yes, within 6 or 12 months	18	(30.5)	9	(23.7)	10	(27.0)	
Not within 12 months	40	(67.8)	29	(76.3)	27	(73.0)	
Missing	1	(1.7)	0	(0.0)	0	(0.0)	

reported most often as missing by the RNs in the critical care units in all samples. This result correlates with the results from Higgs et al. (2020), which showed that RNs working in critical/emergency care reported the most missing items in basic care compared to RNs working in surgical or medical units. On the other hand, our results differ from the results of Chaboyer et al. (2021) who showed that MNC was reported in information-sharing, planning, self-management and education. One reason for this difference could be the increased demands on the nursing workforce due to the complexity of care in relation to COVID-19 and patient needs, which led to prioritising assessment of needs (for example assessment of vital signs) to prevent further deterioration in critical illness or other not known reasons. Another explanation could be that RNs reported MNC, when patients actually were not able to feed themselves when cared for in the critical care unit, and instead received parenteral nutrition, or were fed through a feeding tube, all according to the recommendations of Singer et al. (2019) stating that medical nutrition therapy should be offered to critical care patients during the first 48 h of critical care.

The fact that ambulation and turning patients every two hours were the most reported MNC items in all periods needs to be highlighted. This result is well in line with the result reported by Albsoul et al. (2019). Both aspects of care, i.e. mobilisation and ambulation, are well known factors that prevent several complications such as pain, agitation, delirium (Devlin et al., 2018), and pressure injury (Alderden et al., 2020). Furthermore, these nursing activities improve patients' functional capacity and muscle strength which result in a shorter duration of mechanical ventilation as well as a better perception of the health-related quality of life (Zang et al., 2020). Mobilization also requires more nursing staff and support staff, such as physiotherapists, when the patients are sedated or need support for other reasons. Healthcare managers should take all this into consideration when planning a sufficient workforce to meet patient needs.

When investigating differences in MNC regarding critical care, surgical and medical specialties, Higgs et al. (2020) found a correlation between more reported MNC by those RNs who had been working as an RN for a longer period of time. In the present study, most of the participants in all samples had working experience in their current position for more than 10 years, which could imply that if there had been more participants with shorter lengths of working experience, different results would have been obtained.

Two reasons for MNC, 'medications were not available when needed' and 'supplies/ equipment not available when needed', contributed significantly less to MNC during the pandemic. Possible explanations for this are that, at the time of the second and third waves of the pandemic (from November 2020 onwards), the hospital implemented new roles at the critical care units focused on COVID-19 patients; RNs and support personnel were made responsible for all pharmaceuticals and medical equipment used with all patients at the unit, rather than the bedside RN taking this responsibility. This enabled RNs to focus on patient care.

Although no significant statistical difference was found between the academic levels of the RNs, the fact that the academic competence was differently distributed between the samples needs to be acknowledged. Our result show a decrease in the percentage of RNs with higher academic degrees and one reason could be the need to increase the number

of RNs without critical care specialisation due to the increased number of patients with COVID-19. Another reason could be that experienced RNs specialised in critical care had left the workforce due to the psychological as well as physiological strain from working in the front-line of COVID-19, and therefore the need to employ RNs without specialisation occurred.

Somewhat surprisingly, the results show that RNs perceived that the staffing was adequate more than 50% of the time and those perceptions did not differ throughout the pandemic waves. We believe that this might be explained by the fact that a large number of temporary support personnel were either employed or relocated from other areas in the hospital. Further research is necessary to understand the full impact of COVID-19 on the nursing workforce. The literature has shown that the amount of MNC has an impact on nursing outcomes because of decreased patient safety, which leads to an increase in intention to leave (Cho et al., 2020) among nurses. However, in our results, there was no impact on either the RNs' perception of quality of care or on intention to leave. As the COVID-19 pandemic has had a major impact on critical care nurses' working environment around the world, one of the most important issues for the future is to measure both patients' related outcomes as well as nursing outcomes in order to improve the work environment so that RNs remain in the field of nursing.

It is important to highlight that the median nurse/patient ratio throughout the samples was 1:2. This is not in line with the golden standard for critical care which suggests that critically ill patients require one registered nurse at all times (World Federation of Critical Care Nurses, 2019). Reports on the nurse-patient ratio during Covid-19 show a great variation throughout Europe, from 1:1 in Swiss ICUs (Jeitziner et al., 2021), 1:2 in Germany (Grimm et al., 2021), 1:3 in Belgium (Bruyneel et al., 2021) and 1:6 in the U.K. (Dunhill, 2020). Moreover, our results show less MNC in the later samples compared to before the COVID-19 pandemic. This could mean that the critical care in Sweden was compromised during a non-pandemic period, which could be related to the fact that Sweden has one of the lowest reported numbers of critical care beds in Europe (Bauer et al., 2020). Another reason for less MNC in some items during the pandemic could be that care needs differ between patients and therefore the items are not considered missing in different critical care settings. The fact that other support personnel were recruited to critical care units, also reported by Grimm et al. (2021), could have had an impact on the result that mouth care was reported to be missing to a higher extent in the later samples compared to before the COVID-19 pandemic. One reason for the latter might be that the RNs did not participate in this care situation instead, other healthcare professionals performed this basic care, and therefore RNs perceived it as missing. On the other hand, the RNs' perception of fewer missed items between the samples may have had an impact on the RNs' perception of teamwork, quality of care and patient safety as they were reported differently in the samples.

The high workload for the RNs employed in the critical care units during the COVID-19 waves, with more patients with severe critical care needs requiring significantly more nursing time, as reported by Bruyneel et al. (2021) and Hoogendoorn et al. (2021), also resulted in a high demand on the RNs to act as supervisors/preceptors and to teach other health professionals about high technological critical care (Bergman et al., 2021). Despite this, teamwork was reported as good throughout the samples, which shows the importance of flexibility and competence among the RNs with a specialty in critical care. Further research is needed to be able to fully understand the required nursing competence based on patient needs in critical care, considering other aspects in addition to the nurse/patient ratio.

Critical care units are designed for acute care and unexpected situations; however, as our results show, the high technological care at the university hospital did not meet the patients' basic needs according to RNs. The RNs also reported a high number of unbalanced patient assignments and heavy admission and discharge activity, which could imply that the organisation of care and competence of nurses could not meet the patient needs in unplanned situations. As also suggested by Albsoul et al., (2019), healthcare managers need to consider and investigate the difference between patient needs in planned or unplanned care as well as possible differences in healthcare personnel's competencies (RNs, NAs, and support personnel). Therefore, healthcare managers need both adequate competencies and the support systems for continued evaluation of MNC and the perceived quality of care based on nursing in order to meet the demands of patients for optimal workforce planning.

Limitations

The low response rate is the major limitation of the study and could have an impact on the external validity of our results. External validity consists of two underlying concepts, generalisability, and applicability. Generalisability is related to the representativeness of the sample and the sample size, while applicability concerns whether inferences in a study can be used in any other population and is evaluated by determining how similar the two populations are in terms of outcomes (Murad et al., 2018). Thus, our small sample sizes imply that the results cannot be generalised, but we consider the samples representative. Since similar results on workload and nurse/patient ratio during the pandemic have been presented elsewhere Bruyneel et al. (2021) and Hoogendoorn et al. (2021), we suggest that our results are applicable to other critical care contexts, but the results should be interpreted with caution, and in relation to the specific context.

There may be several reasons for our low response rates. The lists of RNs who were included in our study were collected from human resources department. Therefore, there might be nurses that received the questionnaires that were not working at the wards, e.g., nurses that had recently left their employment, were on sick leave or maternity leave, or had left the workplace for other unknown reasons. Moreover, the possibility to participate in the study may have been limited since the invitation and the link to the questionnaire were sent to potential participants' work email addresses, and it is unknown to what extent they had access to or used that email address from home. Thus, the only opportunity to fill in the questionnaire was at work, where time was probably highly limited. Ebert et al. (2018) identify the availability of a computer and access to email as a prerequisite for web-based questionnaires. Another reason may be research fatigue, which results in decreasing response rates in research during and after pandemics and disasters. Research fatigue occurs when a population tires of participating in research, and the suggested main driving factors are lack of positive changes, lack of interest in some of the elements of the project, and practical barriers, for instance lack of time (Patel et al., 2020). All these driving factors may have been applicable in this study.

Clearly, our response rates are low. On the other hand, there is no agreed norm on acceptable response rates in academic questionnaire-based studies, and response rates have decreased historically. The average response rate in questionnaire-based studies fell from 64% to 48% between 1975 and 1995 (Baruch, 1999), and has continued to decline thereafter (Cull et al., 2005). Moreover, email surveys generally have about 20% lower response rates on average in comparison to mail surveys (Shih and Fan, 2008). Another factor to take into account when discussing response rates is whether returned questionnaires are usable, i.e. to consider the amount of missing data (Baruch, 1999). In our study, all questionnaires were considered usable, and we present missing data in each item throughout the results.

Another limitation is that the *MISSCARE survey* is a generic instrument, some items may suit different care specialties differently well. This is apparent in the items on feeding patients with warm meals and setting up meals for patients who feed themselves – which might not be applicable in critical care where parenteral nutrition is common. The Swedish version of the *MISSCARE survey* does not include the answering option 'not applicable' (Nymark et al., 2020). It is unclear which answering option participants choose when they find that there is no

suitable answering option in an item, and we believe that is a cause to missing data. A Further development of the Swedish version is therefore needed.

Conclusion

The pandemic had a great impact on the critical care workforce in terms of more overtime hours and the number of days absent from work due to illness. The increased nurse/patient ratio reveals an increased workload. MNC was more frequently reported in the patients' basic care needs. To measure MNC as a quality indicator of nursing could be one way to improve the managers' ability to meet changes in patient needs with different workforce approaches in critical care settings. Healthcare managers need support systems for continued evaluation of MNC and the perceived quality of care based on nursing. To reduce the amount of missed MNC, healthcare managers could improve patient outcomes which itself could improve nursing outcomes such as reduced burnout, intention to leave and limit nursing turnover.

Acknowledgements

We are grateful to all nurses who participated in the study.

Conflict of interest statement

The authors declare no conflicts of interest.

Funding

The authors have no funding sources to declare.

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