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Research Article

Burden of care related to monitoring patient vital signs during intensive care; a descriptive retrospective database study

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ABSTRACT

Objective: The aim of this study was to describe burden of care related to monitoring patient vital signs of intensive care unit patients in a Swedish hospital.
Setting: Data collected by "The Swedish Intensive Care Registry" from one general category II intensive care unit in a Swedish hospital was included in this study. Data from year 2014 to 2020 was analysed comprising a total of 3617 intensive care episodes and 29,165 work shifts.
Research methodology: This is a retrospective database study. Descriptive statistics gave an overview of the dataset. To test for differences between variables related to burden of care for "Documentation of monitoring" Mann Whitney *U* test and Kruskal Wallis test was performed using STATA.
Results: "Documentation of monitoring" was reported to generate a prominent burden of care during intensive care. Nearly all patients had continuous monitoring. Comparison for burden of care related to "Documentation of monitoring" for sexes generated no statistically significant difference. Comparison for burden of care related to "Documentation of monitoring" among age groups, diagnose groups and time of day generated statistically significant differences.
Conclusion: Monitoring patient vital signs was clearly present during intensive care, hence impacting intensive care nurses' clinical practice. Further research is endorsed to improve and facilitate monitoring to keep improving patient safety.

Implications for clinical practice

- Almost all intensive care patients have continuous monitoring, and monitoring is clearly present during clinical practice regardless of patient characteristics or time of day.
- Documentation of monitoring generates a prominent burden of care during intensive care.
- Continuous research is endorsed to facilitate intensive care nurses' monitoring of vital signs.

Introduction

Monitoring of patient vital signs is crucial during intensive care where patients have imminent or manifest failure in one or more vital organ functions. Changes in patients' condition can occur in seconds, and vital signs can indicate if the patients' state is about to deteriorate. Deterioration may rapidly develop into a life-threatening event that might be preventable if noticed and managed correctly. Examples of vital signs that can indicate such deterioration are blood pressure, heart rate and respiratory rate (Morton and Fontaine, 2018). In addition to being used to track changes in patient status during routine monitoring, vital signs are used for goal-state achievement and verification, problem

Abbreviations: ICU, Intensive Care Unit; SIR, The Swedish Intensive Care Registry.

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solving and interpretation of historical data (Seagull et al., 2000). Thus, monitoring of patients' vital functions is one of many important responsibilities for nurses at intensive care units (ICUs) and is essential for providing safe care for critically ill patients (Henneman et al., 2012; Morton and Fontaine, 2018).

The workload for nurses in ICUs can vary greatly depending on patients' status. Several factors influence the overall workload, and monitoring patients' vital functions is one of those factors. Already in 1974 it was suggested that by measuring the overall workload care could be optimised and a quantitative scoring system for patient care was presented (Cullen et al., 1974). Today, several such workload measurement systems exists (Greaves et al., 2018; Hoogendoorn et al., 2020; Miranda et al., 2003). The term "burden of care" is commonly used in Sweden to describe workload. One system in Sweden to measure burden of care is VTS2014, a set of guidelines from The Swedish Intensive Care Registry (SIR). SIR is a non-profit national quality register for intensive care that in year 2020 gathered data from 82 of Sweden's 84 ICUs. The primary purpose of SIR is to improve intensive care. The aim of VTS2014 is to measure the number of health care professionals, and the proportion of each work shift, required to meet an ICU patient's intensive care needs.

The importance of monitoring vital signs for critically ill patients is well established (Mok et al., 2015). This is also known through clinical experience by ICU nurses. Hence, we hypothesized that monitoring would be clearly present during intensive care and thereby generate an evident burden of care. We also hypothesized that there would be some minor differences related to time of day, age and diagnoses, although not between sexes. However, little research attention has been paid to how monitoring vital signs influences everyday clinical practice during intensive care. To our knowledge it is not known how monitoring vital signs is reflected in burden of care. Through research on burden of care related to monitoring vital signs the gap between theory and practice can be reduced, and suggestions for further research can be made. This is important in the continuous process of developing and improving patient care and patient safety, and part of evidence-based practice. Therefore, the aim of this study was to describe burden of care related to monitoring patient vital signs of ICU patients in a Swedish hospital.

Methods

Design

This study is a retrospective database study. To increase transparency, this study is reported according to "The Reporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement" (Benchimol et al., 2015).

Data source

Pseudonymised data from SIR was used in this study. In April 2014, SIR started to collect data regarding burden of care through VTS2014. Data collected by SIR is intended for research among other things. Using VTS2014, nurses in participating Swedish ICUs register burden of care each work shift (3 times/24 h; day, evening and night). This registration of data on burden of care is part of the daily work at participating ICUs. The instrument is based on 11 indicators, among others one indicator for "Documentation of monitoring". Each indicator is graded on a 4-point scale (0–3 points), which entails a total maximum burden of care of 33 points/shift (Supplementary Material 1). 3 points for "Documentation of monitoring" is given if the patient has continuous monitoring and manual documentation is required at least two times per hour. For 2 points the patient has continuous monitoring and manual documentation is required at least one time per hour. For 1 point the patient has continuous monitoring but no manual documentation is required, and 0 point is given for intermittent monitoring. Manual documentation includes documentation of nursing care, vital signs, and information from medical equipment.

Setting

This study is based on data from one general ICU, category II. Swedish ICUs can be category I, II or III. ICUs category I are often located at smaller hospitals. They provide intensive care but not at the same level as ICU category II or III. ICU category II provides intensive care for patients with acute disability in most organ systems. Although, category II ICUs can not provide the most qualified monitoring and treatment provided by category III ICUs. ICUs in category III can be located at regional university hospitals, and can be both general and specialised (SFAI and SIS, 2015). Category II ICUs in Sweden had on average 6 beds in 2020. The average staffing except physicians was 0.78 nurses and 0.72 assistant nurses per care place according to SIRs annual report (https://portal.icuregswe.org/seiva/en/rapport?year=2020, accessed 22.01.18). Patients of all ages and with all diagnoses could be admitted to the ICU included in this study. For patients in need of intensive care at category III ICUs, for example a neonatal ICU or burn ICU, the episode of care at the current hospital could be very short aiming to stabilise and prepare the patient for transport. Data from patients admitted from April 7th, 2014 (when VTS2014 was introduced), to December 31st, 2020 was used in this study. All registered patients from the chosen hospital were included, comprising a total of 3754 episodes of care. In addition to burden of care, the following data were used: time of day, age, sex and code of diagnosis according to the International Statistical Classification of Diseases and Related Health Problems (ICD-10). Patients in need of intensive care often have complex conditions with multiple diagnoses. In this study the diagnose causing most of the intensive care need, the main diagnose, was used. Diagnoses were grouped according to the 22 chapters of ICD-10 (Supplementary Material 2). Patients were also grouped by age using the same groups as the United Nation (United Nations, 2017).

Data analysis

To answer the aim descriptive statistics were analysed for all variables using STATA (Stata/SE 16.1 for Windows). Data related to the total burden of care was normally distributed and is presented using mean. The distribution of data related to burden of care for "Documentation of monitoring" was skewed and is therefore mainly presented using median and interquartile range (IQR). To compare burden of care for "Documentation of monitoring" between sexes Mann-Whitney *U* test was used. For the other variables with 3 or more groups Kruskal Wallis test was used to compare mean rank score. A p-value < 0.05 was considered statistically significant.

Table 1
Patient characteristics.

	Total number N (%)	Females N (%)	Males N (%)
Episodes of care	3617	1588 (43.90)	2029 (56.10)
Shifts[a]	29,165	11,999 (41.18)	17,142 (58.82)
Age distribution within shifts[b]	Min 0, Max 98		
Mean	62.75	62.00	63.27
Median	68	67	69
Age group 0–9	444 (1.52)	226 (1.88)	218 (1.27)
Age group 10–24	1205 (4.14)	546 (4.55)	659 (3.85)
Age group 25–59	8034 (27.58)	3723 (31.04)	4311 (25.16)
Age group 60–79	15,504 (53.22)	5628 (46.92)	9876 (57.64)
Age group 80-	3944 (13.54)	1873 (15.61)	2071 (12.09)
Top main diagnoses ICD-10[c]			
N of main diagnoses	489		
I469 (cardiac arrest)	215 (5.94)	79 (4.97)	136 (6.70)
R572 (septic shock)	179 (4.95)	85 (5.35)	94 (4.63)
J969 (respiratory failure)	163 (4.51)	77 (4.85)	86 (4.24)
Top ICD-10 within shifts			
R572 (septic shock)	2245 (7.70)	828 (6.90)	1417 (8.27)
I469 (cardiac arrest)	1960 (6.73)	720 (6.00)	1240 (7.23)
J969 (respiratory failure)	1678 (5.76)	715 (5.96)	963 (5.62)

[a] Data on sex missing for 24 shifts.
[b] Data on age missing for 34 shifts.
[c] Based on episodes of care.

Results

A total of 3754 episodes of care was registered in SIR from the included hospital from April 7th, 2014, to December 31st, 2020. Of these episodes of care, 137 did not have any burden of care registrations. They were all from 2014 when VTS2014 was introduced, and these 137 episodes of care were excluded from analysis. Patient characteristics from included patients are provided in Table 1.

Burden of care was measured for 29,165 shifts. The total points for burden of care per shift varied from 0 to 33 points, mean 18.0548 points, 95% CI 18.0125 to 18.0972 (Fig. 1).

Most patients (74.69%) received maximum score for burden of care related to "Documentation of monitoring" and 99.48% had continuous monitoring (Fig. 2, Supplementary Material 1).

The mean value for "Documentation of monitoring" was 2.7237

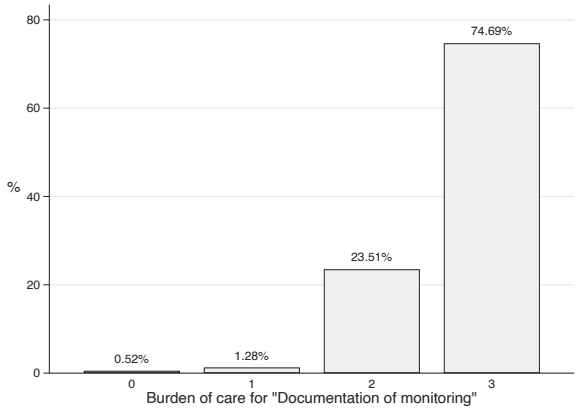

Fig. 2. Burden of care for "Documentation of monitoring" in % of shifts.

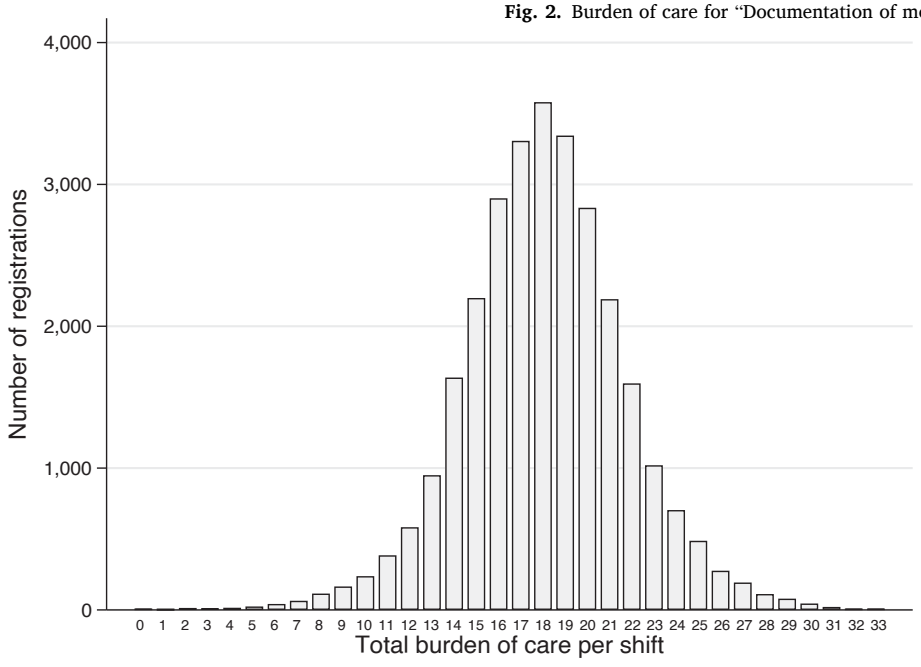

Fig. 1. Total burden of care per shift for 2014–2020.

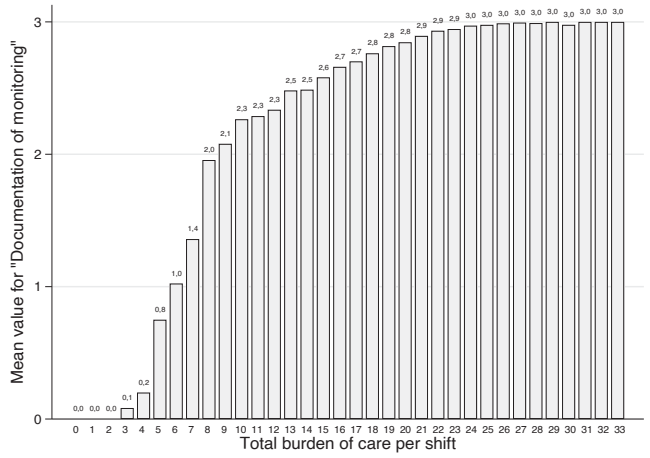

Fig. 3. Mean value for burden of care related to "Documentation of monitoring" per shift.

points, median 3, IQR 2–3. The mean value for "Documentation of monitoring" was 2.0 points or above if the total burden of care for the shift was 8 or above (Fig. 3).

Comparing burden of care for "Documentation of monitoring" between sexes generated no statistically significant difference ($p = 0.129$) (Table 2). Age group comparison for burden of care related to "Documentation of monitoring" showed some statistically significant differences in mean rank score between age groups. Mainly, the youngest age group differed statistically significant from all other age groups (Supplementary Material 3). The youngest age group had the highest proportion (90.09%) of 3-points registrations (Table 2). Burden of care related to "Documentation of monitoring" for diagnose groups also showed some statistically significant differences in mean rank score between diagnose groups. Diagnose group U (codes for special purposes) had the highest mean rank score and differed statistically significant from all other diagnose groups (Supplementary Material 4). All diagnose groups had very few (<1%) 0-point registrations. 3-points registrations ranged from 64.47% to 89.81% (Table 2).

Finally, burden of care related to "Documentation of monitoring"

Table 2
Data from analysis for burden of care related to "Documentation of monitoring" for included variables.

	IQR[a]	Range	Median	% 0 reg[b]	% 3 reg[c]
Sex[d]					
Female	3–3	0–3	3	<1	75.22
Male	2–3	0–3	3	<1	74.37
Age group[e]					
0–9	3–3	0–3	3	<1	90.09
10–24	2–3	0–3	3	<2	73.44
25–59	2–3	0–3	3	<1	72.87
60–79	3–3	0–3	3	<1	75.04
80 up	3–3	0–3	3	<1	75.89
ICD group[f]					
AB: Certain infectious and parasitic diseases	3–3	0–3	3	<1	82.99
CD: Neoplasms	2–3	1–3	3	<1	70.73
E: Endocrine, nutritional and metabolic diseases	3–3	0–3	3	<1	75.78
F: Mental and behavioural disorders	3–3	0–3	3	<1	78.23
G: Diseases of the nervous system	2–3	0–3	3	<1	70.70
I: Diseases of the circulatory system	3–3	0–3	3	<1	76.17
J: Diseases of the respiratory system	2–3	0–3	3	<1	73.90
K: Diseases of the digestive system	2–3	0–3	3	<1	70.77
M: Diseases of the musculoskeletal system and connective tissue	3–3	0–3	3	<1	80.87
N: Diseases of the genitourinary system	2–3	0–3	3	<1	74.57
R: Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	2–3	0–3	3	<1	73.56
ST: Injury, poisoning and certain other consequences of external causes	2–3	0–3	3	<1	71.81
U: Codes for special purposes	3–3	0–3	3	<1	89.81
VY: External causes of morbidity and mortality	3–3	0–3	3	<1	78.89
Z: Factors influencing health status and contact with health services	2–3	0–3	3	<1	64.47
Time of day					
Day	3–3	0–3	3	<1	75.94
Evening	3–3	0–3	3	<1	75.16
Night	2–3	0–3	3	<1	72.84

Groups with less than 100 registrations are not specified due to patient confidentiality.

[a] Interquartile range (IQR).

[b] % of 0 point registrations of burden of care for "Documentation of monitoring". Small values are not specified due to patient confidentiality.

[c] % of 3 points registrations of burden of care for "Documentation of monitoring".

[d] Data on sex missing for 24 observations.

[e] Data on age missing for 34 observations.

[f] Groups according to the 22 chapters of ICD-10. For more information see Supplementary Material 2.

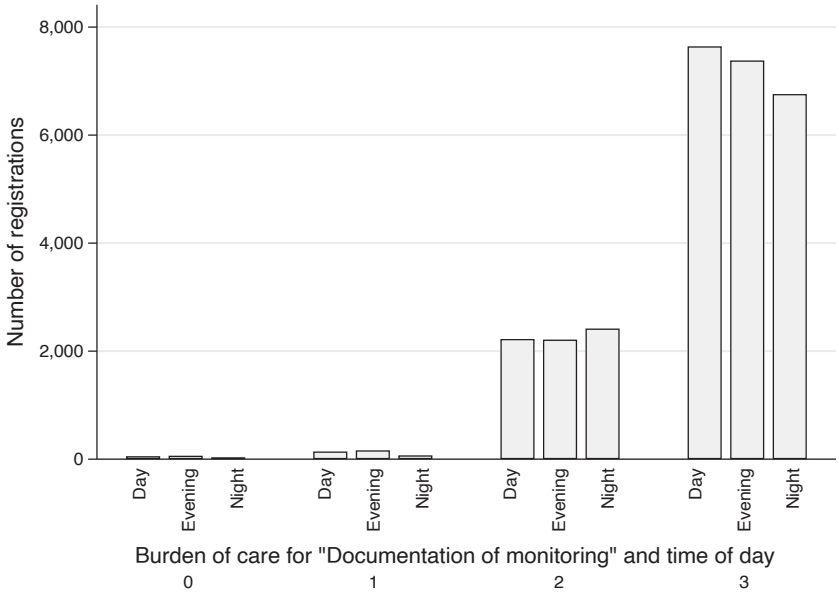

Fig. 4. Visualization of burden of care for "Documentation of monitoring" related to the time of day.

compared to the time of day generated statistically significant differences between day and night (p=<0.001) and between evening and night (p = 0.009) (Table 2). Night shifts had a higher proportion of 2-points registrations and a lower proportion of 3-points registrations (Fig. 4).

Discussion

Monitoring vital signs is an evident and ever-present part of intensive care. This is visible through measurement of burden of care related to "Documentation of monitoring" collected by SIR. This is known by ICU nurses through clinical experience, but to our knowledge sparsely highlighted in previous research.

Research to close the gap between theory and practice is imperative. It is part of the development of evidence-based practice (Mackey and Bassendowski, 2017). Evidence-based practice has been defined as: "The conscientious use of the best available evidence combined with the clinician's expertise and judgment and the patient's preferences and values to arrive at the best decision that leads to high-quality outcomes" (page 2, Mackey and Bassendowski, 2012). Nurses are encouraged to contribute to developing evidence-based practice and increased patient safety (Mackey and Bassendowski, 2017) and studies like this are one way to contribute. Since our study shows that "Documentation of monitoring" impacts ICU nurses' daily workload research to improve and facilitate monitoring is endorsed. This have also been highlighted by others. Further, they suggest that monitoring in ICUs could benefit from improvement (Poncette et al., 2020). One way to improve monitoring could be to increase access to vital signs in innovative ways (Romare et al., 2021, 2018; Schlosser et al., 2019).

Our study is based on data collected by SIR using the instrument VTS2014. A recent review shows that the Nursing Activities Score (NAS) was the most used instrument to measure nursing workload in ICUs (Hoogendoorn et al., 2020). It can be challenging to create an instrument that accurately measures all the aspects of the complex nursing care conducted in ICUs (Greaves et al., 2018; Palese et al., 2016). This might be true for both NAS and VTS2014. However, both NAS and VTS2014 includes an indicator focusing on monitoring confirming that monitoring is essential during intensive care, which is also clinically known. This is further stressed by the high mean score for "Documentation of monitoring" presented in our study. Nevertheless, we suggest that data is interpreted with caution and merely seen as an indication of burden of care.

More patients received 3 points for "Documentation of monitoring" during daytime than during nights (Fig. 4). One explanation to this finding could be that some examinations and treatments might be scheduled for daytime if feasible. It is known that certain examinations and treatments demand intensified monitoring (Morton and Fontaine, 2018). This result is in accordance with earlier research using NAS showing that the overall nursing workload was higher during daytime than during nights. In contrast to our findings, they also found that male patients were associated with higher workload (Moghadam et al., 2021). Although, they investigated overall workload using the instrument NAS not VTS2014. Also, they did not investigate workload for monitoring specifically.

Further, it is not surprising that burden of care related to "Documentation of monitoring" generated the highest proportion of 3-points registrations for the youngest age group (Table 2). It has been stressed that age specific considerations need to be taken into account when monitoring children's vital signs. Their physiological and psychological immaturity entails that they have different needs compared to adults. Their response to illness differs and deterioration of their vital signs might be even more rapid (Rees et al., 2017). However, age group 0–9 years had fewer registrations (1,52% of the registered shifts, Table 1) than the other age groups possibly biasing the result.

Additionally, analyses of burden of care for "Documentation of monitoring" between diagnose groups revealed some statistically significant differences (Supplementary Material 4). Diagnose group U (codes for special purposes) was the only group that differed statistically significant from all other diagnose groups. Diagnose group U includes the ICD-10 code for Covid-19. Our result is in line with earlier research showing that patients with Covid-19 had significantly higher NAS score than patients with other diagnoses, including NAS score for monitoring (Hoogendoorn et al., 2021). The status of patients with Covid-19 can deteriorate rapidly. Due to this, experienced nurses highlight the importance of close monitoring for patients with Covid-19 (Anton et al., 2021). Our results shows that this is adapted by ICU nurses in their care for patients with diagnoses such as Covid-19. We also found that some other diagnose groups differed statistically significant compared to each other. Although, the clinical relevance of this finding is most likely limited. However, a challenge regarding diagnoses is that patients in need of intensive care often have complex needs and multiple diagnoses. It might be difficult to accurately decide which diagnose causes most of

the intensive care need, hence which diagnose is the main diagnose. There was also a variance among the number of registrations within ICD-groups (Supplementary Material 2). This might bias the results.

Finally, the mean value for burden of care related to "Documentation of monitoring" was 2 points or above if the total burden of care for the shift was 8 or higher (Fig. 3). This indicates that burden of care related to "Documentation of monitoring" can generate a high workload for ICU nurses, even if the total burden of care for the shift is in the lower range. This reveals that ICU nurses adhere to the well-known importance of monitoring critically ill ICU patients' vital signs (Henneman et al., 2012; Mok et al., 2015; Morton and Fontaine, 2018). This is also highlighted by the fact that almost all patients in this study had continuous monitoring (Fig. 2).

Limitations

This study has both strengths and limitations. The design is a strength since retrospective database studies can examine care as it occurs in clinical practice without interference (Motheral et al., 2003). Though the size of our dataset also is a strength of this study, data from only one hospital was included thus limiting the generalizability of the findings. Although, both average burden of care and the most common main diagnoses from the included hospital are similar to other category II ICUs in Sweden according to publicly available data from SIR's "Data output portal" (https://www.icuregswe.org/en/data–results/data-output-portal/, accessed 21.04.21). The most common main diagnoses in our study are also highlighted in the literature (Morton and Fontaine, 2018), indicating that the results from our study could be representable for other general ICUs as well. Nevertheless, local routines and conditions might differ and influence workload assessment. Hence, whether the results from our study is representable for other general ICUs needs to be shown in future studies including other ICUs that report burden of care using VTS2014.

Conclusion

Monitoring is clearly present during clinical practice in the ICU regardless of patient characteristics or time of day. ICU nurses report a prominent burden of care related to "Documentation of monitoring", supporting the importance of monitoring vital signs during intensive care. This highlights the need for continuous research to improve and assist monitoring of vital signs to facilitate ICU nurses work and safe patient care.

Ethical approval

This study was performed in line with the principles of the Declaration of Helsinki (World Medical Association, 2013). Ethical approval was obtained from the Regional Ethical Board in Lund, Sweden (Dnr 2016/773 and 2020/05520). Data was handled according to Blekinge Institute of Technology's regulations regarding research on personal data.

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Authors' contributions

CR and LS contributed to conceptualization and design. All authors contributed to methodology, formal analysis, and validation. CR contributed visualizations and wrote the original draft of the manuscript. All authors reviewed, edited and approved the final article.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.iccn.2022.103213.

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