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Unfinished nursing care in intensive care units and the mediating role of the association between nurse working environment, and quality of care and nurses' wellbeing

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ABSTRACT

Objectives: Unfinished care refers to the situation in which nurses are forced to delay or omit necessary nursing care. The objectives was: 1) to measure the prevalence of unfinished nursing care in intensive care units (ICUs) during the COVID-19 pandemic; 2) to examine whether unfinished nursing care has a mediating role in the relationship between nurse working environment and nurse-perceived quality of care and risk of burnout among nurses.
Design: A national cross-sectional survey.
Setting: Seventy-five ICUs in Belgium (December 2021 to February 2022).
Main outcome measures: The Practice Environment Scale of the Nursing Work Index (PES-NWI) was used to measure the work environment. The perception of quality and safety of care was evaluated via a Likert-type scale. The risk of burnout was assessed using the Maslach Burnout Inventory scale.
Results: A total of 2,183 ICU nurse responses were included (response rate of 47.8%). Seventy-six percent of nurses reported at least one unfinished nursing care activity during their last shift. The staffing and resource adequacy subdimension of the PES-NWI had the strongest correlation with unfinished nursing care. An increase in unfinished nursing care led to significantly lower perceived quality and safety of care and an increase in high risk of burnout. Unfinished nursing care appears to be a mediating factor for the association between staffing and resource adequacy and the quality and safety of care perceived by nurses and risk of burnout.
Conclusions: Unfinished nursing care, which is highly related to staffing and resource adequacy, is associated with increased odds of nurses being at risk of burnout and reporting a lower level of perceived quality of care.
Implications for clinical practice: The monitoring of unfinished nursing care in ICU is an important early indicator of problems related to adequate staffing levels, the well-being of nurses, and the perceived quality of care.

Introduction

A large body of evidence exists regarding associations between nurse staffing levels/nurse working environment, adverse patient outcomes (e.g., falls, hospital-acquired infections, pressure sores, mortality), and nurses' wellbeing (e.g., risk of burnout) in general hospital wards (Cho et al., 2015; Lake et al., 2020; McHugh et al., 2021; Needleman et al., 2020). Although less often researched, similar observations have been made in the setting of intensive care units (ICUs) (Bruyneel et al., 2021b; Kester et al., 2021; Margadant et al., 2020; Rae et al., 2021). Unfinished care is an umbrella term encompassing several concepts (e.g., care left undone, missed care), that describe the situation in which nurses are forced to delay or omit necessary nursing care (Jones et al., 2015). Several scales exist to assess unfinished care and include several categories such as clinical care, communication with patients and families, and documenting nursing care. There have been indications from studies conducted in general hospital wards that unfinished nursing care plays a role in the associations between in-patient

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outcomes and nurse wellbeing (Ball et al., 2018; Bhatraju et al., 2020; Cho et al., 2020; Griffiths et al., 2018b).

It has been previously reported that unfinished nursing care occurred only infrequently in hospital wards during the COVID-19 pandemic (Labrague et al., 2022; Vogelsang et al., 2021). In contrast, a study of ICUs in Sweden reported an increase in unfinished nursing care in basic ICU care (Falk et al., 2022). Also, studies have reported an increased workload associated with the care of patients with COVID-19 in ICUs (Bruyneel et al., 2021a; Hoogendoorn et al., 2021). Therefore, it is of interest to assess the rates of unfinished nursing care in ICUs during the pandemic.

Several factors have been found to be associated with unfinished nursing care, including the work environment, staffing levels, and resource adequacy (Pereira Lima Silva et al., 2020; Simonetti et al., 2022). Associations between a better working environment, adequate staffing levels for nurses, and lower levels of unfinished nursing care have already been demonstrated in ICUs (Chiappinotto et al., 2022; Duffy et al., 2018; Liu et al., 2016; Vincelette et al., 2022). Some studies have indicated a mediating role for unfinished nursing care in the relationship between nurse working environment (including nurse staffing levels) and adverse patient outcomes in the context of general hospital wards (Ball et al., 2018; Bruyneel et al., 2015). However, despite this evidence of the importance of unfinished nursing care and the analysis of risk factors, the underlying mechanisms are less well studied in the ICU setting.

Given the association between unfinished nursing care and adverse patient outcomes, nurses' perceptions of the quality and safety of care are also relevant outcomes to study. Research has shown that these outcomes and nurses' general opinion of their work are connected (Bai et al., 2015). A study in the ICU showed that the perception of quality of care was associated with the work environment and, more specifically, with perceived staff adequacy and patient care (Stalpers et al., 2017). Furthermore, given the psycho-emotional impact of unfinished nursing care on nurses, the risk of burnout is also an important outcome to focus on (Piotrowska et al., 2022; Uchmanowicz et al., 2021).

This study focused on the prevalence of unfinished nursing care in the ICU given the potential high impact of COVID-19 on factors related to unfinished nursing care. A second objective of the study was to examine whether unfinished nursing care has a mediating role in the associations between nurse working environment, nurse-perceived quality of care, and risk of burnout among nurses. It was assumed that when problems in the work environment (with staffing and resource adequacy, in particular) occur, nurses are forced to leave necessary care undone, which jeopardizes both the quality of patient care and the wellbeing of nurses.

Methods

Study design

This was a cross-sectional study exploring the relationship between nurse working environment, unfinished nursing care, and three outcome variables: perceived quality delivered in the ICU, perceived patient safety in the ICU, and risk of burnout in ICU nurses.

Data from the Belgian Health Care Knowledge Centre, based on ICU nurse data conducted in Belgium (December 2021 to January 2022), were incorporated into the results (Van den Heede et al., 2022b).

An invitation email was sent in the first week of September 2021 to all chief nursing officers in Belgian hospitals with an ICU (100 hospitals with ICUs at 123 different hospital sites) asking them to participate in the study. In case of no response, a reminder was sent after 14 days. The call to participate was open until 1 October 2021. All ICUs from the participating hospitals were included. However, hospitals with ICUs at several sites could limit their participation to one hospital site. All registered nurses from the included ICUs were invited to participate except nurses on leave (sick leave, maternity leave, or holiday), agency nurses, and ward managers. In addition, healthcare assistants and other non-nursing staff were excluded (Bruyneel et al., 2023; Van den Heede et al., 2022b).

The data collection was mainly based on studies by the RN4CAST (Registered Nurse Forecasting) research group which has investigated the associations between nurse staffing levels, the work environment, nurse outcomes, and adverse patient outcomes (Sermeus et al., 2011). The RN4CAST research group was launched in 2009 as part of the European Union's Seventh Framework Programme for Research and Development, the Predictive Study of Nursing Needs in Europe, and was completed in 2011. The consortium has published more than 50 studies, conducted in more than twelve different countries (Dall'Ora et al., 2020). Except for some minor modifications to better match the context of the ICU setting, the same survey was used as in previous nationwide studies conducted in hospital ward units in 2009 and 2019 (Van den Heede et al., 2019). The professional organisations for intensive care nurses in Belgium were consulted to perform a face validity check for the minor changes made to adapt the survey to the ICU context.

Measures

This study included four types of measures: 1) the dependent variables of interest, including nurse-reported outcomes (section 2.2.1); 2) independent variables, including measures of the nursing work environment and nurse staffing levels (section 2.2.2); 3) unfinished care as a mediating variable (section 2.2.3) and, 4) control variables to adjust the analyses (section 2.2.4).

Outcome variables

There were three main dependent variables at the individual level.

Perceived quality in the ICU was measured based on the question *"In general, how would you describe the quality of nursing care delivered to patients on your unit?"* with 4 possible responses (1 = poor, 2 = fair, 3 = good, 4 = excellent). The variable was dichotomized into good/excellent versus poor/fair.

Perceived patient safety in the ICU was the second outcome variable and was based on the question *"Please give your unit an overall grade on patient safety."* with 5 response options (1 = failing, 2 = poor, 3 = acceptable, 4 = very good, 5 = excellent). The variable was dichotomized into acceptable/very good/excellent versus failing/poor.

Risk of burnout was assessed using the validated Maslach Burnout Inventory (MBI) scale (Dion and Tessier, 1994; Maslach et al., 1986). Each of 22 situational descriptions were scored on a 7-point scale (from 0 = never occurring to 6 = occurring every day). Binary variables per burnout dimension were calculated, indicating if a high risk of burnout was identified based on the sum score of the relevant items: emotional exhaustion (EE) with score 26 or higher, depersonalisation (DP) with score 9 or higher, and reduced personal achievement (PA) with score 33 or lower (Maslach et al., 1986). To estimate the overall prevalence of burnout, a composite measure was used with a high risk in each subdimension (Rotenstein et al., 2018).

These three variables have demonstrated good predictive validity and psychometrics in several studies (Dall'Ora et al., 2020; Sermeus et al., 2011).

Nurse working environment

The explanatory variable of primary interest was the nurse working environment, which was measured using the Practice Environment Scale of the Nursing Work Index (PES-NWI) (Lake, 2002). This scale comprises 32 items with an ordinal score (from 1 = strongly disagree to 4 = strongly agree) to assess 5 subdimensions of the environment: (1) Nurse participation in hospital affairs, (2) nursing foundations for quality of care, (3) nurse manager ability, leadership, and support of nurses, (4) staffing and resource adequacy, and (5) collegial nurse-

physician relations. The reliability (Cronbach's alpha coefficient) of the PES-NWI subscales ranges from 0.71 to 0.84 (Lake et al., 2020). These subscales have been shown to have high predictive validity for staff stability issues and quality of care in hospitals (Bruyneel et al., 2017).

Items are positively framed, so that higher scores reflect a more favourable working environment. A composite score at the hospital site level was calculated as the mean score across all items. Additionally, the mean score in each subdimension at the hospital site level was calculated. It was hypothesized that unfinished nursing care is a mediator for the staffing and resource adequacy component of the PES-NWI. To calculate the mean scores, we treated the ordinal scale as continuous, which makes the interpretation of the resulting variable less intuitive. Therefore, it was decided to standardize the variable (by subtracting the sample mean and dividing the result by the sample standard deviation).

Unfinished nursing care

To assess unfinished nursing care, nurses were asked to indicate for 15 activities whether or not they were necessary but were left undone because of time constraints. Among the activities, there are items related to clinical care (adequate patient surveillance, skin care, oral hygiene, pain management, treatments and procedures, administering medications on time, frequently changing patient position, hand hygiene, aspiration of airways), planning and communication (comforting/talking with patients/family, preparing patients for discharge from ICU, developing or updating nursing care plans/care pathways, planning care, multidisciplinary consultation meetings), and documenting nursing care. Based on the responses, the number of unfinished nursing care items at the individual level, the percentage of nurses per unfinished nursing care item, and the percentage of unfinished nursing care at the hospital site level were calculated.

Control variables

All regression models included hospital site level control variables for region (Brussels, Wallonia, Flanders) and type of hospital site (university hospital or general hospital), and individual-level control variables for gender, age group, and qualification of the nurse.

Ethics

The ethics committee of University Hospital Leuven approved this study (S65994) on November 12, 2021. The data were processed according to the Belgian law of July 30, 2018 and with Regulation (EU) 2016/679 of 27 April 2016, concerning the protection of natural persons in respect of processing activities and to ensure the free flow of personal data.

All nurses were informed via the information letter and electronically signed a Declaration of Consent via the software platform.

Statistical analyses

Descriptive analysis

Nurses are considered key sources of information for the assessment of performance at the hospital site level (Aiken et al., 2014). Hospital site descriptive statistics were computed by averaging answers from nurses within the same hospital site. Arbitrarily, at the level of a hospital site, a minimum of 10 respondents or a response rate of 75 % was required to include the hospital site in the final sample, being sufficiently representative. Results at the national level were calculated as weighted average percentages by hospital site, the weight being the number of respondents at the hospital site. Median (Mdn) variables and InterQuartile Ranges [p25–p75] were used to describe all variables.

Mediation analysis

Mediation analysis was performed following the PROCESS procedure (Hayes, 2022) to test the mediating effect of the nurse working environment. In two other studies, comparable models were proposed with unfinished nursing care as mediator, nurse working environment as explanatory variable, but with mortality as outcome variable (Ball et al., 2018; Bruyneel et al., 2015). A conceptual diagram is shown in Fig. 1 and hypothesizes that nurse working environment is associated with the relevant outcomes in both a direct way (blue path) and an indirect way through unfinished nursing care (orange path). In our main analysis, it was hypothesized that unfinished nursing care is a mediator of the staffing subdimension of the nurse working environment, but a more general specification with unfinished nursing care as mediator of the composite score of the nurse working environment was tested as sensitivity analysis (see section 2.3.3). Percentage unfinished nursing care is expressed as a value between 0 and 100, to facilitate interpretation of the regression output in terms of percentage points.

Both the mediator model (multiple linear regression with ordinary least squares between unfinished nursing care and nurse working environment) and the outcome model (multiple logistic model between outcome, unfinished nursing care, and nurse working environment) include control variables. The PROCESS procedure allowed for splitting of the effect between nurse working environment and the three outcome variables into the direct effects and the indirect effects.

Odds ratios (OR) with 95 % confidence intervals (95 % CI) and p-values are reported based on bootstrapped standard errors (with 10,000 replications). A p-value < 0.05 was considered statistically significant. All analyses were performed in R 4.1.2.

Sensitivity analysis

Three alternative specifications were estimated to assess the robustness of the results with respect to the specification of the outcome variables, the mediator, and the explanatory variable.

Alternative outcome variables were used, based on the underlying ordinal (quality and patient safety) or continuous score (burnout) before dichotomization. These outcome variables were treated as continuous, standardized, and estimated by multiple linear regression. Treating ordinal variables as continuous is appropriate when ordinal variables have at least five categories, which is the case for patient safety, while for quality this threshold is not reached (Detollenaere et al., 2017).

The mediator effect tested unfinished nursing care on an alternative question in the survey. A yes/no question asked nurses if they were able to perform all necessary care in their most recent shift. The percentage of respondents at the hospital site level unable to perform all necessary care provides an alternative measure for unfinished nursing care and was used to test the robustness of the mediator.

In the main analysis, a distinction is made between the five subdimensions of the nurse working environment under the hypothesis that unfinished nursing care is a mediator for the staffing subdimension. In an alternative specification, the composite score of nurse working environment is applied without distinguishing between subdimensions and unfinished nursing care is assumed to mediate the overall effect of the nurse working environment, similar as in two previous studies (Ball et al., 2018; Bruyneel et al., 2015).

Results

Descriptive results

In total, 2321 of 4851 invited ICU nurses completed the questionnaire (response rate of 47.8 %). For the data analysis, 24 hospital sites with 138 respondents (5.9 %) were excluded because they did not reach the minimum of 10 respondents nor a response rate of 75 %. Therefore, the final sample consisted of 2183 respondents from 68 hospitals and 78 hospital sites. The median age [p25–p75] of nurses per

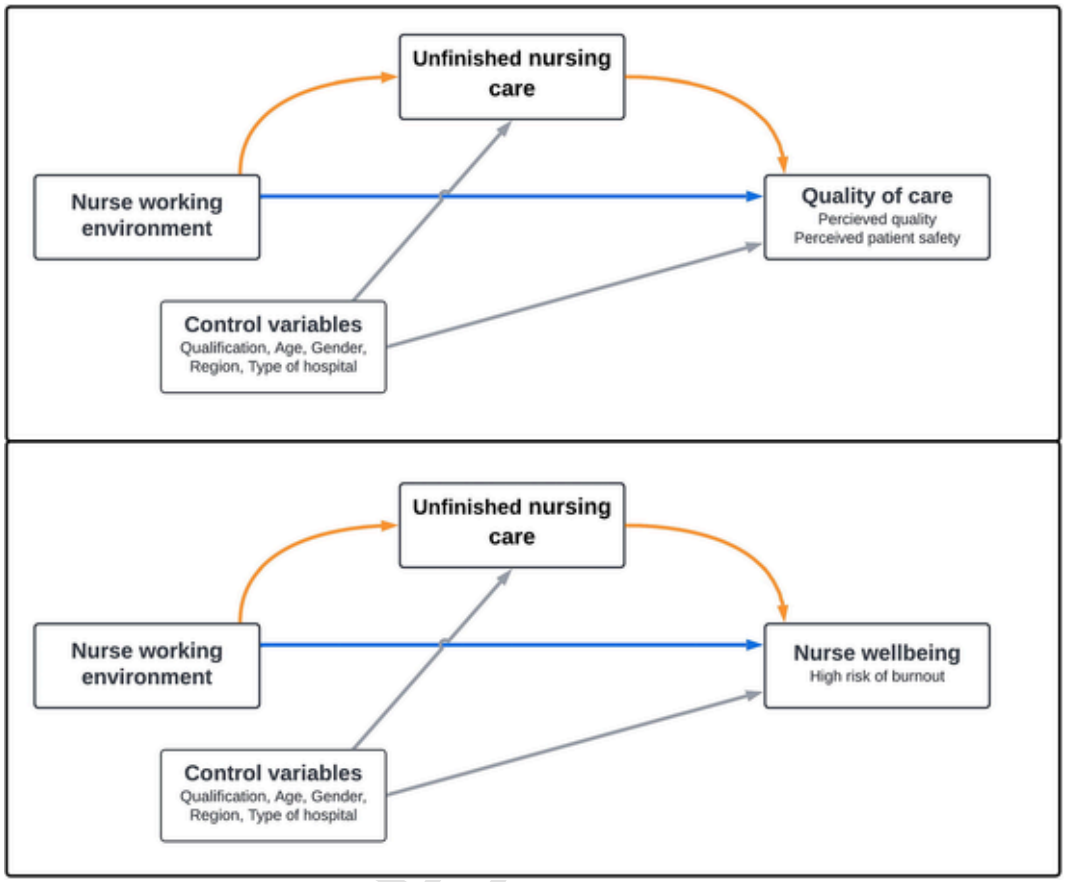


Fig. 1. Conceptual diagram of the mediation analysis *Blue path: the direct pathway; Orange path: the indirect pathway; Grey path: control variables.* (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

hospital site was 35 years [28–47] and the proportion of women was 74.5 %. A total of 59.8 % of the nurses worked full time and 72.2 % of nurses in the sample had an advanced ICU education and 10.6 % had both an advanced ICU education and a university degree (Table 1).

Perceived quality and safety of care and burnout risk

As shown in Fig. 2, the median proportion of nurses at the hospital site level that perceived quality of care as good or excellent was 65.0 % [57.9 %–75.7 %], while this was 91.3 % [86.4 %–97.0 %] for patient safety.

The median prevalence at the hospital site level for risk of burnout (high risk on all three dimensions) was 17.6 % [10.0 %–28.8 %]. The analysis of high risk of burnout by subdimension showed a median prevalence at the hospital site level of 42.9 % [30.8 %–55.8 %] for emotional exhaustion, 45.0 % [27.9 %–57.7 %] for depersonalisation, and 46.0 % [34.3 %–56.4 %] for reduced personal achievement (Fig. 2).

Table 1
Description of characteristics of respondents.

Variables	Results *(n = 2,183)*
Age (year), median [p25–p75]	35 [28–47]
Gender, female, (%)	74.5 %
Experience in ICU (years), median [p25–p75]	11 [4–22]
Full-time employed, (%)	59.8 %
Education/training, (%)	
Bachelor's degree	13.9 %
Advanced training in critical care nursing	72.2 %
Master's degree	1.6 %
Specialized nurses and Master's degree	10.6 %
Nurses w/o bachelor's (diploma level)	1.7 %

ICU: Intensive Care Unit.

Working environment

The overall mean score of the nurse working environment at the hospital site level was 2.43 ± 0.16. There were three subscales with a higher mean score (nurse-physician collegial relationship; foundations for nursing quality of care; manager ability, leadership, and support) and two subscales with a lower median score (staffing and resource adequacy; participation in hospital affairs). The mean score of the subscale "staffing and resource adequacy" was 2.10 ± 0.24 (Fig. 3).

Unfinished nursing care

About 76.0 % of nurses reported unfinished nursing care during their last shift. The most frequent unfinished nursing care items were in the category of planning and communication including emotional support to patients and family (49.2 %), documentation of unperformed care (40.4 %), and multidisciplinary consultation meetings (38.8 %). For the clinical care dimension, the unfinished nursing care items with a frequency above 20 % were: frequent changing of patient position (35.1 %), administering medications on time (29.1 %), oral hygiene (28.6 %), and adequate patient surveillance (24.5 %). The median number of items that were necessary but not performed was 3 [1–6] out of a list of 15. At the hospital site level, the median prevalence of unfinished nursing care was 26.3 % [21.2 %–29.8 %], which means that more than a quarter of necessary care was not performed (Fig. 4).

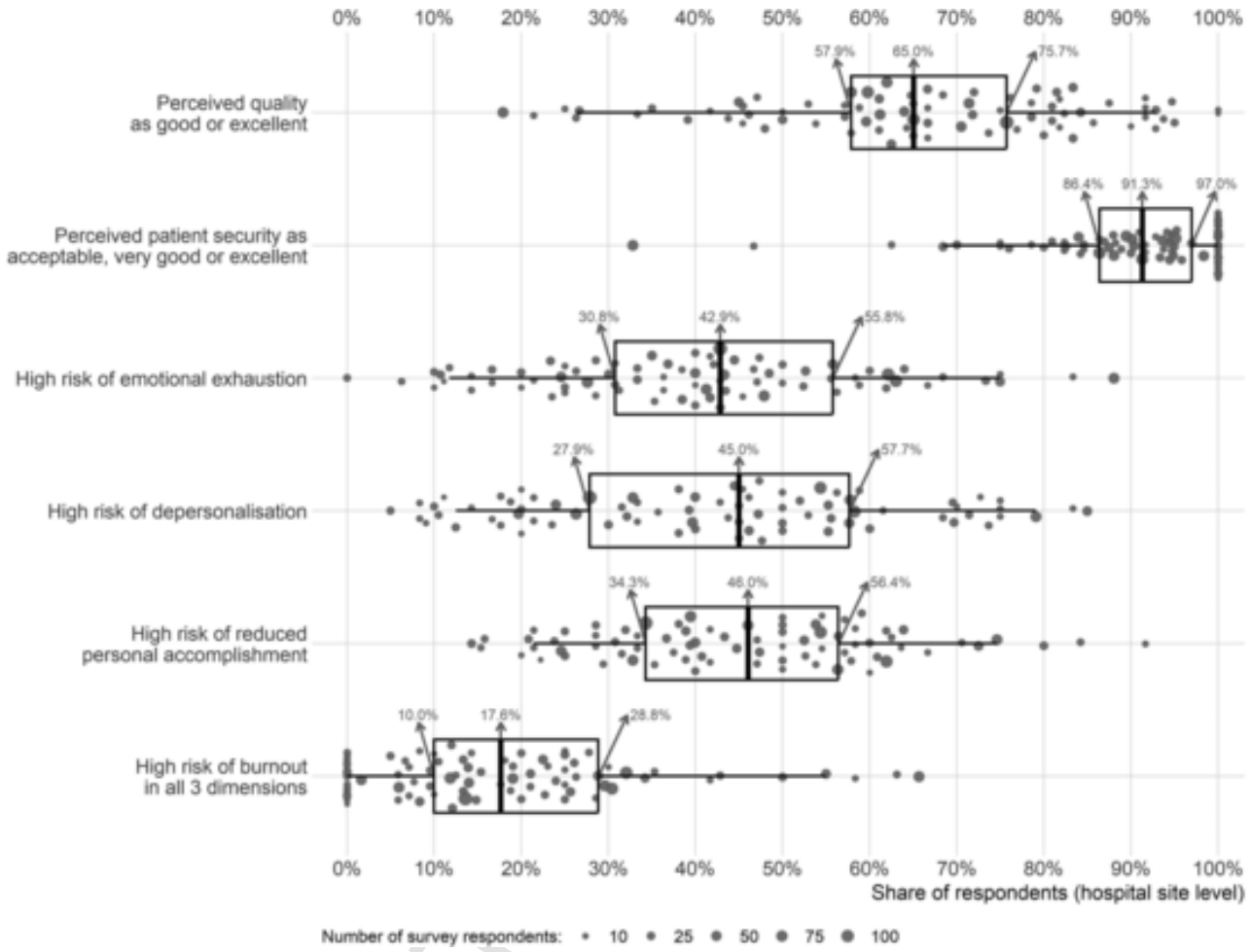


Fig. 2. Nurses' perceived quality and safety of care and nurses' risk of burnout, mean value at the hospital site level *Boxplot tails indicate 5th and 95th percentile value.*

Mediation effects

Results of the mediation analysis are reported in Table 2. Coefficient values from the mediator model (column 1) indicated that an improvement in the score of the staffing and resource adequacy subdimension by 1 standard deviation is associated with a reduction in unfinished nursing care of about 4 percentage points (OLS: −3.90, 95 % CI: −4.25 – −3.54). This effect exceeds the impact of any other subdimension by a factor of 4 or more, showing that it is primarily the subdimension 'staffing and resource adequacy' that is associated with unfinished nursing care.

Results of the outcome models (columns 2 to 7) demonstrate that unfinished nursing care was significantly associated with all outcomes. An increase in the percentage of unfinished nursing care was negatively associated with perceived quality of care (OR = 0.98, 95 % CI: 0.96–1.00) and perceived patient safety (OR = 0.95, 95 % CI: 0.92–0.97) and positively associated with the risk of burnout on all dimensions (e.g., high risk of depersonalisation, OR = 1.04, 95 % CI: 1.02–1.06).

Bringing both elements together, it is possible to calculate the effect of changes in the staffing and resource adequacy subdimension on the outcomes mediated through unfinished nursing care, also known as the indirect effect. There was a significant indirect effect on the perception of quality of care, that is an improvement by 1 standard deviation in the score of the staffing and resource adequacy subdimension implies that the odds to perceive quality as good or excellent are 1.07 times higher (OR = 1.07, 95 % CI: 1.01–1.15) and this is because of the 4 percentage point reduction in unfinished nursing care. Similarly, a positive indirect effect was found for patient safety (OR = 1.24, 95 % CI: 1.11–1.39). Significant negative indirect effects were observed with regard to the risk of burnout, with an improvement in the staffing and resource adequacy subdimension and the associated decrease in unfinished nursing care being associated with a reduction in the high risk of emotional exhaustion (OR = 0.90, 95 % CI: 0.84–0.96), the high risk of depersonalisation (OR = 0.87, 95 % CI: 0.81–0.93), the high risk of reduced personal accomplishment (OR = 0.93, 95 % CI: 0.87–1.00), and the composite measure of the risk of burnout (OR = 0.81, 95 % CI: 0.73–0.88).

Also, the direct effect of the staffing and resource adequacy subdimension on outcomes was calculated, that is the impact attributable to this variable, but not mediated by unfinished nursing care. Except for high risk of reduced personal accomplishment, the direct effect runs in the same direction as the indirect effect. A significant direct effect was found only for the high risk of emotional exhaustion, showing that an improvement in the staffing and resource adequacy subdimension was associated with a reduced risk (OR = 0.78, 95 % CI: 0.67–0.89). An important positive association was also observed between an improvement in the score of the quality of care foundation subdimension, on the one hand, and perceived quality of care (OR = 1.72, 95 % CI: 1.48–2.06), perceived safety of care (OR = 2.11, 95 % CI: 1.68–2.80), and a lower risk on high emotional exhaustion (OR = 0.83, 95 % CI: 0.71–0.96) and reduced personal accomplishment (OR = 0.79, 95 % CI: 0.68–0.91), on the other hand. We verified that this subdimension is not being mediated by unfinished nursing care, that is, the indirect effect is small and generally insignificant.

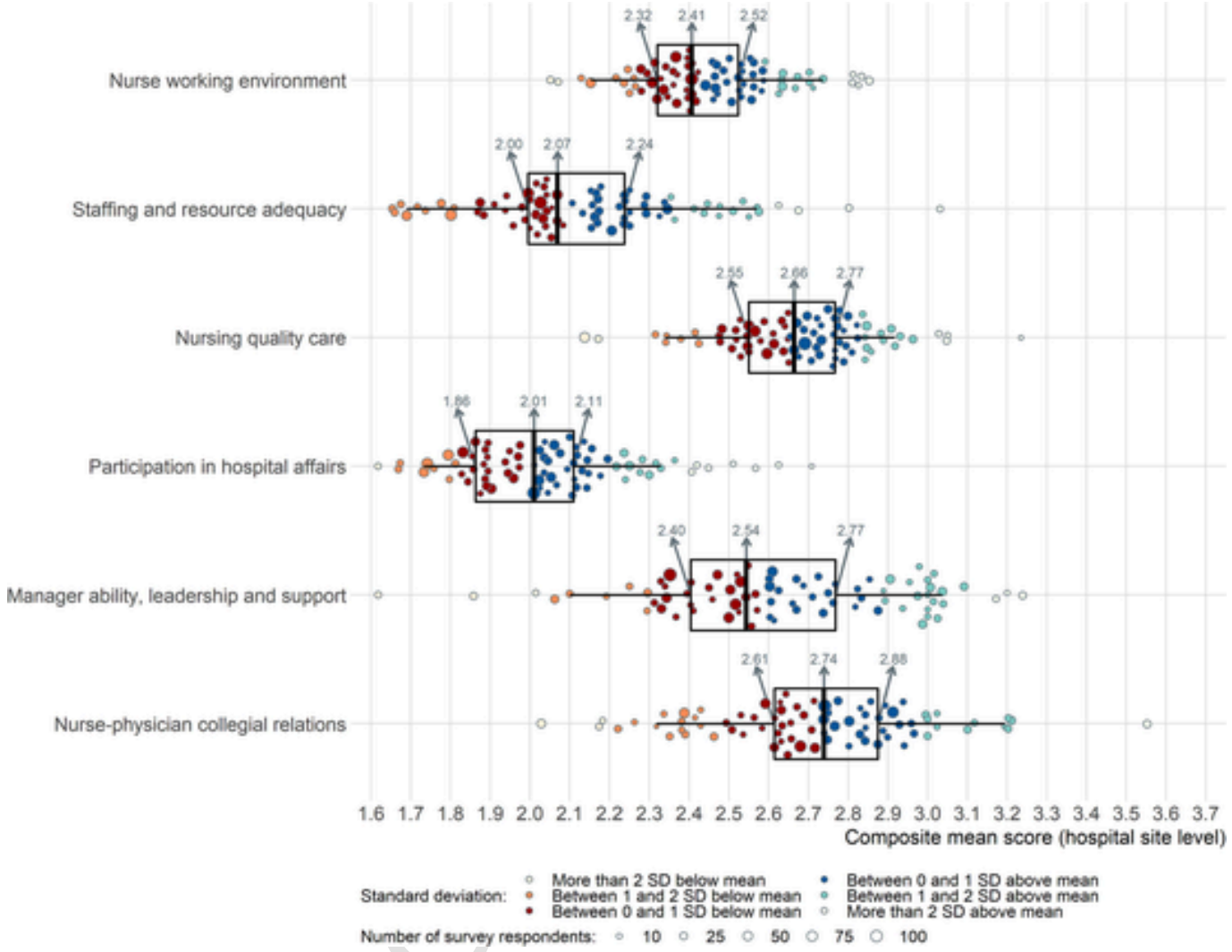


Fig. 3. Mean score for nurse working environment at the hospital site level.

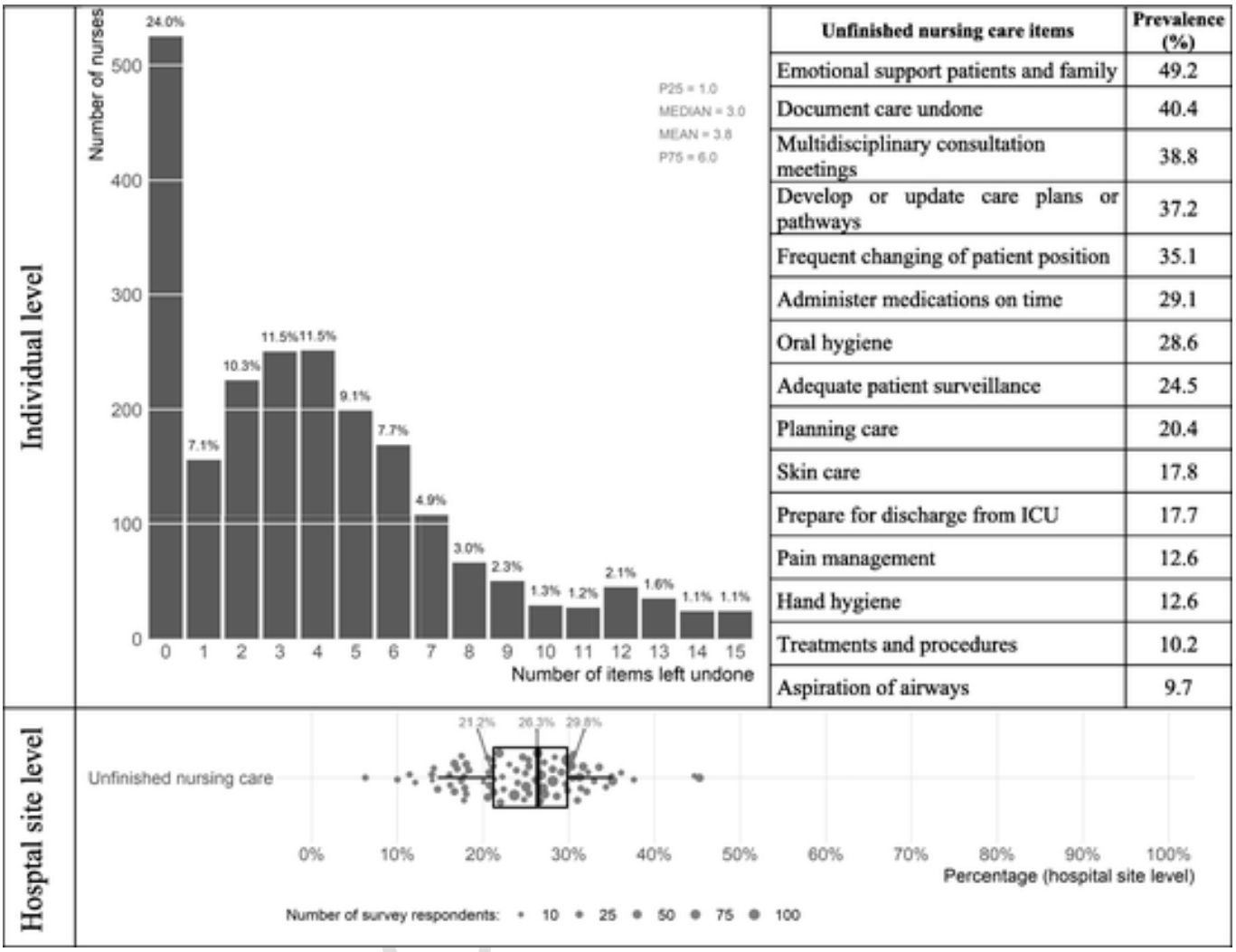
Results from the sensitivity analysis confirm the robustness of our results. Indirect effects were generally of similar sign and magnitude. Indirect effects estimated using continuous outcome variables and the composite score of nurse working environment are, however, more precisely estimated. The direct effect of nurse working environment when using the composite score was stronger as it combines the direct effects of the different subdimensions (supplementary, Tables 1–3).

Discussion

This study evaluated the prevalence of unfinished nursing care in the ICU setting and its mediating role in the associations between the staffing and resource adequacy dimension of the nurse working environment, and quality of care and nurses' wellbeing from December 2021 to January 2022, during the COVID-19 pandemic.

Although the calculation methods are quite different, the prevalence of unfinished nursing care in this study is high compared to other ICU-based studies conducted before and during the pandemic COVID-19 (Falk et al., 2022; Liu et al., 2016; Vincelette et al., 2022). Compared to a study carried out in the same country in hospital wards just before the onset of the COVID-19 pandemic, the overall prevalence was twice as high (Van den Heede et al., 2019). Potential explanations for this high prevalence are the COVID-19 context and inadequate staffing levels. Indeed, our results demonstrate that hospitals with a better score on 'staffing and resource adequacy' had lower unfinished nursing care, which is in line with the international literature (Ball et al., 2018; Griffiths et al., 2018b). The staffing and resource adequacy measure is a composite score including four items of the PES-NWI covering the availability of supporting staff as well as the availability of sufficient registered nurses to provide high quality of care. As such, overlap exists with the patient-to-nurse ratio concept. The patient-to-nurse ratio is, on average, 2.3 in Belgian ICUs (Bruyneel et al., 2023), which is high compared to most other European countries (Bruyneel et al., 2019; Khanna et al., 2022). In addition, due to the COVID-19 pandemic, the workload was higher and ICUs were staffed with more non-ICU nurses, which potentially led to an increase in the amount of unfinished nursing care (Bruyneel et al., 2021a; Hoogendoorn et al., 2021).

In this study, unfinished nursing care items were most frequently related to planning and communication. This finding differs from similar studies where the impact of unfinished ICU nursing care was found to significantly impact basic care such as early mobilisation (Falk et al., 2022; Vincelette et al., 2022). It should be noted that during the study period, there were still limitations on patient visits due to COVID-19 and this might have influenced the results (e.g., distance communication with the family has increased the workload and increased the unfinished nursing care in these items). In addition, this increase in workload also reduced patient support, which is included in the same item as emotional support for the family. Finally, ICU nurses may have focused on clinical care (e.g., aspiration of airways, treatment, and procedures) given the direct impact on patient safety. However, for clinical care



Unfinished nursing care items	Prevalence (%)
Emotional support patients and family	49.2
Document care undone	40.4
Multidisciplinary consultation meetings	38.8
Develop or update care plans or pathways	37.2
Frequent changing of patient position	35.1
Administer medications on time	29.1
Oral hygiene	28.6
Adequate patient surveillance	24.5
Planning care	20.4
Skin care	17.8
Prepare for discharge from ICU	17.7
Pain management	12.6
Hand hygiene	12.6
Treatments and procedures	10.2
Aspiration of airways	9.7

Fig. 4. Prevalence of unfinished nursing care at the individual level (top panel) and at the hospital site level (bottom panel).

items left undone, the same order of frequency was observed as in the other studies (e.g., change of position, mouth care) (Falk et al., 2022; Vincelette et al., 2022).

Based on the results of the mediation analysis, some important observations can be made. The analysis of the mediating effect of unfinished nursing care in the association between staffing and resource adequacy and perceived quality and safety of care are in line with previous research on clinical outcomes related to quality of care. Indeed, unfinished nursing care has been identified as mediating the relationship between staffing levels and patient outcomes such as in-hospital mortality (Ball et al., 2018).

These data demonstrate that unfinished nursing care has a mediating effect on the association between staffing and burnout. This sheds light on the potential underlying mechanism: if staffing levels are insufficient, nurses will abandon necessary care which might contribute, in part, to an increase in the risk of burnout (Nantsupawat et al., 2023; Stemmer et al., 2022). It is therefore essential to improve staffing levels and provide adequate resources to break this vicious cycle (Uchmanowicz et al., 2021). For this, there are different strategies requiring multiple interventions such as improving the nurse-to-patient ratio, more task differentiation in combination with more support roles, reorganisation of care in view of the global nurse shortage, improving job attraction and retention (Cho et al., 2020; Griffiths et al., 2018a; Lucchini et al., 2021; Van den Heede et al., 2022a; World Health Organization, 2022). The levels of staffing and adequate resources are not the only determinants of the risk of burnout. Indeed, other factors, found in the literature, should be limited to prevent it: shifts ≥ 12 h, low schedule flexibility, time pressure, high professional and psychological demands, low task variety, role conflict, low autonomy, negative nurse-physician relationship, low supervisor/leader support, poor leadership, negative team relationship, job insecurity, a lack of support from colleagues and the hierarchy, and shortage of COVID-19 protective equipment (Bruyneel et al., 2021b; Dall'Ora et al., 2020; Khan et al., 2022). Finally, the indirect effect of staffing and resource adequacy (via unfinished nursing care) was highly related to depersonalisation which is a distant or indifferent attitude towards work and can also be defined as cynicism (Atroszko et al., 2020). This finding supports the assumption that being unable to provide quality care due to inadequate staffing might result in an attitude of being indifferent to work and the care provided. In addition, ICU nurses may also try to distance themselves from their patients as a coping mechanism, because they feel unable to provide all the necessary care due to an insufficient level of staffing.

For the direct effect, three dimensions of the work environment were found to have an impact on the results. Adequate staffing and resources have a direct impact on reducing the high risk of emotional exhaustion. Concerning the latent profile of burnout, an inadequate level of staffing and resources has already been shown to be associated with a profile called "overextended", which means high emotional exhaustion when the workload is too high (Leiter and Maslach, 2016). The founda-

Table 2
Mediation analyses of the effect of nursing staffing of the work environment on the perception of quality and safety of care and the risk of burnout through unfinished nursing care (UNC).

Variables	Mediator	Outcome Variables –perceived quality of care		Outcome Variables – high risk of burnout by subdimension			
	Percentage UNC	Perceived quality (good/ excellent)	Perceived patient safety (acceptable/ very good/excellent)	Emotional exhaustion	Depersonalisation	Reduced personal accomplishment	Risk in all 3 subdimensions of burnout
	OLS coefficients	*Odds Ratios (OR)*					
Mediator							
Percentage UNC		0.98 [0.96–1.00]*	0.95 [0.92–0.97]***	1.03 [1.01–1.05]**	1.04 [1.02–1.06]***	1.02 [1.00–1.04]*	1.06 [1.03–1.08]***
Hospital-level work environment (standardised score)							
Staffing and resource adequacy	−3.90 [−4.25–−3.54]***	1.16 [1.00–1.34]	1.17 [0.93–1.50]	0.78 [0.67–0.89]***	0.95 [0.83–1.10]	1.10 [0.96–1.26]	0.91 [0.76–1.08]
Participation in hospital affairs	−0.09 [−0.48–0.31]	0.89 [0.78–1.03]	0.96 [0.76–1.22]	0.92 [0.80–1.05]	0.89 [0.78–1.02]	0.99 [0.87–1.13]	0.89 [0.75–1.04]
Foundations for quality of care	0.71 [0.24–1.20]**	1.72 [1.48–2.06]***	2.11 [1.68–2.80]***	0.83 [0.71–0.96]*	0.98 [0.84–1.15]	0.79 [0.68–0.91]**	0.86 [0.71–1.03]
Manager ability, leadership and support	0.44 [0.16–0.72]**	0.98 [0.87–1.09]	0.76 [0.62–0.90]**	1.10 [0.99–1.23]	0.99 [0.89–1.11]	1.08 [0.98–1.20]	1.14 [1.00–1.31]
Collegial nurse-physician relations	−0.90 [−1.20–−0.60]***	1.02 [0.91–1.14]	0.89 [0.72–1.08]	1.01 [0.91–1.12]	0.95 [0.85–1.05]	1.00 [0.91–1.11]	1.00 [0.88–1.13]
Indirect effect of the staffing and resource adequacy subdimension of the nurse working environment		1.07 [1.01–1.15]*	1.24 [1.11–1.39]***	0.90 [0.84–0.96]**	0.87 [0.81–0.93]***	0.93 [0.87–1.00]*	0.81 [0.73–0.88]***

The presented statistics are OLS coefficient estimates for the mediator model and odds ratios for the outcome models. 95 % confidence intervals between brackets are based on 10,000 bootstrap samples. All results were generated using the PROCESS procedure as described in (Hayes, 2022). Control variables (region, type of hospital site, gender, age group, and qualification of the nurse) are included in all regressions, but are not reported in the table. Significance levels: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001. UNC: unfinished nursing care, OLS: Ordinary least squares.

tion for quality of care was associated with the perception of good or excellent quality of care and safety of care, demonstrating a concordance between this dimension of the work environment and both outcomes. In addition, this subdimension was also associated with the risk of emotional exhaustion and reduced personal accomplishment. This can be explained by a lack of job satisfaction and feeling ineffective in care. The subdimension for manager ability, leadership, and support is directly associated with the perception of safety of care which shows the importance of the nurse manager in ICU care (Fukuda et al., 2020).

In summary, our results confirm that the prevalence of unfinished nursing care is an important indicator to signal problems in quality of care and the wellbeing of nurses in the ICU. It would, therefore, be recommended to monitor this outcome as a quality indicator as is done in some European countries (Department of Health, 2018; Jones et al., 2015). Finally, this study shows that nurse working environment must be properly considered in hospital management to decrease the prevalence of unfinished nursing care. In addition, sufficient resources and staffing levels are essential to ensure a consistent quality of care, which would also enable nursing staff to respond to the constant changes in acuity and severity of patients in the ICU.

Limitations and strengths

This study has some limitations. Specifically, the study was cross-sectional in nature, which means that it provided a description of the variation in nurse working environments and nurse outcomes across hospital sites and provided a way to study the relationships between these concepts but causal interpretations should be avoided because many other factors may influence the results. Moreover, the most important limitation is that the results are self-reported and need to be further explored with additional, more objective measures of staffing levels, unfinished nursing care, and quality. However, previous research on nurse-reported outcomes, such as quality of care, have shown that nurse reports are a good representation of actual patient mortality derived from independent sources. In addition, it would be interesting to repeat the same study with an objective assessment of the workload even though the nurse-to-patient ratio was tested to show relevant results. Furthermore, although experience and qualifications were requested, the skill levels and impact of non-ICU nurses are missing from the analyses. Finally, though the response rate of 47.8 % is acceptable, it is at the lower end of rates reported in similar studies conducted prior to the pandemic (from 40 % to 80 %, depending on the country) (Aiken et al., 2014; Van den Heede et al., 2019). Also at the hospital and hospital site level, the sample is quite representative for the Belgian hospital setting, with a small underrepresentation of hospital sites with smaller ICUs. The sample included six out of seven university hospitals, 63.4 % of all hospital sites with ICUs, and accounted for 1,517 operational beds or 75.9 % of the estimated operational ICU beds in Belgium.

Conclusions

In this study conducted during the COVID-19 pandemic, the prevalence of unfinished nursing care in ICUs was high and the most frequently unfinished items were in the planning and communication category. Adequate staffing and resources had a direct impact on reducing the high risk of emotional exhaustion. In addition, unfinished nursing care had a mediating effect between adequacy of staffing and resources and perceived quality and safety of care and the burnout risk among ICU nurses. Improving staffing levels appears to be a key strategy to reduce unfinished nursing care and its negative impact on these outcomes. It must be noted that unfinished nursing care can also be seen as a warning signal of potential staffing and work environment issues.

Consent to participate

The authors affirm that signed informed consent was obtained from all individual participants included in this study.

Consent for publication

The authors affirm that individual participants provided informed consent for publication of their data.

CRediT authorship contribution statement

Arnaud Bruyneel : Conceptualization, Writing – review & editing. **Nicolas Bouckaert :** Methodology, Software, Data curation, Formal analysis, Visualization. **Magali Pirson :** Validation, Supervision. **Walter Sermeus :** Validation, Supervision. **Koen Van den Heede :** Validation, Supervision, Writing – review & editing, Project administration.

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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Ethical approval

The ethics committee of University Hospital Leuven approved this study (S65994) on November 12, 2021. The data were processed according to the Belgian law of July 30, 2018 and with Regulation (EU) 2016/679 of 27 April, 2016, concerning the protection of natural persons in respect of processing activities and to ensure the free flow of personal data.

All nurses were informed via the information letter and electronically signed a Declaration of Consent via the software platform.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.iccn.2023.103596.

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