Exploring Nurses' Planning and Execution of Prospective Memory Activities

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Abstract

Background: During the planning and execution of nursing activities in a hospital, intended activities are sometimes delayed and omitted, which affects patient safety and patient and nurses' satisfaction. Delays and omissions can occur due to prospective memory (PM) failures, which means not remembering to perform a planned intention, or due to conscious decisions, like having other priorities. To gain insight, current study captured nurses' intentions to perform activities during a shift and investigated execution and priority.

Aim: To gain insight into the nurses' planning and execution of PM activities, in a hospital ward.

Method: Descriptive study on twelve registered nurses, using observations per nurse to quantitatively measure the nurses' planning and execution of PM activities, followed by qualitative listing of captured intentions and a subsequent questionnaire to quantitatively measure the nurses' perspective of execution (in time, delayed, omitted) and prioritizing (Visual Analogue Scale 1-10).

Results: Out of the 978 measured intentions to perform PM activities, 25.4% were delayed or omitted and 30.2% of these delays and omissions occurred due to PM failures. Nurses attached a significantly lower priority to the PM activities that were omitted due to PM failures, compared to the PM activities that were executed in time ($p<0.05$). One of the most common reasons for conscious delays and omissions was 'no priority'.

Conclusion: PM failures played an important part in the measured delays and omissions. Prioritizing of PM activities turned out to be an essential factor in both omissions due to PM failures and conscious delays and omissions.

Recommendations: Further research, focused on other hospitals and wards, age differences, personal differences in need for cues, optimal ways to plan and execute activities, and strategies to improve retrieval of intentions with a lower perceived priority.

Keywords: nursing, memory, intention, task performance and analysis, health priorities

Samenvatting

Achtergrond: Tijdens het plannen en uitvoeren van verpleegkundige activiteiten in een ziekenhuis, worden beoogde activiteiten soms uitgesteld of niet uitgevoerd, wat patiëntveiligheid en tevredenheid onder patiënten en verpleegkundigen kan beïnvloeden. Activiteiten kunnen uitgesteld of niet uitgevoerd worden vanwege falen van het prospectief geheugen (PG), wat het niet herinneren om een geplande intentie uit te voeren betekent, of door bewuste redenen, zoals andere prioriteiten. Om inzicht te verkrijgen, heeft deze studie intenties van verpleegkundigen voor PG activiteiten achterhaald gedurende een dienst en uitvoering en prioritering onderzocht.

Doel: Inzicht verkrijgen in de planning en uitvoering van PG activiteiten van verpleegkundigen, op een ziekenhuisafdeling.

Methode: Beschrijvende studie betreffende twaalf verpleegkundigen. Tijdens observaties werd de planning en uitvoering van PG activiteiten kwantitatief gemeten per verpleegkundige. Na iedere observatie werd op kwalitatieve wijze een lijst gemaakt van de onderschepte intenties, gevolgd door een vragenlijst over uitvoering (op tijd, uitgesteld, niet uitgevoerd) en prioritering (Visueel Analoge Schaal 1-10) (kwantitatief; verpleegkundig perspectief).

Resultaten: Van de 978 gemeten intenties voor PG activiteiten, werd 25.4% uitgesteld of niet uitgevoerd, waarbij 30.2% gebeurde door falen van PG. Verpleegkundigen verbonden een significant lagere prioriteit aan niet uitgevoerde PG activiteiten door falen van PG, in vergelijking met op tijd uitgevoerde PG activiteiten ($p < 0.05$). Eén van de meest voorkomende redenen voor bewust uitstellen of niet uitvoeren van PG activiteiten was 'geen prioriteit'.

Conclusie: Falen van PG speelde een belangrijke rol bij uitgestelde en niet uitgevoerde PG activiteiten. Prioriteren bleek een belangrijke factor bij zowel niet uitgevoerde activiteiten door falen van PG als bij bewust uitgestelde en niet uitgevoerde PG activiteiten.

Aanbevelingen: Verder onderzoek, gericht op andere ziekenhuizen en afdelingen, leeftijdsverschillen, verschillen in behoefte aan herinneringen, optimale manieren voor planning en uitvoering van activiteiten, en strategieën om terughalen van intenties met lagere prioriteit te bevorderen.

Trefwoorden: verpleegkunde, geheugen, intentie, taakuitvoering en analyse, gezondheidsprioriteiten

Introduction

The nursing hospital environment is changing, due to shorter hospital admissions, higher patient turnover, increased patient acuity and higher care intensity.[1] These changes result in an increasing workload, which influences the planning and execution of nursing activities,[2,3] and is revealed in Western countries, including the Netherlands.[2,4,5] More omissions and delays of nursing activities occur,[2,3,6] and serious medical errors happen due to forgetting of activities.[7] These omissions, delays and errors lead to deficits in the quality of care,[3,6,8] which decreases patient satisfaction[9,10] and could jeopardise patient safety.[7,8,11] Furthermore, lacks in quality of care can cause nurses' job dissatisfaction,[12] burnout and intentions to leave their job.[4,6] Exhausted and dissatisfied nurses also affect, on their turn, the quality of care,[6] which weakens the quality of care even more. To be able to enhance patient safety and increase satisfaction among patients and nurses it is important to analyze and improve the planning and execution of nursing activities in a hospital.

In the hospital, nurses perform around 84 different types of activities during a shift.[13] Some of these activities are executed immediately after the intention is formed, like filling a glass of water directly after patient X asks for it. A nurse could also plan the filling of this glass of water after she finishes the care for patient Y. Nurses need their prospective memory (PM) to remember such a delayed intention at a moment later in time.[14-17] PM is the ability to remember to execute an activity at a suitable moment in the future, when the initial intention to perform this activity was formed before.[18] These kinds of activities, with a delay between intention and execution, are called PM activities and play a substantial role in the nursing environment.[14,15,19-21] There are different types of PM activities, including event-based PM activities (retrieval when event happens), time-based PM activities (retrieval at a specific time) and interrupted PM activities (retrieval at the end of the interruption).[17,22]

When the nurse (temporarily) forgets to fill the glass of water, after she finishes the care for patient Y, a PM failure occurs.[20] This PM failure could lead to a delay in the execution of this activity or even to an omission, when the patient never got the glass of water during the nurses' shift. Whether or not an activity is executed could be influenced by the number of intentions in the nurses' mind, waiting to be performed, the prospective load.[15] The more intentions the nurse needs to remember, the harder it gets to remember to fill the glass of water.[23] Cues can help a nurse to improve the retrieval of intentions and thus decrease PM failures.[14,16,20] A spoken reminder from patient X, or visual cues, like seeing a colleague walk around with a glass of water or seeing a tap and prompt remember to fill the glass of water, are referred to as external cues. Internal cues are defined as cues the nurse creates herself, like writing down the intention on a to-do list. Type of PM activity could influence the retrieval of intentions as well and thus the occurrence of PM failures.[17,22] Besides PM failures, when a nurse is unaware of the delay or omission of a PM activity, a

nurse can consciously delay or omit a PM activity. For instance (in the example of the glass of water), because the nurse feels annoyed with patient X or because other activities have a higher priority.[23] Considering the existing literature on PM in nursing, it remains unclear whether delays and omissions of PM activities occur consciously or due to PM failures, since the main focus of these previous studies was classifying PM activities by using an existing taxonomy[21] and exploring the nature of nursing work.[24] Insight in reasons for delays and omissions is crucial in order to enhance the planning and execution of nursing activities.

Current study aimed to provide insight into the nurses' planning and execution of PM activities by capturing the nurses' intentions to perform PM activities, investigating whether these intended PM activities were executed in time, were delayed or omitted, examining reasons for delays and omissions and exploring the role of priority. Once it is clear how nurses plan and execute their PM activities and why nurses delay or omit PM activities, appropriate solutions and strategies can be explored in further research, in order to improve the planning and execution of nursing activities and thus improve patient and nurses' satisfaction in hospital care.

Aim

The aim of current study was to gain insight into the nurses' planning and execution of PM activities, in a hospital ward.

Method

Design

Current study concerned a descriptive study, using structured, non-participative observation resulting in quantitative data, followed by qualitative listing of captured intentions and a subsequent questionnaire resulting in quantitative data. Figure 1 shows the main study procedures. The observations were a suitable way to determine behaviors and actions of the nurses.[25] The questionnaire was efficient, provided to-the-point answers and presumably minimized the proportion of socially acceptable answers.[25]

Population & domain

The study population consisted of twelve registered nurses, working in two surgical wards of a top-clinical hospital in the Netherlands. A convenience sample was used in order to find motivated, native Dutch-speaking participants, since participants needed to speak out loud during the observation.

Data collection

The method of structured, non-participative observation was applied per nurse to quantitatively measure the nurses' planning and execution of activities. Data was collected on intentions, internal/external cues, actions and interruptions (Table 1). Intentions to perform PM activities were captured by using the Think Aloud method, in which the nurse spoke out

loud the thoughts occurring in his/her short-term memory,[26] and hereby every decision, intention and plan. This approach involved minimal interference with the nurses' work.

A questionnaire was used subsequently and was based on the captured intentions during the observation period. The questionnaire quantitatively measured the nurses' perception of the priority he/she attached to each PM activity (Visual Analogue Scale 1-10) and the nurses' perspective of execution of each PM activity (in time, delayed or omitted) (Table 2).

Procedures

Two pilot observations were performed prior to the start of the data collection, and contributed to the observation skills of the first author (a nurse with three years of experience in hospital care) and a refinement of the study procedures, which was important to minimize biases.[25]

All nurses of particular wards received an invitation letter for joining in current study and were recruited in subsequent team meetings. Recruited nurses received an information leaflet with Think Aloud instruction, and were able to ask questions during a telephone call with the second author (a researcher on the interaction of the built environment and people) the day before observation. The hospitalized patients involved in the observation received an information letter in advance and verbal permission was asked. Staff and visitors were informed through information letters at the entrance of the ward.

To reduce the chance of influencing the nurses' behavior, nurses were told that the research was performed to gain insight into nursing activities, without mentioning the focus on PM. Therefore, participating nurses gave written permission for data gathering only (observation and questionnaire) before participation.

Observations (7:00am-10:00am) took place during a morning shift on a weekday and started at the change of shift report. Observation time was limited to three hours, since the list of captured intentions (questionnaire) was presented to the nurse during lunch break, and could not be too long. During the observation, the first author followed the nurse and wrote down data on a predetermined observation model. After the observation (10:00am-12:30pm), the first and second author formed the list of captured intentions based on the written data, which was used to create the questionnaire. This was done by two authors with different backgrounds in order to enhance confirmability.[25]

During lunch break (12:30pm-13:00pm), the questionnaire was submitted to the nurse. At that time the true purpose of the study was explained and the informed consent was signed, according to the procedure of retrospective informed consent.

Data analysis

The first author analyzed the data quantitatively using IBM SPSS Statistics 23. Results were discussed with the second author. Number of registered intentions to perform

PM activities and number of executed non-PM activities were determined per nurse, and means and standard deviations were calculated. Per nurse, the number of internal and external cues were obtained, and the prospective load per minute was calculated (number of measured intentions (PM) - number of executed PM activities). The course of the prospective load during the observation period was presented in a timeline per nurse.

In further analysis all measured intentions to perform PM activities were examined (of all twelve nurses). The number of delayed and omitted PM activities were obtained, according to the nurses' perspective, and the proportion of delays and omissions that occurred consciously or due to PM failures was determined. Possible differences in occurrence of internal/external cues, type of PM activity and nurses' perception of priority of each planned PM activity were examined between PM activities executed in time, and delayed and omitted PM activities due to PM failures. The Pearson chi-square test was applied to determine possible differences in the categorical variables internal/external cues and type of PM activity. The Mann-whitney u test was performed to discover possible differences in the nurses' perception of priority of each planned PM activity, which was a non-normally distributed continuous variable. Statistical significance was assumed for $p < 0.05$.

To attach meaning to the results, the first and second author performed a qualitative analysis subsequently. The authors developed a decision tree (figure 2) based on the specific reasons nurses gave for consciously delaying or omitting a PM activity. Conscious delays and omissions were categorized according to this decision tree. Furthermore, the authors determined for each delayed or omitted PM activity whether this specific activity could possibly result in an effect on patient safety or satisfaction, or could affect colleagues. This was done through reasoning, based on the first authors' experiences as a nurse. Reasoning of possible effects of delays and omissions on colleagues was performed as follows. A colleague could be affected by having to take over an omitted PM activity in a subsequent shift, or by an increase in workload due to a delayed or omitted PM activity. The following cases show a reasoning example of possible effects of delays and omissions on patient safety and satisfaction. Patient safety was possibly affected when a patients' blood sugar was measured after breakfast (delay) or not at all (omission). Perhaps the value would have been too low/high before breakfast (in time), which required an action (administering more/less insulin). Such delays and omissions with a possible effect on patient safety could affect patient satisfaction as well. Switching off a nebulizer after 30 minutes (delayed) or not at all (omission), would not affect patient safety but could affect patient satisfaction since a nebulizer should be switched off after 10 minutes (in time), which could make the patient feel neglected. Whether possible effects actually occurred was not registered.

Ethical issues

Current study was conducted according to the principles of the Declaration of Helsinki[27] and was assessed to be a non-WMO study (16-706/C). Participating nurses, patient' room numbers, observation date and ward were encoded, to ensure confidentiality.

Results

The twelve observations involved a total of 37.5 observation hours. General data about the participating nurses is depicted in table 3. The sample consisted of nurses with an age ranging from 22 until 32. A total of 978 intentions to perform PM activities (range per nurse: 64-109) were registered during the observations with the TA method and 2468 non-PM activities (range per nurse: 165-282) were recorded. Number of internal cues ranged from six until 43 and number of external cues from five until 28. Figure 3 shows the timelines per nurse, displaying the course of the prospective load during the observation period. The prospective load increased fast in the beginning of the shift, in eleven out of the twelve nurses. After that, the course of the prospective load differed per nurse.

Reasons for delays and omissions

Out of the 978 formed intentions to perform PM activities, 724 (74.0%) PM activities were executed in time, 73 (7.5%) PM activities were delayed and 175 (17.9%) PM activities were omitted, according to the participating nurses. Reasons for delays and omissions are presented in table 4. Seventy five (30.2%) delays and omissions occurred due to PM failures and 173 (69.8%) happened consciously. Most common reasons for conscious delays and omissions were: event did not occur yet (n=36; 20.8%), PM activity was no longer required (n=33; 19.8%) and no priority (n=32; 18.5%).

It could occur that in the care process the nurse decided that a PM activity was no longer required. During the authors' reasoning of possible effects on patients and colleagues these PM activities were not taken into account. Since the questionnaire was submitted to the nurse during lunch break, PM activities for the afternoon ('point in time/event did not occur yet') were not taken into account as well for this analysis.

Possible effects on patients

Table 5 shows the number of delays and omissions with a possible effect on patients. Nine delays (seven due to PM failures) had a possible effect on patient safety. For example: 'responding to a patient call', 'measuring blood pressure' and 'measuring blood glucose'. Patient safety was possibly affected by 30 omissions (19 due to PM failures), such as: 'measuring weight', 'administering an enema' and 'observing haematuria'.

Patient satisfaction was possibly affected by 31 delays (ten due to PM failures). For instance: 'switching off a nebulizer', 'providing ADL-care', and 'administering medication'. Thirty six omissions (15 due to PM failures) had a possible effect on patient satisfaction.

Examples were: 'organizing discharges', 'making a bed' and 'explaining postoperative pain medications'.

Possible effects on colleagues

The number of delays and omissions with a possible effect on colleagues are shown in table 6. Eight delays (five due to PM failures) possibly resulted in extra work for colleagues, like 'participating in daily meeting at start shift' and 'communicating with colleague after medical round'. Seven omissions (six due to PM failures) possibly resulted in extra work for colleagues. For example: 'discussing patient medical care plan during medical round' and 'taking patient identification label to surgery'.

A colleague possibly needed to take over the activity in the case of 31 omissions (16 due to PM failures). Examples were: 'applying an arm sling', 'organizing discharges' and 'arranging an anti-decubitus cushion'.

PM failures

Table 7 presents possible differences between PM activities executed in time, and delayed and omitted PM activities due to PM failures. No significant differences were found in the appearance of internal and external cues, although external cues seemed to occur less often in omissions (p=0.168).

The portion of PM failures in event-based, time-based and interrupted PM activities, was respectively 5.7%, 8.5% and 3.3%. Event-based activities seemed to be delayed less often and interrupted activities appeared to be delayed and omitted less often. However, no significant differences were found in type of PM activity.

The median priority of each planned PM activity, according to the nurses' perception, was significantly lower in omissions compared to execution in time (p=0.001). No significant difference was found in median priority for delays, compared to execution in time.

Discussion

Aim of the current study was to gain insight into the nurses' planning and execution of PM activities, in a hospital ward. The findings show that, according to the nurses' perspective, 25.4% of the 978 PM activities were delayed or omitted and 30.2% of these delays and omissions happened due to PM failures. Current study found that nurses attached a significantly lower priority to the PM activities that were omitted due to PM failures, compared to the PM activities that were executed in time. 'No priority' was also one of the most common reasons for conscious delays and omissions, besides 'event did not occur yet' and 'PM activity was no longer required'.

To attach meaning to the results, current study explored the possible impact of the measured delays and omissions on patients and colleagues. During the 37.5 observation hours, patient safety was possibly affected by 39 delays and omissions, patient satisfaction by 67 delays and omissions, 15 delays and omissions possibly resulted in extra work for

colleagues and in the case of 31 omissions a colleague possibly needed to take over the activity. Results of previous studies strengthen these findings by finding associations between delayed and omitted nursing activities and patient safety and satisfaction.[8,10,11,28- 32] Some studies used surveys to measure delays and omissions as reported by nurses according to their last shift(s). These studies found associations with nurses' ratings of patient safety and quality of care,[8] readmissions,[28] mortality,[29] adverse events[30,31] and patient satisfaction.[10,32] One study had been identified that linked patient reports of delays and omissions to adverse events.[11]

Current study measured PM activities, determined prospective loads and discovered the PM activities that were delayed or omitted. To be able to do this, it was essential to capture the intentions a nurse formed in his/her mind. Considering the existing literature, two studies had been identified that intended to capture the nurses' intentions to perform PM activities in a hospital.[21,24] One study used video recordings to capture intentions.[21] The video analysis created a high risk of missed intentions, since nurses usually form several intentions in their minds without speaking those intentions out loud.[21] The other study identified intentions by interviewing the observed nurse during the observation and by predictions of the author.[24] This method could have caused bias, since interviewing could have interfered with the nurses' work and it remained uncertain if the nurse actually formed the predicted intentions. Current study used a different approach to capture nurses' intentions to perform PM activities, by using the Think Aloud method. This method involved minimal interference with the nurses' work and revealed the intentions the nurse formed in his/her mind, without making predictions, which enhanced reliability of the results.[25] It is reasonable to assume that the nurses did not speak out loud all their intentions to perform PM activities, resulting in missed intentions. Number of captured intentions in current study could not be compared to results of the previous two studies, since those studies did not mention the number of measured intentions.

The use of the Think Aloud method was a strength of current study. Another strength involved the measurement of actual delays and omissions of PM activities during a nursing shift. While previous research identified omissions by determinations of the researchers,[33] current study measured execution according to the nurses' perspective which did not involve interpretations of the authors. This enhanced objectivity of the results.[25] The measurement of perceived priority per PM activity was another strength, since this enabled the authors to explore the role of priority in the occurrence of PM failures. Some important limitations have to be mentioned as well. When the questionnaire was submitted to a nurse, it was emphasized that he/she would not be criticized when an activity was forgotten. But some delays and omissions, especially the ones due to PM failures, might still have been missed, because of possible hesitations of nurses to admit forgotten activities.[20] The subsequent

qualitative analysis involved an enrichment of the quantitative data, but had a subjective nature. The decision tree was developed by the first and second author and content validity should have been determined,[25,34] but has not been done in current study because of time limitations. Possible effects of delayed and omitted PM activities on patients and colleagues were only based on the first authors' experiences as a nurse, which could have caused bias. Another limitation was the relatively young age of the participating nurses (22-32), which made it impossible to investigate possible age differences in the nurses' planning and execution of PM activities. Since current study was conducted in two surgical wards of one hospital, additional research is required to confirm the findings in other wards and hospitals, in order to enhance generalizability.[25]

Implications for clinical practice can be derived from the results of current study and are described below. Since almost one third of the measured delays and omissions occurred due to PM failures, it seems especially important to find ways to improve the nurses' retrieval of intentions, in order to decrease PM failures. Previous studies mentioned cues as a way to improve retrieval of intentions.[14,16,20] Current study did not found significant differences in internal and external cues, when comparing PM activities executed in time to delayed or omitted PM activities due to PM failures. But when comparing the twelve nurses, number of internal cues varied between six and 43 and number of external cues between five and 28. This seems to indicate that some nurses need more internal and/or external cues to remember the same number of PM activities. Personal differences in the need for internal/external cues should be explored in further research.

Literature described the level of prospective load as another factor that could influence retrieval of intentions.[15,23] The prospective load timelines per nurse that were obtained in current study, indicated that nurses form most of the intentions to perform PM activities at the beginning of their shift, and that after this initial strong increase in prospective load, nurses have different ways to further plan and execute their activities during the shift. Further research should examine the effects of the level and course of prospective load on execution of PM activities and explore optimal ways for nurses to plan and execute activities during a shift.

Another relevant aspect in the retrieval of intentions is priority.[23] Current study found prioritizing to be an important factor in the occurrence of omissions due to PM failures. No priority was also a main reason for consciously delaying and omitting PM activities. This implicates that prioritizing is a crucial part in the nurses' planning and execution of activities and that (novice) nurses should be taught how to prioritize nursing activities. Perhaps, PM failures could be decreased by using more internal and external cues for the PM activities with a lower perceived priority. Further research should focus on strategies to improve the retrieval of intentions with a lower perceived priority.

Conclusion

During the planning and execution of nursing activities, a substantial number of PM activities were delayed or omitted, in which PM failures played an important part. Prioritizing of PM activities was an essential factor in both omissions due to PM failures and conscious delays and omissions. Further research should focus on the planning and execution of PM activities in other wards and hospitals, age differences, personal differences in the need for cues, optimal ways to plan and execute activities related to level and course of prospective load, and strategies to improve the retrieval of intentions with a lower perceived priority.

References

1. Haberfelde M, Bedecarré D, Buffum M. Nurse-sensitive patient outcomes: an annotated bibliography. J Nurs Adm 2005;35(6):293-299.

2. Aiken L, Sloane D, Bruyneel L, Van den Heede K, Sermeus W. Nurses' reports of working conditions and hospital quality of care in 12 countries in Europe. Int J Nurs Stud 2013;50(2):143-153.

3. Duffield C, Diers D, O'Brien Pallas L, Aisbett C, Roche M, King M, et al. Nursing staffing, nursing workload, the work environment and patient outcomes. Appl Nurs Res 2011;24(4):244-255.

4. Aiken L, Sermeus W, Van den Heede K, Sloane D, Busse R, McKee M, et al. Patient safety, satisfaction, and quality of hospital care: cross sectional surveys of nurses and patients in 12 countries in Europe and the United States. BMJ 2012;344:e1717-e1717.

5. CBS. Centraal Bureau voor de Statistiek. Werknemers in zorg ervaren hoge werkdruk 2016 [Internet]. Available from: https://www.cbs.nl/nl-nl/nieuws/2016/46/werknemers-in-zorg-ervaren-hoge-werkdruk. [Accessed 13th December 2016].

6. Aiken LH, Clarke SP, Sloane DM, Sochalski JA, Busse R, Clarke H, et al. Nurses' reports on hospital care in five countries. Health Aff (Millwood) 2001;20(3):43-53.

7. Rothschild J, Landrigan C, Cronin J, Kaushal R, Lockley S, Burdick E, et al. The Critical Care Safety Study: The incidence and nature of adverse events and serious medical errors in intensive care. Crit Care Med 2005;33(8):1694-1700.

8. Ball J, Murrells T, Rafferty A, Morrow E, Griffiths P. 'Care left undone' during nursing shifts: associations with workload and perceived quality of care. BMJ Qual Saf 2014;23(2):116-125.

9. Kutney Lee A, McHugh M, Sloane D, Cimiotti J, Flynn L, Neff D, et al. Nursing: a key to patient satisfaction. Health Aff (Millwood) 2009;28(4):w669-w677.

10. Lake E, Germack H, Viscardi M. Missed nursing care is linked to patient satisfaction: a cross-sectional study of US hospitals. BMJ Qual Saf 2016;25(7):535-543.

11. Kalisch B, Xie B, Dabney B. Patient-reported missed nursing care correlated with adverse events. Am J Med Qual 2014;29(5):415-422.

12. Kalisch B, Tschannen D, Tschanen D, Lee H. Does missed nursing care predict job satisfaction? J Healthc Manag 2011;56(2):117-31; discussion 132.

13. Tucker A, Spear S. Operational failures and interruptions in hospital nursing. Health Serv Res 2006;41(3):643-662.

14. Grundgeiger T. Prospective memory in the ICU: The effect of visual cues on task execution in a representative simulation. Ergonomics 2013;56(4):579-589.

15. Fink N. Prospective memory in the nursing environment: Effects of type of prospective task and prospective load. [Santa Monica, CA]: The Human Factors and Ergonomics Society; 2009. p. 1669-1673.

16. McDaniel MA. Delaying execution of intentions: Overcoming the costs of interruptions. Applied cognitive psychology 2004;18(5):533-547.

17. Einstein GO, McDaniel MA. Normal aging and prospective memory. J Exp Psychol Learn Mem Cogn 1990;16(4):717-726.

18. McDaniel M, Guynn M, Einstein G, Breneiser J. Cue-focused and reflexive-associative processes in prospective memory retrieval. J Exp Psychol Learn Mem Cogn 2004;30(3):605-614.

19. Dismukes RK. Prospective memory in workplace and everyday situations. Current Directions in Psychological Science 2012;21(4):215-220.

20. Fink N. A survey of nurses self-reported prospective memory tasks: What must they remember and what do they forget? [Santa Monica, CA]: The Human Factors and Ergonomics Society; 2010. p. 1600-1604.

21. Grundgeiger T. Distributed prospective memory: An approach to understanding how nurses remember tasks. [Santa Monica, CA]: The Human Factors and Ergonomics Society; 2009. p. 759-763.

22. Dodhia RM. Interruptions create prospective memory tasks. Applied cognitive psychology 2009;23(1):73-89.

23. Walter. How important is importance for prospective memory? A review. Frontiers in Psychology 2014;5:657.

24. Wolf L, Potter P, Sledge J, Boxerman S, Grayson D, Evanoff B. Describing nurses' work: combining quantitative and qualitative analysis. Hum Factors 2006;48(1):5-14.

25. Polit DF, Beck CT. Nursing Research: Generating and assessing evidence for nursing practice. 9th ed. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2012. p. 175, 180, 191-192, 283-284, 286, 298, 305, 313, 318-319, 336-337, 585.

26. Siirala E, Peltonen L, Lundgrén Laine H, Salanterä S, Junttila K. Nurse managers' decision-making in daily unit operation in peri-operative settings: a cross-sectional descriptive study. J Nurs Manag 2016;24(6):806-815.

27. WMA. Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA. 2013; 310(20):2191-4.

28. Carthon JMB, Lasater K, Sloane D, Kutney Lee A. The quality of hospital work environments and missed nursing care is linked to heart failure readmissions: a cross-sectional study of US hospitals. BMJ Qual Saf 2015;24(4):255-263.

29. Schubert M, Clarke S, Aiken L, de Geest S. Associations between rationing of nursing care and inpatient mortality in Swiss hospitals. Int J Qual Health Care 2012;24(3):230-238.

30. Kalisch B, Tschannen D, Lee K. Missed nursing care, staffing, and patient falls. J Nurs Care Qual 2012;27(1):6-12.

31. Schubert M, Glass T, Clarke S, Aiken L, Schaffert Witvliet B, Sloane D, et al. Rationing of nursing care and its relationship to patient outcomes: the Swiss extension of the International Hospital Outcomes Study. Int J Qual Health Care 2008;20(4):227-237.

32. Bruyneel L, Li B, Ausserhofer D, Lesaffre E, Dumitrescu I, Smith H, et al. Organization of Hospital Nursing, Provision of Nursing Care, and Patient Experiences With Care in Europe. Med Care Res Rev 2015;72(6):643-664.

33. Potter P, Wolf L, Boxerman S, Grayson D, Sledge J, Dunagan C, et al. An Analysis of Nurses' Cognitive Work: A New Perspective for Understanding Medical Errors. Rockville (MD): Agency for Healthcare Research and Quality (US); 2005.

34. Vet HC de, Terwee CB, Mokkink LB, Knol DL. Measurement in Medicine. 4th ed. Cambridge: Cambridge University Press; 2015. p 155-159.
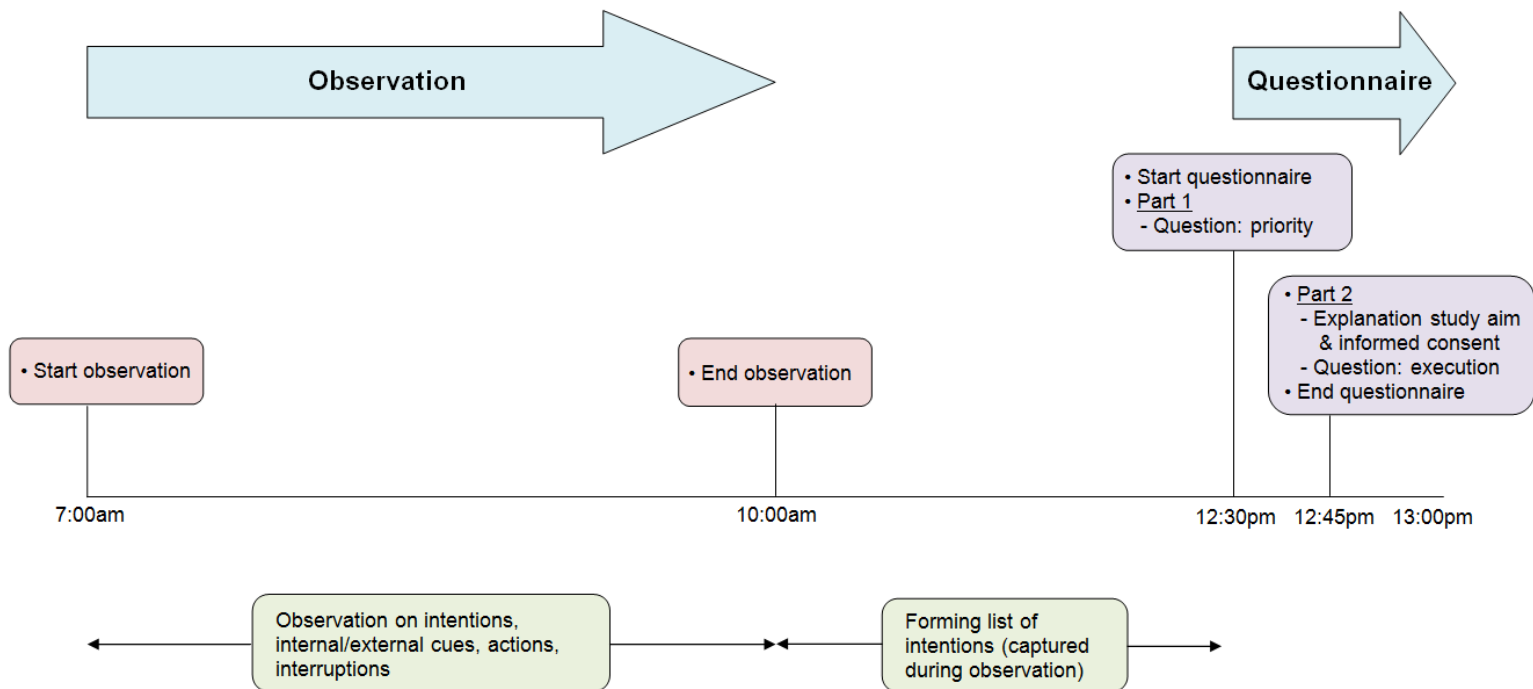
Tables and figures

Figure 1. Flowchart of study procedures.

Table 1
Data collection observation

Data collected during observation, using one minute intervals
Intentions
All intentions to perform PM activities, spoken out loud by nurse (execution of activity not immediately after intention is formed) ➤ Intentions include: •*Event-based PM activities* (retrieval when event happens) •*Time-based PM activities* (retrieval at specific time or after duration of period of time)
Cues

•*Internal cues*
  Reminders nurse creates herself (e.g. writing down intention on to-do list)
•*External cues*
  Reminders provided by environment (e.g. spoken reminder from patient/colleague, visual cue)

Actions

All activities a nurse executes, including:
•*PM activities*
  Nurse executes activity some time after intention is formed (nurse needs to remember delayed intention)
•*Non-PM activities*
  Nurse executes activity immediately after intention is formed
 	
When a nurse hands over an activity to a colleague, the activity will be marked as executed

Interruptions
Execution of activity is interrupted, it is assumed that nurse forms intention to resume activity at the end of the interruption ➤ Intentions include *interrupted PM activities*

Note. PM=prospective memory.

Table 2
Data collection questionnaire

Data collected during questionnaire
Question 1: Priority
Priority the nurse attached to each PM activity, according to the captured intentions ➤ VAS scale of ten centimeters per PM activity, ranging from low priority till high priority
Question 2: Execution
Nurses' perspective of execution of each PM activity, according to the captured intentions ➤ Nominal scale per PM activity, containing the answers: •Yes, in time •Yes, too late (aware) •Yes, too late (unaware) •No (aware) •No (unaware) ➤ For each consciously delayed/omitted PM activity: Nurses' explanation of the reason why he/she consciously delayed or omitted this PM activity

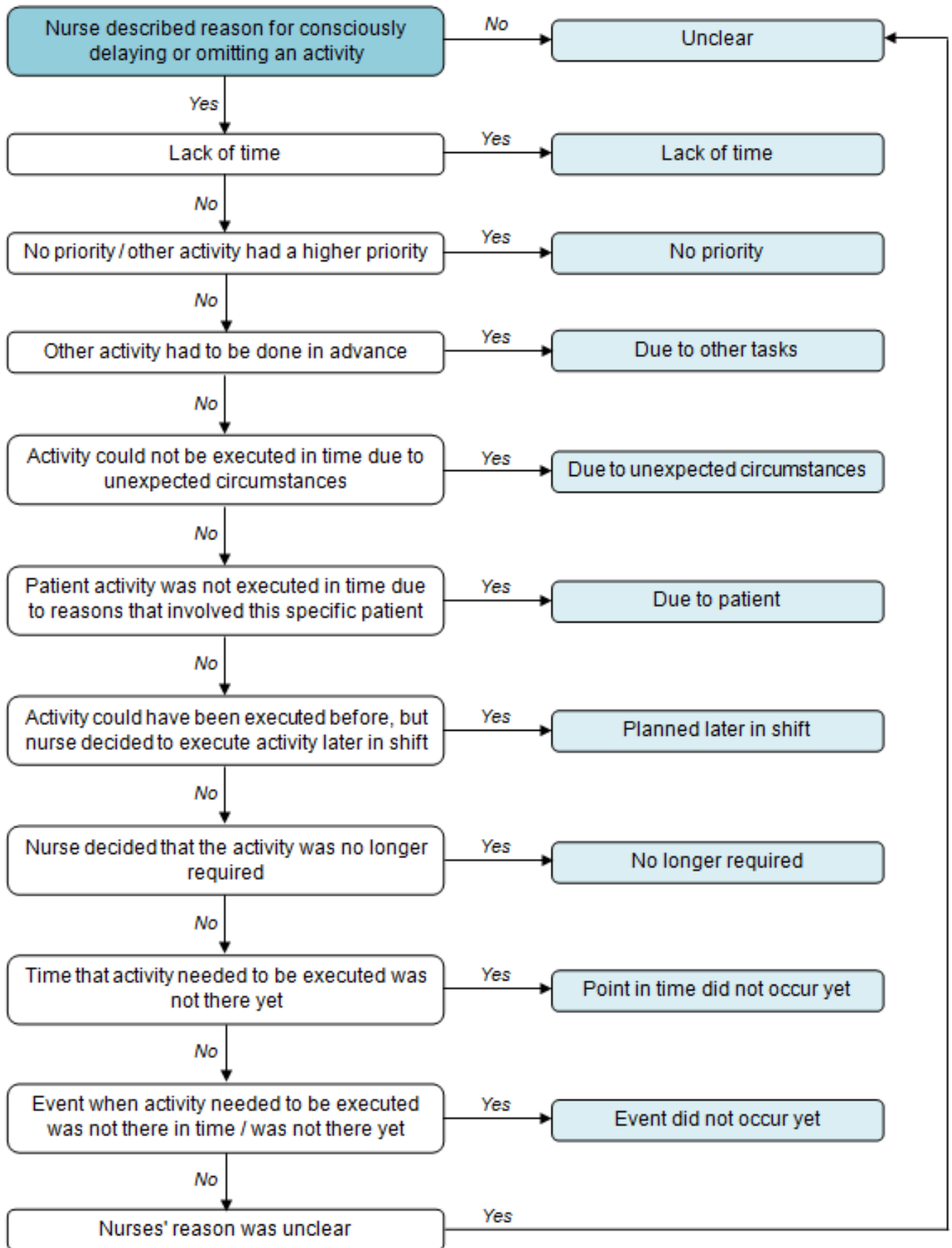*Note.* PM=prospective memory; VAS=visual analogue scale.

Figure 2. Decision tree: nurses' reasons for conscious delays and omissions.

Table 3

General data participating nurses (n=12)

Characteristics nurse	
Age in years, mean (SD)	26.2 (3.0)
Sex: female, n	11
Education[a]:	
MBO, n	5
HBO, n	7
Work experience: total in years, mean (SD)	4.7 (3.1)
Work experience: ward in years, mean (SD)	2.1 (2.0)
Characteristics observation	
Ward:	
X, n	6
Y, n	6
Observation time, mean (range)	3h 2m (2h 34m - 3h 21m)
Measured intentions to perform PM activities, mean (SD)	81.5 (15.9)
Executed non PM activities, mean (SD)	205.7 (36.0)
Internal cues, mean (range)	18.5 (6-43)
External cues, mean (range)	16.3 (5-28)
Mean prospective load, range	16.5-36.3

Note. n=number; SD=standard deviation; [a]=according to Dutch education system; h=hours; m=minutes; PM=prospective memory.
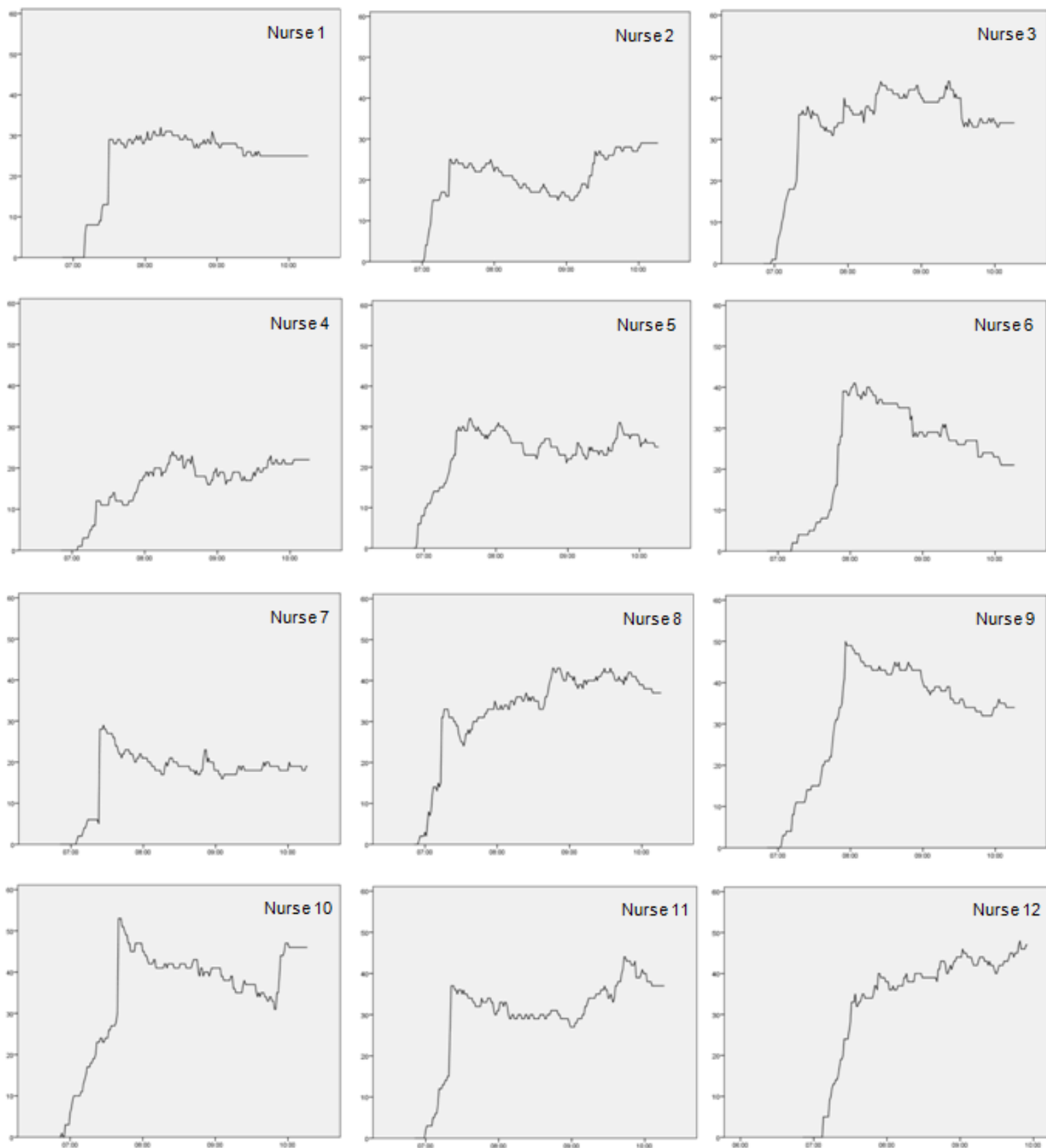
Figure 3. Timelines prospective load per nurse.

Table 4

Reasons for delays and omissions

		Delays, n (%)	Omissions, n (%)
	PM failure	33 (45.2)	42 (24.0)
Conscious	No priority	9 (12.3)	23 (13.1)
	Lack of time	2 (2.7)	1 (0.6)
	Due to other task(s)	8 (11.0)	1 (0.6)
	Due to unexpected circumstances	7 (9.6)	2 (1.1)
	Due to patient	3 (4.1)	2 (1.1)
	Planned later in shift	2 (2.7)	15 (8.6)
	No longer required	3 (4.1)	30 (17.1)
	Point in time did not occur yet	0 (0.0)	17 (9.7)
	Event did not occur yet	3 (4.1)	33 (18.9)
	Unclear	3 (4.1)	9 (5.1)
	Total	73 (100.0)	175 (100.0)

Note. PM=prospective memory; n=number; %=percentage.

Table 5

Possible effects on patients

	Delays		Omissions	
	PM failure, n (%)	Conscious, n (%)	PM failure, n (%)	Conscious, n (%)
Possible effect on patient safety	7 (21.2)	2 (5.0)	19 (45.2)	11 (20.8)
Possible effect on patient satisfaction	10 (30.3)	21 (52.5)	15 (35.7)	21 (39.6)
No possible effect on patients	16 (48.5)	17 (42.5)	8 (29.0)	21 (39.6)
Total	33 (100.0)	40 (100.0)	42 (100.0)	53 (100.0)

Note. PM=prospective memory; n=number; %=percentage.

Table 6

Possible effects on colleagues

	Delays		Omissions	
	PM failure, n (%)	Conscious, n (%)	PM failure, n (%)	Conscious, n (%)
Possibly resulted in extra work for colleague(s)	5 (15.2)	3 (7.5)	6 (14.3)	1 (1.9)
Colleague possibly needed to take over activity, no extra work required	-	-	16 (38.1)	15 (28.2)
No possible effect on colleagues	28 (84.8)	37 (92.5)	20 (47.6)	37 (69.8)
Total	33 (100.0)	40 (100.0)	42 (100.0)	53 (100.0)

Note. PM=prospective memory; n=number; %=percentage.

Table 7

Execution in time vs. delays and omissions due to PM failures

		PM failure			
	Execution in time (n=724)	Delays (n=33)	Omissions (n=42)	**p-Value** *(delays vs. execution in time)*	**p-Value** *(omissions vs. execution in time)*
Internal cues, n (%)	140 (19.3)	6 (18.2)	9 (21.4)	**0.869**	**0.739**
External cues, n (%)	170 (23.5)	9 (27.3)	6 (14.3)	**0.616**	**0.168**
•execution immediately after	*130 (18.0)*	*6 (18.2)*	-	*0.974*	-
Event-based PM tasks, n (%)	118 (16.3)	3 (9.1)	7 (16.7)		
Time-based PM tasks, n (%)	552 (76.2)	29 (87.9)	34 (81.0)	**0.296**	**0.462**
Interrupted PM tasks, n (%)	54 (7.5)	1 (3.0)	1 (2.4)		
Priority, median (IQR)	7.0 (4.8-8.8)	6.9 (3.5-8.1)	5.0 (2.6-8.0)	**0.522**	**0.001**

Note. PM=prospective memory; n=number; %=percentage; IQR=interquartile range.