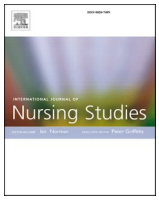
International Journal of Nursing Studies 164 (2025) 105018

Contents lists available at ScienceDirect

International Journal of Nursing Studies

journal homepage: www.elsevier.com/locate/ns



Why vital signs observations are delayed and interrupted on acute hospital wards: A multisite observational study

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ARTICLE INFO

Keywords:
Vital signs
Interruptions
Nursing care
Acute hospitals
Workflow
Missed care

ABSTRACT

Background: Vital signs monitoring is key to identifying deteriorating hospital patients. However, adherence to monitoring protocols is limited, with observations frequently missed or delayed. Previous studies of interruptions and delays to vital signs observations have been descriptive, with none attempting to conceptualise the types of tasks that are prioritised over vital signs observations.
Objective: This paper aims to explore how nursing teams perform vital sign observations on acute hospital wards and conceptualises which types of work delay or interrupt them.
Design: Non-participant observational study.
Setting(s): Four hospitals in the south of England.
Methods: Eligible adult wards (surgical and medical) within each hospital were randomly sampled for inclusion. Four sets of two-hour daytime observation sessions were undertaken on each ward. Two observers recorded structured and unstructured observations (open comments, field notes) on a tablet with adapted QI Tool software. We collected data over 128 h, including 715 sets of vital signs observations and 1127 interruptions. We undertook a qualitative content analysis of interruptions and delays to planned vital signs observations using both structured and unstructured observations.
Results: We identified eight reasons why vital signs were delayed or interrupted: fixed routines, staff availability, bundled care, proximity-related activities, collaborative care, patient inaccessible or unavailable, requests for or responses to time-critical activities, or limited context available. We propose a new concept of 'temporal status.' Flexible care (vital signs observations, 'bundled care' and 'proximity-related care') has a low temporal status so is delayed in favour of higher temporal status activities (fixed routines and time-critical care).
Conclusions: Our findings could explain why vital signs taken early in the morning and evening are least likely to be postponed, as there may be fewer competing tasks with a higher temporal status at these times. Our work also challenges binary conceptualisations of interruptions as 'beneficial' or 'detrimental', recognising the complexity of nursing care decisions on a moment-by-moment basis. Our new framework suggests the lower temporal status of vital signs observations (and other flexible care) means they are delayed by higher temporal status tasks during daytime shifts in acute hospitals, regardless of their clinical priority.
Registration: 10863045, ISRCTN (6/8/2019).

What is already known

- Vital signs monitoring plays a key role in identifying deterioration in hospital patients.
- Adherence to monitoring protocols is limited, but the reasons for non-adherence are poorly understood.

What this paper adds

- Our study identified high rates of interruptions to the work of undertaking vital signs observations and categorised the underlying causes into bundled care, proximity-related activities, collaborative

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https://doi.org/10.1016/j.ijnurstu.2025.105018
Received 30 July 2024; Received in revised form 29 January 2025; Accepted 30 January 2025
Available online 9 February 2025

care, patient inaccessible or unavailable, requests for and responses to time critical activities
- Some interruptions result from attempts to improve efficiency by bundling other care activities with vital signs observations
- Vital sign observations scheduled according to a personalised protocol are accorded a lower temporal status (treated as flexible and 'fitted in' around fixed routines and time critical care activities) regardless of clinical priority

1. Background

Vital signs monitoring is key to identifying patient deterioration in hospital, with inadequate monitoring and delayed response linked to avoidable deaths (Griffiths et al., 2018; Smith et al., 2020). The National Early Warning Score (NEWS2) has been widely adopted across the NHS (NICE, 2020) following national guidance on the care of the deteriorating patient in the United Kingdom (Royal College of Physicians, 2017).

NEWS2 is an aggregated score calculated based on six physiological parameters: respiration rate, oxygen saturation, systolic blood pressure, pulse rate, level of consciousness or new confusion, and temperature (Royal College of Physicians, 2017). According to the NEWS2 guidelines, higher scores—indicating greater deviation from parameter-defined norms—prompt increased frequency of vital signs monitoring.

While evidence is limited for the optimal frequency of observations to identify deterioration early in all patients (Smith et al., 2017; Briggs et al., 2024), the introduction of Early Warning Scores has been associated with reduced mortality and other serious adverse events (De Meester et al., 2013). However, there is evidence of significant non-adherence with Early Warning Score-scheduled vital signs observations, which are missed and delayed particularly in high acuity patients who require the most frequent observation (Hands et al., 2013; Redfern et al., 2019; Eddahchouri et al., 2021). While Early Warning Scores should provide an individualised schedule, some studies find adherence appears highest for observations scheduled at the beginning or end of daytime shifts (Hands et al., 2013; Yoder et al., 2013). The lower compliance with the observation intervals expected for higher acuity patients suggests that taking vital signs more frequently is challenging (Eddahchouri et al., 2021) and vital signs may still be taken in "rounds" at set times of day for all patients (Hands et al., 2013). Studies in this field have highlighted the need for further research to explore barriers to adherence with early warning score protocols (Hands et al., 2013; Eddahchouri et al., 2021).

Audit studies have addressed rates of delayed observations (undertaken at a time substantially later than scheduled) or missed observations (where a scheduled observation is not taken at all) (e.g. Hands et al., 2013; Redfern et al., 2019). Although audit studies can show *when* vital signs are missed or delayed, they cannot provide the context of other care demands that can enable us to understand *why*. Studies exploring why vital signs are missed or delayed report nurses experiencing frequent interruptions or 'multi-tasking' (Watson et al., 2014) while taking vital signs observations. In qualitative research, staff report finding it hard to prioritise 'time-rigid' vital signs observations with other priorities (McGaughey et al., 2017), citing under-staffing and time constraints as reasons for missing or postponing them (Petersen et al., 2017). As a result, staff have reported using workarounds such as software loopholes to avoid missed observations being tracked by the hospital system (Hope et al., 2019), or informal triages by physicians or nurses to focus efforts on the most acutely unwell patients (Petersen et al., 2017), although audit data studies suggest this final approach is not routinely used (Hands et al., 2013; Redfern et al., 2019; Eddahchouri et al., 2021).

Studies exploring interruptions to vital signs observations resulting in either delayed or missed observations have been descriptive rather than conceptualising the types of tasks prioritised instead. Some studies list a range of undifferentiated interruptions when staff take a set of vital signs on a patient, for example phone calls, conversations initiated by doctors or relatives, the patient requiring the commode or patients talking to the nurse (Wheatley, 2006; Ansell et al., 2014; Watson et al., 2014; Cardona-Morrell et al., 2015). Other studies describe nursing teams moving vital signs rounds to windows of time that do not overlap with shift handovers (Petersen et al., 2017), patient sleep (Hope et al., 2018), or delaying vital signs monitoring when patients are not at the bedside or have visitors (Petersen et al., 2017).

This lack of conceptual development is mirrored in wider research exploring interruptions to nursing tasks (Monteiro et al., 2015). Authors have characterised nurses' workflows as 'chaotic' (Cornell et al., 2010; Jennings et al., 2022), 'seemingly random' (Cornell et al., 2010) or 'turbulent' (Jennings et al., 2022). Other studies have focused on attempts to categorise interruptions as either beneficial or detrimental (Myers et al., 2016). As a result, researchers exploring interruptions to nurses' work have highlighted the need for a deeper level of interpretation (Hopkinson and Jennings, 2013). Given the importance of vital signs in identifying deterioration and the patient safety issues raised by a significant delay or omission, a conceptualisation of the types of activities that delay or interrupt nursing teams from taking planned vital signs observations is critical. Understanding this will enable us to develop strategies to improve nursing practice, inform policy to tackle missed or delayed vital signs, and move the research literature to a deeper understanding of why adherence to Early Warning Score protocols is so difficult. This paper aims to explore how nursing teams perform vital sign observations on acute hospital wards and conceptualise which types of work delay or interrupt them.

2. Methods

This paper describes results from a non-participant observational study (Bryman, 2008). Following Yeung et al. (2012) we collected qualitative observations describing interactions within a quantitative time-motion study. Our study was part of a wider project exploring the balance between optimal vital sign monitoring and staff workload (Briggs et al., 2024) The research was carried out in sixteen inpatient adult general wards within four acute NHS hospitals in the south of England.

Hospitals were sampled to ensure variation in approaches to vital signs recording methods (three used electronic and one used paper-based recording). All hospitals used NEWS2-based protocols. The lead contact at each trust identified eligible wards using the following inclusion criteria: i) Adult (18+) patients. Wards that occasionally admit adolescents of younger age would remain eligible. ii) Open at weekends with most patients experiencing overnight stays of one day or more iii) Ward provides general acute care. Four eligible wards in each hospital were randomly selected to participate, then approached for permission. If refused, another ward was randomly selected (see 10863045, ISRCTN (6/8/2019) protocol]).

Based on the standard errors of mean times observed in a study with a similar clustering structure (Wong et al., 2017), we calculated that the minimum sample size required (640 sets of observations) would allow us to estimate a mean observation time with a precision of approximately +/- 10 %.

A ward profile form was completed in meetings with each ward leader. This included the details of times each day when ward staff planned to collect vital signs observations, who in the nursing team (nurses, unregistered nursing assistants and/or student nurses) took vital signs observations, how they were taken, and the use of other protocols (e.g. post-operative) that affected frequency of vital signs observations. Study information posters were displayed on the wards and information leaflets were distributed during study observation sessions.

Observation data was recorded using bespoke software on an Android tablet using a validated method developed for measuring vital signs observations and the interactions that co-occur with and interrupt

Table 1
Frequencies and lengths of interruption categories.

Non vital signs activity (frequency, %) (n = 1127)	Total time taken (hours: minutes, % of total)	Range (minutes: seconds)	Median (minutes: seconds)	Mean (minutes: seconds)
Bundled care (n = 380, 33.7 %)	03:42, 23.3 %	00:02–05:00	00:27	00:35
Proximity-related activities (n = 339, 30.1 %)	06:39, 41.9 %	00:02–14:39	00:35	01:11
Collaborative care (n = 159, 14.1 %)	02:30, 15.7 %	00:03-07:18	00:26	00:57
Patient inaccessible or unavailable (n = 24, 2.1 %)	00:37, 3.9 %	00:18–09:08	00:51	01:34
Requests for and responses to time critical activities (n = 22, 2.0 %)	00:49, 5.1 %	00:06–11:08	01:25	02:13
Limited context available (n = 203, 18 %)	01:36, 10.1 %	00:02–14:35	00:27	00:52

them. This method adapted the Quality of Interactions (QI) tool (Bridges et al., 2018; Dall'Ora et al., 2020) to measure and record vital signs rounds, individual observations and all interactions happening with the nurse or patient involved in the vital signs measurements. The QI Tool is a real time, time-sampling program used on tablets to record the length, quality, and frequency of interactions between staff and patients. It includes the QI schedule, a widely-used and validated tool to capture the quality of staff-patient interactions (Dean et al., 1993). We adapted this through designing checklists and flow charts to enable the recording of vital-signs related activities, drawing on a tool developed to study paper and electronic documentation for recording vital signs observations (Wong et al., 2017; Bridges et al., 2018). A full record of the options available on the software for each observation session is given in supplementary material Table 1. Once an observation session had been started, the observer selected (in real time) the interactions they were observing from this menu. Two observers [first and second authors] collected data. [Second author] was a qualified nurse and researcher, [first author] was a researcher who has carried out previous vital signs research. [First author] also attended a simulated skills session with nursing students on taking and interpreting vital signs observations. Observers were trained using an observation guide using protocols and training material based on the combined tools (Dean et al., 1993; Wong et al., 2017). A high level of inter-rater agreement was achieved with a mean difference between raters of 3 s per set of vital signs (mean vital signs set estimate 3 min 47 s) and limits of agreement from +19 to −13 s (Dall'Ora et al., 2021).

We received ethical approval from the NHS Health Research Authority and South Central – Berkshire Research Ethics Committee (ref: 19/SC/0190). Ward leaders gave written consent for observations on their wards, with nursing staff given the option to opt out during observation sessions. Nursing staff were approached and given information about the study, with oral consent required before observations began. If consent was not given, observations were not taken, and staff members entered their details and signature onto an opt-out record form. Individual consent for staff who did not opt out was recorded, based on ward rosters. Patients and relatives were informed about the study through the posters displayed on the ward, information leaflets distributed during sessions and explanations by the researcher before observations were taken. While the observations focused on the process of care delivery by nursing staff and no personal information from or about patients or staff was collected, patients were asked permission before observations of nursing staff began and observations were not carried out if patients refused. The observer positioned herself to discreetly shadow a nurse about to undertake vital signs observation and remained outside bed curtains and rooms during personal care.

Non-participant observation by a single observer was carried out in four two-hour sessions per ward (each observer did two sessions on each ward). The observation session time reflected the time when vital signs observation rounds were planned (as recorded on the ward profile form) during daytime shifts (08:00–20:00). If on entering the ward or calling the ward as suggested prior to taking observations, observers were told that planned vital signs observation rounds (as described by the ward manager in the ward profile) had been postponed by ward staff, observers changed the observation session time on ward staff advice. Each observer carried out two sessions per ward. The observation period ran from 06/08/2019 to 15/01/2020. Observers began sessions by locating the vital signs equipment cart and waiting for a staff member to begin an observation round.

Using the bespoke software, the observer recorded time taken to conduct rounds, individual sets of vital signs observations and all other activities that occurred during vital signs rounds or sets. A vital signs round was defined as starting every time nursing staff sourced vital signs equipment or vital signs documentation and finishing when one or more sets of patient vital signs were taken and the vital signs equipment and/or documentation were replaced. A vital signs set was defined as starting when a nurse entered the bedspace and measured one or more of the six physiological parameters of the NEWS2 scoring system and ending when the nurse left the bed space and the measuring of vital signs as defined by NEWS2 had finished. The observer selected pre-existing activity categories on the software, with further details added as free text (see supplementary material Table 1 for full details). The observer also made brief fieldnotes at the beginning and end of the session, including notes about reasons for delays to staff beginning planned vital signs observation rounds. Before finishing the session, the observer asked nurses who had been observed if they felt our observations had affected their behaviour, and recorded their response in the session data.

A qualitative content analysis (Graneheim and Lundman, 2004; Schreier, 2012) was carried out on the observation data and qualitative fieldnotes to conceptualise reasons for interruptions and delays to vital signs observations. A Microsoft Excel spreadsheet generated by the tool software listed each recorded activity as a separate row, ordered chronologically. The cleaning and initial coding of the data into broad categories of 'vital signs related' and 'non-vital signs related' activity is described in (Dall'Ora et al., 2021). In addition to vital signs observations and rounds, activities were coded as 'vital signs related' whenever the activity would not have occurred unless vital signs were being taken (e.g. cleaning vital signs monitoring equipment, escalation to other staff members if vital signs were abnormal). 'Not vital signs related' activities are the units of coding analysed in this paper.

As a qualitative (rather than quantitative) data analysis our coding frame used a combination of concept- and data- driven coding (Schreier, 2012). Every coding unit already had a concept-driven index code attached from the adapted QI tool, describing the type of non-vital signs interaction recorded (see supplementary material Table 1). [Lead author] created a set of new data-driven index codes through comparing the QI tool code with context units (surrounding interactions and open text comments) (Schreier, 2012). From these [lead author] created an initial hierarchical coding framework, which grouped these index codes into categories and subcategories. By each index code she listed all further details from the original dataset, including all open text data, any further contextual details or any missing information. [Second author and final author], who are qualified nurses, gave feedback on categories, interpretations and exhaustiveness and an amended coding frame was created in response. [Lead author] piloted the initial coding frame with the full dataset and added further data-driven codes to the coding frame. Following the process of validation described by Graneheim and

Lundman (2004) all coauthors discussed this amended coding frame. Improvements were suggested by all coauthors to reduce ambiguity in category definitions and improve the decision rules for each category. [Lead author] then recoded the entire dataset using the final agreed coding frame. [Lead author] then explored the results for patterns and co-occurences and constructed an initial typology to focus on the relationship between categories (following Schreier, 2012). This was discussed with all coauthors with amendments made until consensus was reached (Graneheim and Lundman, 2004).

3. Results

The sixteen wards included general surgery, orthopaedics, vascular surgery, general medicine, stroke, respiratory, cancer, and gastrointestinal (see Dall'Ora et al. (2021)for further details). The number of beds per ward ranged from 17 to 36, with an average occupancy rate of 81.2 %–100 % during the study period. All ward names used are pseudonyms.

We recorded 715 sets of vital signs measurements across 64 observation sessions (128 h), clustered into 260 rounds. A median of two patients (interquartile range: 1–4; range 1–11) had vital signs observation sets taken per round Registered nurses carried out nearly half of the vital signs sets (n = 355, 49.7 %), followed by healthcare assistants (n = 217, 30.3 %) and then student nurses (n = 143, 20 %). The average time taken to measure and record a set of vital signs observations including all interruptions (total round length divided by the number of vital signs sets) was 6 min and 26 s (95 % confidence interval = 6:01–6:50). In five of the 64 observation sessions, a staff member reported they felt their behaviour had changed as a result of being observed, suggesting limited impact across the dataset. Further details about our vital signs data is available in Dall'Ora et al. (2021).

Our findings are presented in the following order. Firstly, the planned organisation of vital signs observations, as described by ward managers. Secondly, the observed organisation of vital signs based on our observation data and fieldnotes. Finally, we propose a typology of how vital signs observations are prioritised on wards.

3.1. Planned organisation of vital signs observations

Three of the four hospitals provided their policies on the adoption and use of the UK's National Early Warning Score (NEWS2) (Royal College of Physicians, 2017). All included some ability to deviate from the NEWS2 standard escalation and observation scheduling requirements, after review and sign-off from a senior doctor.

All ward leaders reported using NEWS2 plus additional protocols that affected monitoring frequency. These included protocols for patients who had sustained a fall, were new admissions or had recently undergone specific investigations or treatments (e.g., Patient Controlled Analgesia, endoscopy, chemotherapy, thrombolysis, or a surgical procedure).

Fifteen of the sixteen ward leaders reported planning to take patients' vital signs in rounds at specific times during the day. Only one ward (B3: medicine) specified they did not use rounds, taking vital signs according to patients' individual NEWS2 schedules.

Regular observations (typically every 4 h) were planned on general surgical wards (A1, B1, C4, D4), oncology wards (A2, A4), an orthopaedic ward (B2) and a neurology (surgical and medical) ward (who also did 6 hourly observations: A3). Rounds could also be organised around the lower frequencies required for patients with lower NEWS2 scores, e.g. 6 hourly and 12 hourly intervals on a ward for older people (e.g. D2). The times of day planned for taking vital signs monitoring rounds were scheduled to avoid busy times anticipated by the ward leader, such as when admissions and discharges were expected (e.g. C1 and C2: both acute medicine and rehabilitation wards). Some wards observing four hourly observations planned longer intervals in the middle of the day to avoid the lunchtime period (e.g. 10.30–11.30 then 16.30–17.30 on C3: acute medicine). One ward organised their observation frequency to ensure NEWS2-led observations were completed before they flagged as late on the hospital performance management software (B4: orthopaedic ward). On some wards, staff were more explicit about 'fitting in' the observations sessions flexibly, for instance scheduling for mid-morning or, if this was unsuccessful, delaying them until after lunch. In fact two wards (D1: acute/rehabilitation and D2: older people) suggested we should ring or visit them in the morning to see if they had already taken their observations or if they had been delayed.

3.2. Observed organisation of vital signs observations

Our units of coding were short fieldnotes and individual interruptions to ongoing vital signs rounds or vital signs sets (Schreier, 2012). Before coding our data, we identified and labelled all further interactions from our observations database that could be vital signs-related (n = 68). This left 1152 non-vital-signs-related interactions. We then excluded interactions related to this research study (n = 21). Finally, in four coding units more than one second-order coded activity took place in the time recorded, so these were removed from the

Table 2
Prioritisation of activities by temporal category.

Temporal category	Observations	Fieldnotes
Fixed routines (reducing windows of time to begin or complete vital signs rounds, leading to delayed vital signs rounds)	n/a	• Meal delivery: 'All due at teatime so clashed with food' • Nursing team handover: 'Started late as waiting for handover to finish'/ Nursing handovers • 'Ward rounds (Doctors)' • 'Doctors' ward round until 10.40 am (fixed care), then lunch at midday (fixed care), Even post op obs were late'
Flexible care (needs to be carried out by a certain point or at regular [unfixed] intervals)	• Bundled care (e.g. other assessments [pain, nausea, fluids] other protocols [cognitive assessments, post-fall assessments], food choices) • Proximity-related activities (often fundamental care – happens when other care is happening, including vital signs care)	• Vital signs observations: 'Just speaking to the ward leader, she says obs are often delayed eg 10.30 [were carried out] at 1.30 today'
Time critical activities (delay or supersede the taking of vital signs)	• Patient inaccessible or unavailable • Requests for and responses to time critical activities	• Completing time-critical tasks – e.g. admission, discharge – which can delay beginning or completing vital signs rounds: 'people going to and from operations means 10.30 obs different to do. even post-op obs late'
Continuous organisational work (overlaps with and interrupts vital signs)	• Collaborative care: sharing information, equipment and care organisation at patient, ward and hospital level according to the availability of other staff	

quantitative description of frequencies and lengths of interactions as it was not possible assess the time each took individually (Schreier, 2012). This did not affect our qualitative coding framework as no categories or subcategories were deleted. These were all retained on the spreadsheet as context units (interactions providing further information to interpret units of coding) but were not included in our figures. Our remaining interruption interactions (n = 1127) ranged from 2 s to 14 min and 39 s. This reflects our ability to record very brief interactions in real time, for example brief assessment questions about experiencing pain or nausea. Interruptions were skewed toward interactions of less than a minute (n = 893, 79 %), with a median of 27 s and a mean of 51 s.

Eight categories were created (see supplementary material Table 2). Six related to interruptions observed during sets and rounds of vital signs observations: bundled care, proximity-related activities, collaborative care, patient inaccessible or unavailable, requests for and responses to time-critical activities and limited context available. Table 1 presents descriptive statistics for total number, length and time taken for interruptions during vital signs monitoring in each of these categories to provide wider context in line with good practice for qualitative content analysis (Schreier, 2012). Two further categories coded from fieldnotes related to reasons for vital signs rounds being delayed or postponed: fixed care and staff availability.

Bundled care described tasks that needed to be completed during the day or by (but not at) a specific time for most or all patients. These tasks were regularly 'bundled' with vital signs observations for patients on individual wards. Examples included other kinds of assessments (e.g. pain, nausea, bowel movements, fluids, post falls assessments), asking the patients if they needed specific things (a drink, repositioning), how they were feeling, and completing food orders. Bundled care was the most frequent kind of activity and the second most time consuming activity overall, accounting for 23.3 % of time coded. However the mean time per interaction was the shortest overall, the majority being short verbal interactions.

Proximity-related care described activities related to a nursing staff member's presence at the bedside or in the bay when taking vital signs. They excluded requests from other members of staff, from patients in other bays and from call bells. Proximity-related care activities tended to increase the quality of care for the individual, patient involvement, and the meeting of fundamental care needs. They were slightly less frequent than bundled care but took the most time overall (41.9 % of time coded). The briefest interactions in this group (<10 s) were short questions and responses, providing reassurance or comfort, and moving/tidying items in the bedspace. Longer interactions included more detailed discussions with patients and relatives, fundamental care (e.g. supporting drinking, fetching a blanket, taking someone to the toilet), changing soiled bedding, adjusting equipment like intravenous lines, cannulas and catheters, changing dressings, supporting patients to reposition, getting items for patients, patient-specific assessments like blood glucose checks, clearing up spillages and helping patients use equipment.

Collaborative care described communications and activities between the staff member carrying out vital signs and other staff (including other members of the nursing team, doctors, porters, physiotherapists, and specialist nurses). Collaborative care included sharing and maintaining equipment, contributing to shared patient documentation, sharing patient information, communicating with other staff (answering colleagues' questions, seeking assistance to move a patient, student nurse education), care planning, ward organisation, and liaising with other wards or services. It could also involve social support and social interactions within the team including 'checking in' on colleagues and 'chatting'.

Collaborative care activities were less frequent and took less total time (14.1 % of time coded) than bundled or proximity-related care. Overall bundled care, proximity-related care, and collaborative care accounted for 81 % of coded interruption activities.

'Patient inaccessible or unavailable' described occasions when patients were absent when the nursing team member approached the bedside, bed access was temporarily obstructed, patients were engaged in other activities, or conversing with others during their vital signs set. These delayed vital signs observations were infrequent and took 3.9 % of overall time coded. Reasons for patients' absence included using the toilet, going for a walk, having left the bed 'wandering and agitated' or for unknown reasons. These interruptions could include the staff member waiting for the patient to return, in one case for over 9 min, with the staff member undertaking unspecified activities while waiting. Activities that delayed vital signs observations from commencing included conversations with other staff or relatives (including phone calls), the patient sleeping, support from another healthcare worker (e.g. a physiotherapist), eating or drinking, or requesting or receiving pet therapy. On one occasion bedside access was blocked while another bed was moved and, on another, the nurse waited for a cleaner to finish mopping the floor. The final set of interruptions was patients conversing with other people during their vital signs observation set – including other patients, a visitor and researchers from other studies. We also found examples of this in the fieldnotes about delays to commencing vital signs sets.

Requests for, and responses to, time critical activities described urgent care requested for non-proximal patients. They included requests from other staff needing urgent help (e.g. cleaning a commode, supporting a discharge process for another patient), from call bells, from a machine alarm, and in one case a member of staff drinking juice to manage her diabetes. The briefest interactions included communicating an urgent care requirement, communicating with a distressed patient (often someone who was disoriented or confused) or responding to an equipment alarm. Longer interactions included checking an unresponsive patient, administering cannulated medication after a machine alarm, supporting a porter to move a patient, supporting toileting, or emptying a commode. We also found evidence of time critical activities in session fieldnotes on why observations were delayed. These included completing admissions paperwork (which must be done when a patient is admitted to the ward), organising discharge, and ward tasks following the death of a patient. They were the least frequent category accounting for 2.0 % of the interruptions and totalled 5.1 % of coded time.

To meet the requirement of our coding frame being exhaustive (Schreier, 2012) we include descriptions and descriptive statistics relating to 'Limited context available' interactions. These were coding units with limited detail in the contextual units and open response descriptions relating to who was involved in interactions, or how they were initiated. Seventy-two percent (n = 146) of these were communications (coded using concept driven coding from the QI tool as 'communication information' or 'communication other conversation'). Of these two included details of one of the communication partners involved but gave no details of the content of the conversation, with only three including some details of the content (request – details unknown, personal conversation, 'asking where doctor is'). The remainder related to concept-driven codes from the options on the QI tool - 'functional' care (e.g. food and drink), planning care, personal care, treatments – other, or other.

The two final categories were coded from fieldnotes. 'Fixed routines' reduced the windows of time in which vital signs rounds could be completed. This included ward routines that happened at the same time every day (such as doctors' rounds and mealtimes) and are described in Table 2 with examples of when planned vital signs rounds (described in the ward profiles) were delayed by them. 'Lower staff availability' was also recorded in fieldnotes as having influenced staff decisions to delay planned vital signs observations.

3.3. Prioritisation of vital signs observations on wards

Following (Schreirer 2012) we explored our results for patterns and co-occurences to construct an overarching typology on the relations between categories. Our resulting typology of 'temporal status' described how different activities during hospital daytime shifts affected

how vital signs observations were prioritised (see Table 2). We describe four temporal status types: fixed routines, flexible care, time-critical activities and continuous organisational work. Table 2 shows how our four temporal status categories relate to the eight categories of interruptions described in the observations and fieldnotes. Fixed routines were led or initiated by groups of staff external to the ward, who visited the ward at a set time (meal delivery, doctors' rounds) and these were treated as reasons to delay commencing vital signs rounds. Although early warning score protocols specify the length of interval between each set of vital signs observations for each patient, vital signs were taken in rounds in 15 out of 16 wards. These rounds, planned for specific times of day, were effectively treated as flexible and 'fitted in' by nursing staff (as described by ward managers in the ward profile and by ward staff in fieldnotes) around these fixed routines. In cases where there was low staff availability, vital signs, as a form of flexible care, were delayed in favour of care tasks with a higher temporal status. As found in our observational data, vital signs were also often 'bundled' with other forms of flexible care, which elongated the time to complete vital signs observations, and could be further extended by proximity-related care tasks and requests. Once vital signs and other forms of flexible care were in progress, time-critical activities from patients delayed and interrupted them and colleagues and continuous organisational work from nursing colleagues and other staff overlapped with and interrupted them.

4. Discussion

Our study presents novel findings about how nursing teams perform vital signs observations on acute hospital wards and the activities that delay and interrupt them. It also presents a new conceptualisation of why vital signs are delayed and interrupted: temporal status. Our findings demonstrate that vital signs observations were treated as flexible care that was 'fitted in' around fixed care routines, and delayed by time-critical events and lower staff availability. Vital signs observations also served as a vehicle in which other care that could be scheduled flexibly (proximity-related care and bundled care) was undertaken, meaning vital signs sets became even more prone to interruptions or delays by increasing the window required to complete them. When vital signs observations were underway they were interrupted by time-critical activities and continuous organisational work. This concept of temporal status challenges prevailing notions of 'beneficial' versus 'detrimental' interruptions (Myers et al., 2016) by recognising the complexity of nursing work but highlighting that it is not primarily organised around clinical priority. Our findings support existing research, where nurses have reported delaying planned vital signs monitoring to accommodate other ward routines or delaying or missing vital signs observations when patients are not at the bedside or have visitors (Petersen et al., 2017). We also provide a framework to conceptualise how the frequent distractions, interruptions and multi-tasking observed in, and described by, nurses while taking vital signs observations are prioritised in practice (Wheatley, 2006; Ansell et al., 2014; Watson et al., 2014).

While NEWS2 (with individualised vital signs monitoring) has been adopted widely in the UK (NICE, 2020), the majority of wards in this study planned to carry out vital signs rounds with a set of patients at regular (though flexible) intervals, which were planned to be completed at specific times of day, as described on the ward profiles for each ward. This might explain why vital signs observations are more often missed in high acuity patients who require the most frequent observations (Hands et al., 2013; Redfern et al., 2019; Eddahchouri et al., 2021), which will lie outside a four-hourly or lower rounds frequency.

Our findings could also explain why a previous analysis of Early Warning Score data shows a strong rounds-based patterning with most observations carried out in the evening or early in the morning, regardless of EWS-led scheduling (Hands et al., 2013). This reflects existing qualitative research about the difficulties of prioritising 'time-rigid' vital signs observations against other ward priorities (McGaughey et al., 2017) especially under common conditions of time constraints and under-staffing (Petersen et al., 2017). Early in the morning and in the evening there may be fewer competing care tasks (from daytime fixed routines), fewer collaborative care interruptions (involving communication with a range of other health professionals), patients are less likely to be unavailable, and visiting hours are limited (reducing proximity-related care requests from visitors and patients being engaged in tasks with visitors). It is possible that vital signs rounds planned early in the morning and in the evening may be quicker and easier to complete as they involve fewer interruptions and fit more easily into available windows of time before or after fixed routines begin, but further research is required to explore this proposition.

While 'bundled care' tasks extended the time at the bedside with patients, they were likely to represent an overall time saving by reducing time overheads of approaching patients, gathering equipment, and taking notes. Indeed, some of these assessments were built into hospitals' Early Warning Score software and undertaken alongside NEWS2 observations.

Our concept of the temporal – not clinical - status of different kinds of nursing work also suggests a mechanism for why lower staff availability and higher workload may lead to delayed or missed vital signs (Wheatley, 2006; Foley and Dowling, 2019). Indeed, other kinds of flexible care identified here (bundled care and proximity-related care) mirror the types of care found most likely to be missed in other studies (e.g. emotional support, fundamental care, assessment, medication requests, toileting, basic care and planning) (Kalisch, 2006; Kalisch et al., 2009). This suggests that when there are fewer staff to share the workload of a ward during daytime hours, staff may be more likely to prioritise completing higher temporal status activities (fixed routines and time-critical activities) than lower status flexible care activities (vital signs, bundled care and proximity related care), regardless of clinical priority.

It was significant that vital signs were far more likely to be interrupted with requests from proximate patients (in more frequently occurring proximity-related care), rather than the extremely low incidence of patients using their call bells to request care that was sometimes urgent (in relatively infrequent 'requests for, and responses to, time critical activities'). This supports wider research that has found that patients avoid the use of call bells and wait until a nurse appears both available and caring before making urgent requests in order to avoid being perceived as 'difficult' (Maben et al., 2012; Hope et al., 2022). If vital signs monitoring becomes remote, checked at the nurse's station rather than the bedside, our findings support the concerns of patients that this might reduce contact time with staff (Weenk et al., 2020; Areia et al., 2022). This could have a significant and adverse impact on the quality of patient care and reduce opportunities for patients to ask for care without feeling they are being 'difficult'. It may also reduce opportunistic acts of fundamental care we identified here, based on 'noticing' patients need for water, for a blanket, and for their bed to be changed, which can lead to deterioration and poor outcomes if left unaddressed.

Our category of 'collaborative care' (or continuous organisational work) supports research on the invisible organising work of nurses in managing patient trajectories through collaboration with a range of health professionals (Allen, 2015). This is essential nursing work but is situated in and produced by the activities of groups of staff and is therefore unpredictable and dynamic (Allen, 2015; Allen, 2019). This means it may not be accounted for when planning care in comparison to more visible (often protocolised) forms of care.

Our conceptualisation of the types of care that 'interrupt' vital signs observations demonstrate the difficulties nursing teams face in managing competing demands on their time. All the care categories we highlight comprise important care and care management tasks. This challenges existing conceptualisations of interruptions that attempt to differentiate between beneficial (or necessary) and detrimental interruptions (Myers et al., 2016).

Moreover, our work suggests that rather being chaotic, decisions about the prioritisation of care activities involve active in-the-moment choices that are influenced by temporal status rather than by clinical priority. In practice this means flexible care tasks are more likely to be delayed in deference to fixed routines or time-critical care, regardless of ultimate clinical priority. Consequently, interventions designed to improve adherence to daytime vital signs scheduling that do not take their low temporal status into account are unlikely to succeed, explaining why individualised observation schedules may be particularly difficult to implement (Hands et al., 2013). Further research could explore whether – as tentatively posited here - vital signs observations planned for early in the morning and in the evening may be easier to defend from interruptions. Finally, because interruptions to vital signs can result in better patient care, there may be negative consequences from approaches that prevent nurses from 'interrupting' vital signs observations to undertake other aspects of care.

5. Limitations

Eighteen percent of our observation data had limited details about content or context. However while we cannot be certain there were no other categories of care in the excluded data, our categories and activities concur exceptionally well with existing research (Kalisch, 2006; Wheatley, 2006; Maben et al., 2012; Ansell et al., 2014; Watson et al., 2014; Cardona-Morrell et al., 2015; Petersen et al., 2017; Allen, 2019; Hope et al., 2022) suggesting comprehensive conceptual coverage. As we rang ahead to some wards to ask if they had already taken vital signs or not, our data is likely to underrepresent how often wards' planned vital signs observation rounds are delayed due to fixed routines or time critical activities. While our data is suggestive of how temporal status might lead to vital signs being missed, as we did not have access to individual patient data and observation frequency required under the NEWS2 schedule so we could not see whether individually-scheduled vital signs observations had been completely missed or only postponed, and therefore the severity of the impact. Instead as described, all but one ward planned to take vital signs observations in rounds rather than individually. Our findings therefore relate to how planned observation *rounds* (described by nursing teams as the times planned to take vital signs rounds of more than one patient) were delayed. However, as argued above, the concept of temporal status could provide an explanation for the seemingly paradoxical finding in audit studies (e.g. Hands et al., 2013) that the most acutely unwell patients experience the most missed vital signs. Finally, as all our data was collected between the hours of 09:30 and 17:45 our findings are specific to daytime vital signs observations.

6. Conclusions

This paper has moved beyond descriptions of interruptions and conceptualisations of nurses' workloads as 'chaotic', 'turbulent' and 'seemingly random'. It also challenges dichotomised conceptions of interruptions as 'beneficial' versus 'detrimental', instead presenting a new explanatory concept of temporal status. Our new framework suggests that it is the lower temporal status of vital signs observations (and other flexible care) that may lead to interrupted, missed or delayed observations during daytime shifts in acute hospital wards. While temporal status is clearly a powerful influence on how ward care is organised, we have shown it does not necessarily accord with the clinical priority of vital signs observations given the negative consequences of significantly delayed or missed observations.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijnurstu.2025.105018.

CRediT authorship contribution statement

Joanna Hope: Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review and editing, Visualisation. **Chiara Dall'Ora:** Investigation, Writing – review and editing. **Oliver Redfern:** Conceptualisation, Methodology, Formal analysis, Data curation, Writing – review and editing, Funding acquisition. **Julie L. Darbyshire:** Writing – review and editing. **Peter Griffiths:** Conceptualisation, Methodology, Writing – review and editing, Supervision, Project administration, Funding acquisition.

Funding sources

This report presents independent research funded by the UK's National Institute for Health Research (NIHR) Health Services and Delivery Research Programme (award number 17/05/03). The views and opinions expressed in this publication are those of the authors and do not necessarily reflect those of the NHS, the NIHR, NETSCC, the Health Services and Delivery Research Programme or the Department of Health and Social Care.

Declaration of competing interest

Given their Editorial roles, Chiara Dall'Ora and Peter Griffiths had no involvement in the peer-review of this article and had no access to information regarding its peer-review. Full responsibility for the editorial process for this article was delegated to the Editor-in-Chief Ian Norman.

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.

Data availability statement

All files (interruptions database, anonymised fieldnotes and anonymised ward profiles) will be available at the University of Southampton's data repository (Pure) on the following DOI which is currently inactive but will be made active on publication: https://doi.org/10.5258/SOTON/D2876.

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