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How much time do nurses in Norwegian emergency departments spend on different work tasks with and without a clinical pharmacist present—a time and motion study

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Abstract

Background The emergency department (ED) is a demanding work environment where nurses undertake a variety of clinical and administrative tasks, including medication-related tasks. The integration of a clinical pharmacist into the ED team represents a complex intervention with potential implications for nurses' distribution of work time, particularly concerning medication-related tasks. This study examined the distribution of work time among ED nurses and assessed the impact of a clinical pharmacist's presence on this distribution, with an emphasis on medication-related work tasks.

Methods A direct observational time and motion study was conducted to evaluate the work time distribution of nurses in three Norwegian EDs, applying the Work Observation Method By Activity Timing (WOMBAT) methodology. Time distributions were measured for non-medication-related tasks, medication-related tasks, standby and movement, both in the absence and presence of a clinical pharmacist in the same ED.

Results A total of 298 h of nursing work time were observed, comprising 138 h *without* pharmacists present and 160 h *with* pharmacists present. In the absence of a pharmacist, nurses spent 62.7% of their time on non-medication-related tasks, 34.7% on standby and movement, and 3.3% on medication-related tasks. The introduction of a clinical pharmacist did not significantly change the overall distribution of nurses' work time, although some variations were noted across the EDs.

Conclusion ED nurses in three Norwegian EDs dedicated only 3.3% of their work time to medication-related tasks. The presence of clinical pharmacists did not substantially affect the distribution of nurses' work time.

Keywords Emergency department, Acute care, Nurses, Pharmacists, Time distribution, Time and motion study, Medication-related tasks, WOMBAT

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Introduction

The emergency department (ED) is a demanding work environment characterized by its fast pace and unpredictability. The interdisciplinary ED team may consist of physicians, nurses, pharmacists, social workers, and administrative personnel. Registered nurses and licensed practical nurses constitute the bulk of the ED workforce, attending to a diverse patient population presenting with trauma, injuries, or other acute medical conditions that require urgent care [1]. Nurses are responsible for triaging patients and the initiation of appropriate care [2]. Their roles are multifaceted, encompassing assessment of medical severity, provision of critical support to mitigate long-term consequences or preserve life, insertion of intravenous lines, and medication administration. They are also responsible for the management of medical records and participation in public health initiatives aimed at injury prevention and health promotion [3–6]. In addition, a considerable proportion of nursing time is allocated to non-clinical and organizational tasks, which account for 35–70% of their workday [7, 8]. A time and motion study conducted in the US revealed that ED nurses spent 27% of their time on managing electronic health records [9]. This included organizing patient information, categorizing medical records for insurance processing, and ensuring data accuracy for insurance verification. The study identified that 25% of nurses' time was dedicated to direct patient care, 17% to standby, i.e., when nurses were present and available in the ED but not actively engaged in patient care tasks, and 15% to indirect patient care [9]. The study did not, however, provide details of how much time was spent on specific tasks within the direct patient care, which also includes medication-related tasks.

Medications are the most common form of treatment in healthcare and require particular attention in the ED, where prompt recognition of patients' medication histories can be crucial for initial assessment and diagnosis [10]. Collaborative practices between nurses and pharmacists have been shown to enhance medication safety [11–13], reduce medication discrepancies at admission [14], decrease medication errors [15, 16], and improve nurses' proficiency in managing medication-related problems [17, 18]. Although much of the research targets community settings or general acute care, nurse-pharmacist collaboration principles are directly applicable to EDs. In these high-pressure environments, quickly identifying and resolving medication-related issues is crucial for patient safety. Despite these benefits, a recent international survey across 17 European countries, including Norway, found limited interprofessional collaboration between nurses and physicians, with even fewer interactions between nurses and pharmacists [19]. In Norway, the scarcity of pharmacists in EDs may contribute to this limited collaboration. This dynamic may be further explained by the concept of the "doctor-nurse game" described by Stein in 1967, where nurses traditionally sought approval from physicians and adhered to hierarchical role expectations [20]. While this game has been primarily observed between physicians and nurses, it is plausible that similar dynamics influence the collaboration between nurses and pharmacists, with ingrained professional roles and expectations potentially hindering effective interprofessional teamwork.

The Pharmacist in the ED (PharmED) trial investigates the impact on patient outcomes of integrating clinical pharmacists into three Norwegian EDs [21]. Introducing a new professional role into the already established ED interdisciplinary team constitutes a complex intervention with the potential to alter ED care delivery [22]. The UK framework for the development and evaluation of complex healthcare interventions extends beyond assessing the success of an intervention [22]. It advocates a thorough examination of interventions from multiple perspectives, including efficacy, effectiveness, theory-based evaluations, and systems thinking. According to the UK framework, one of the six key elements to investigate is: "How does the intervention interact with its context?". A significant context for the PharmED study is the existing healthcare personnel in the EDs, who must adapt to a new colleague and potentially adjust their time allocation when a new team member is introduced. Previous studies have examined the distribution of work tasks for both physicians and pharmacists [23, 24]. The aim of this study was to explore the work task distribution among the ED nurses at the three involved study sites, and to investigate the impact of introducing clinical pharmacists, with an emphasis on medication-related tasks.

Methods

Study design and setting

This was a direct observational time and motion study of nurses working in three EDs in North Norway, conducted as a sub study of the PharmED project [21]. The annual patient volumes for these EDs were 15,000, 12,000 and 6,000, respectively. The nursing staff operated on a three-shift system encompassing morning, evening, and night shifts. At any given time, between five and seven nurses were on duty in each ED. The 12-month study intervention employed a stepped wedged design to introduce clinical pharmacists to the EDs. After a three-month control period in all EDs, pharmacists were introduced in a staggered manner, beginning with ED1. After an additional three months, pharmacists were introduced to ED2, and three months later, they were introduced to ED3. Consequently, pharmacists worked in ED1, ED2, and ED3 for a total 9, 6 and 3 months, respectively. The Work Observation Method By Activity Timing (WOMBAT) was used

to observe and record time for different activities performed by nurses in the EDs both before the pharmacists were implemented, followed by observations while pharmacists were present. This approach allowed for a comparative analysis of nurses' time spent on various tasks before and after the intervention.

Data collection tool and piloting

Data collection was conducted using the validated WOMBAT software [25]. WOMBAT was developed for direct observational studies of healthcare personnel, facilitating structured observations and the documentation of multi-dimensional features of work and communication patterns. The software operates on a tablet, automatically time-stamping recorded tasks, thereby capturing task durations, interruptions, and instances of multi-tasking [26].

The WOMBAT tool allows for observations across four dimensions; what, where, how and with whom. The *WHAT* dimension specifies the activities being performed. The *WHERE* dimension identifies the location of the activities. The *WITH WHOM* dimension details the individuals the nurses interact with during the activities. The *HOW* dimension describes the manner in which the activities are conducted, such as face-to-face, on the computer, or via phone. When utilizing the WOMBAT tool, observers are required to record one category from the *WHERE* and at least one from *WHAT* dimensions for each observation. Depending on the nature of the observed task(s), additional categories from the remaining dimensions may be recorded concurrently.

In our study, within the *WHAT* dimension, certain categories included sub-categories that differentiated between medication-related and non-medication-related tasks. The categories "Movement" and "Standby" were not subdivided into medication-related or non-medication-related tasks. Movement was recorded when a nurse relocated from one place to another. Movement could occur simultaneously with another task i.e. multitasking. Standby referred to periods when nurses were not performing any tasks or were taking personal time, and could not be registered as multitasking.

To tailor the WOMBAT observation dimensions for the study settings, two observers (MF and RVH) shadowed and talked to nurses in the EDs. This process facilitated the identification and definition of the nurses' work tasks, the location where these tasks took place, the individuals with whom the nurses interacted, and the tools and resources utilized. As a result, four dimensions and 53 mutually exclusive categories of interest were defined, see Fig. 1 for an overview of tasks and Supplement 1 and 2 for more details on all categories. An experienced WOMBAT observer and researcher (ECL) initially reviewed and tested the categories. Subsequently, the three observers (MF, RVH, AM) conducted a pilot data collection, resulting in further adjustments to categories and definitions. The pilot phase continued until all work tasks were thoroughly accounted for and definitions were unambiguous, ensuring that subsequent observations could be accurately categorized without uncertainty.

To ensure reliability and consistency between observers, inter-rater reliability was assessed by having two observers independently record the same situation

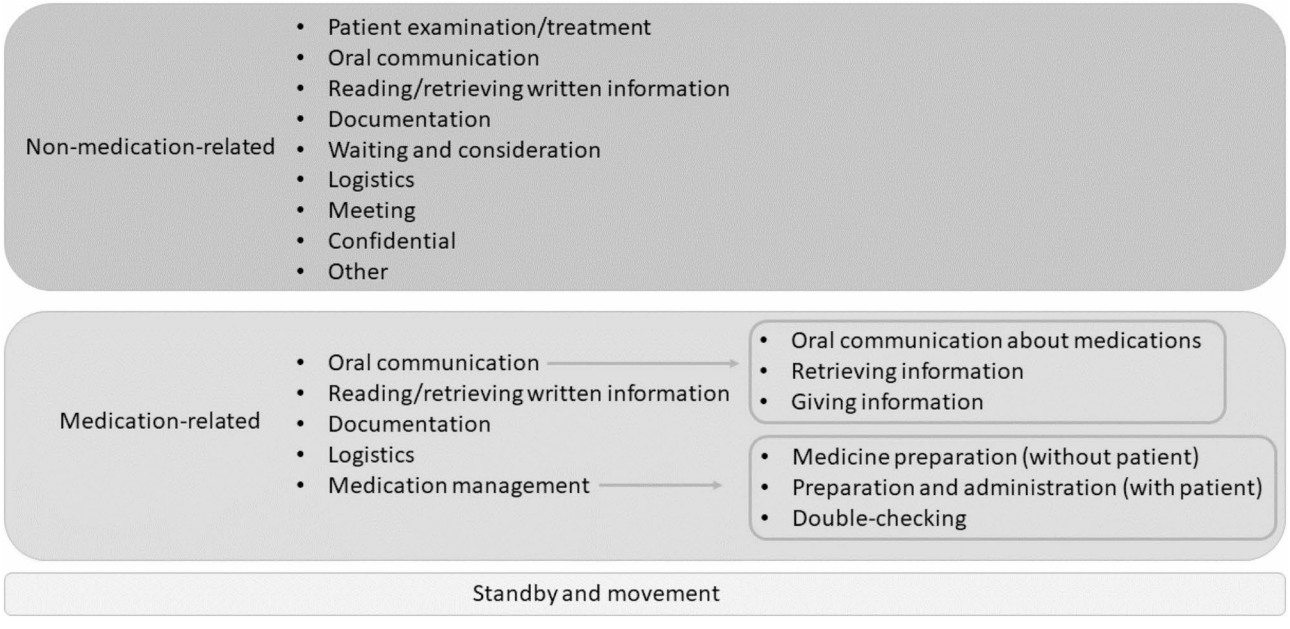

Fig. 1 Overview of the "WHAT" categories and sub-categories in the WOMBAT tool

simultaneously, without speaking to each other. This procedure was conducted both prior to and during the data collection phase, in sessions lasting 20–30 min. Observer agreement was quantified using Cohen's kappa [27]. Kappa values were interpreted as poor (< 0.00), slight (0.00 to 0.20), fair (0.21 to 0.40), moderate (0.41 to 0.60), substantial (0.61 to 0.80), or almost perfect (0.81 to 1.00) [28]. We established an acceptable threshold of concordance, characterized by a kappa statistic reflecting a minimum of moderate agreement.

Data collection

Data were collected during two distinct periods; the pre-intervention period, prior to pharmacists joining the ED team, and the intervention period, during which pharmacists were present. The stepped-wedge non-randomized controlled trial design, as described in our study protocol [21], involved sequential rollout of the intervention across the three EDs. This design facilitated within and between ED comparisons, ensuring that each ED eventually received the intervention. Three observers trained in the WOMBAT methodology (MF, RVH and AM) conducted 60 h of observation in each ED for each period (Table 1). The number of hours chosen was based on previous studies applying the WOMBAT methodology [25, 29, 30].

Observations in the pre-pharmacist period took place from November 2020 to October 2021, on weekdays between 8:00 am and 8:00 pm. Observations were conducted in two-hour intervals (each interval equals one observation session) adhering to a predetermined observation schedule to mitigate observer and nurse fatigue. A schedule imitating pharmacist work shifts was developed when quantifying nurses' time distribution. Each workday was divided into morning (8:00 am-11:30 am), midday (11:30 am-3:30 pm), and afternoon (3:30 pm-7:00 pm) shifts.

During observations in the intervention period, from October 2021 to January 2022, the same observation schedule was utilized. ED1 and ED2 implemented two pharmacist shifts on weekdays to ensure comprehensive coverage: an early shift from 8:00 am to 3:30 pm and a late shift from 11:30 am to 7:00 pm, with an overlap period to accommodate peak activity times. In contrast, ED3, with its lower patient volume, employed a single pharmacist on weekdays, available from 11:30 am to 7:00 pm.

All ED nurses were informed about the study, including their right to withdraw from the observations at any time. At the start of each observation session, any nurse present in the ED who had provided written consent was eligible for observation. Preference was given to nurses who were assigned tasks at the time and had not been previously observed. The selected nurse was then continuously observed for the duration of one observation session. While patients themselves were not the subject of observation, the number of patients attended to by the ED nurses during each session, as well as the time spent on each patient, were documented.

Data analysis

Nurses' work time distribution, quantified by the time spent on each work task, is presented as proportion (%) of the total observed time. The 95% confidence intervals (CI) for both proportions and rates were determined using a bootstrap method, employing SAS Macro programs specifically designed for WOMBAT data [31]. Differences were considered statistically significant if the 95% CIs did not overlap. It is worth noting that non-overlapping CIs provide a slightly more conservative estimate of significant differences compared to hypothesis testing. An independent samples t-test, conducted using IBM SPSS Statistics version 29, evaluated whether the presence of a pharmacist influenced the mean number of patients attended to by the nurse per session and the mean duration of care provided to each patient per session. The significance level (α) was set to 0.05.

Results

During the period *without* clinical pharmacists in the ED, 81 observation sessions of 64 nurses were conducted, totalling 138 h 21 min and 5 s, and encompassing care for 237 patients. In the period *with* pharmacists present, 89 observation sessions of 67 nurses were completed, totalling 160 h 34 min and 45 s, with 302 patients involved. The work tasks performed were categorized into 20 "WHAT" categories and sub-categories, with nine identified as directly medication-related, see Fig. 1.

Distributions of nurses' work tasks

Nurses predominately spent their time on non-medication-related tasks, accounting for 62.7% in the period *without* pharmacists, varying from 66.6% (ED2) to 59.9% (ED3), see Fig. 2; Table 2. Time spent on standby and

Table 1 Observation periods and observer distribution at three study sites, with and without pharmacists present

	Without pharmacist present		With pharmacist present	
	Observer	**Observation period**	**Observer**	**Observation period**
ED1	Observer 1	November 2020-February 2021	Observer 1	October 2021-November 2021
ED2	Observer 2	February 2021-July 2021	Observer 3	November 2021-December 2021
ED3	Observer 1	August 2021-October 2021	Observer 1	November 2021-January 2022

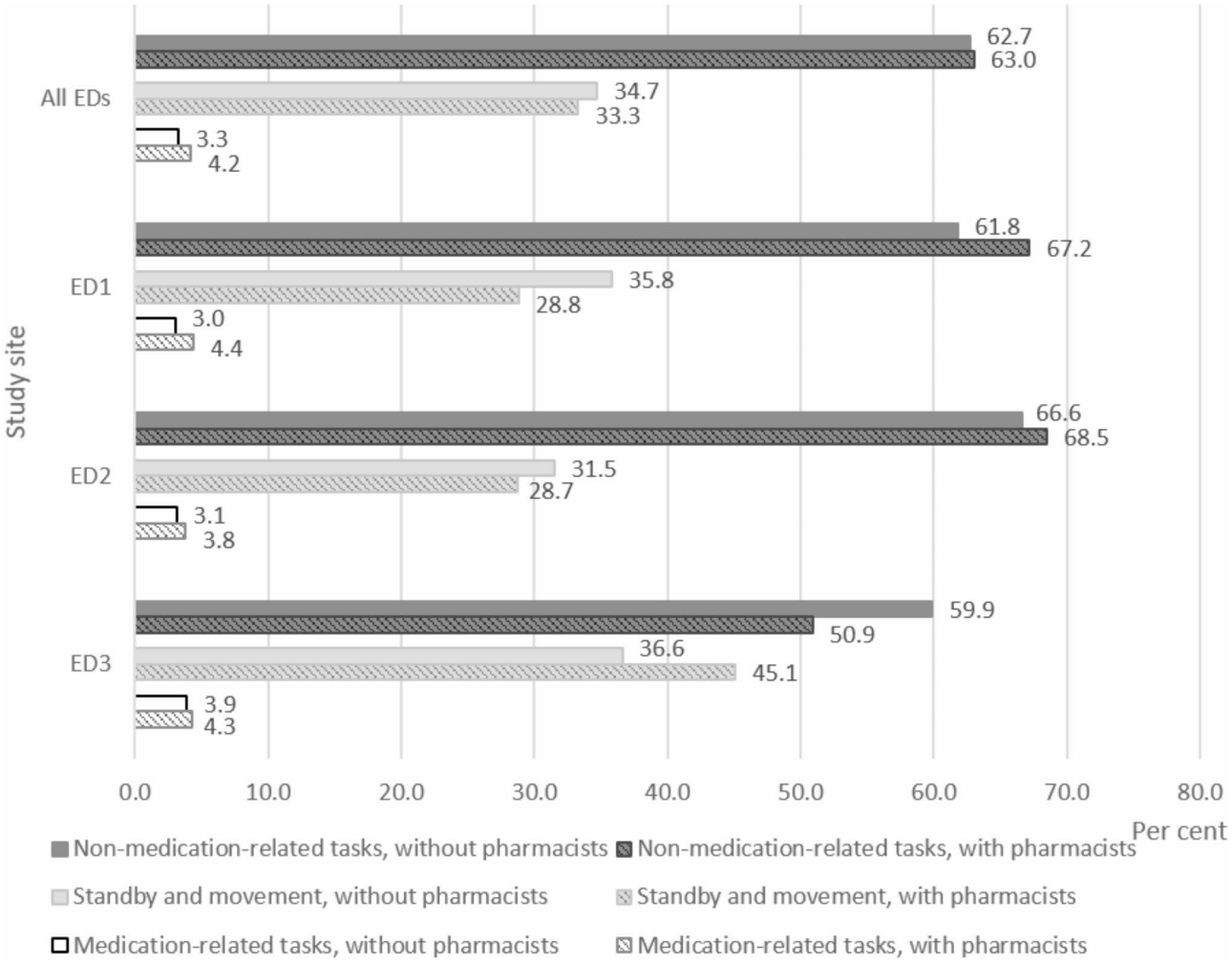

Fig. 2 Nurses' task time distribution, with and without pharmacists present, overall and by individual emergency department

movement constituted 34.7%, varying from 31.5% (ED1) to 36.6% (ED3). Medication-related tasks comprised 3.3% of the time, with a range from 3.0% (ED1) to 3.9% (ED3). The introduction of pharmacists altered neither the ED nurses´ work time distribution, nor the proportion of time spent on medication-related work tasks in any of the EDs, see Fig. 2.

Table 2 details the proportion of time spent on specified work tasks during periods *with* and *without* pharmacists, both overall and for each individual ED. In the absence of pharmacists, the most time-consuming non-medication-related tasks were patient examination and treatment (19.3%), oral communication (18.1%), and logistics (13.2%). The introduction of pharmacists did not significantly change these proportions. However, the time dedicated to waiting and considerations was significantly reduced from 3.7 to 2.5% *with* the presence of pharmacists. Documentation time in ED1 increased significantly from 4.6 to 7.4% when pharmacists were present, while in ED2, it decreased significantly from 4.5 to 2.6%. In ED3, the time spent on logistics significantly decreased from 15.4 to 8.7% *with* pharmacists present.

Among the medication-related tasks, communication about medication with other healthcare personnel was the most frequently observed work task, accounting for 0.8-1.0% of the observed time in both periods. We detected significant changes in medication-related logistics, with an increase from 0.3 to 1.4% when pharmacists were present, primarily in ED2 and ED3. In contrast, nurses in ED2 dedicated significantly less time to retrieving medication-related information *with* pharmacists present, while nurses in ED3 spent significantly less time on preparation of medications *with* pharmacists present.

Face-to-face interactions

Face-to-face interaction encompassed all personal encounters, such as patient examination/treatment or in-person oral communication. We identified a significant increase from 35.0 to 39.5% in the nurses´ face-to-face interactions during the period *with* pharmacists

Table 2 Task time distribution overall and by emergency department during periods with and without pharmacists present

	ALL EDs				ED1				ED2				ED3			
	Without pharmacists		With pharmacists		Without pharmacists		With pharmacists		Without pharmacists		With pharmacists		Without pharmacists		With pharmacists	
Total observed time (TOT)	138 h 21 min 05 s		160 h 34 min 45 s		52 h 59 min 43 s		51 h 21 min 36 s		43 h 45 min 48 s		62 h 09 min 42 s		41 h 35 min 34 s		47 h 3 min 27 s	
	% of TOT	95% CI	% of TOT	95% CI	% of TOT	95% CI	% of TOT	95% CI	% of TOT	95% CI	% of TOT	95% CI	% of TOT	95% CI	% of TOT	95% CI
Non-medication-related	62.7	(59.5–66.0)	63.0	(58.9–66.3)	61.8	(56.9–67.1)	67.2	(63.3–72.6)	66.6	(61.4–72.1)	68.5	(61.4–76.2)	59.9	(54.7–65.6)	50.9	(46.9–55.7)
Patient examination/treatment	19.3	(17.4–21.1)	21.3	(18.9–23.8)	15.5	(12.5–18.8)	13.3	(10.7–15.8)	30.2	(26.4–34.5)	34.1	(28.9–40.0)	12.9	(10.0-16.1)	13.0	(10.4–15.7)
Oral communication	18.1	(16.9–19.3)	18.8	(17.6–20.1)	18.9	(17.2–20.9)	20.1	(19.3–23.1)	13.6	(11.8–15.4)	15.4	(13.5–17.6)	21.9	(19.5–25.1)	20.8	(18.3–24.1)
Logistics	13.2	(11.6–15.3)	11.7	(10.3–13.6)	12.6	(10.0–16.0)	16.1	(13.8–19.0)	11.8	(9.1–14.7)	10.4	(7.6–13.8)	**15.4**	**(12.0-19.3)**	**8.7**	**(6.5–11.6)**
Reading/retrieving written information	3.6	(3.0-4.3)	2.6	(2.2–3.1)	5.4	(4.0-7.1)	3.9	(3.2–4.6)	2.6	(1.9–3.5)	1.4	(1.0–2.0)	2.3	(1.6–3.2)	2.7	(1.8-4.0)
Waiting/consideration	**3.7**	**(3.1–4.3)**	**2.5**	**(2.1–2.9)**	4.8	(3.9-6.0)	4.0	(3.1–4.9)	**2.8**	**(1.9–4.1)**	**1.4**	**(1.0-1.9)**	3.2	(2.2–4.4)	2.3	(1.7–3.1)
Documentation	4.0	(3.5–4.6)	4.5	(3.8–5.1)	**4.6**	**(3.7–5.8)**	**7.4**	**(6.0–9.0)**	**4.5**	**(3.6–5.5)**	**2.6**	**(1.9–3.4)**	2.6	(2.2–3.4)	3.7	(3.0-4.5)
Meeting	1.2	(0.5–2.3)	1.5	(0.7–2.7)	1.0	(0.0-3.2)	0.5	(0.0-1.4)	2.4	(0.9–4.6)	2.6	(0.8–5.8)	0.4	(0.0-0.9)	0.9	(0.1–2.2)
Confidential	1.8	(0.9–2.9)	0.9	(0.3–1.9)	0.3	(0.1–0.6)	2.7	(0.9–5.8)	3.3	(1.3–6.3)	0.0		2.1	(0.4-5.0)	0.0	
Other	0.1	(0.1–0.2)	0.8	(0.2–2.8)	0.2	(0.1–0.4)	0.3	(0.1–0.5)	0.0		1.7	(0.1–5.6)	0.2	(0.1–0.3)	0.2	(0.1–0.4)
Medication-related	3.3	(2.8–3.8)	4.2	(3.4–4.9)	3.0	(2.2–3.9)	4.4	(3.5–5.5)	3.1	(2.3-4.0)	3.8	(2.9–4.8)	3.9	(3.0–5.0)	4.3	(2.8–6.3)
Oral communication																
About medications	0.9	(0.7–1.1)	0.8	(0.7–1.1)	0.8	(0.6–1.2)	0.8	(0.6–1.1)	0.9	(0.6–1.4)	0.8	(0.5–1.3)	1.0	(0.7–1.5)	0.9	(0.6–1.4)
Retrieve information	0.4	(0.3–0.5)	0.2	(0.2–0.3)	0.3	(0.2–0.5)	0.5	(0.4–0.7)	**0.4**	**(0.2–0.6)**	**0.1**	**(0.1–0.2)**	0.3	(0.2–0.6)	0.1	(0.0-0.2)
Give information	0.3	(0.2–0.5)	0.1	(0.1–0.2)	0.4	(0.1–0.9)	0.1	(0.0-0.3)	0.4	(0.1–0.8)	0.2	(0.1–0.3)	0.2	(0.1–0.4)	0.0	(0.0-0.1)
Medication Management																
Preparation/administration (with patients)	0.5	(0.3–0.7)	0.8	(0.5–1.2)	0.4	(0.2–0.6)	0.9	(0.5–1.6)	0.7	(0.4–1.2)	1.2	(0.6-2.0)	0.4	(0.2–0.8)	0.1	(0.0-0.2)
Preparation (without patient)	0.7	(0.4–1.1)	0.4	(0.2–0.6)	0.6	(0.2–1.4)	0.7	(0.3–1.3)	0.6	(0.2–1.3)	0.3	(0.1–0.6)	**0.8**	**(0.3–1.5)**	**0.0**	**(0.0-0.1)**
Double control	0.2	(0.1–0.3)	0.3	(0.2–0.5)	0.2	(0.0-0.6)	0.6	(0.3–1.1)	0.2	(0.1–0.4)	0.4	(0.1–0.6)	0.1	(0.0-0.3)	0.0	
Logistics	**0.3**	**(0.2–0.5)**	**1.4**	**(0.9-2.0)**	0.3	(0.1–0.6)	0.4	(0.1–0.9)	**0.0**		**0.8**	**(0.4–1.4)**	**0.8**	**(0.3–1.4)**	**3.1**	**(1.7–5.1)**
Reading/retrieving written information	0.0	(0.0-0.1)	0.0	(0.0-0.1)	0.1	(0.0-0.1)	0.1	(0.0-0.2)	0.0	(0.0–0.0)	0.0	(0.0–0.0)	0.0		0.0	(0.0–0.0)
Documentation	0.1	(0.1–0.2)	0.1	(0.1–0.2)	0.1	(0.0-0.2)	0.3	(0.2–0.4)	0.1	(0.0-0.2)	0.1	(0.0-0.1)	0.2	(0.1–0.4)	0.0	(0.0-0.1)
Standby and movement	34.7	(30.6–39.1)	33.5	(30.0-37.5)	35.8	(28.4–45.1)	28.8	(23.5–34.6)	31.5	(24.5–38.9)	28.7	(23.7–34.4)	36.6	(29.9–44.2)	45.1	(35.4–56.0)
Standby	29.4	(25.0-34.1)	28.6	(24.7–33.3)	30.3	(22.4–40.2)	23.4	(18.7–29.1)	26.2	(19.8–33.7)	23.7	(18.6–29.0)	31.5	(24.9–39.1)	40.9	(32.4–51.1)
Movement	5.3	(4.9–5.7)	4.9	(4.6–5.2)	5.5	(4.8–6.3)	5.4	(4.9–5.9)	5.3	(4.6-6.0)	5.0	(4.5–5.6)	5.1	(4.5–5.8)	4.3	(3.7–4.7)

CI, Confidence interval; ED, Emergency department; TOT, Total observed time

Figures in bold indicate that confidence intervals do not overlap

The sum of proportions exceeds 100 per cent due to multitasking

present, predominately due to the data from ED2 (Table 3). Nurses primarily engaged in face-to-face communication with patients and their relatives. This interaction remained unaltered in ED1 *with* pharmacist present, but increased from 27.6 to 35.5% in ED2 and decreased from 19.5 to 14.2% in ED3. The second most commonly observed face-to-face interaction was with other nurses, increasing significantly from 9.7 to 12.2% *with* pharmacists present, mainly driven by the increase in ED3 from 12.8 to 19.2%. Face-to-face interactions with pharmacists constituted only 0.2% of the nurses' time *with* pharmacists present.

Number of patients and time per patient

During the period *without* pharmacists present, nurses attended to a mean of 2.9 patients per session, spending a mean of 20 min and 28 s on each patient. In the period *with* pharmacists present, the mean number of patients cared for by nurses increased to 3.4 patients per session, with a mean time of 16 min and 41 s spent per patient, see Table 4. These differences were not statistically significant when considering the overall data. However, at the individual ED level, significant changes were observed: In ED1, the mean number of patients cared for per session increased from 2.5 to 3.7 ($p = 0.033$) *with* pharmacists present. In ED2, the mean time spent per patient per session decreased from 23 min to 26 s to 14 min and 44 s ($p = 0.016$) *with* pharmacists present, see Table 4.

Discussion

In this study, we identified that ED nurses in three Norwegian EDs spent about two thirds of their working hours on non-medication-related tasks, and only 3.3% on medication-related tasks. The remaining time was spent on standby and movement. Most of their time was devoted to patient examination/treatment and oral

Table 3 Mean proportion of time spent by nurses on face-to-face interactions with and without pharmacists present

	Without pharmacists present		**With pharmacists present**	
	% of total observed time	**(95% confidence intervals)**	**% of total observed time**	**(95% confidence intervals)**
	In total		**In total**	
All EDs	**35.0**	**(33.8–36.2)**	**39.5**	**(38.4–40.5)**
ED1	30.9	(29.0-32.9)	33.4	(31.8–35.0)
ED2	**40.1**	**(37.9–42.4)**	**48.6**	**(46.6–50.5)**
ED3	34.6	(32.5–36.7)	34.0	(32.0–36.0)
	With patients/relatives		**With patients/relatives**	
All EDs	22.6	(21.6–23.7)	24.3	(23.4–25.3)
ED1	20.8	(19.1–22.5)	19.9	(18.5–21.3)
ED2	**27.6**	**(25.5–29.6)**	**35.5**	**(33.7–37.4)**
ED3	**19.5**	**(17.7–21.3)**	**14.2**	**(12.7–15.7)**
	With nurses		**With nurses**	
All EDs	**9.7**	**(8.9–10.4)**	**12.2**	**(11.4–12.9)**
ED1	9.4	(8.2–10.6)	10.0	(9.0–11.0)
ED2	7.1	(5.9–8.3)	8.7	(7.6–9.8)
ED3	**12.8**	**(11.3–14.3)**	**19.2**	**(17.5–20.9)**
	With physicians		**With physicians**	
All EDs	3.9	(3.4–4.4)	3.2	(2.8–3.6)
ED1	**4.8**	**(4.0-5.7)**	**2.9**	**(2.4–3.5)**
ED2	3.1	(2.3–3.9)	3.7	(3.0-4.4)
ED3	3.7	(2.8–4.5)	2.9	(2.2–3.6)
	With pharmacists		**With pharmacists**	
All EDs	0.0	(0.0-0.1)	0.2	(0.1–0.3)
ED1	**0.0**		**0.1**	**(0.0-0.3)**
ED2	0.0	(0.0-0.3)	0.2	(0.1–0.4)
ED3	**0.0**		**0.2**	**(0.0-0.5)**
	With others*		**With others***	
All EDs	2.7	(2.3–3.1)	2.8	(2.4–3.1)
ED1	2.5	(1.8–3.1)	3.2	(2.6–3.8)
ED2	2.6	(1.9–3.3)	1.9	(1.4–2.5)
ED3	3.1	(2.3–3.8)	3.4	(2.6–4.1)

*= paramedics, students, other healthcare personnel or patient caretakers, unknown

Figures in bold indicate that confidence intervals do not overlap

The sum of proportions exceeds "total" per cent due to multitasking

Table 4 Number of patients treated by nurses and time spent per patient per observation session

A: Mean number of patients treated per observation session with and without pharmacists present								
	Number of sessions (*n*)		**Mean number of patients per session (SD)**		**Mean difference**	**95% Confidence interval**		***p*-value**
	Without	**With**	**Without**	**With**		**Lower**	**Upper**	
Overall	81	89	2.93 (1.5)	3.39 (2.0)	0.47	-0.07	1.01	0.089
ED1	32	28	**2.50 (1.3)**	**3.68 (2.5)**	1.18	0.10	2.25	**0.033**
ED2	25	36	2.68 (1.2)	3.44 (1.7)	0.76	-0.03	1.56	0.058
ED3	24	25	3.75 (1.8)	3.00 (1.9)	-0.75	-1.79	0.29	0.154
B: Time spent per patient (min: sec) per observation session*with* and*without* pharmacists present								
	Number of sessions (n)		**Mean time per patient per session**		**Mean difference**	**95% Confidence interval**		***p-value***
	Without	**With**	**Without**	**With**		**Lower**	**Upper**	
Overall	79	86	20:28	16:41	-03:47	-07:54	00:27	0.079
ED1	31	27	22:36	18:53	-03:43	-12:14	04:47	0.385
ED2	25	36	**23:26**	**14:44**	-08:43	-15:40	-01:46	**0.016**
ED3	23	23	14:21	17:11	02:50	-03:37	09:18	0.381

ED, Emergency department; SD, Standard deviation

Figures in bold indicate statistically significant differences

communication with colleagues about patient care. Introducing clinical pharmacists into the ED teams did not significantly alter the general work task distribution, although time for some work tasks changed significantly within single EDs.

The observed duration of work time dedicated to medication-related tasks by ED nurses appears low, yet it is consistent with other research, which reports a range of 3–18% [29, 32, 33]. Despite this, the scant proportion was unexpected, given our awareness of the extensive medication-related responsibilities that Norwegian nurses undertake. A plausible explanation for the low proportion of time spent by ED nurses on such tasks might be that they prioritize only the most critical duties in the ED, deferring others until the patient is transferred to a hospital ward [34]. Alternatively, certain tasks might have been completed prior to the patient's arrival in the ED, thus eluding our measurement. Another reason why Norwegian nurses spent less time on medication-related tasks, compared to other countries, may be that Norwegian ED physicians have the predominant role in these tasks. When considering the frequency of medication errors and the consequent patient harm reported in EDs [35], the modest proportion of time that ED healthcare personnel, both nurses and physicians dedicate to medication-related tasks is concerning [23]. In many countries, the ED pharmacist is included in the ED team to perform medication-related tasks and consequently increase medication safety [36]. This interdisciplinary approach is the cornerstone of a robust healthcare system. As medication experts, pharmacists provide valuable support to nurses and physicians [37]. The integration of pharmacists in EDs in Norway is an advisable initiative that can utilize their expertise in medication management to enhance patient outcomes. However, it was initially unclear how this would affect the time usage of nurses, particularly regarding medication-related tasks, and we were curious to see if their time allocation would change. We look forward to the results from the PharmED study, which we believe will provide substantial support and valuable insights.

In the PharmED study, the aim has been to increase medication safety by introducing clinical pharmacists in the EDs [21]. The pharmacists were hired to integrate into the team and perform mainly medication-related tasks to deliver better and safer patient care. This included finding their place in the interdisciplinary team and offering medication-related support as needed by other healthcare professionals. We assumed that the pharmacists would assist and collaborate with the ED nurses. However, contrary to expectations, our data show that the involvement of a clinical pharmacist did not alter the time spent on medication-related tasks, for either the nurses observed in this study or the physicians in a parallel study (yet unpublished). Additionally, we identified little interaction between the nurses and the pharmacists, despite some small differences between the EDs. The explanations to this may be multifactorial. *One explanation* may be that the pharmacists bridged a gap in work tasks, undertaking medication-related tasks that otherwise might not have been performed were it not for the pharmacists. Consequently, the nurses could be more efficient in their patient care. Evidence of this is seen in the increased patient load managed by nurses in ED1 *with* pharmacists present, and in a reduction of time nurses spent on medication-related tasks per patient in ED2. This is also supported by evidence from the previously mentioned parallel study, where we identified that

ED physicians' work time distribution was also not significantly altered by the pharmacist presence (yet unpublished). Still, the physicians were very satisfied with the pharmacist collaboration, and experienced an increased patient safety [38]. *Another explanation* may be that work distribution alterations varied between the EDs, but that the overall time distribution did not change because the inter-ED-variations were cancelled out in the overall results. This is supported by the evidence of significant task-specific changes in the individual EDs. *A third explanation* may be that the pharmacists did not directly assist or work with the nurses (evident by the low face-to-face interaction time), but rather worked autonomously or with the physicians. We have detailed the pharmacists' activities in two of the three EDs in our published article on the WOMBAT of emergency department pharmacists [24]. Introducing complex interventions in health care may take time [39], and health care professionals do not necessarily always know each other and each other's competences [40, 41], potentially causing an absence of familiarity and trust across the professions. *A final explanation* for the unchanged time distribution may be the potential oversight in capturing some tasks undertaken by nurses while not being observed. For instance, nurses' educational activities might not have been fully captured, and ED pharmacists may have assisted with these tasks as part of their role [42]. Furthermore, integrating new team members, such as clinical pharmacists, into an ED setting may require additional time for them to fully adapt and become active contributors, similar to what has been observed with new nurses and physicians [43].

Strengths and limitations

To our knowledge, this study represents the first time-and-motion analysis conducted on nurses in EDs to compare their time distribution with and without the presence of pharmacists. The primary strength of this study lies in the application of the WOMBAT observation methodology, which offers a structured observation framework that minimizes observer fatigue and ensures precise replication of the observations during the second period when pharmacists are present [29, 44, 45]. Another significant advantage is the meticulous development and validation of the observation categories, which enhances the feasibility of the observations and the validity of the results. The generalizability of the findings is further reinforced by the inclusion of three distinct EDs and the observation of a substantial number of nurses. However, the study is not without limitations. These include: (i) The potential for the Hawthorne effect, where nurses might alter their behaviour because they are aware of being observed [46]; (ii) The inherent biases and confounding associated with the before-and-after study design, as referenced in the literature [47]; (iii) The observational setup did not allow for tracking a single nurse throughout an entire day, which could have provided more comprehensive insights into the distribution of time throughout their shift. Additionally, the studies used to determine the number of needed observation hours were conducted in another departments, not EDs. Those different environments may not fully reflect the unique nature of EDs; (iv) There was an inconsistency in observation times between ED1 and ED2 compared to ED3, caused by the different times of day during which observations were conducted; (v) A potential multiple testing problem, given that an extensive number of statistical tests was performed. This increases the risk of type I errors with a probability of false positives (FWER, Family Wise Error Rate) close to 100%. Cautious interpretation of the significant results is necessary; (vi) A potential mutual dependency from observing some nurses more than once. As the proportion with two observations was fairly similar before (27%) and during (33%) the intervention, we do not expect a large influence. However, we did not specifically test for mutual dependency in our data analysis. Future studies should consider this factor and possibly employ methods to account for it to ensure robustness of the findings. And vii), it is acknowledged that the lack of time between the measurement periods may have affected the integration of pharmacists into the ED workflow. The first period was conducted without pharmacists, while the second included them, but the short duration may not have allowed for full integration. As the study was designed to span 12 months to assess the impact of pharmacists in emergency departments, observations at later stage were not feasible. We recommend future research to allocate considerably longer timeframes for similar interventions to ensure comprehensive integration and observation. These limitations should be considered when interpreting the study's findings and considering its implications for practice and future research.

Conclusion

In this study, we observed that nurses in three Norwegian EDs spent only 3.3% of their time on medication-related tasks, and that the introduction of clinical pharmacists did not significantly alter their overall time distribution. While the study provides valuable insights into the work tasks of ED nurses, it is important to consider that there may be multiple factors contributing to these findings. One possible explanation is that clinical pharmacists did not collaborate extensively with nurses or take over any of their existing tasks. Further research is needed to investigate the optimal roles and responsibilities of ED pharmacists, as well as the barriers and enablers to effective nurse-pharmacist collaboration.

Abbreviations

CI	Confidence Interval
ED	Emergency Department
SD	Standard Deviation
UiT	University of Tromsø
UNN	University Hospital of North Norway
WOMBAT	Work Observation Method By Activity Timing

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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Author contributions

RVH, ECL, TJ, BZH, KS, TR, EHO, RE and BHG had the original idea to the study. ECL trained the observers and led the piloting process. RVH, MF and AM performed the observations. RVH, MW, FS, SRW and KS have performed the statistical analyses. All authors have participated in discussion and interpretation of statistical analyses, and result presentations. RVH has drafted the manuscript and prepared tables and illustrations. All authors have contributed in writing the manuscript, and confirmed the final submission.

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Data availability

The data that support the findings of this study are available upon reasonable request from the corresponding author RVH.

Declarations

Ethics approval and consent to participate

The study received approval from the Data Protection Officer at the Hospital Pharmacy of North Norway Trust (letter dated November 28, 2019) who has the project responsibility, as well as from the three participating hospitals; Data Protection Officers at University Hospital of North Norway Trust in Tromsø and in Harstad (No. 02330), and Data Protection Officer at Nordland Hospital Trust in Bodø (No. 28 – 19). These entities serve as the ethical representatives for studies that fall outside the jurisdictions of the Regional Committees for Medical and Health Research Ethics in Norway. This particular study was deemed outside their jurisdiction because it did not involve the collection of patient-sensitive information. The study was conducted in compliance with the protocol, the principles of Good Clinical Practice, and the Declaration of Helsinki [48]. Written informed consent was obtained from the nurses before initiating any observations. Patients and collaborating healthcare personnel were informed about the ongoing study and the observer's role, both verbally by the observer and through written information.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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