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Hospital pharmacy implementation of a unit dose dispensing system: A qualitative interview study to determine experiences, views and attitudes of nursing staff

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ABSTRACT

Background: Evolving automated technologies in the dispensing process promise effective solution to reduce medication error rates. The Unit-Dose-Dispensing-System (UDDS) is an essential element of the "Closed Loop Medication Management System" that enables the tracking of single medication items across the entire medication workflow thereby improving transparency, patient safety and healthcare efficiency".
Objective: The aim of this study was to determine hospital nurses' attitudes towards the unit dose dispensing system implemented by the hospital pharmacy department, examine their perceptions of opportunities and barriers in everyday practice and explore their experiences with its implementation.
Methods: A qualitative interview study with 23 nurses from the Barmherzige Brüder Hospital Linz, Austria was conducted. The validated and piloted semi-structured interview guide was based on best practice guidelines for qualitative interview studies and the Consolidated Framework for Implementation Research (CFIR). Interviews were transcribed verbatim and mapped against the Framework of Implementation of Services in Pharmacy (FISpH) by two researchers independently.
Results: Twenty-three nurses were interviewed. Despite the overwhelmingly positive experiences with ease of use, resultant time saving, improved collaboration, patient safety, patient autonomy and a better facilitated discharge process considered as some of the positive attributes, several barriers were identified. Nurses commented on a lack in standardised workflow, erosion of knowledge and sustainability.
Conclusion: Nurses highlighted key factors for implementation success and advantages of the unit dose dispensing system, suggesting a need to adapt to local conditions and full electronic integration into patient care. Suggestions to further improve the reliability and efficiency were made.
What does this paper contribute to the wider global clinical community?:

- There is no research qualitatively exploring the implementation facilitators and barriers of a unit dose dispensing system at hospital ward level from the nurses' perspectives.
- Insights are provided into the significance of good collaboration between all ward staff to ensure the necessary workflow adaptations, the necessity of a seamlessly integrated IT system and the adaptability of the system depending on the patient population.
- The findings highlight key factors for a successful implementation of a unit dose dispensing system at ward level while underlining its advantages for workload, staff shortages and patient safety.

1. Introduction

Medication errors are recognised as a significant global issue impacting patient safety and healthcare outcomes.[1] The WHO estimates that the global cost associated with medication errors is approx. US$42 billion annually and calls for global action.[1] The European Medicines

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Agency defines a medication error as "*an unintended failure in the drug treatment process that leads to, or has the potential to lead to, harm to the patient.*".[2] This drug treatment process is a complex multistep process that includes prescribing, transcribing, dispensing, administration, monitoring and documenting of medicines as well as a multitude of healthcare professionals including prescribers, nurses, pharmacists, technicians and the patients themselves.[3] Multiple *co*-morbidities and resultant Polypharmacy increases the complexity of a patient's medication regime and the risks for significant medication errors.[4]

The implementation of automated technologies in the dispensing process may offer an important solution to reduce medication error rates.[5–7] Although errors can occur at any point in the medication process, various tools have been created to aid in different stages. For example, computerised prescribing with decision support assists in the prescribing process, barcoding or automated dispensing and unit-dose systems aid in the dispensing process, and electronic medication administration records and smart pumps support the administration process.[5] Automated dose dispensing was originally developed as a tool to enable unit dose provision in institutional settings, as a technical aid to free up resources for patient care. Barcode technology has extended its application and use.[8] Unit dose dispensing (UDDS) is a pharmacy-coordinated, automated method for packaging and distributing medication.[9] Individual rations of prescribed drugs are pre-packaged individually for each patient in unit dose blisters, labelled and subsequently sent to the wards.[9] Medication to be taken at the same time can be provided in one blister. UDDS is an essential element of the "Closed Loop Medication Management System". This describes a self-contained medication management process that enables the tracking of single medication items across the entire medication workflow (i.e. prescribing, dispensing, administration and documentation) thereby improving transparency and safety.[10] Aside from the improvement to medication management and dispensing error rates, the implementation of a UDDS system has been reported to increase several other factors. These include work efficiency within pharmacy and on the ward, precise medication labelling to allow correct medication identification and the release of a significant portion of pharmacist technicians and nurses time resources.[11] This allows a more efficient allocation of human resources which is especially crucial in times of significant nurse's staff shortages worldwide emphasising it's advantages compared to other automated systems.[12]

In the Austrian healthcare system, medical prescribers are responsible for the diagnosis, treatment, prescribing and administration of medication.[13] Qualified nursing staff may implement medical – therapeutic measures in accordance with a doctor's order, which includes the administration of medicines, while nursing assistants are only authorized to assist with therapy and administration of medicines.[14] Specialist nursing assistants have the same legal rights as the nursing assistants but are solely responsible for their actions.[15] Pharmacists have a medication supply, logistics and manufacturing function which does not include the legal right to administer medication.[16] The recent Austrian healthcare reform (July 2024) allows qualified nurses to independently prescribe medical devices.[17] Further hospital pharmacists are allowed by law to carry out adjustments to the dosage form, quantity and strengths as well as substitution, termination, continuation or interruption of drug therapy in accordance with a medical prescribers written instructions, spelling out a significant professional role extension for hospital pharmacist.[18]

Staff shortages during the second wave of the COVID-19 pandemic in November 2020, which have since prevailed, was a key driver for the implementation of the UDDS system at the Barmherzige Brüder hospital in Linz, Austria.[19,20] The strict hygiene guidelines, measures for patient isolation, personal protection equipment, physically as well as mentally burdensome working conditions and staff shortages due to sickness and quarantines resulted in a heavy workload and arduous working conditions for nurses.[21] The decision was taken by the hospital pharmacy together with the medical and nursing management to implement a UDDS system with the aim to improve the dispensing efficiency and safety. While a UDDS system had already been established in 2004, which received its Good Manufacturing Practice (GMP) licence in 2011, to facilitate the medication dispensing service in local care homes and other long-term care facilities, hospital procedures and patient requirements are a lot more complex. This poses a challenging implementation climate. While unit dose dispensing systems are quite common in the US and in northern European countries, the use of UDDS in Austria is only slowly becoming commonplace in long-term care facilities with the "Neuverblisterungsbetriebsordnung (NVBO)" forming the legal basis.[22] The Barmherzige Brüder hospital in Linz is the only Austrian hospital to have implemented the UDDS system on a range of inpatient wards. While there is a paucity of international literature exploring the experiences of nursing staff with the implementation of the UDDS system in a hospital setting, a single centre quantitative evaluation study at a German teaching hospital reported that nurses appreciated the implementation of a UDDS and cited a reduction in drug stocks on the ward and a time saving for medication dispensing from 4.52 ± 0.35 min to 1.67 ± 0.15 min/day/patient as key benefits. The study reports a reduction of 7.36 FTE nurses time across the entire hospital setting/ year but also reports the need for 6.5FTE hospital pharmacists to ensure the supply.[23] No other reliable international studies exists that allow an insightful comparison between healthcare systems. Real world implementation studies are a key stage of the translational research continuum within implementation science to better understand if a newly implemented service is effective.[24] Experiences of nursing staff with this implementation are key to identify barriers and facilitators in an inpatient environment to help facilitate national implementation and ensure its effectiveness and sustainability. More well-designed qualitative research projects are needed to support the implementation of UDDS systems in hospital practice. A qualitative approach is more suitable to capture the in-depth experiences of the nurses, shedding light on the complexities of workflow changes and the nuanced impact on patient care. This method allows for a more comprehensive understanding of the barriers and facilitators in UDDS implementation, which would not be possible with a quantitative approach.

1.1. Aim

The aim of this study was to determine hospital nurses' attitudes towards the unit dose dispensing system implemented by the hospital pharmacy department, examine their perceptions of opportunities and barriers in everyday practice and explore their experiences with its implementation.

2. Method

2.1. Ethical considerations

The study followed the Declaration of Helsinki on ethical principles for medical research involving human subjects. The study protocol for this project was submitted to the ethics committee of the Johannes Kepler Universität Linz, Austria (23.12.2022). They advised that no hospital ethics approval was needed. All participants were informed that their personal details would be kept confidential and that they could withdraw from the study at any point without providing a reason.

2.2. Study design

This qualitative phenomenological interview study followed a phenomenological approach using semi-structured, face-to-face interviews. Phenomenology sets out to explore participants' views on, and experiences with, a given phenomenon (in this case the implementation of a novel process: unit dose system (UDDS)).[25]

2.3. Theoretical framework

The Consolidated Framework for Implementation Research (CFIR) was used to guide the development of the semi-structured interview topic guide.[26] This practical framework offers a comprehensive taxonomy of influencing factors across several socioecological levels that help guide the systematic assessment of potential barriers and facilitators of a newly implemented service.[27]

It consists of five domains, which are further subdivided into several constructs. Table.1 includes all constructs used in the design of the semi-structured interview guide used in this study.

Table 1
An adapted illustration of the Consolidated Framework of Implementation Research (CFIR)[19] showing the five domains with the constructs used in the design of the semi-structured interview guide.

Consolidated Framework for Implementation Research (CFIR)		
Construct		Short Description
I. Intervention Characteristics		
A	Intervention Source	Perception of key stakeholders about whether the intervention is externally or internally developed.
C	Relative Advantage	Stakeholders' perception of the advantage of implementing the intervention versus an alternative solution.
D	Adaptability	The degree to which an intervention can be adapted, tailored, refined, or reinvented to meet local needs.
F	Complexity	Perceived difficulty of implementation, reflected by duration, scope, radicalness, disruptiveness, centrality, and intricacy and number of steps required to implement.
H	Cost	Costs of the intervention and costs associated with implementing the intervention including investment, supply, and opportunity costs.
II. Outer Setting		
D	External Policy & Incentives	A broad construct that includes external strategies to spread interventions, including policy and regulations (governmental or other central entity), external mandates, recommendations and guidelines, pay-for-performance, collaboratives, and public or benchmark reporting.
III. INNER SETTING		
3	Relative Priority	Individuals' shared perception of the importance of the implementation within the organisation.
2	Available Resources	The level of resources dedicated for implementation and on-going operations, including money, training, education, physical space, and time.
3	Access to Knowledge & Information	Ease of access to digestible information and knowledge about the intervention and how to incorporate it into work tasks.
IV CHARACTERISTICS OF INDIVIDUALS		
A	Knowledge & Beliefs about the Intervention	Individuals' attitudes towards and value placed on the intervention as well as familiarity with facts, truths, and principles related to the intervention.
B	Self-efficacy	Individual belief in their own capabilities to execute courses of action to achieve implementation goals.
C	Individual Stage of Change	Characterization of the phase an individual is in, as he or she progresses towards skilled, enthusiastic, and sustained use of the intervention.
V. PROCESS		
B	Engaging	Attracting and involving appropriate individuals in the implementation and use of the intervention through a combined strategy of social marketing, education, role modeling, training, and other similar activities.

2.4. Study setting and recruitment

The study was conducted at the Barmherzige Brüder Hospital Linz. A 331-bed hospital with 416 nursing staff. As the unit dose dispensing system has been well established on five inpatient wards (wards: 31,42,22,52,54) nursing staff across all five wards were invited to participate in the study (Sampling frame: $n = 110$). Nursing staff were chosen for this study as they are typically responsible for dispensing and administrating medications to all patients on the wards. They are the group of healthcare professionals who are impacted the most by the implementation of a UDDS system. The sampling frame and the criteria used were sufficient to gather diverse insights, particularly from nurses directly impacted by UDDS implementation. Participants were approached by the lead nurses on each ward after facilitation by the lead pharmacist (TS). Participants were provided with a participation information leaflet, a short demographic background questionnaire and a consent form. Once written consent was obtained a suitable time for a face-to-face interview was arranged.

2.5. Inclusion and/or exclusion criteria

Participants were eligible for inclusion in the study if they were graduated hospital nurses who had direct responsibility for the daily medication of inpatients and had worked on the ward for at least six months prior to the introduction of the UDDS. Assistant nurses without a diploma and nurses who started working on the ward after the introduction of the UDDS or who were transferred to another ward after the UDDS implementation were excluded from the study.

2.6. Data collection tool development

The questions in the semi-structured interview guide were devised to provide an understanding of nurses experiences, views and attitudes of the implementation of UDDS and its applicability to daily clinical hospital practice and patient care. The interview guide was reviewed for credibility by members of the research team providing breadth of expertise in clinical pharmacy and research. Key questions and prompts used to elicit further in-depth information are provided in **Table 2.** It contained open questions and prompts on knowledge, experience, ease of use, advantages, barriers, economics, training, resources and patient satisfaction. The interview guide was piloted (by TD) in two ward nurses to establish nurses understanding of the interview questions and the duration of the interview. Very minor changes were made to the wording of the interview guide. The pilot interviews were not included in the final dataset for analysis.

2.7. Data collection

All interviews took place in a private room on the hospital premises to ensure participant confidentiality. Interviews were conducted solely by a trained female student researcher unknown to the participants (TD). Interviews were conducted until data saturation was achieved, determined using a stopping criterion of three, meaning that following the principal investigators notion that data saturation had been reached, interviews were continued until no new themes emerged in three consecutive interviews.[28] Interviews were audio recorded and transcribed verbatim using a denaturalised approach. As this was a single centre study there was no advantage in using field notes or a naturalised transcription process as capturing cultural, social and linguistic nuances and impressions was outwith the scope of the study aim. Transcriptions were anonymised and checked for accuracy by a second researcher (AEW).Participants were not asked to provide feedback and no field notes were taken.

Table 2
Questions & prompts used in the semi-structured interview guide with ward nurses experienced in the use of the UDDS system at the Barmehrzige Brüder, Linz.

Key questions	Prompts
Can you start by telling me what you know about the unit dose system?	The unit dose system is intended to make the daily medication of inpatients easier and safer by automating the dispensing into individual blister packs.
Have you already gained experience with the introduction of unit dose systems?	If yes: What helped? / What was a particular hindrance? Question: How did you proceed?
How easy or difficult is it to use a unit dose system on the ward?	Why (easy/not easy)? What/which factors help in particular? E.g. work processes; training etc. In your opinion, is the unit dose system easy to adapt to the circumstances of the individual wards?
What are the advantages of a unit dose system for everyday ward life?	Why not? Necessity for patients / care? Who do you see as responsible for medication therapy safety in connection with the unit-dose system?
Are there any concerns about the introduction and use of a unit dose system in everyday practice on the ward?	Why? Can you elaborate on this a little more?
Have the hospital wards incurred additional costs OR cost savings as a result of introducing the unit-dose system?	If so, which ones?
Are the nursing staff well equipped for the introduction of unit dose systems on the ward?	Why (not)? To what extent does the introduction of a unit dose system affect the daily routine of your ward?
Are there sufficient resources for the implementation of the unit dose system on the ward?	e.g. training; space; time; material etc.
How would you rate patient satisfaction with the unit dose system?	Why? OR Can you tell me more about it?
Are there other pharmaceutical services you would prefer to see introduced?	Why?
Would you like to add anything else?	

2.8. Data analysis

Deductive coding of Interviews was carried out against the domains of the Framework for Implementation of Services in Pharmacy (FISpH) providing an underpinning for professional service implementation in hospital practice.[29] Theory-based interpretative data analysis was used for the analysis. All transcripts were coded by two researchers ((TD/TS) & TD/AEW)) independently against the Framework for the Implementation of Services in pharmacy (FISpH). Discrepancies were resolved by discussion with a third researcher (TS/ AEW) consulted where no consensus could be found. Coding took place with the help of NVIVO (2023).Results were reported in accordance with the COREQ criteria for reporting qualitative research.[30] No patient or public contribution was sought and no intercoder reliability (ICR) was assessed.

2.9. Rigour and reflexivity

Two of the three researchers had extensive experience in hospital pharmacy (TS/AEW). One (TS) is an expert in the implementation of UDDS as a hospital pharmacy service, while AEW has extensive experience in clinical pharmacy research including qualitative research and implementation science. TD was a student researcher who received training as part of this project. Neither the student researcher (TD), nor AEW were known to the nursing staff. The involvement of TS in the recruitment of nurse participants may have resulted in participation bias.

3. Findings

3.1. Participant characteristics

Twenty-three graduate hospital nurses across five different wards (surgery #31; internal medicine #42,44; Neurology #52,54) were interviewed. 91,3 % ($n = 21$) of participating nurses had been working on their respective ward for nine months or more. While all nurses ($n = 23$; 100 %) had experience of using the UDDS for inpatient care on their ward, three nurses (13 %) also reported experience with UDDS from a previous healthcare setting (different hospital ($n = 1$; 4,35 %), care home ($n = 2$; 5,71 %). Four of the approached participants declined to participate stating time-constraints and personal reasons. The interviews lasted between 15 and 35 min.

3.2. Qualitative findings

All findings are presented within the FISpH domains (External system, Local setting, Organisation, Innovation (UDDS) characteristics, Individual (nurse)) (Table 3). To address the specific research findings on nurses' attitudes towards the unit dose dispensing system implementation and their perceived opportunities and barriers in everyday practice nurses´ experience of implementation factors are presented as facilitators or barriers with suggestions for potential improvement provided separately and out with the FISpH domains. No experiences were coded to the External System domain. Findings are illustrated in (Fig. 1). Data saturation was achieved.

3.3. Innovation (UDDS) characteristics

The implementation of the UDDS and daily working practice with the system was considered to be simple and very self-explanatory. Especially the clear blister labelling was considered particularly easy to use in daily practice.

> *"It's all written on [the blister]. The time [of administration]is written down. The date [of administration]is written down. Patient ID. Everything." [T3]*

The UDDS implementation necessitated a range of changes in the daily workflow and staff habits which was particularly welcomed in relation to the 3 pm deadline for sending the daily UDDS medication

Table 3
Explanation of the focus of each of the five Framework of Implementation of Services in Pharmacy (FISpH) used in the coding of the 23 nurses' interviews presented in this study.

FISpH Domain	Explanation
Innovation (UDDS) characteristics	This domain focuses on the characteristics of the UDDS (innovation) such as complexity, design quality and packaging, adaptability and cost. The benefits to caregivers, patients and the organisation are also covered.
Organisation	This domain includes all aspects of the Barmherzige Brüder Hospital Linz in which the UDDS is to operate, such as staffing, layout and workflow, available resources, training, teamwork and organisational support.
Individuals: Nurses	The roles and characteristics of the hospital nurse participants including knowledge, beliefs, personal attributes, values & motivation, and technical skills.
Local Setting	This domain relates to the setting in which the innovation is implemented. It focuses on inter-and intra-professional networks, demand, peer pressure, relationship with patients, patient needs & resources.
External System	Concerns the wider political and healthcare. system including regulating authorities and professional. bodies.

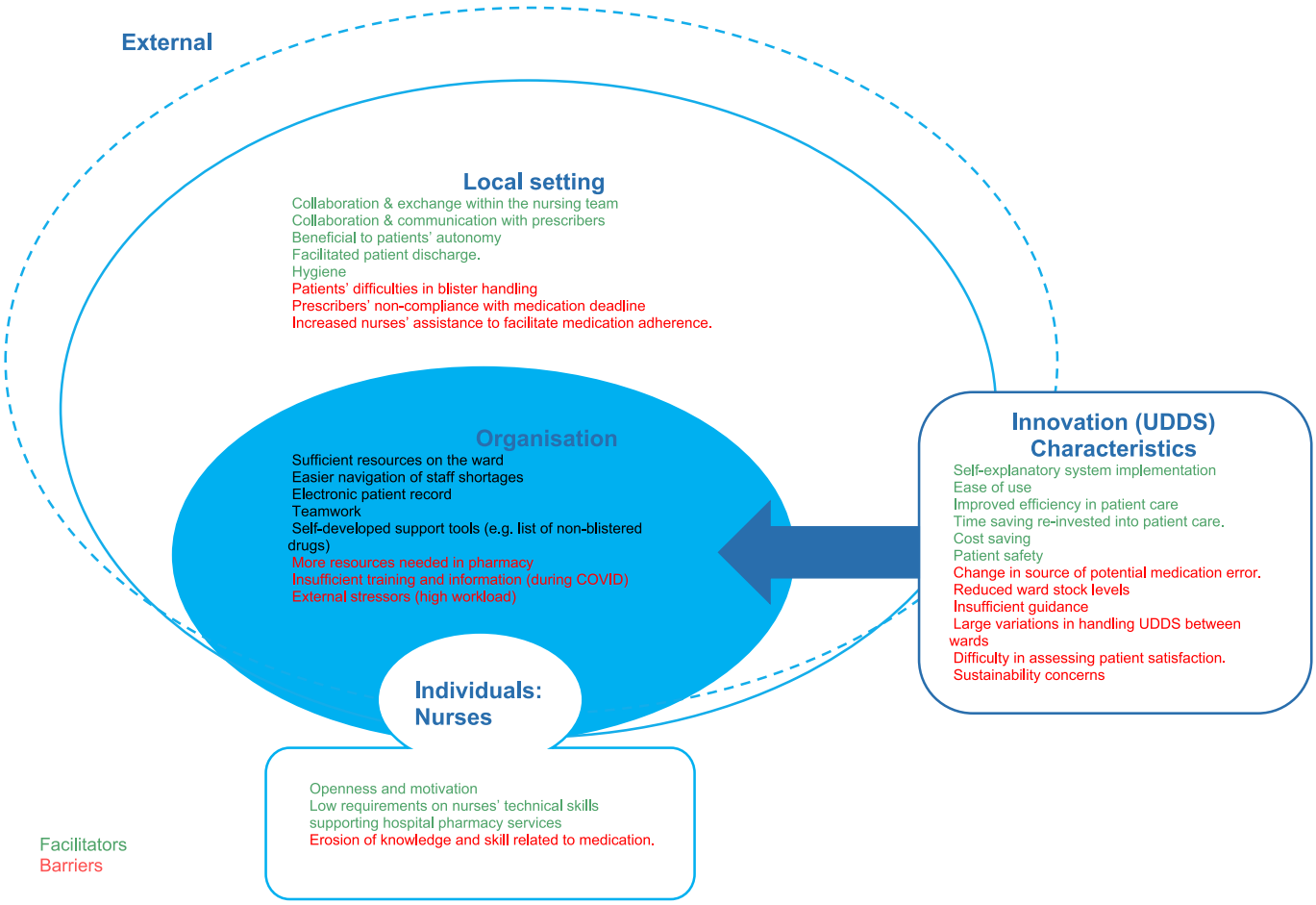

Fig. 1. Summary of barriers and facilitators coded against the Framework of Implementation of Services in Pharmacy (FISpH).

order to the pharmacy department. This deadline requires prescribers to have completed all patient medication changes resulting in improved polypragmasie and efficiency in patient care on the ward.

> *"It's an improvement [for the daily ward routine] because the change [in medication] only takes place once and the prescribers cannot take until 5 pm or later. …." (T20).*

One key advantage that is felt is the overall time saving due to a reduction in the time spent dispensing, administering and checking stock levels with some nurses estimating that as much as 50 % of time spent preparing medications has been saved. One exception was the smaller ward stock, resulting in medication shortages if new patients were admitted at the weekend. As a result, night-shift nurses often had to make phone calls to other wards to source the correct medication.

> *"It's simply a time saver. You don't have to search for the medicine packet, dispense each tablet individually and stow the packet away again." [T1].*

> *"Previously [I worked on] a 36-bed ward. [We had] nothing but in-patients with multiple tablets [each]. [The nurse] really sat there for two to three hours simply dispensing the medication. … all in all, it now takes [the nurse] about an hour, including all the changes [in medication]." [T6].*

> *"It happens more and more often that we don't have all the medicines on the ward, so we have to call around [during the night shift]. As most wards now also have the UDDS, they too have fewer drugs, and it results in a bit of a hunt." [T8].*

While nurses were largely unable to comment on the economic impact the UDDS implementation may have had, they expect there to have been a cost saving considering a lack of medication wastage, reduction in medication ordering and reduction in staff time preparing medication.

> *"There is a difference between ordering a pack of 30 and having it invoiced or having the [exact] number of tablets I need for my patients invoiced." [T17].*

> *"It's a time saver. That means, it's a cost saving of time." [T1].*

Nurses felt that the efficiency savings in the workflow allow them to directly re-invest the time gained into the patients' care. While the improved workflow, labelling and handling of medication was perceived to result in fewer errors and increased patient safety.

> *"You have more time for the patients."*
>
> *[T18]*

> *"We used to dispense the tablets during the day and … you got disrupted all the time. It is much safer now and the patients get the correct medication."*
>
> *[T4]*

Despite the perceived simplicity and ease of implementation the necessitated changes to the daily workflow and habits resulted in some difficulties. One such concern was clear guidance on how to deal with late medication changes; the correct process to deal with medications that are not able to be added to the blister (e.g. antibiotics; certain blood thinners; narcotics) and requirement for safety checks prior to dispensing to the patient.

"[At the beginning] we wondered: How do we go about it? Do we have to add [the tablets] to the patients dosette system or do we give the unit dose blisters to the patients? … what's the best way?" [T12].

"This has always been a topic for discussion …. [One part of the nursing staff] checks what is inside the unit dose blister. Does [the tablet] really look like an Aspirin? The other part [of the nursing staff] says I have to rely on its accuracy. Personally, I check the number [of tablets] as I don't know every tablet off by heart." [T20].

As a result, the way in which nurses handle unit dose blisters varies from ward to ward. In a bid to save time and keep patient safety high some wards re-dispense all blisters into patients dosette boxes, while others deal with additional non-blistered medication by providing both the UDDS blister and the dosette/ cup containing the additional medication to avoid missing any medication.

"For example, I have three unit dose blisters for [patient name] … and an additional patient dosette system with his Augmentin. I then have two medication systems for [the patient] and the problem arises that you might forget something. That's why we put everything into the patient's dosette system…." [T1].

"… it simply has its advantages if we deal with it in such a way that …the changes [to the medication] are put in [the patient's] dosette system and the unit dose blisters are hung over the top of it." [T6].

In fact, one nurse notes a shift in the source of medication errors away from traditional dispensing mistakes towards a new error potential in the way staff deal with late medication changes. Therefore, the frequency of medication change affects how well the UDDS system works.

"I think the main source of error is not that the drugs are blistered incorrectly. … But to ensure that changes [in medication] are actually carried out. So if the content [of the blister] has been changed, ensuring it's properly documented and actually carried out. That now carries the greatest potential for error." [T23].

"I think it's easy [to implement the UDDS] on the surgical ward. … I don't think they have as many changes in the patients' permanent medication as we do [on the internal medicine ward]…." [T15].

As the majority of patients receive all their medication in a dosette box system it is difficult for nurses to gauge the patient's satisfaction with the UDDS.

"I think patients don't notice [the UDDS] at all. Because they still get the tablets in exactly the same way as they did before." [T3].

Equally their opinions on sustainability aspects of UDDS were mixed, complaining about the large amount of packaging waste, but conceding that medication waste has also been reduced.

"The waste … hurts. It's just a bit too much plastic. We talk about reducing plastic everywhere and this produces twice or three times as much." (T13).

"We no longer have as many medicines expiring on the ward." (T4).

Although the unit dose blisters are not being used as originally intended, the majority of nurses consider them to be a great help in their day-to-day work.

"Nevertheless, it's a relief to have it pre-blistered. Even if you end up putting it in a patient dosette system, you don't have to dispense all [the medication]." [T16].

"Because we often only have time to dispense the tablets late in the evening …. If I only have to check [the unit dose blisters] once more and the correct medicine is already stated [in the blister] … I find it makes my job a lot easier." [T1].

3.4. Local setting

A strong collaboration and exchange within the nursing team (Interprofessional communication) on any given ward was perceived as helpful to facilitate the initial implementation of the unit dose delivery system.

"I think talking to each other and sharing experiences within the team …. That has helped us." [T11].

Nurses articulated an appreciation for the prescribers who themselves had to adapt to the new way of working to ensure all prescription changes were completed by 3 pm, thereby allowing nursing staff to comply with the medication order deadline.

"The doctors also had to adapt by completing the medication changes by 3 p.m. …." [T8].

"We have communicated [the deadline for medication changes] well and it is clear to the prescribers." [T20].

By and large this collaboration was perceived to work well but non-compliance of prescribers with the order deadline resulted in additional stress and complications for the nursing team.

"[…] first you have to find the correct blister, […] which tablet I have to remove. Then I have to go back to the medicine cabinet and look for the new tablet. I might not have this one on the ward, which means I have to look for it on another ward first. Then I have to add it back into [the blister] and document that it has been hanged." [T23].

An impact on the communication between wards (Intraprofessional communication) within the hospital was not mentioned.

Overall nurses consider the UDD systems to be of benefit to the patient's autonomy as the patient receives the information about the medication, they have been prescribed printed on the blister pack which improves transparency and understanding.

*"… I think [patients] appreciate [the UDDS]. Because they can read exactly what's inside them. They usually don't need anyone to explain what drug it is or what it looks like." [*T19].

Patients' ability to handle and use the unit dose blisters however depends on their age and state of health.

"The older clientele, … are overwhelmed in my opinion as they can't open it [the unit dose blisters]. They usually can't read it [the writing on the blister] either. … It's certainly great for younger patients who have no cognitive or motor impairments." [T5].

Poor dexterity and motor impairments pose a real challenge for patients when opening the blisters.

"I often find [the blister] difficult for older patients who no longer have good dexterity. … They can't open [the unit dose blisters] themselves." [T5].

As does visual impairment and more than one unit dose blister per time point.

"*Often [the writing on the blister] is too small, so that [patients] cannot read it." [T14].*

"…often older patients can't quite cope with the unit dose blisters. …the patients forget that they should be taking the medication, especially if there are more than one unit dose blisters to take…." [T7].

This results in increased nurses' assistance in order to facilitate medication adherence and avoid missed doses.

"… I have to check many patients whether they are taking their medication. I open the blister for them on the spot and make sure that the patient takes the tablet in my presence. For those patients I can be sure that they are compliant …." [T19].

"This morning, for example, I saw a patient's fasting tablet Euthyrox still lying on the table. He hadn't seen it …. Normally when we give out the tablets, they are in a green cup. [The fasting tablet] was in a blister and he didn't notice it." [T1].

As many patients are familiar with the dosette box system, they are still seen as a suitable alternative especially in patients who struggle to comprehend and use the UDDS blister packs.

"[Patients] know the blue patient dosette system. They are used to them. They may also have them at home.… [The dosette box] says morning, noon, night. Large [writing]. Very simple."[T14].

"If [the patients] want us to put [the drugs in a dosette system], we put them in their personal dosette box." [T11].

Consequently, the UDDS blisters are seen as particularly useful on wards with patients who have a long length of stay, are on long-term medication and are cognitively able.

"Especially if it is an acute geriatric ward, for example, I can well imagine [the usefulness of the UDDS]. The medication stays the same. … The patients stay [in hospital] longer on average …." [T11].

"If you take a surgical or gynaecological ward as an example. They are much easier to provide unit dose blisters for, and the dispensing [to the patient] is much easier too. Patients are cognitively able. They walk. For the most part, they are admitted healthy, and they are discharged healthy. And on our [internal medicine ward], most of the patients are already admitted sick, and they are still sick or even sicker when they get discharged. Cognitively, the majority of patients are not able to grasp [the unit dose blisters]." [T20].

Unit dose blisters are considered to improve the hygiene of handling medication and improve the safety of discharge medication compared to dosette systems as they safeguard that no medication is lost in transit.

"I think it [the USD blister] is much more hygienic compared to punching each tablet out of its blister. It's a hygienic system."[T4].

"[Patients] don't think [the UDDS] is so bad. Because when they take [their medication] home [in unit dose blisters], no tablets fall out." [T10].

3.5. Organisation

Nurses considered there to be enough resources such as space, IT facilities and staff, for the implementation and daily use of the UDDS system on the ward. As the UDDS allowed staff resources needed for the medication dispensing process to be reduced, staff shortages could be navigated more easily. They did however consider that more resources were needed within the pharmacy department as they had now taken on most of the workload around dispensing medication.

"Due to the shortage of nursing staff, we have become increasingly understaffed and with the introduction of the UDDS we have gained in this regard." [T6].

"You should ask the pharmacy [if there are enough resources to implement the UDDS on the ward]. … Because most of the work is done by the pharmacy, in my opinion. The ward is just the distributor." [T18].

The long-established electronic patient record was deemed to be a significant facilitator for UDDS implementation and the seamless integration into the electronic working platform was welcomed.

"… there are medicines that are printed in bold. Black, in bold. That means that it's a special order …. Red are [the blood thinners such as] Marcumar. That's done really well."[T18].

"And if something has changed [in the patient's medication] …, there is a red STOP-sign and it lights up immediately." [T13].

As the UDS System was first introduced during COVID, the speed of implementation and physical restrictions posed a barrier to the provision of wide-spread training. As a result, many nursing teams had to train each other resulting in workflows and handling of the UDDS varying from ward to ward and sometimes between nurses. While some nurses would have welcomed more training there is also an acknowledgment that the system isn't complex enough to warrant extensive training and that the information provided by the pharmacy department was sufficient.

"Initially we had to find a consensus among the team. How to deal [with the UDDS]. Who distributes [the unit dose blisters to the patients]? Is it the night shift …? Do we generally put [the tablets] in the individual patient dispenser for those patients who cannot handle the unit dose blisters, or not? These were questions that were resolved over time. Just by what's practicable." [T6].

"I don't think we would have needed any special training. Perhaps tips and tricks on how best [to handle the unit dose blisters]. … Or how other wards are handling them. " [T15].

Daily work stressors were identified as one barrier to the safe use of UDDS. Blister checks and ordering of missing medications from the pharmacy were particularly impacted.

"Theoretically you should check if it's the medication with the correct size. So, I check everything. But if you're stressed, you might just count the tablets to see if the number [of tablets in the blister] is correct…." [T13].

"[At night] the pharmacy is shut. … yet I am missing a particular drug. So, he [the patient] doesn't get it in the morning either…. Of course, the pharmacy is open again, but it's everyday life. Nobody has time to quickly run down [to the pharmacy] and pick it [the medicine] up. Let alone that the pharmacy has dispensed it already." [T13].

3.6. Individuals: nurses

Overall, the implementation of the UDDS is seen as a positive by most nursing staff while openness and motivation are considered implementation facilitators.

"We only got [the UDDS] as a result of COVID-19 and we kept it. Thank God because we are very happy with it." [T9].

"You must not resist new things. You have to try something [new] and we have now experienced that [the UDDS] is an insane time saver …." [T6].

As the technical skill and task complexity of dispensing medication manually is much higher the simplification and ease of the UDDS system was seen both as a blessing and curse. While it saved staff time and was intuitive to use, nurses noted an erosion of knowledge and personal skill. Nurses' active involvement in patients' pharmacotherapy decreased. Since knowledge about medicines was considered a prerequisite for a seamless delivery of the UDDS system there was a perception that young, inexperienced nurses may have difficulty checking the unit dose blisters due to a lack of background knowledge. Whence it was seen as an advantage as still having a wide choice of experienced staff on the team.

"One disadvantage [of the UDDS] … is that you no longer deal with the medication directly [so you no longer notice if a medication is not suitable for a patient]." [T5].

"… nevertheless, we still have a relatively large number of old staff in the house who … have dispensed the medication in the past [without the UDDS]. This means that they still remember certain active ingredients and formulations differently … [than the young nurses]." [T21].

Nurses really appreciated the range of supporting hospital pharmacy services, including pharmaceutical consultations, medication management, information, if medicines are allowed to be divided, probed or

crushed and the development of an 'Apo-Info' button. This allows all nursing staff to easily identify all drugs through the provision of photos of each drug, the packaging and the patient information leaflet. These resources were considered useful in overcoming some of the knowledge gaps.

> *"Our pharmacy provides many [services]. [The pharmacists] check the patients' medication to make sure they are correct. You can also send requests to see if the medicines are allowed to be crushed. … Most medicines have a short description and a photo [on the computer system]. I have to say, we are very well organised." [T5].*

3.7. Suggestions for potential improvement

Despite the overwhelmingly positive experiences of nursing staff with the unit dose system, they had several suggestions for improvement. These included additions or changes to the UDDS system as well as recommendations for improved handling of the medication on the ward and documentation of narcotics (Table 4). Main drivers for these suggestions were further improvements to ward efficiency and patient safety.

Table 4
Summary of suggested improvements to the UDDS System with the aim to improve efficiency and safe.

UDDS Aspect	Suggested Improvement	Quote
Additions to UDDS	Including non-blistered drugs in the blistering process	*"We would really benefit if the antibiotics were also included in the unit dose blister. … Or the chemo drug. The UDDS would then be perfect." [T20]*
	Inclusion of ready-to-use infusion bags	*"[A ready-to-use infusion bag] would perhaps also be a considerable relief for Novalgin. We often have 30 infusions in the morning and spend an hour preparing them. … That would be a great help for us."[T9]*
Changes to UDDS	Increasing the font size of the label	*"Often [the writing on the blister] is too small, so that [patients] cannot read it." [T14]*
	Adding a tear indicator onto the blister	*"If there was an arrow on the side [of the blister] indicating where to tear, it might be easier for older patients [to use the unit dose blisters]." (T5)*
Handling of UDDS	More efficient storage system for both UDDS & additional medication (per room/ per patient)	*"I am now looking for dividers …. We now have 33 patients and they [their medication] needs to be organised properly. … per room. Ideally, [the dividers for] each room have three compartments, as there are between one and three patients in each room." [T20]* *I know from … American hospitals that the medicine cabinets are digitised and indicate to pharmacy procurement how many are stored on the ward. I think that would be much quicker … if the [machine] would automatically dispense the correct drug … compared to me… having to search through all cabinets …." [T23]*
Documentation	Digital documentation of narcotics	*"Narcotics are also an issue I would like to see changed. … the doctors sign the booklet but do not verify [the narcotics] on the computer. That's old-school. I stopped doing that fifteen years ago at a different hospital." [T20]*

4. Discussion

Nurses reported an overwhelmingly positive attitude towards the implementation of the unit dose dispensing system (UDDS) stating ease of use and resultant time saving as two key aspects. The time saved allowed them to better navigate staff shortages and re-invest the time directly into patient care. They felt that the required adjustments to the daily workflow necessitated increased collaboration within the nursing team and with the prescribers, with the implementation of a daily order deadline resulting in improved patient care efficiency on the ward. The UDDS was considered to improve patient safety, patient autonomy and facilitate patient discharge. New potential sources for medication errors were however identified. These resulted mainly from the incorrect handling, documentation and processing of late medication changes and high workload stressors. The number of late medication changes and an easy-to-use integration into the electronic patient record were seen as crucial for the successful delivery of the UDDS. A resultant natural differentiation of acute vs. chronic and cognitively able vs. unable patient groups, was made. The observation that each ward uses the UDDS differently could be a direct result of the diverse patient groups, while a further observation that each nurse has a different approach to the handling of UDDS could be a result of insufficient training as shift work complicates communication. Younger, less experienced nurses reported an erosion of their knowledge and skills related to medication and highlighted the comprehensive range of pharmacy support services in relation to the identification, handling and administration for all medications as very positive. Suggestions for improvement were made in relation to the additional medication being dispensed as part of the UDDS service, changes to the font size, ease of handling and documentation of narcotics.

4.1. Perceived opportunities for clinical practice

Implementation of the UDDS across several hospital wards was characterised by its ease of use and low level of technical skill required. Despite some initial scepticism the time saving afforded by the UDDS, and resultant workload reduction especially for the night-shift staff was highlighted as a major advantage. The time saving was estimated to be as high as 50 % on medication related tasks. While the exact time spent is difficult to quantify, a recent time and motion study states that daily nursing activities relating to scheduled medication make up as much as 23.7 % of their working hours.[31] Nurses felt that they spent more time providing direct patient care as a result. A study published in the New England Journal of Medicine examined the relationship between the amount of nursing care provided in hospitals and the hospital patient outcome. It reported that a greater number of hours of care per day is associated with improved health outcomes such as a significant shorter length of stay ($p = 0.01$), reduced development of complications ($p = 0.03$), upper gastrointestinal bleeding ($p = 0.07$) and reduced "failure to rescue" ($p = 0.05$).[32] This is significant, considering the nursing staff shortages worldwide, which the WHO describes as a "ticking time bomb".[33] Nurses reported that the reduced workload allowed them to navigate these staff shortages much more easily. Given the direct link between resources, workload and nursing staff turnover/retention these findings are key.[34] The greatest impact was reported on night-shift staff who traditionally dispensed all ward medication for the preceding day. Several studies have shown that the error rate for nurses working night shift is significantly higher than the error rate of nurses working the day shift, due to circadian rhythm changes and sleep deprivation.[35] The significantly higher rate of medication errors and near misses results in significant patient safety concerns. Improved patient safety was also reported by the nurses in this study who attributed this mainly to fewer

dispensing errors overall. Studies report the dispensing error rate of robotic systems to be 0.5 % at maximum[9] with accuracy checking of the final product, i.e. the blisters, reducing this rate further.[36]Participants however highlighted new emerging sources of medication errors such as inaccurate processing of late medication changes made by the prescriber after the UDDS order had already been sent and a deteriorating knowledge about drugs across all nursing staff. There is compelling evidence that more knowledgeable and more highly trained nurses will affect better patient outcomes overall thereby contributing to patient safety.[37] While nurses were extremely satisfied with the extensive range of hospital pharmacy services provide to support all aspects of medication identification, administration and information this attrition of knowledge could also be counteracted by ensuring training of nurses on all aspects of the UDDS system including the legal requirements for end-checking prior to administration to the patient, handling of specials and non-blistered medication and correct handling strategies of multi dose dispensing.

4.2. Identified barriers for everyday clinical practice

Training may also be required for prescribers to better appreciate the impact of late medication changes on ward-based workflow and patient safety. While it is clear that these cannot be avoided in acute hospital settings, their avoidance in non-acute ward settings is imperative for the effective and safe patient management on the ward.[38] While nurses clearly stated that they considered the clear communication of a midday cut-off for medication changes as a very welcome advantage which has improved communication and collaboration within the nursing team and with prescribers, they acknowledged the problems that arise from the prescriber's non-compliance with this deadline leading to fragmentation of care.[31] This need to adapt workflows, daily routines and workload distribution following UDDS implementation is well documented and is imperative in avoidance of ineffective patient care and dissatisfied staff.[39] An additional factor to consider is the competence of patients to use UDDS blisters correctly. This was highlighted to be a complication for cognitively impaired patients or those lacking the dexterity or vision. Nurses have adapted by spending more focused time on ensuring adherence and by dispensing blisters using the previous dosette system. A mixture of both systems (blisters & dosette) has also been reported to be in use, especially when non-blistered items or specials are prescribed, dispelling the notion of a "one-size fits all"approach. Some nurses even reported that each nurse seems to have a different approach to blister handling highlighting the crucial importance of conducting a pre-operational risk assessment, considering facilities, skills needed, current work practices, technical support and patient groups prior to the implementation of a UDDS system to allow tailoring of the service.

Nurses acknowledged the more sustainable use of medication through the minimisation of ward stock levels and fewer expired drugs. Commented however also on the huge amount of plastic packaging waste generated by the individual blister packs. The WHO estimates that high-income countries generate an average of 0.5Kg of hazardous waste per hospital bed per day, with hazardous waste only making up 15 % of the total amount generated (e.g. expired medication).[40] 85 % is general, non-hazardous waste such as blister wrapping. Considering that plastic is recyclable while medication is not, the benefits of UDDS on medication waste through technologically supported stock management have been documented.[9] This is in line with and contributes to the aims of the International Pharmaceutical Federations agenda for sustainability in Health Care.[3]

4.3. Strengths and limitations of the work

To the best of our knowledge this is the first study exploring the nurses experience, views and attitudes with the implementation of the UDDS in practice. Use of the FISpH Framework to analyse the complex implementation experiences ensured a theoretical underpinning of the research and allowed a more meaningful analysis of barriers and facilitators. Data saturation was achieved through the use of a stopping criterion, and coding analysis was done using multiple researchers independently. Recruitment was done by pharmacy staff (TS) known to the nursing staff which may have introduced participation bias. Purposive sampling ensuring an equal number of nurses from each ward were recruited was not achieved. Results reflect the experiences, views and attitudes of nurses in a single centre only limiting the transferability of the results.

4.4. Recommendations for future research

Given the paucity of literature on implementation factors and guidelines for UDDS systems across all healthcare settings further research should explore the barriers and facilitators experienced in other settings including a broad range of healthcare staff (nurses, pharmacists, prescribers) in order to build a comprehensive picture that allows a generalised implementation strategy to be developed. Of equal importance are robust pharmacoeconomic studies which aim to quantify the time saving, cost implications and changes in patient outcomes before and after UDDS implementation. Further, an exploratory study that captures the experiences of patients before and after the implementation of UDDS care would provide details on the impact and consequences on patient safety and autonomy.

4.5. Implications for policy and practice

Understanding barriers to a successful implementation of UDDS systems in hospital practice is key to an effective implementation process with the aim of achieving the WHO mandate towards eliminating avoidable harm in health care. Making prescribers and organisations aware that requesting late medication changes and having a seamlessly integrated electronic patient medication record are crucial factors in the successful use of UDDS in daily practice. Fostering an understanding that a "one-size fits all" approach does not allow for optimised patient safety and that the use of the UDDS has to be tailored to different patient groups.

5. Conclusion

Results have highlighted several key facilitators and barriers when implementing UDDS Systems into daily ward practice. Understanding that clear, unified handling procedures, adaptation of workflow collaborations, tailored training programs and a seamlessly integrated IT system are key to its implementation success leads to the suggestion that the impact of this automated dispensing technology may vary between institutions. The positive impacts on nurse's time, workload, error rates and patient safety in combination with integrated IT Systems should encourage hospitals to not only invest in automation but to ensure that UDDS is fully integrated into a closed loop medication management system. This would not only take some of the nurses suggested improvements into account, provide actionable insights but also help to meet the global strategy to improve the reliability and efficiency of the medication process to eliminate patient harm.

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CRediT authorship contribution statement

Theodora Steindl-Schönhuber: Writing – review & editing, Supervision, Investigation, Funding acquisition, Data curation, Conceptualization. **Theresa Drechsel:** Writing – review & editing, Visualization,

Investigation, Data curation. **Gunda Gittler:** Writing – review & editing, Conceptualization. **Anita Elaine Weidmann:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

None of the authors are aware of any potential conflict of interest that might be relevant to the contents of this manuscript.

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Appendix A. Supplementary data

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References

1.. World Health Organisation. Global patient safety action plan 2021–2030. Towards eliminating avoidable harm in health care. https://www.who.int/teams/integrated-health-services/patient-safety/policy/global-patient-safety-action-plan#::text=The%20purpose%20of%20the%20actionrecommendations%20at%20the%20point%20of; 2021.
2.. European Medicines Agency. Medication errors. https://www.ema.europa.eu/en/human-regulatory-overview/post-authorisation/pharmacovigilance-post-authorisation/medication-errors#::text=A%20medication%20error%20is%20anto%2C%20harm%20to%20the%20patient; 2023.
3. McDowell SE, Ferner HS, Ferner RE. The pathophysiology of medication errors: how and where they arise. *Br J Clin Pharmacol*. 2009;67(6):605–613. https://doi.org/10.1111/j.13665-2125.2009.03416.x.
4. Rasool MF, Rehman AU, Imran I, et al. Risk factors associated with medication errors among patients suffering from chronic disorders. *Front Public Health*. 2020. https://doi.org/10.3389/fpubh.2020.531038.
5.. Seidling HM, Bates DW. Evaluating the impact of health IT on medication safety. *Stud Health Technol Inform*. 2016;222:195–205.
6. Watts EJ, Jackson J. Automated Dispensing Cabinets and Nursing Workarounds: How Nurses Silently Adapt Clinical Work. *Computers Informatics Nursing*. 2024;42(10):691–693. https://doi.org/10.1097/CIN.0000000000001148.
7. Ahtiainen HK, Kallio MM, Airaksinen M, Holmström AR. Safety, time and cost evaluation of automated and semi-automated drug distribution systems in hospitals: a systematic review. *Eur J Hosp Pharm*. 2020;27(5):253–262. https://doi.org/10.1136/ejhpharm-2018-001791.
8.. European Directorate for the Quality of Medicines & HealthCare of the Council (EDQM). Automated Dose Dispensing (ADD) Guidelines on best practice for the ADD process, and care and safety of patients. https://www.edqm.eu/en/-/new-automated-dose-dispensing-add-guidelines; 2018.
9. Hänninen K, Athiainen HK, Suvikas-Peltonen EM, Tötterman AM. Automated unit dose dispensing system producing individually packaged and labelled drugs for inpatients: a systematic review. *Eur J Hosp Pharm*. 2023;20:127–135. https://doi.org/10.1136/ekhpharm-201-003002.
10. Zheng WY, Lichtner V, Van Dort BA, Baysari MT. The impact of introducing automated dispensing cabinets, barcode medication administration, and closed-loop electronic medication management systems on work processes and safety of controlled medications in hospitals: a systematic review. *Res Soc Adm Pharm*. 2021;17(5):832–841. https://doi.org/10.1016/j.sapharm.2020.08.001.
11. Carvalho MF, Marques JM, Marta CB, Peregrino AAF, Schutz V, Silva RCLD. Effectiveness of the automated drug dispensing system: systematic review and meta-analysis. *Rev Bras Enferm*. 2020;73(5), e20180942. https://doi.org/10.1590/0034-7167-2018-0942.
12.. Haddad LM, Annamaraju P, Toney-Butler. *Nursing Shortage*. Stat Pearls Publishing; 2023. https://www.ncbi.nlm.nih.gov/books/NBK493175/.
13.. Österreich B. Bundesgesetz über die Ausübung des ärztlichen Berufes und die Standesvertretung der Ärzte (Ärztegesetz 1998 – ÄrzteG 1998). Available at: https://www.ris.bka.gv.at/NormDokument.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10011138&FassungVom=2023-11-23&Artikel=&Paragraf=3&Anlage=&Uebergangsrecht=#:~:text=Paragraph%203%2C,1a)%20vorbehalten; 2025.
14.. Österreich B. Bundesgesetz über Gesundheits- und Krankenpflegeberufe (Gesundheits- und Krankenpflegegesetz – GuKG 2016). Available at: https://www.ris.bka.gv.at/NormDokument.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10011026&FassungVom=2016-11-23&Artikel=&Paragraf=15&Anlage=&Uebergangsrecht; 2025.
15.. Österreich B. Bundesgesetz über Gesundheits- und Krankenpflegeberufe (Gesundheits- und Krankenpflegegesetz – GuKG). Available at: https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10011026; 2025.
16.. Österreich B. Gesamte Rechtsvorschruft für Apothekengesetzt. Art.1 BGBl I Nr. 75/2008. Available from: https://www.ris.bka.gv.at/Dokument.wxe?Abfrage=BgblAuth&Dokumentnummer=BGBLA_2008_I_75; 2025.
17.. Österreich B. Bundesgesetz über Gesundheits- und Krankenpflegeberufe (Gesundheits- und Krankenpflegegesetz – GuKG 20204). Available at: https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10011026; 2025.
18.. Bundesgesetz über die gehobenen medizinisch-therapeutische-diagnostischen Gesundheitsberufe (MTD Gesetzt 2024- MTDG). Artikl 3, § 36a Tätigkeit nach Ärztlicher Anordnung. Available from: https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10010701; 2025.
19.. Gittler G, Steindl-Schönhuber T. Multi Dose Versorgung im Konventhospital der bermherzigen Brüder Linz [PowerPoint slides]. Plattform Patient:innensicherheit, Wien. https://www.plattformpatientensicherheit.at/download/APSA-2021/21_APSA%202021%20Gittler%20Steindl.pdf; 2021.
20. Steindl-Schönhuber T, Gittler G. Arzneimittelversorgung auf Unit-Dose Eine Antwort auf COVID-19 mit entscheidenden Vorteilen im Krankenhaus. *Krankenhauspharmazie*. 2022;43:440–446.
21. Koontalay A, Suksatan W, Prabsangob K, Sadang JM. Healthcare workers' burden during the COVID-19 pandemic: a qualitative systematic review. *J Multidiscip Healthc*. 2021;14:3015–3025.
22.. Rechtsinformationssystem des Bundes. Verordnung des Bundesministers für Gesundheit betreffend Betriebe, die Arzneimittel neuverblistern und in Verkehr bringen (Neuverblisterungsbetriebsordnung). https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20007067; 2011.
23. Herrmann S, Giesel-Gerstmeier J, Steiner T, Lendholt F, Fenske D. Introduction of unit-dose care in the 1,125 bed teaching hospital: practical experience and time saving on wards. *J Multidiscip Healthc*. 2024;14(17):1137–1145. https://doi.org/10.2147/JMDH.S450203.
24. Landsverk, et al. Chapter 12, figure 12–1. Stages of research and phases of dissemination and implementation research. In: Brownson, Colditz, Proctor, eds. *Dissemination and Implementation in Health: Translation Science to Practice*. Oxford: Oxford University Press; 2012.
25.. van Manen M. But is it phenomenology? *Qual Health Res*. 2017;27(6):775–779.
26. Damschroder LJ, Reardon CM, Widerquist MAO, Lowery J. The updated consolidated framework for implementation feedback based on user feedback. *Implement Sci*. 2022;17(75). https://doi.org/10.1186/s13012-022-01245-0.
27. Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander JA, J.C.. Lowery fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. *Implement Sci*. 2009;4:1–15. https://doi.org/10.1186/1748-5908-4-50.
28. Francis JJ, Johnston M, Robertson C, et al. What is an adequate sample size? Operationalising data saturation for theory-based interview studies. *Psychol Health*. 2010;25(10):439. https://doi.org/10.1080/08870440903194015.
29. Moullin JC, Sabater-Hernández D, Benrimoj SI. Qualitative study on the implementation of professional services in Australian community pharmacies using framework analysis. *BMC Health Serv Res*. 2016;16:439. https://doi.org/10.1185/s12913-016-1689-7.
30.. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a re-item checklist for interviews and focus groups. *Int J Qual Health C*. 2007;19(6):349–357. https://doi.org/10.1093/intqhc/mzm042.
31.. Kim, Y., Lee, M.J., Choi, M., Cho, E., Ryu GW. (2023). Exploring nurses' multitasking in clinical settings using a multimethod study. Nat Sci Rep, 13:5704. doi:https://doi.org/10.1038/s41598-023-32350-9.
32.. Needleman J, Buerhaus P, Mattke S, Stewart M, Zelevinsky K. Nurse-staffing levels and the quality of care in hospitals. *N Engl J Med*. 2002;346:1715–1722. https://doi.org/10.1056/NEJMsa012247.
33.. World Health Organisation. Ticking timebomb: Without immediate action, health and care workforce gaps in European region could spell disaster. https://www.who.int/europe/news/item/14-09-2022-ticking-timebomb–without-immediate-action–health-and-care-workforce-gaps-in-the-european-region-could-spell-disaster; 2022.
34. de Vires N, Boone A, Godderis L, et al. The race to retain healthcare workers: a systematic review on factor that impact retention of nurses and physicians in hospitals. *Inquiry*. 2023;60, 00469580231159318. https://doi.org/10.1177/00469580231159318.
35. Hughes V. Is there a relationship between night shift and errors? What nurse leaders need to know. *Athens J Health*. 2016;3(3):217–228. https://doi.org/10.30958/ajh.3-3-2.
36.. Malik M, Eisend S, Kunze T. EInführung der Unit-Dose-Versorgung: Einfluss auf die arzneimittelbezogenen Versorgungsprozesse Arzneimittelkommission der deutschen Ärzteschaft. https://www.akdae.de/fileadmin/user_upload/akdae/Arzneimitteltherapie/AVP/Artikel/201804/057.pdf; 2018.
37. Aiken LH, Sloane DM, Brom HM, et al. Value of nurse practitioner inpatient hospital staffing. *Med Care*. 2021;59(10):857–863. https://doi.org/10.1097/MLR.0000000000001628.

38. Risør B, W., Lisby, M., Sørensen, J.. Complex automated medication systems reduce medication administration errors in a Danish acute medical unit. *Int J Qual Health Care*. 2018;30:457–465. https://doi.org/10.1093/intqhc/mzy042.
39. Veyrier M, Nicolas L, Cavagna P. Integration of an automated personalised drug dispensing system within a hospital pharmaceutical service: prospective processes analysis and implementation of corrective measures. *Le Pharm Hosp Clin*. 2019;54:145–155.
40.. World Health Organisation (WHO). Health-care waste. https://www.who.int/news-room/fact-sheets/detail/health-care-waste; 2018.