Evidence-Based Quality Improvement: A recipe for improving medication safety and handover of care

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CHAPTER 4

Quiet please!

Drug round tabards: are they effective and accepted?

A mixed method study

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Abstract

Background
The use of drug round tabards is a widespread intervention that is implemented to reduce the number of interruptions and medication administration errors (MAEs) by nurses, however, evidence for their effectiveness is scarce.

Purpose
Evaluation of the effect of drug round tabards on the frequency and type of interruptions, MAEs, the linearity between interruptions and MAEs, as well as to explore nurses’ experiences with the tabards.

Study design
A mixed methods before-after study, with three observation periods on three wards of a Dutch university hospital, combined with personal inquiry and a focus group with nurses.

Methods
In one pre-implementation period and two post-implementation periods at 2 weeks and 4 months, interruptions and MAEs were observed during drug rounds. Descriptive statistics and univariable linear regression were used to determine the effects of the tabard, combined with personal inquiry and a focus group to find out experiences with the tabard.

Findings
A total of 313 medication administrations were observed. Significant reductions in both interruptions and MAEs were found after implementation of the tabards. In the third period, a decrease of 75% in interruptions and 66% in MAEs was found. Linear regression analysis revealed a model $R^2$ of 10.4%. The implementation topics that emerged can be classified into three themes: personal considerations, patient perceptions, and considerations regarding tabard effectiveness.

Conclusions
Our study indicates that this intervention contributes to a reduction in interruptions and MAEs. However, the reduction in MAEs cannot be fully explained by the decrease in interruptions alone; other factors may have also influ-
enced the effect on MAEs. We advocate for further research on complemen-
tary interventions that contribute to a further reduction of MAEs.

Clinical relevance
We can conclude that drug round tabards are effective to improve medica-
tion safety and are therefore important for the quality of nursing care and the
reduction of MAEs.

Keywords: Patient safety, drug round tabard; evidence-based practice;
focus group; intervention research; medication administration errors; quality
improvement

INTRODUCTION
The possible effect of medication errors (MEs) on patient safety raises
concerns for healthcare safety boards worldwide. In reaction to this problem,
boards incorporate quality items and safety goals into their programs that
require action by the hospitals. Literature indicates that the ME rate may
vary from 5% to 25% in all episodes of in-hospital drug administration, but
only 19% are reported. This could indicate that the actual incidence rates
might be higher. Therefore, MEs endanger the safety of patients. MEs occur
in every stage of the medication process, with 50% of them associated with
medication administration. In hospitals, nurses are generally responsible
for this stage in the medication process.
In general, interruptions or distractions are recognized to reduce efficiency
and contribute to errors. In specific, interruptions appear to be a prominent
causative factor for medication administration errors (MAEs).
The literature describes several initiatives that influence nursing medication
practice to reduce MAEs. One of these interventions includes tabards, or
vests, with the inscription “do not disturb” or visible signage.
The use of drug round tabards is a widespread, in-expensive intervention
that is thought to reduce the number of interruptions during drug rounds
and MAEs. However, in practice the tabards are unpopular among nurses;
they doubt their effectiveness and do not feel comfortable wearing them.
Additionally, the evidence on effectiveness of using tabards is limited.
When evidence is lacking, the incentive to wear a tabard will be especially
PART I - Medication safety

weak and one can become reluctant to implement interventions. If the effectiveness of these tabards can be established and barriers and facilitators can be identified, implementation in clinical practice will be facilitated and endorsed. Therefore, the aim of our study is to evaluate the effect of drug round tabards on (a) the frequency and type of interruptions, (b) the number and type of MAEs, and (c) the magnitude of the relation between interruptions and MAEs during the process of preparation, distribution, and administration of medication in hospital wards. In addition, we explored nurses’ perspectives and experiences with drug round tabards to identify barriers and facilitators for implementation.

METHODS

Setting
Three wards in a Dutch 1,024-bed university hospital contributed to this study: neurology, neurosurgery, and a combined ward with dermatology, ophthalmology, and ENT-services. In total, these wards contain 60 beds. Each ward has a closed medication storage and preparation room where medication carts are stored for use during drug rounds. These carts are equipped with drawers and files containing computer-printed medication prescriptions for each patient. All oral medications are distributed for 24 hrs and are checked once by the ward’s night shift. Fluids, intravenous medications, and other medications for injection are prepared and double-checked during each drug round directly before drug administration.

Population
The participants were all registered nurses. Each had an individual responsibility for distributing medications to their assigned patients.

Study design
We performed a mixed method study, using a before-after design to collect the number of interruptions and MAEs during drug rounds before the implementation of the tabard in April 2012 (period 1), as well as 2 weeks and 4 months after tabard implementation (i.e., in May and September 2012, respectively periods 2 and 3). An interruption or a distraction was defined as an event initiated by another professional(s) or something else, and when a nurse interrupted him- or herself. In this study, the term interruption was used for distractions as well as for interruptions. MAEs are defined as a breach of one of the seven rights of medication administration: correct
patient, drug, dose, time, route, reason, and documentation. During period 2, nurses’ perspectives regarding the tabard were collected by documenting spontaneous remarks and asking a single question at the end of the observation: “What is your experience with the drug round tabard?” In period 3, in-depth information on nurses’ perspectives, experiences, and views was collected in a focus group setting to gain insight in barriers and facilitators for implementation of the drug round tabards.

Ethical approval
Ethical approval was not considered necessary by the Institutional Review Board of the Academic Medical Center at the University of Amsterdam. This is in accordance with the Dutch Medical Ethics Law.

Intervention
Following baseline observation period 1, the intervention was introduced during a 5-day implementation week. All nurses working on the participating wards were instructed to wear the tabards while preparing and administering the medications. Instructions were given by e-mail, posters, and a promotional film. Tabards were fluorescent yellow with printed text on the back and small text on the chest, reading “Do not disturb, medication round in progress.” After the implementation week, we refrained from instruction on behavior during the drug rounds to determine the unbiased effect of the tabard. Information on the exact observer’s task, documentation frequency, type of interruptions, and MAEs per observed nurse remained blinded.

Observers
All observers (n = 6) were final phase baccalaureate nursing students who have followed approximately 2 years of apprenticeship. The observers got instruction on how to score and interpret the items on the observation checklist and also to interfere if they observed MAEs that might be harmful to the patient. Although the students had not graduated yet at the time of the study, we were convinced that they had sufficient knowledge and awareness to assess the severity of clinical situations.

Data collection
Quantitative data were collected on eight different categories of interruptions that are grouped into either verbal or non-verbal interruptions, based on a previously published observation form (Table 1).
Table 1. Definition of interruptions during medication preparation and administration

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal colleague</td>
<td>Colleague initiates a dialog with nurse</td>
</tr>
<tr>
<td>Verbal person</td>
<td>Nurse initiates a dialog</td>
</tr>
<tr>
<td>Verbal patient</td>
<td>Patient initiates a dialog with nurse</td>
</tr>
<tr>
<td>Non-verbal colleague</td>
<td>Colleagues initiates an interruption, e.g. getting supplies in the vicinity</td>
</tr>
<tr>
<td>Non-verbal person</td>
<td>Nurse initiates interruption, e.g. helping a colleague, pager response</td>
</tr>
<tr>
<td>Non-verbal patient</td>
<td>Patient initiates interruption, e.g. being in the vicinity of the nurse</td>
</tr>
<tr>
<td>Non-verbal surrounding</td>
<td>Surrounding environment, e.g. cleaning or stock working staff</td>
</tr>
<tr>
<td>Non-verbal logistics</td>
<td>Missing supplies for preparing the medications</td>
</tr>
</tbody>
</table>

To observe the frequency and type of MAEs, we merged it with the “seven right” items of Pape et al. that we converted into “seven wrongs”: wrong patient, dose, medication, timing, route, indication, and reporting. In a pilot phase, the observers performed eight observations in pairs to validate the checklist. To determine observation agreement on the counting of interruptions and MAEs, the inter-observer agreement was calculated using the interclass correlation coefficient (ICC). Of the 14 items, 12 items scored an ICC > .80 (almost perfect agreement) and 2 items (i.e., verbal interruptions caused by patients and non-verbal interruptions caused by the surrounding) scored an ICC between .55 and .60 (moderate agreement). To solve inter-observer variety on the two moderate scored items, they were discussed with the first author. After addressing the disagreements, we considered the observation checklist to be reliable. Observations were performed 7 days per week during six drug rounds per day that occurred at 8 a.m., 12 p.m., 4 p.m., 6 p.m., 8 p.m., and 10 p.m. We randomly selected the nurse to be observed for each drug round, which resulted in a randomly selected patient mix as well. Focus group participants (n = 9) were selected using purposive sampling based on their expressed attitudes regarding the tabard during observations in period 2 to have a representative mix of posi-
tive and negative attitudes. Discussion topics were derived from the observations and nurses’ expressions during period 2 (Table 2).

The focus group was led by a moderator and an observer. The moderator facilitated an open discussion, which was structured around the derived topics. Special attention was paid to all participants contributing their opinions. The focus group session was taped and transcribed.

### Table 2. Focus group topics

<table>
<thead>
<tr>
<th>Topics</th>
<th>Sub headings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug round tabards and safe medication administration</td>
<td>Experience positive / negative and why?</td>
</tr>
<tr>
<td></td>
<td>Do you wear the tabard and why?</td>
</tr>
<tr>
<td></td>
<td>What additional interventions will contribute to medication safety?</td>
</tr>
<tr>
<td></td>
<td>What do you think of checklists, visual reminders and a do not disturb zone?</td>
</tr>
<tr>
<td>Colleagues who do not wear the tabard</td>
<td>Do you or don’t you confront your colleagues when they do not cooperate and why?</td>
</tr>
<tr>
<td>Pros and cons regarding implementation</td>
<td>What factors contribute to your choice whether to wear or not to wear the tabard?</td>
</tr>
<tr>
<td></td>
<td>What is needed for successful implementation?</td>
</tr>
<tr>
<td>Patients and visitors should be informed about the purpose of the tabard</td>
<td>Why should we or shouldn’t we inform?</td>
</tr>
<tr>
<td></td>
<td>How should we inform?</td>
</tr>
</tbody>
</table>

### Data entry and crosscheck

The six observers entered their own data, and they cross-checked each other. One researcher compared all entered data with the original observation.

### Sample size and data analysis

Because the effect of tabards on MAEs is unknown, we were unable to calculate the sample size based on this end point; therefore, we used the effects on interruptions. Based on previously published interruption rates of 15% to 50%, we hypothesized an average reduction of 30% for the power calculation.\(^9\)\(^1\)\(^2\)\(^6\) A sample size of 100 observations before and 100 observations after the intervention would have 90% power to detect the effect of the tabards with a .05 significance level.

Descriptive statistics were used to summarize the demographics and frequencies of different types of interruptions and MAEs. A Kruskal-Wallis
test was performed to compare the interruptions and MAEs due to a skewed
distribution of the data. After a natural logarithmic transformation, we
performed a univariable linear regression analysis of MAEs (dependent) on
interruptions (independent). All statistical analyses were performed using
IBM SPSS statistics version 18.0 (SPSS Inc., Chicago, IL, USA). Data collected
during the observations and the focus group session was analyzed itera-
tively by four of the six observers. By discussing the interview and focus
group items, they coded topics and built a coding tree. Next they grouped
the topics and identified the most relevant themes related to nurses' expe-
riences with the drug round tabards regarding barriers and facilitators for
implementation.18,19

RESULTS
A total of 313 medication administrations were observed. Distribution of
data collection and observations on each ward was distributed evenly on
all rounds and for each period, with 40% of the observations occurring
during the evening rounds (6 p.m., 8 p.m., and 10 p.m.) and 20% during the
weekend rounds. The characteristics of the observed nurses were equally
distributed during each period as well (Table 3).

Interruptions
A reduction of 75% of interruptions was found after implementing
the drug round tabards (Table 4, Figure 1). The majority of interruptions
that were observed during period 1 were of verbal origin, and most were
caused and initiated by colleagues and persons other than patients. The
most common non-verbal interruptions were caused by the surroundings
(e.g., the telephone, radio, or conversations of others nearby). In period 2,
there were fewer interruptions than in period 1. The median total verbal
interruptions were reduced over the periods. The median non-verbal
interruptions were only reduced in period 3. A significant effect of the	
tabards was found for both the verbal and non-verbal interruption rates. The
individual interruptions showed a significant decrease, with the exception of
verbal and non-verbal interruptions initiated by patients. Most decreases
in interruptions were seen at the drug rounds occurring at 8 a.m., 12 p.m.,
and 6 p.m. For the drug rounds at 8 p.m. and 10 p.m., we observed a slight
increase in interruptions in period 2, although in period 3 a further decrease
occurred (see Figure 1).
Table 3. Demographics

<table>
<thead>
<tr>
<th></th>
<th>Period 1</th>
<th>Period 2</th>
<th>Period 3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (%)</td>
<td>N (%)</td>
<td>N (%)</td>
<td>N (%)</td>
</tr>
<tr>
<td>Observations</td>
<td>105</td>
<td>104</td>
<td>104</td>
<td>313</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>16 (15)</td>
<td>27 (26)</td>
<td>14 (13)</td>
<td>57 (18)</td>
</tr>
<tr>
<td>Female</td>
<td>89 (85)</td>
<td>77 (74)</td>
<td>90 (87)</td>
<td>256 (82)</td>
</tr>
<tr>
<td>Age</td>
<td>40 (22-64)</td>
<td>42.5 (22-63)</td>
<td>45 (22-62)</td>
<td>42 (22-64)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bachelor</td>
<td>41 (39)</td>
<td>46 (45)</td>
<td>53 (51)</td>
<td>140 (45)</td>
</tr>
<tr>
<td>Community college</td>
<td>17 (16)</td>
<td>15 (14)</td>
<td>5 (5)</td>
<td>37 (12)</td>
</tr>
<tr>
<td>Inservice</td>
<td>45 (42)</td>
<td>43 (41)</td>
<td>46 (44)</td>
<td>134 (42)</td>
</tr>
<tr>
<td>Other</td>
<td>2 (2)</td>
<td>0</td>
<td>0</td>
<td>2 (1)</td>
</tr>
<tr>
<td>Observations/ward</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neurology</td>
<td>39 (37)</td>
<td>36 (35)</td>
<td>37 (35)</td>
<td>112 (36)</td>
</tr>
<tr>
<td>Neuro-surgery</td>
<td>35 (33)</td>
<td>40 (38)</td>
<td>33 (32)</td>
<td>108 (34)</td>
</tr>
<tr>
<td>Derm- Opht-ENT</td>
<td>31 (30)</td>
<td>28 (27)</td>
<td>34 (33)</td>
<td>93 (30)</td>
</tr>
<tr>
<td>Medication rounds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.00</td>
<td>20 (20)</td>
<td>19 (18)</td>
<td>19 (18)</td>
<td>58 (19)</td>
</tr>
<tr>
<td>12.00</td>
<td>20 (19)</td>
<td>20 (20)</td>
<td>19 (18)</td>
<td>59 (19)</td>
</tr>
<tr>
<td>16.00</td>
<td>22 (21)</td>
<td>20 (20)</td>
<td>26 (25)</td>
<td>68 (21)</td>
</tr>
<tr>
<td>18.00</td>
<td>14 (13)</td>
<td>15 (14)</td>
<td>16 (15)</td>
<td>45 (14)</td>
</tr>
<tr>
<td>20.00</td>
<td>14 (13)</td>
<td>15 (14)</td>
<td>11 (11)</td>
<td>40 (13)</td>
</tr>
<tr>
<td>22.00</td>
<td>15 (14)</td>
<td>15 (14)</td>
<td>13 (13)</td>
<td>43 (14)</td>
</tr>
</tbody>
</table>
PART I - Medication safety

Table 4. Interruptions during medication administration rounds

<table>
<thead>
<tr>
<th></th>
<th>Period 1 (N=105)</th>
<th>Period 2 (N=104)</th>
<th>Period 3 (N=104)</th>
<th>Kruskal-Wallis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number Median (IQR)</td>
<td>Number Median (IQR)</td>
<td>Number Median (IQR)</td>
<td>p</td>
</tr>
<tr>
<td>Verbal Total</td>
<td>391 3 (4)</td>
<td>297 2 (4)</td>
<td>94 1 (1)</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Verbal colleague</td>
<td>168 1 (2)</td>
<td>122 1 (2)</td>
<td>26 0 (0)</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Verbal patient</td>
<td>94 0 (1)</td>
<td>71 0 (1)</td>
<td>44 0 (1)</td>
<td>.09</td>
</tr>
<tr>
<td>Verbal person</td>
<td>130 1 (2)</td>
<td>104 1 (2)</td>
<td>24 0 (0)</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Non-verbal Total</td>
<td>126 1 (2)</td>
<td>151 1 (2)</td>
<td>15 0 (0)</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Non-verbal colleague</td>
<td>15 0 (0)</td>
<td>11 0 (0)</td>
<td>1 0 (0)</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Non-verbal patient</td>
<td>4 0 (0)</td>
<td>4 0 (0)</td>
<td>0 NA</td>
<td>.13</td>
</tr>
<tr>
<td>Non-verbal person</td>
<td>20 0 (0)</td>
<td>24 0 (0)</td>
<td>0 NA</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Non-verbal surrounding</td>
<td>94 0 (1)</td>
<td>112 1 (2)</td>
<td>14 0 (0)</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Total</td>
<td>517 4 (5)</td>
<td>448 4 (4)</td>
<td>112 1 (2)</td>
<td>&lt;.05</td>
</tr>
</tbody>
</table>

Medication administration errors

A 66%, and significant, reduction in MAEs was found after implementing the tabards (Table 5, Figure 2). The most frequent procedural MAEs are the absence of patient identification, incorrect administration time (either too early or too late), and not reporting in accordance with standard procedures. Individual MAEs that did not decrease significantly were administering the wrong medication, administration through the wrong route, and administration for an incorrect indication. Decreased MAEs were mainly found in the drug rounds at 8 a.m., 8 p.m., and 10 p.m. (see Figure 2).
Regression Model
The univariable linear regression model revealed interruptions as a significant predictor for MAEs ($p < .05$; Table 6). The $R^2$ of the model is 10.4%, which indicates that approximately one tenth of the MAEs can be explained by interruptions.
Table 5. Medication administration errors during medication administration rounds

<table>
<thead>
<tr>
<th></th>
<th>Period 1 (n=105)</th>
<th>Period 2 (n=104)</th>
<th>Period 3 (n=104)</th>
<th>Kruskal-Wallis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number (Median IQR)</td>
<td>Number (Median IQR)</td>
<td>Number (Median IQR)</td>
<td>p</td>
</tr>
<tr>
<td>Wrong patient</td>
<td>194 (2)</td>
<td>183 (2)</td>
<td>119 (1)</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Wrong dose</td>
<td>16 (0)</td>
<td>9 (0)</td>
<td>0 NA</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Wrong medication</td>
<td>7 (0)</td>
<td>6 (0)</td>
<td>0 NA</td>
<td>0.08</td>
</tr>
<tr>
<td>Wrong timing</td>
<td>91 (1)</td>
<td>64 (1)</td>
<td>1 (0)</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Wrong route</td>
<td>4 (0)</td>
<td>4 (0)</td>
<td>0 NA</td>
<td>0.13</td>
</tr>
<tr>
<td>Wrong indication</td>
<td>0 NA</td>
<td>1 (0)</td>
<td>0 NA</td>
<td>0.37</td>
</tr>
<tr>
<td>Wrong reporting</td>
<td>126 (2)</td>
<td>82 (1)</td>
<td>0 NA</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Total</td>
<td>432 (3)</td>
<td>349 (3)</td>
<td>120 (1)</td>
<td>&lt;.05</td>
</tr>
</tbody>
</table>

Table 6. Parameter estimate for intercept MAEs and variable interruptions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter estimate (B)</th>
<th>Standard error</th>
<th>Test statistic</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>800</td>
<td>0.065</td>
<td>12.361</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Interruptions</td>
<td>271</td>
<td>0.045</td>
<td>6.005</td>
<td>&lt;.05</td>
</tr>
</tbody>
</table>

Nurses’ experiences with wearing the tabard

By documenting remarks during the drug rounds and asking a single interview question at the end of drug rounds, we collected nurses’ experiences with and opinions about wearing the tabards. The reactions ranged from positive and enthusiastic to negative and even refusal to wear the tabard. Experiences with wearing the drug round tabards were related to three main topics: personal considerations, patient perceptions, and considerations regarding the effectiveness of the tabards.
Personal considerations.
Frequently mentioned personal considerations include the nurses’ perception of their appearances while wearing the tabards.

“I definitely won’t wear the tabard, it is ridiculous! … I am in for any kind of intervention and improvement, but in this tabard, I stand just like an idiot.”

The nurses also mentioned hygienic issues as a personal barrier to wearing the tabard.

“I purposively do not wear the tabard because I think it is filthy. Everybody wears it, contaminating it with sweat or spilling dirt or things on it.”

Patient perceptions.
Nurses have concerns about the way in which patients and visitors might perceive the tabard. These remarks sometimes represented the nurses’ opinion that the tabard led the patients to consider the staff to be unapproachable.

“I think the tabard gives an unfriendly signal to the patient. When patients have questions or need any kind of assistant or care, they should not need to hesitate in asking their nurse.”

The nurses sometimes expressed feelings about the opposite effect:

“The intention of the tabard is good; it gives a clear signal that you need to concentrate on the medication task. However, the tabard looks quite outstanding, and because of this, it attracts patients’ and visitors’ attention, and this results in questions about the reason for wearing the tabard, which distracts eventually from your medication task. But overall, they are an excellent idea.”

Effectiveness considerations
Perspectives on the effectiveness of the tabard varied. Some felt that it did not work at all.

“I think it is nonsense and don’t think it is effective.”
Other nurses mentioned that the tabard was only useful at certain times:

“\textit{It is a very good idea, especially during daytime. It will make people think about “do not disturb,” but I think that during evening shifts it is more efficacious, that is the time when there are many visitors. I really think it is a good idea!”}\n
“\textit{The intervention works as a signal for colleagues, they realize that you are doing medication. However, I do not think the tabard is effective in an evening shift when there are many visitors, no secretary to answer telephone calls etc.”}\n
Six of the nine invited nurses were able to attend and participate in the focus group discussion. They discussed the prominent color of the tabard as a barrier for use as some patients complained about the fluorescent yellow color. The participants suggested another color might solve this problem. Hygiene issues were not considered a problem for exchanging the tabard among nurses; nevertheless, the participants found it important to establish a cleaning protocol for the tabards with the hospital laundry service. All participants frequently were asked questions about the purpose of the tabards from visitors and patients. These questions distracted them from their tasks. Therefore, they suggested informing patients and visitors about the tabard upon admission or entry to the hospital. In addition to the drug round tabards, they expressed thoughts about the importance of focusing on team culture, where it is considered normal to not disturb each other during tasks and where it is acceptable to address disturbances when they do occur. The group also discussed the importance of leadership and team member role models as they considered this to be an important stimulus and good motivation for nurses to wear the tabard.

**DISCUSSION**

This study shows a significant effect of drug round tabards on interruptions and MAE rate and a significant linearity between interruptions and MAEs ($R^2$ of 10.4%). Therefore, we can conclude that the tabards were effective in improving medication administration safety. However, from the nurses’ experiences it became clear that they have mixed emotions about wearing the tabard. Nurses feel awkward and uncomfortable in the tabard, but they are prepared to wear the tabard if its effectiveness can be demonstrated.
as also found by Scott et al. In the focus group, suggestions were made to change the color and appearance of the tabard. When asked about the effectiveness of the tabard, some nurses had positive experiences, but others expressed doubts about its effectiveness. Patients are not always aware of the tabard’s purpose, and wearing a tabard did not change the patients’ attempts to attract the nurses’ attention. This was confirmed by the quantitative outcomes that showed a non-significant effect of the tabard on interruptions caused by patients. The nurses also expressed their opinion that patients should always feel free to ask the nurses questions. Additionally, the nurses reported that the main sources of interruptions during drug rounds are colleagues and not patients. Another important item to consider is hygiene; some nurses complained that the tabards are worn by multiple nurses and are not personal items. The focus group suggested a cleaning protocol to address the hygiene issue. In their study concerning the infection risk of tabards, Scott et al. indicated that all tested swabs were negative for methicillin-resistant Staphylococcus aureus but had a positive general culture. We suggest a well-defined hygiene protocol when implementing the drug round tabard in a hospital.

Our results of the regression model show a significant linearity, but the magnitude of the contribution of interruptions on MAEs seems small. This does not support the result found in other studies, which indicate a greater effect of interruptions on MAEs. In contrast, another study showed the results of implementing a multi-intervention program, including tabards, in which the number of interruptions by staff increased significantly. This indicates that there are more factors than the tabard alone that influence the resulting effect. Given the literature, we hypothesize that paying attention to the process made nurses more aware of their tasks in medication administration, possibly leading to increased concentration and dedication. Another possible contributing factor was more involvement of the ward managers during drug rounds. They were eager to reduce MAEs and wanted to contribute to the study. These factors may have caused nurses to realize the importance of their task. Because previously published studies have suggested that nurses should change their behavior to reduce interruptions and MAEs, the drug round tabard can be considered a tool for changing nurses’ behavior. In conclusion, the drug round tabards created an observed effect on MAEs that was most likely not only the result of the tabards. This explains the significant results on both MAEs and interruptions and the low regression model R².

To obtain representative results, we observed all drug rounds. with the
exception of night shifts, on both surgical and internal medicine wards. The mixed method approach with a combination of quantitative data collection on the effect of the tabards with experiences and perspectives of the participants in a mixed methods design proved a valuable research design because it uncovered all incentives. The combined checklist was validated during this study using a nested inter-observer agreement test (ICC) where 2 of the 14 observation items scored moderate agreement among observers, which could be considered a weakness for the observation process. However, 12 items scored almost perfect agreement, and after discussing the interpretation of the two moderate scored items, we considered the checklist reliable. Furthermore, this study has some limitations. Although some form of observer effect could not be eliminated in our study, we assume that this hardly influenced the effects since Barker, Flynn, and Pepper stated that observations are a valid, efficient, and accurate method of detecting MAEs and that there is no significant effect of observers on the observed personnel. Secondly, all observers were final phase nursing students, and one can argue their ability to observe the complex task of medication preparation and administration. However, they are trained and experienced in medication management, and since they have no relationship with the team under observation, they are able to get unbiased information and observations. Lastly, in a before-after design, one cannot correct for changes over time. Although we carefully selected the observation periods, we could not prevent the influence of low bed occupancy on all three observed wards during the different observation periods. In future research, one could consider more robust study designs to address this issue (e.g., a cluster randomized controlled trial or a controlled before-after study). In contrast to previous studies on multifaceted strategies, we would recommend analyzing the single contribution of each intervention to avoid the implementation of unnecessary and non-evidence-based interventions.

Conclusions and implications for further research
The implementation of the drug round tabards on hospital wards led to a significant reduction in interruptions and MAEs. However, the reduction in MAEs cannot be fully explained by the decrease in interruptions. Other factors tended to influence the number of MAEs during the implementation process. We suggest that hospitals implement the drug round tabards on their wards. Even if there is a possible side effect of the tabard, such as increased awareness
and dedication, this is a positive result caused by implementing the tabard. We suggest further research on the contribution of each additional intervention for reducing interruptions and MAEs to avoid the implementation of unnecessary and non-evidence-based interventions.

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Authors’ contributions
HV, acquisition of funding and study design; LV, data checking, analyses, interpretation of data and drafting the manuscript; MS, analyses and interpretation of data; JM, methodological advise and interpretation of data; all authors, revising the manuscript for intellectual content and final approval.

Competing interest
The authors declare that they have no competing interests.

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