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RESEARCH ARTICLE

Best practice strategies to safeguard drug prescribing and drug administration: an anthology of expert views and opinions

Hanna M. Seidling[1,11] · Marion Stützle[1,11] · Torsten Hoppe-Tichy[2,11] · Benoît Allenet[3] · Pierrick Bedouch[3] · Pascal Bonnabry[4,5] · Jamie J. Coleman[6] · Fernando Fernandez-Llimos[7] · Christian Lovis[8] · Maria Jose Rei[9] · Dominic Störzinger[2] · Lenka A. Taylor[2] · Sarah K. Pontefract[6] · Patricia M. L. A. van den Bemt[10] · Heleen van der Sijs[10] · Walter E. Haefeli[1,11]

Abstract *Background* While evidence on implementation of medication safety strategies is increasing, reasons for selecting and relinquishing distinct strategies and details on implementation are typically not shared in published literature. *Objective* We aimed to collect and structure expert information resulting from implementing medication safety strategies to provide advice for decision-makers. *Setting* Medication safety experts with clinical expertise from thirteen hospitals throughout twelve European and North American countries shared their experience in workshop meetings, on-site-visits and remote structured interviews. *Methods* We performed an expert-based, in-depth assessment of implementation of best-practice strategies to improve drug prescribing and drug administration. *Main outcome measures* Workflow, variability and recommended medication safety strategies in drug prescribing and drug administration processes. *Results* According to the experts, institutions chose strategies that targeted process steps known to be particularly error-prone in the respective setting. Often, the selection was channeled by local constraints such as the e-health equipment and critically modulated by national context factors. In our study, the experts favored electronic prescribing with clinical decision support and medication reconciliation as most promising interventions. They agreed that self-assessment and introduction of medication safety boards were crucial to satisfy the setting-specific differences and foster successful implementation. *Conclusion* While general evidence for implementation of strategies to improve medication safety exists, successful selection and adaptation of a distinct strategy requires a thorough knowledge of the institute-specific constraints and an ongoing monitoring and adjustment of the implemented measures.

✉ Hanna M. Seidling
hanna.seidling@med.uni-heidelberg.de

1 Department of Clinical Pharmacology and Pharmacoepidemiology, University of Heidelberg, Im Neuenheimer Feld 410, 69120 Heidelberg, Germany

2 Pharmacy Department, University Hospital of Heidelberg, Heidelberg, Germany

3 Department of Pharmacy, CNRS, TIMC-IMAG UMR 5525, Themas, Grenoble-Alpes University, Grenoble University Hospital, Grenoble, France

4 Pharmacy, Geneva University Hospitals (HUG), Geneva, Switzerland

5 School of Pharmaceutical Sciences, University of Geneva, University of Lausanne, Geneva, Switzerland

6 University Hospitals Birmingham NHS Foundation Trust, University of Birmingham, Birmingham, England, UK

7 Research Institute for Medicines (iMedULisboa), Department of Social Pharmacy, University of Lisboa, Lisbon, Portugal

8 Division of Medical Information Sciences, Geneva University Hospitals, University of Geneva, Geneva, Switzerland

9 Pharmacy Department, Hospital da Luz, Lisbon, Portugal

10 Department of Hospital Pharmacy, Erasmus University Medical Center Rotterdam, Rotterdam, The Netherlands

11 Cooperation Unit Clinical Pharmacy, University of Heidelberg, Im Neuenheimer Feld 410, 69120 Heidelberg, Germany

Impacts of findings

- Instead of consecutively adapting a list of best-practice strategies, institutions aiming at implementing a safety strategy should assess their medication processes and errors for risk before selecting a strategy.
- A liable, multidisciplinary team should be set in place that both triggers and monitors the implementation of safety strategies.
- More than one strategy targeting the same problem may be implemented at different wards in one institution, particularly to safeguard drug administration.

Introduction

It is well known that drug treatment is a risky endeavor [1] and, therefore, health care professionals, institutions, and even entire countries have developed strategies to improve medication safety. As a result, there is a rapidly increasing body of literature on quality improvement strategies and error prevention techniques. Unfortunately, many of these are not comparable due to a variation in the definitions of strategies used or the outcome variables measured [2]. Moreover, the transferability and generalizability of a singular improvement strategy to a different setting appears low; identical interventions that have worked well in one setting have failed in another [3, 4]. Interventions to improve safety are often complex and rarely target a single process. They are much more likely to target an intertwined workflow that depends on the collaboration of numerous health care professionals [5]. A decisive factor for the success of complex interventions is their implementation period which includes the adaptation of a tool to the individual setting [6, 7]. For example, the failure of a safety intervention such as electronic prescribing could be related to poor implementation [8], the use of a poorly working system [9], or the fact that electronic prescribing alone will never improve the overall treatment process. The implementation phase of an intervention is rarely described in detail in published studies, which mainly focus on outcomes. Therefore, knowledge on why one safety intervention was favored above other strategies in the first place, and how it was subsequently adapted and shaped to fit a specific setting is not disseminated and tends to remain local site knowledge. Likewise, most internationally renowned recommendations on preferential implementation of medication safety strategies rely on expert consensus [10–12] and, again, generally these recommendations do not reflect the train of thoughts that led the experts to their conclusions. This study invited colleagues to join an expert group and share relevant events and experiences, critical steps, and challenges they encountered in their institutions while implementing strategies to safeguard drug prescribing and drug administration. We compiled and jointly communicated details of such implementation processes that were perceived relevant in retrospect for success or failure of a particular intervention.

Aim of the study

The purpose of this assessment was to gather and structure knowledge in order to support other health care professionals, institutions, and policy makers in their decision-making process which medication safety strategies could be adopted in a specific institution. We further aimed at collecting information on context factors that might foster or hinder a successful implementation.

Ethical approval

This qualitative study reports data gathered from expert group discussions, personal interviews, and questionnaires. All interactions were open thus revealing identity of the respondent and the affiliated institution. The participating experts agreed on the study goals and the publication and all are listed either as authors or mentioned in the acknowledgement section. Therefore, no ethical approval was deemed necessary.

Methods

The study was put out to tender by the German Ministry of Health as research project analyzing the medication process and the potential impact of medication safety strategies in five countries.

The assessment focused on medication safety strategies tailored to the prescribing and/or administration process as these are considered the two most error prone steps during inpatient care [13].

From May till November 2012, we conducted an open, prospective, qualitative assessment with international experts from European and non-European countries. Thereby, experts participated either in the core project team (N = 10, Table 1) or as consultant experts (N = 10, Table 2). Experts from the core project team represented five institutions from five European countries (Table 1). They participated in a group meeting and a final workshop in Heidelberg, Germany

Table 1 International experts' allocation of the core project team (participation in workshops, on-site-visits)

Country	Site	Experts
England	Birmingham	1 Clinical Pharmacologist/Physician
	University Hospitals Birmingham NHS Foundation Trust	1 Clinical Pharmacist
France	Grenoble	2 Clinical Pharmacists
	Grenoble University Hospital	
Portugal	Lisbon	1 Research Pharmacist
	Hospital da Luz	1 Clinical Pharmacist
Switzerland	Geneva	1 Clinical Pharmacist
	Geneva University Hospitals	1 Physician
The Netherlands	Rotterdam	1 Clinical Pharmacist
	Erasmus Medical Center	1 Clinical Pharmacologist/Pharmacist

Table 2 International experts' allocation involved as consultant experts (contact via email or phone)

Country	Site	Experts
Austria	Vienna	1 Clinical Pharmacist
	Allgemeines Krankenhaus der Stadt Wien	
Denmark	Horsens	1 Clinical Pharmacist
	Hospital Pharmacy Central Denmark Region	
Canada	Montreal	1 Physician (Geriatrics)
	McGill University Health Centre	
Norway	Oslo	2 Clinical Pharmacists
	Oslo University Hospitals	
Spain	Leon	1 Research Pharmacist
	Hospital de Leon	1 Clinical Pharmacist
Sweden	Stockholm	1 Clinical Pharmacist
	Karolinska University Hospital	
	Jönköping	1 Clinical Pharmacist
	Pharmaceutical Supply, Operational Support and Service, Jönköping County Council	
USA	Boston	1 Research Pharmacist
	Brigham and Women's Hospital	

and provided an on-site-visit for the Heidelberg project team in their respective institutions. Experts were preselected based on their expertise in medication safety, their publication record in the field, and international visibility. Moreover, they should work in a hospital setting to have insight into actual medication processes and experience in implementing medication safety strategies. Subsequently they were invited to participate in the project and asked whether they have been deeply involved in leading the deployment of medication safety improvement actions. If so, they needed to be willing to share in-depth knowledge and personal experience with successful and failed medication safety strategies to qualify as participant.

The first group meeting was held as a 1-day workshop in Heidelberg with experts from the core project team. The aim of this meeting was to (1) collect information on the processes of drug prescribing and drug administration in the individual institutions in order to (2) define a generic process description for the prescribing and administration process that allowed to (3) identify error-prone sub-steps of both processes and facilitated (4) a comparison of data from different institutions with regard to their peculiarities. As a flexible tool to structure the processes we applied Ishikawa diagrams [14]. While Ishikawa diagrams are typically used to analyze cause and effect of a certain event, we choose their structure to display the respective drug treatment processes with their pertinent sub-processes following a chronological order. Hence, an error-free process would presume error-free sub-processes as well and thereby, the Ishikawa diagrams helped to identify error-prone sub-steps and also to align reported strategies to improve medication safety to a specific step in the process (Fig. 1a, b). Results from expert group discussions with the core group were documented during the discussions on flipcharts and posters. Therefore, the key findings were immediately collected, shared with the team, and discussed and clarified if necessary. Therefore, no audiotaping or videotaping was conducted.

In preparation of the on-site visits, experts were asked to specify medication safety strategies that were implemented in their institution to safeguard a specific sub-step via a paper-based survey. During the on-site visits at the expert's local institution, described medication safety strategies were discussed with regard to selection criteria and reasons why one specific strategy was chosen over another one. On-site visits were documented on predefined documentation sheets by a Heidelberg study team member. After the visits, the handwritten notes were transferred to electronic format and send via email to the respective expert for double check and verification.
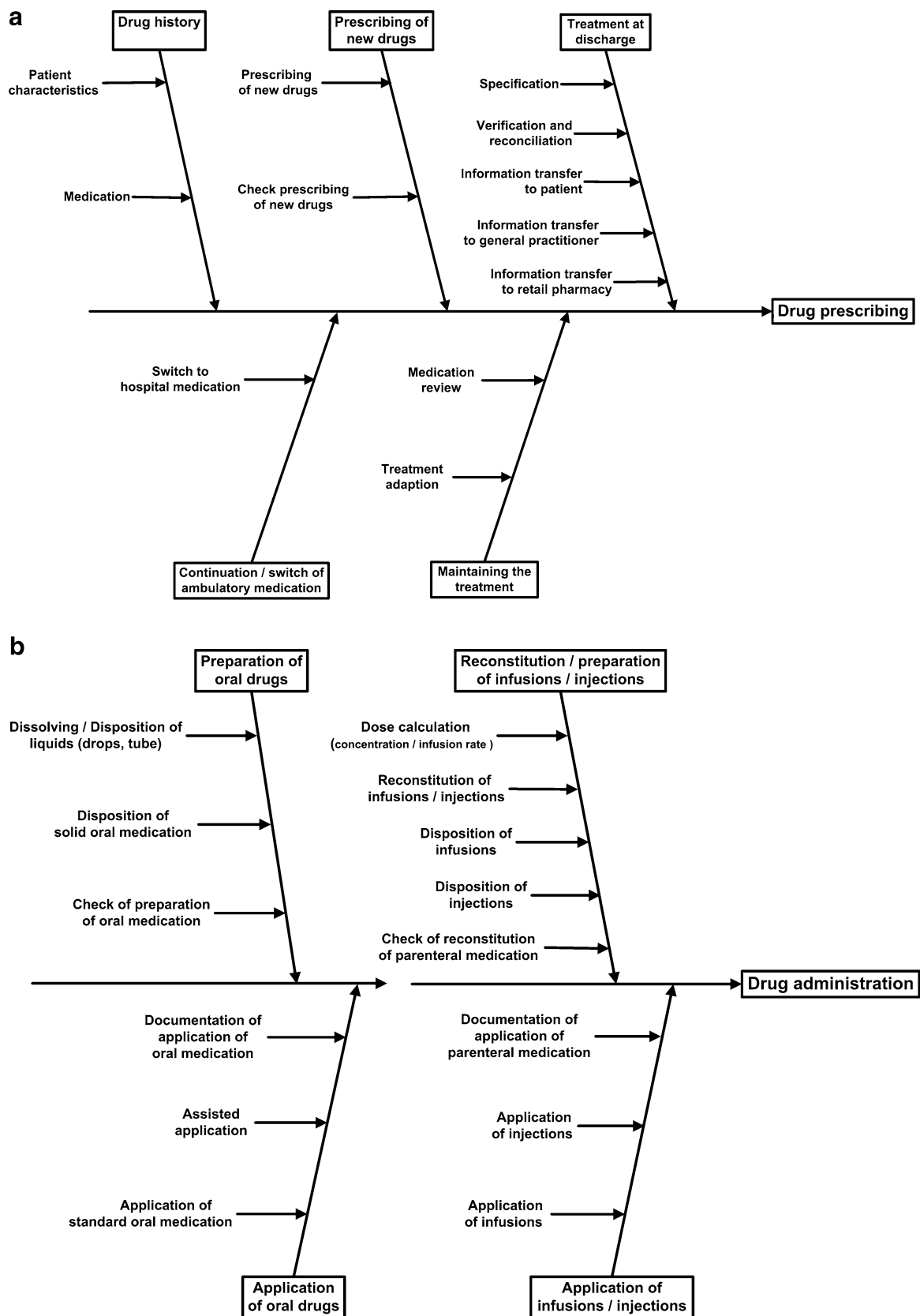
Fig. 1 **a** General specification of the drug prescribing process shown as chronological sequence of sub-steps. **b** General specification of the drug administration process shown as chronological sequence of sub-steps for oral and parenteral medication

After termination of the on-sites visit, consultant experts from additional European countries as well as from the US, Canada, and Australia as international reference countries were invited via email to participate. Ten experts from eight additional institutions in Austria, Denmark, Norway, Spain, and Sweden as well as from the US and Canada followed the invitation (Table 2). After instruction via email and phone they were asked to fill in the documentation material with regard to their institution. This included the specification of the drug prescribing and administration process alongside the Ishikawa diagrams, identification of error-prone sub-steps and description of implemented medication safety strategies. The information provided in the semi-structured questionnaire survey among the consultant experts was analysed by two members of the Heidelberg study team and uncertainties or ambiguities were clarified with the expert abroad.

In order to correlate implementation medication safety strategies with local and national constraints, all international experts involved in the study were asked to complete a questionnaire on locally and nationally available context factors that might impact the selection and implementation of medication safety strategies. Again, this questionnaire was read by two members of the Heidelberg study team and uncertainties or ambiguities were clarified with the expert abroad.

A final workshop with the core expert team and additional invited national experts and decision-makers from Germany was held in Heidelberg to discuss the aggregated results from each institution also with regard to potential applicability for the German health care system. Subsequently, experts should rank the suggested medication safety strategies considering the needed resources, the effort of implementation, the potential acceptance of the strategy and the benefit for medication and patient safety to adapt a list of recommended best-practice strategies both on a national and institutional level.

Results

Implemented medication safety strategies

During the expert discussions it became evident that interventions of the same nomenclature actually varied largely in how they were understood and carried out in different institutions. Hence, in order to harmonize the discussion and introduce a common denominator, we introduced a glossary with strategies mentioned during the assessment and added a short description that was used throughout the project (Table 3). Across the 13 institutions, 13 different main medication safety strategies were implemented alone or in combination (Table 4).

Interventions targeting drug prescribing were concordant in most institutions and focused on the implementation of electronic prescribing systems, medication reconciliation, and medication review; whereas strategies to safeguard the administration process appeared to be more heterogeneous. In some institutions, multiple differing strategies ensuring safe drug administration, e.g. patient trolleys and satellite pharmacies, were implemented on different wards taking into account the individual structure of the respective setting. Elaboration of medication safety strategies was linked with the local facilities (e.g. staff infrastructure). This highlighted the importance of being able to tailor strategies to individual settings to help eliminate or minimize local drawbacks (Tables 5, 6).

Selection and relinquishment of strategies: influence of error-prone sub-steps

The selection of strategies depended on particular sub-steps that were locally identified or perceived as error-prone. Indeed, we could identify several sub-steps both in drug prescribing and in drug administration that were congruently described as error-prone by the experts (Fig. 2). However, the experts found it challenging to reflect on processes when distinct medication safety strategies were already set in place for a long time and have become routine care.

With regard to drug prescribing, the majority of experts rated the interfaces of care as particularly error-prone in their institutions and concluded that consequent implementation of medication reconciliation helped to reduce errors of omission and documentation. During in-hospital care, transparency and information exchange was facilitated by the implementation of electronic prescribing systems, however, many of these systems were not fully linked to primary care and as a result, medication reconciliation at the interface of care was still deemed necessary. With regard to drug administration, application of parenteral drugs was generally perceived as more challenging than application of oral drugs. This led to the implementation of targeted measures such as the requirement for a double check during the preparation and application of all parenteral drugs. The sub-steps of actual application (i.e. risk of omission) as well as documentation were perceived as error-prone both for parenteral and for oral drugs. However, experts reflected that errors in these sub-steps could be often prevented by implementation of electronic prescribing systems with integrated medication administration records and did not require an additional, stand-alone intervention solely on the level of drug administration. To reduce prevalent errors in drug dispensing in preparation of drug administration, strategies were selected depending on the

Table 3 Glossary of different medication safety strategies with short descriptions as used during the expert discussions

Intervention	Description
Computerized physician order entry (CPOE)	Electronic prescribing systems with basic functions, such as prescribing by generic and brand name based on a comprehensive drug catalogue
Clinical decision support (CDS) systems	Electronic decision support integrated in the CPOE or as stand-alone solution providing basic alerts at least for drug–drug interactions, dosage, duplicates, and drug allergy
Medication reconciliation at hospital admission	Drug history from various sources including a patient encounter is double-checked by a pharmacist/technician/trained nurse and compared to the in-hospital medication
Medication review	New prescriptions are systematically checked by a clinical pharmacist or clinical pharmacologist
Pharmacist on ward rounds	Clinical pharmacists are regularly included in rounds at patient care units
Satellite pharmacies	Outpost of the hospital pharmacy for specific clinics or wards that are responsible for drug dispensing but typically also involved in drug disposal or preparation for the patients
Dispensing cabinets	Electronic cabinets that standardize and guide drug dispensing on the ward
Patient trolleys	Patient specific drawer placed in the patient room which holds all drugs of a patient
Dispensing with single dose packages ("EVA")	Drugs dispensed to the wards are singularly wrapped (e.g. 1 tablet) with drug name and strength clearly written on the package allowing for a second check before application by nurse and patient
Unit dose system for oral drugs and single use drugs	Drugs dispensed to the wards are wrapped in patient-specific packages with patient name and application date
Pharmacy-prepared ready to use formulations	The pharmacy prepares drugs (other than cytotoxics) for the immediate use on the wards (e.g. standard infusions, drugs for tube administration)
Calculation training	Calculation training for nurses before they are allowed to prepare infusions on the ward
Smart pumps	Infusion pumps with implemented drug libraries that standardize infusion rates and potentially provide alerts

patient population, staff resources, and the prescribing pattern on the wards, and included bed-side cabinets, satellite pharmacies or unit-dose systems.

Selection and relinquishment of strategies: influence of context factors

Moreover, we learned that local context factors did substantially determine both the level of activity in different institutions regarding medication safety as well as the selection of distinct strategies. We identified two major types of context factors driving the decision process, namely the overall commitment to a medication safety culture and the available technical equipment including the information technology infrastructure of an individual institution. In our selection of institutions, nine of the 13 sites used hospital-wide electronic prescribing, three institutions were currently implementing an electronic prescribing system, and only one institution had neither planned to nor implemented electronic prescribing. Four out of the nine systems in use were homegrown, and in five institutions prescription was carried out bedside with mobile devices. Six out of nine systems supported mainly a prescription based on active ingredients instead of brands. In particular with regard to the implementation of simple checking for spelling and plausibility versus the integration of clinical decision support, the systems varied considerably in their functionalities and

five systems offered at least simple plausibility checks. In all institutions, electronic prescribing systems were perceived as a vehicle for implementation of further medication safety strategies and as a necessary support tool to continuously monitor prescribing quality. Indeed, seven systems were explicitly used as platform to support medication review by documenting pharmacist recommendations.

Commitment to and awareness of medication safety was rated high in 12 of the institutions, and many offered incentives for medication safety programs (N = 11/13). Moreover, 11 institutions encouraged a lively communication of medication safety aspects with one influential person or committee being particularly responsible for medication safety (N = 10). Medication safety specific training was offered in 11 institutions. The experts reported that the awareness of medication safety and the existing communication and collaboration within and between professions facilitated the implementation and subsequent enhancement of medication safety strategies. According to the experts, further influential factors for the implementation of safety strategies were regional or national programs and the immediate linkage of medication safety programs with incentives. This was particularly evident for two of the strategies: electronic prescribing and medication reconciliation. All institutions with electronic prescribing had a nationally enforced recommendation for implementation and of the ten institutions performing medication

Table 4 List of key interventions, which have been implemented in 13 institutions to optimize drug prescribing and drug administration

	Computerized physician order entry (CPOE)	Clinical decision support (CDS) systems	Medication reconciliation at admission	Medication review	Pharmacists on ward rounds	Satellite pharmacies	Dispensing cabinets	Patient trolleys	Dispensing with single dose packages	Unit-Dose-System	Pharmacy-prepared ready to use formulations (other than cytotoxics)	Calculation training	Smart Pumps
Birmingham (UK) University Hospitals	x	x	x	x	x	x		x					
Boston (USA) Brigham and Women's Hospital	x	x	x	x	x		x			x	x		x
Geneva (CH) University Hospitals	x	x	x	x	x	x					x	x	x
Grenoble (F) University Hospital	x	x	x	x	x	x	x	x	x		x		
Horsens (DK) Aarhus Universitetshospital	x		x	x	x								
Jönköping (SE) Folkhälsa och sjukvård/Läkemedel	x	x	x	x			x	x	x		x	x	
Leon (ES) Hospital de Leon	(x)		x	x	x			x		x	x		
Lisbon(P) Hospital de Luz	x		x	x	x			x		x			
Montreal(CA) McGill University Health Centre	(x)	x	x	x	x	x				x	x		
Oslo(N) University Hospitals	(x)	(x)	x	x	x			x		x		x	
Rotterdam (NL) Erasmus Medical Center	x	x	x	x	x	x			x		x	x	
Stockholm (SE) Karolinska University Hospital	x	x	x	x			x						
Vienna (A) Allg. Krankenhaus der Stadt Wien				x	x								

While computerized physician order entry and clinical decision support systems were only counted in this list if they were hospitalwide implemented, other interventions could refer to specific wards or specialties

(x): intervention was planned for 2013/2014

Table 5 Overview of medication safety interventions and potential problems related to error-prone steps of the prescribing process

Error-prone sub-step	Medication safety intervention	Description/details in different institutions	Challenges for implementation
Drug history			
Missing/ incomplete medication data	Medication reconciliation	Drug history taken by physician and pharmacist/ pharmacy technician/trained nurse	Incomplete data sources on drug history (e.g. missing medication plan from general practitioner)
Wrong medication data		Transfer of paper-based documentation into CPOE with plausibility check	Patient not able to be interviewed
Missing/ incomplete verification of medication		Standardized drug history taken according to national guideline (trained pharmacy technician/double check/ authorization through physician)	Shortage of pharmacy personal
			No financial resources
Continuation/switch of ambulatory medication			
Missing/ incomplete switch	Electronically guided switch	Switch guided by CDSS, checked through pharmacist within 24 h	No electronic support for switch within the CPOE
Wrong switch	Strategy to minimize drug switches	ATC-code based proposition of drugs in CPOE	Limited hospital formulary
		Patients take their own drugs	
Prescription of new drugs			
Missing/ incomplete prescription of new drugs	CPOE with or without CDSS	Prescription generated using mobile device (e.g. laptop in the patient's room or by PC in the physician's room)	CPOE are not compatible (ICU and general wards)
Wrong prescription of new drugs	CDSS alone	Integration of varying CDSS functionalities	CPOE without any medication-related alerts
	Medication review by pharmacists	E-learning for prescribing skills, training in CPOE	New mistakes because of workflow changes e.g. the continued need of some papercharts for difficult prescriptions
Maintaining the treatment			
Missing/ incomplete medication review	Implementation of CDSS	Pharmacists on ward	Shortage of pharmacist to perform medication review for all patients
	Ward/clinic-specific alerts in the CPOE	Written check of every new prescription in the CPOE	Validation takes place only on a logistic level
Missing/ incomplete treatment adaptation		Check of overridden alerts	
	Medication review by pharmacists	Validation before unit dose preparation	
		Automatic identification of high risk patients/ medications to be checked by a pharmacist	
Treatment at discharge			
Missing/ incomplete information for patient	Written medication plan/discharge letter	Standardized interview with the patient according to national guideline	No linkage of systems between health care sectors
		Printed medication plan from the CPOE handed over to the patient	Shortage of staff
	Standardized communication		

Only steps where at least three out of five institutions of the core project team implemented any strategy are mentioned

ATC anatomical therapeutic chemical classification, *CPOE* computerized physician order entry, *CDSS* clinical decision support system

reconciliation, eight were triggered or supported by a corresponding national guideline or program for medication reconciliation. In contrast, for the two institutions without a standardized medication reconciliation process, there was no national program in place. Hence, supportive structures on a national level were identified as particularly important to foster the implementation of cost- and labor-intensive strategies that bear a financial risk for the implementing institution.

Discussion

This qualitative expert anthology suggests help to understand the relationship of (successful) implementation of medication safety strategies with local institutional and national conditions. Overall, 20 experts working at 13 institutions in 12 countries shared their experience and thoughts on the successful implementation of strategies to enhance and promote medication safety during drug

Table 6 Overview of medication safety interventions and potential problems related to error-prone steps of the administration process

Error-prone sub-step	Medication safety strategy/intervention	Description/details of different institutions	Challenges for implementation
Preparation of oral drugs			
Faulty disposition of solid oral medication	Unit dose dispensing including oral liquids	Unit dose dispensing for all wards with drawers for each patient	Certain drugs e.g. oral cytotoxic drugs or refrigerated medication cannot be dispensed in the unit dose system
Faulty disposition of liquid oral medication	Dispensing with single dose packages	Preparing unit dose forms for liquid oral drugs	
	Drug dispensing cabinets	Pharmacy prepared single-dose-packages for specific drugs	
	Satellite pharmacies	Drug dispensing cabinets for outside office hours	
	Trolleys and bedside lockers	Satellite pharmacies for selected wards	
Application of oral drugs			
Faulty/missing application of standard medication	Electronic to do lists from CPOE	Electronic or printed lists have to be ticked off	Administration is documented as complete, but the drug may be left with the patient and not taken
	Dashboards	Dashboards that analyze whether drugs are prescribed but not given or given too late	
	Electronic medication administration record		
Reconstitution/preparation of parenteral medication			
Wrong dose calculation	Second check, four-eyes principle	E-learning modules for nurses and physicians, tests have to be passed	Second check is not documented
	E-learning	Calculation training for nurses	Poorly conducted second check (e.g. suggestive question rather than as open question)
Faulty reconstitution	Disposition of ready-to-use formulations	Pharmacy prepared ready-to-use-formulations	Different wards need different strategies
	Information linked within the CPOE	Lists with the appropriate solvents for the specific drugs in the CPOE	
	Satellite pharmacies with i.v. services	Solvent in the CPOE prescribed	
	Preparation of high risk medication only in the pharmacy		
Application of parenteral medication			
Faulty/missing application of infusions	Dashboards	Dashboards that analyze whether drugs are prescribed but not given or given too late	
	Bar coding	No delay by waiting for a physician	
Faulty/missing application of injections	Application of all parenteral medication by nurses	Bar coding of medication and a unique patient bracelet	
	Use of smart pumps		

Only steps where at least three out of five institutions of the core project team implemented any strategy are mentioned

ATC anatomical therapeutic chemical classification, *CPOE* computerized physician order entry, *CDSS* clinical decision support system

prescribing and drug administration. The discussion underlined the importance of an institution-wide awareness and commitment for medication safety with a strong clinically driven leadership. Only then—in a climate of change [15]—medication safety projects may prosper beyond time-limited pilot projects. Indeed, a leadership facilitating and supporting a safety climate in an institution might foster quality improvement initiatives which again may translate into patient safety [16]. As safety climate was also identified as an independent predictor for patient safety, it is even more important to work on the overall safety climate of an institution in addition to introduction of specific quality improvement strategies [16]. Internal [17] and external benchmarking [18] might help to support a longitudinal improvement. Especially for external benchmarking, self-assessment tools can be used, such as Failure Mode and Effects Analysis (FMEA) used at the University Hospital in Geneva [19]. These are available in a standardized version, e.g. by the Institute for Safe Medication Practices [20], or adapted in a country-specific manner [21]. The experts confirmed that just debating and working on those assessment tools might help to form

a

b
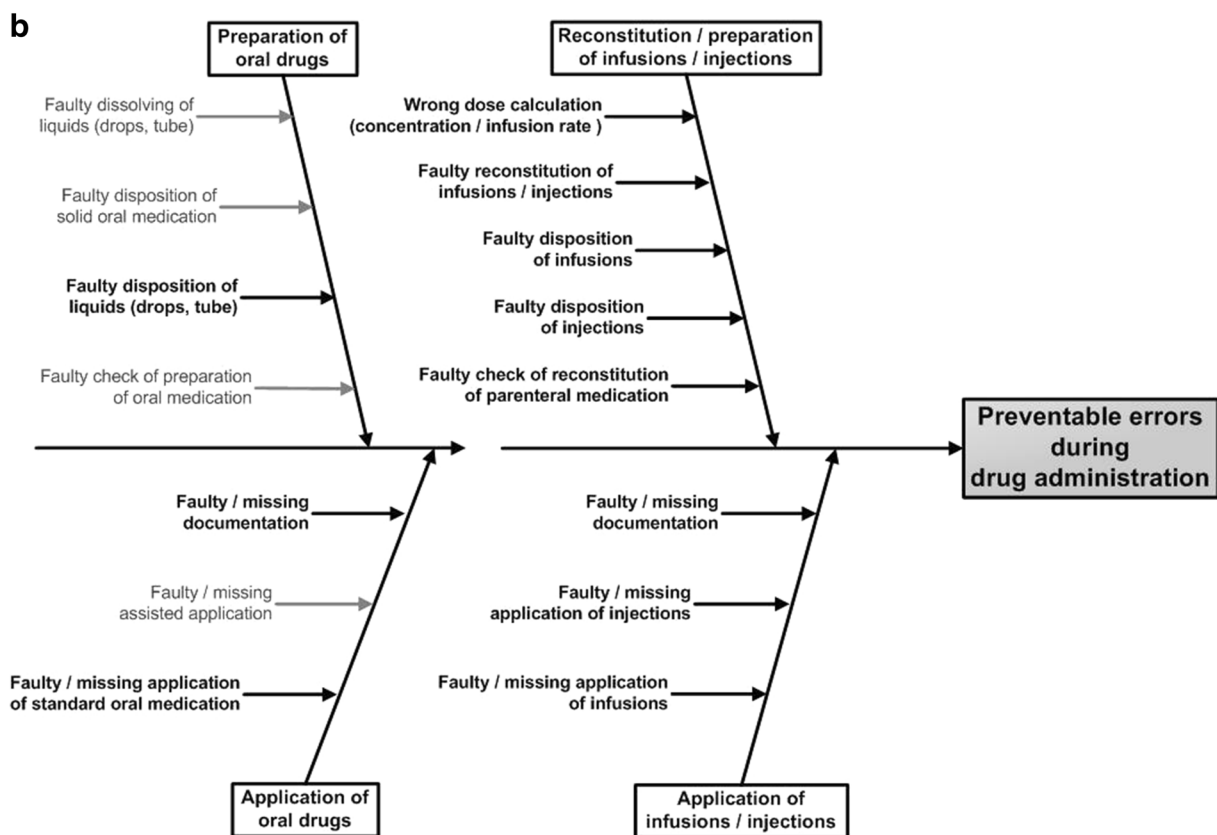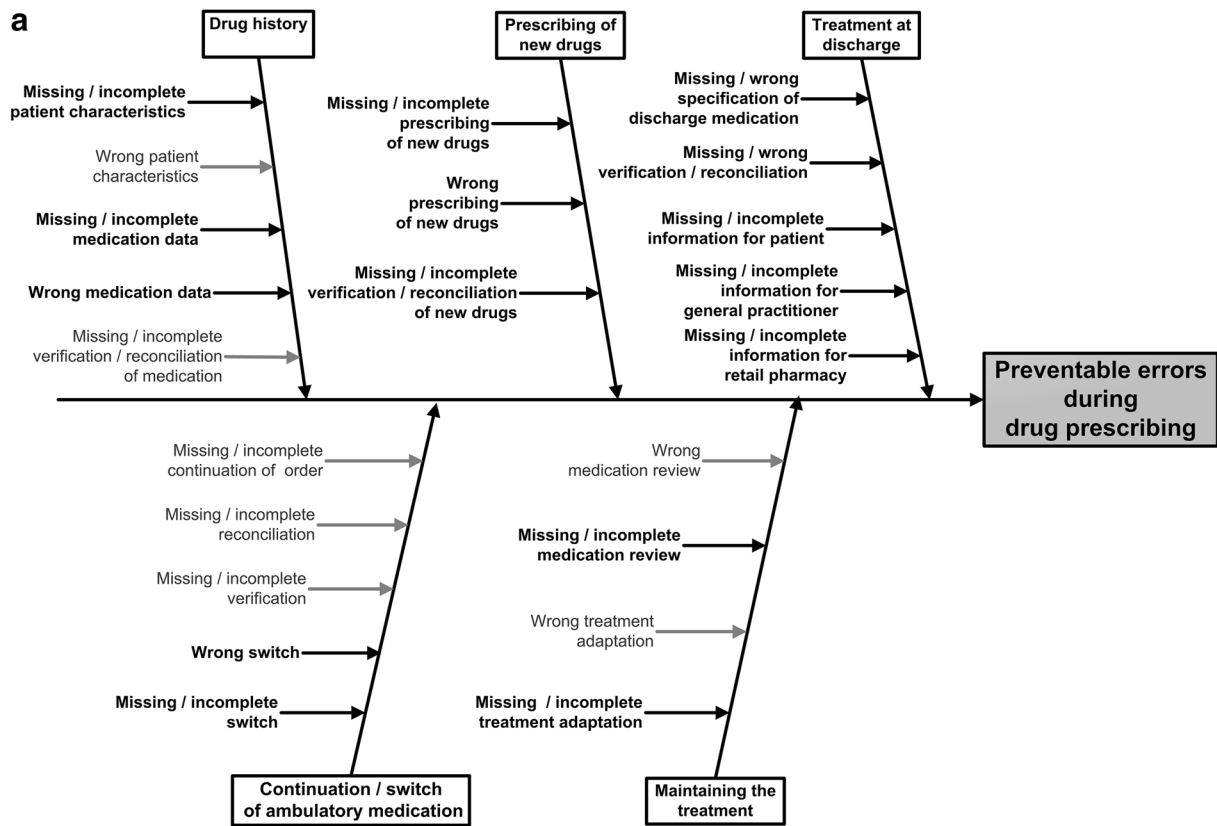
◄**Fig. 2 a** Most frequently mentioned errors occurring in at least six out of 12 institutions during drug prescribing highlighted in *black*. The US hospital is not included in this list because best practice strategies were set in place for so long that none of these steps were perceived error-prone anymore. **b** Most frequently mentioned errors occurring in at least six out of 12 institutions during drug administration highlighted in *black*. The US hospital is not included in this list because best practice strategies were set in place for so long that none of these steps were perceived error-prone anymore

interdisciplinary medication safety teams and to objectively reflect the current (and past) situation of a specific institution. This is even more important when considering how crucially the history and background of an individual institution contributes to the selection and ongoing development of distinct medication safety strategies. As for the institutions in this assessment, hospitals usually started a process of change with one major process-modifying strategy such as electronic prescribing or unit-dose dispensing. Indeed, the implementation of such technical tools might enforce also workflow changes. Based on step-wise adaptation and integration of new features, the workflow was gradually and steadily improved, often taking many years to successfully close the gaps between electronic drug prescribing, dispensing, and drug administration [22]. A long lasting implementation phase requires a defined responsible person or team that advances and pushes the progress, as well as a sustained support from the organization. Often, these teams are not only involved at a higher process level, but also at an operational level, and can thus be concerned with the development, implementation, roll-out and monitoring of the technical tools.

The current assessment and methodology has several limitations to consider. First of all, we invited a limited number of experts on medication safety to participate in this survey—obviously this assessment bears the known weaknesses of any expert-based, subjective methodology with a high selection bias and may not offer a comprehensive, literature-based review of the topic. Nevertheless, we intentionally initiated an expert-based discourse gathering information-rich cases that should be able to provide the greatest insight into the topic [23]. In our set of experts, many clinical pharmacists were involved and discussions could become even more diverse the more different professions are asked. Interestingly, many institutions in this study had implemented technical solutions to foster medication safety, however, also social or leadership aspects can successfully support medication safety. Secondly, data acquisition was performed on-site with the core project team and only remotely with consultant experts. This might have resulted in a reporting bias if questions were misunderstood. We aimed to minimize this error by offering an intense telephone support and verified all statements of all experts in iterative feedback rounds. Lastly, terminology in

the field of medication safety remains challenging [2, 24] and there are few generally accepted definitions of the strategies used. We therefore introduced a glossary (Table 3) and spent a reasonable amount of time to minimize these differences in our groups of experts—at least during discussions. However, it is evident that even if a congruent understanding of a medication safety strategy is found, its elaboration and adaptation to the specific context still varies.

Conclusion

Out of the growing number of (recommended) medication safety strategies, our expert opinion pool favored electronic prescribing with clinical decision support and medication reconciliation as the most promising and basic interventions. However, it became evident that successful implementation of any strategy requires thorough assessment of the local processes, constraints and opportunities in order to prioritize and measure different strategies and elaborate their distinct way of implementation. Therefore the foundation of a locally responsible, multiprofessional medication safety team was strongly recommended. National regulations helped to foster the implementation of a distinct strategy on a regional or national level but were seldom the trigger for unique milestone projects.

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