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Medication Safety in Oncology Care: Mapping Checking Procedures From Prescription to Administration of Chemotherapy

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Disclosures provided by the authors are available with this article at jop.ascopubs.org.

DOI: https://doi.org/10.1200/JOP.2017.026427; published online ahead of print at jop.ascopubs.org on February 26, 2018.

QUESTION ASKED: How many and which types of medication checks are performed along the lifecycle of a prescription from prescribing to administration of chemotherapy?

SUMMARY ANSWER: Checking is considered an important activity to enhance medication safety. However, we found that number and types of checking procedures vary with professional groups, hospitals, units, and administration routes. Compared with pharmacy staff, nurses and physicians have a lot of variation and little consistency in the number and types of checks applied for the same medication phases across hospitals, between different administration routes, and between units and wards (even within a given hospital).

WHAT WE DID: From document analysis and interviews, we assessed all checking procedures applied by nurses, physicians, and pharmacists from prescription to administration. Therefore, we differentiated between three types of activities: (1) single and (2) double checks—two sources of information were compared against each other once or twice, (eg, prescription *v* drug) and (3) plausibility reviews—someone used his or her own knowledge to examine a prescription. We also developed a mapping approach to illustrate and compare the checks performed along three phases of the medication process (prescription, production/preparation, and administration) in three hospitals, and we differentiated by administration routes (intravenous *v* oral) and organizational units (ward *v* ambulatory infusion units). In the mapping approach, a check is represented by a box, and the type of check is described within the box; the line stands for the medication process, and colors indicate the hospital. Our evaluation scheme to categorize checks and the mapping approach was feasible and understandable for practitioners.

WHAT WE FOUND: The mapping approach illustrates the checks performed and allows for a better understanding and overview of the checks applied in the whole medication process. Single checks were common for nurses right before intravenous administration, and they performed double checks at various points in the medication process—most often before administration. According to our assessment, senior physicians usually applied plausibility reviews on prescriptions of resident physicians. In the pharmacy, we found the most detailed documentation of checking procedures and the most standardized checking procedures.

BIAS, CONFOUNDING FACTOR(S), REAL-LIFE IMPLICATIONS: We focused on existing checks in the medication process, so our analysis did not allow conclusions about missing but potentially beneficial checks. Furthermore, we did not assess the actual checking behavior, so we cannot draw conclusions about compliance rates. Assessment and comparison of the use of specific safety activities, such as checking procedures, generate useful results for practitioners and researchers alike. The proposed mapping approach visualizes the check processes in current oncologic practice to better understand and improve them. However, it will not guide the decision about when to introduce checks. The medication hazards should be analyzed carefully, and the checks should be located at points in the process that are most vulnerable to errors. JOP

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Abstract

Purpose

To increase medication safety in oncology, checking procedures are increasingly applied by nurses, physicians, and pharmacists. However, little is known about the number, types, and consistency of implemented checks. The aim of the study was to assess the number and types of different checking procedures that are performed along the lifecycle of a chemotherapy prescription across three hospitals, different care settings, administration routes, and professional groups.

Methods

A scheme to evaluate checking procedures and a mapping approach to illustrate the checks along the phases of the medication process were developed. Checking procedures were assessed on the basis of analysis of internal guidelines and interviews with nurses and physicians who work on wards and in ambulatory infusion units of three hospitals.

Results

There were considerable differences in number and type of checking procedures among administration routes, professional groups, wards and ambulatory infusion units, and hospitals. During the prescribing phase, the lowest number of checks was performed. In internal guidelines, checking procedures were documented poorly, though the pharmacy process was an exception.

Conclusion

In contrast to the pharmacists, nurse and physician clinician checking procedures are less standardized within and across hospitals. The results point to different checking habits for the professional groups; for example, physicians would rather perform plausibility reviews than checks. Our evaluation scheme to categorize checks and the visualized mapping approach was feasible and understandable for practitioners.

INTRODUCTION

Cancer care is provided in a complex environment. Hazards in the medication process often are addressed by implementation of human checks and—if available—barcode scanning checks. Addition of a check to the medication process aims to introduce a safety barrier (ie, a redundancy that is expected to capture potential errors before administration). To augment the effect of a checking procedure, human double checking is applied increasingly in health care; it is expected that four eyes see more than two (ie, find

DOI: https://doi.org/10.1200/JOP.2017.026427; published online ahead of print at jop.ascopubs.org on February 26, 2018.

more errors). Double checking can help identify medication errors,[1] and this is probably the reason for its widespread use. However, prior research and safety theories discuss important weaknesses of double checking as a safety strategy: (1) its effectiveness has not been demonstrated yet[2]; (2) two checks may cause both checkers to pay less attention[3]; (3) both checkers may have the same blind spots because of their cognitive processing or disturbances in their environment and thus oversee the same errors for the same reasons; and (4) as reported by oncology nurses, double checking can lead to increased interruptions in workflows.[4]

Interestingly, even though checking procedures generally are considered a useful safety strategy for the clinical care work processes, their actual execution is usually not trained,[5] nor are the checking procedures and items to be checked defined. There is huge variation in double checks performance in practice, and the checking procedures differ across hospitals, across hospital units, and among professional groups.[4,5] Furthermore, what constitutes an independent (ie, high-quality) double check is not consistently understood.[5,6] Not only does the type of checking procedures vary immensely, but the number of checks performed does also. Griffin et al[7] found far more checks for intravenous (IV) than for oral chemotherapy (57 *v* six checks). In current practice, each professional group introduces checks into their medication process dependent on their own work demands and experiences (eg, past errors), in isolation from what other professional groups may check on the same medication. As a result, implemented safety measures may cluster at some stages or around some potential errors, but not all relevant risks along the lifecycle of a prescription are captured. To have an overview of applied checking procedures in the medication process from prescription to administration, process mapping is a valuable tool. It allows assessment of the checking procedures that different professional groups apply.[8,9] Mapping provides an illustrative overview of relevant steps of a process—in this case, these steps are the checks—and brings together information that is otherwise not easy to grasp simultaneously.

In this study, we examined all checks along the chemotherapy medication process from prescription to administration of the drug. The major aim was to assess the number and types of checks applied from chemotherapy prescription to its administration. We wanted to (1) compare the checks among three hospitals, with ambulatory and inpatient settings, as well as between administration routes (IV, oral, and intrathecal); (2) investigate differences among professional groups in types and number of checks applied; and (3) get a holistic overview of when checks occur along the medication process phases.

METHODS

Sample

Three hospitals (two teaching hospitals and one regional hospital) participated in the study; hereafter, they are termed red, blue, and green hospitals. Each hospital contributed one oncologic ward, the ambulatory infusion unit, and the hospital pharmacy. We analyzed documents about the work processes (eg, internal guidelines) for descriptions of checking procedures. In addition, a physician and a nurse for each ward or ambulatory unit and a pharmacist for each hospital pharmacy answered questions about checking procedures in an interview setting. Thus, 15 people total (n = 3 pharmacists, n = 6 physicians, and n = 6 nurses) took part as information sources in the study. The interviewed professionals were experienced in their domain and unit, and the pharmacists were familiar with chemotherapy production.

Data Gathering and Analysis

We analyzed documents and guidelines about the medication (production) process that we received from the nursing experts of the oncology departments and from the pharmacists. We asked the interviewees for additional documents to make sure that we covered all the available documentation. We developed interview guides to assess the checks along the work processes adapted for each professional group. We went through all of the steps of the medication process together with the interviewee to assess all checking procedures, even if the interviewee would not label them as such. The interviews were conducted in the person's work environment to show us how they performed certain checks, if required. We deliberately asked for the process as designed and did not focus on potential compliance issues. We assessed the work processes from the document analysis, described them, and later categorized them according to our scheme. The interviews were conducted by a pharmacist and a trained work psychologist. Before the interviews, we brought together all information from interviews and documents and mapped the checks for each hospital and administration route to develop a mapping approach that allowed comparison of the routes, the phases, and the hospitals. With these mapped processes, we asked our interviewees if their information was assessed correctly and whether they deemed the maps understandable. This data

validation was done via e-mail and a reminder; we reached a 100% response rate. After integration of the feedback, we analyzed the final process maps that displayed all checks.

Definitions and Evaluation Scheme for Checking Procedures

To evaluate the checks along the medication process, we developed a scheme to guide our data analysis. We first defined criteria to evaluate types of checking procedures: A procedure was only called a check if information from two sources was compared (eg, a prescription *v* a labeled chemotherapy drug, or the prescription from the physician software tool *v* the prescription that was manually transferred into the nursing software tool). If, for example, a prescription was checked against a clinician's own knowledge, not against another physical source of information, we defined this as a plausibility review. We differentiated the number of checks performed (ie, whether it was a single or a double check) and whether the double-checking procedure involved one person or two people. A technologically supported check was defined as a single-person check with technologic support if it was conducted as a barcode scanning procedure. We also differentiated among IV, oral, and intrathecal routes of administration in our scheme so that we could compare practices by administration route.

Mapping of Checks Along the Medication Process

To locate the checks along the course of the medication process, we assigned them to three phases: First, the prescription phase, which incorporates mainly physician work. The second phase is the production of the chemotherapy drug, mainly conducted by pharmacists. For oral chemotherapy, we called this phase preparation, because the tablets are not actually produced. The third and last phase is the administration of the drug, in which mainly the nurses are involved. The main challenge for mapping the checks throughout the process was to develop a visualization that allowed a comparison among the hospitals despite their different work processes. After we pulled together all of the relevant information on the checks from the interviews and the documents, we mapped the checks along the medication process for each hospital, for ambulatory units and wards, and for IV and oral drugs. To maximize comparability and readability, we decided to focus our map solely on the actual checks performed and to omit all other process steps, such as patient consultation with the physician or the delivery of the drug.

RESULTS

All maps to visualize the checking procedures along the medication process were validated by the interviewed professionals and were considered understandable. Figures 1A-1D present the results of our analyses. Each route of administration is presented along the three medication process phases.

Types of Checks Along the Medication Process

In all three hospitals, there were no single-person double check and no technology-based check. Single checks were common for nurses right before IV administration, and double checks were performed at various points in the medication process—most often after production or preparation and before administration.

According to the criteria in our scheme, physicians did not apply any checks except the final check before intrathecal administration in two hospitals (Fig 1C). All other checking-like procedures by physicians were plausibility reviews. For example, a senior physician performed plausibility reviews on the resident physician prescriptions. In some units, the resident physician prescriptions were not systematically checked (oral chemotherapy in red hospital and all chemotherapies in ambulatory infusion unit of green hospital; Figs 1A and 1B). In the ambulatory infusion unit of the green hospital, the resident physicians were supposed to ask for a review by a senior physician if they were unexperienced or felt unsure. However, on the oncologic ward of the same hospital, all resident physician prescriptions were checked systematically by a senior physician. We did not separately display a second plausibility review of the prescription by a senior physician that was done at the day of the first IV administration in the ambulatory infusion unit in the blue hospital only.

During the production phase in the pharmacy, there were two or three single checks of the production materials. These were labeled single checks, because the sources of information for the production materials comparison varied (eg, a production list or the prescription). Before the chemotherapy was dispensed, there was a standardized approval of the produced chemotherapy through a pharmacist.

Number of Checks

The number of checks differs considerably among the hospitals, among the phases of the medication process, and among administration routes. During the prescription phase, the lowest number of checks was performed; in particular,

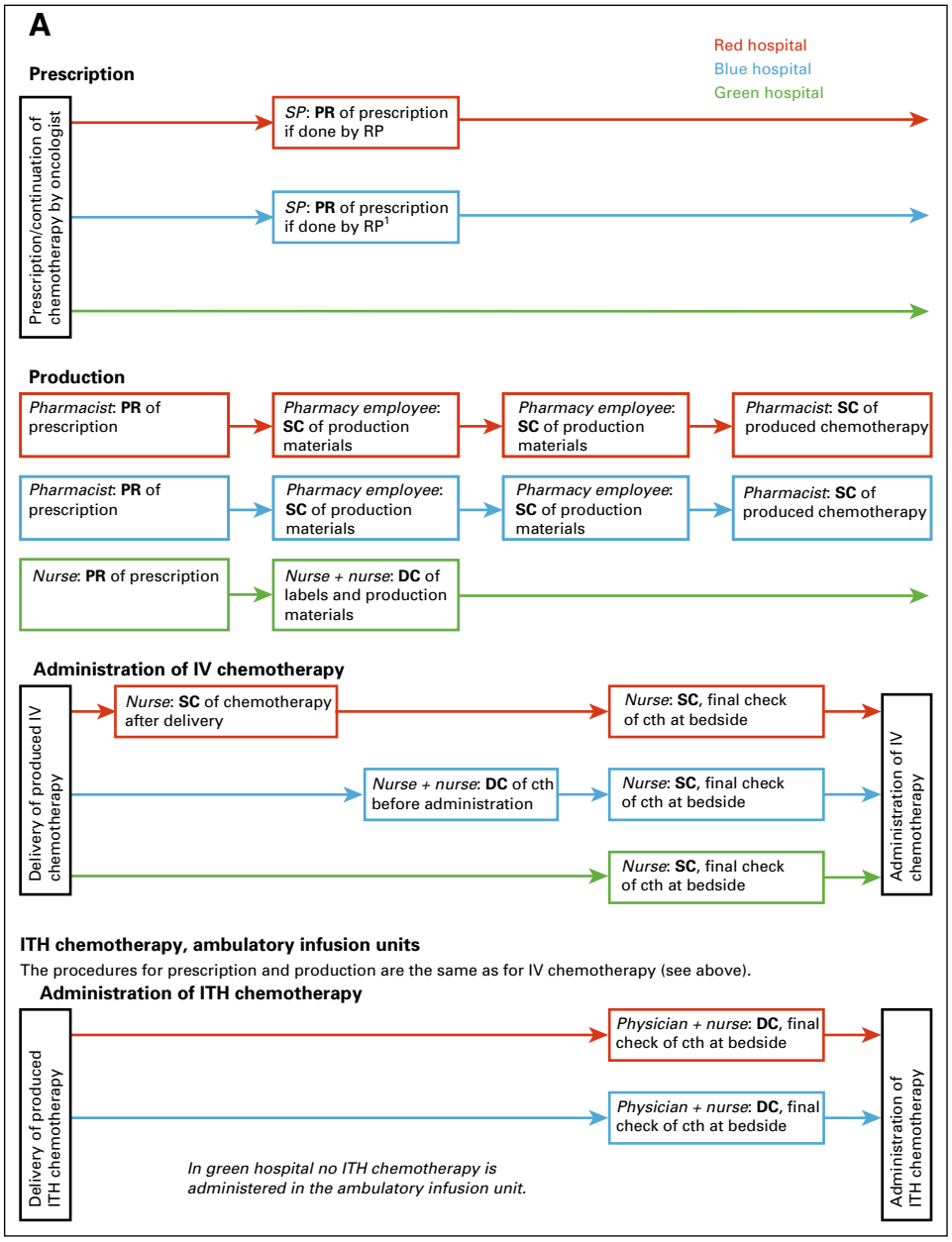


Fig 1. Mapping of medication check processes. (A) Intravenous (IV) chemotherapy, ambulatory infusion units. Note that, in green hospitals, no intrathecal (ITH) chemotherapy is administered in the ambulatory infusion units. (B) Oral chemotherapy, ambulatory infusion units. (C) Intravenous chemotherapy, inpatient settings (wards). (D) Oral chemotherapy, inpatient settings (wards). CTh/cth, chemotherapy; DC, double check: two sources of information (references) are compared two times, either by one (single-person double check) or by two qualified health care workers (eg, one person reads information from the IV bag label while the second compares with the prescription; then they change roles and the second checks the prescription while the first reads information from the label); PR, plausibility review: the check is performed with personal knowledge and experiences instead of comparison of two physical sources of information (eg, a qualified health care worker checks certain elements of the prescription, such as dosage); RP, resident physician; SC, single check: one qualified health care worker compares two sources of information (eg, a nurse compares the prescription to the drug label); SP, senior physician. (*) In blue hospital, for the first prescription of a patient coming the first time, there is a second PR by a SP if patient is treated by a resident physician. (†) In some cantons of Switzerland, only pharmacies are entitled to dispense drugs (out of inpatient settings). Therefore, in the red hospital's ambulatory infusion unit, oral chemotherapy is only prescribed, and the patient then goes to a local pharmacy. (‡) This check is only performed if prescription was entered in CATO. If prescription was entered in another information technology-system that is also used, there is no check.

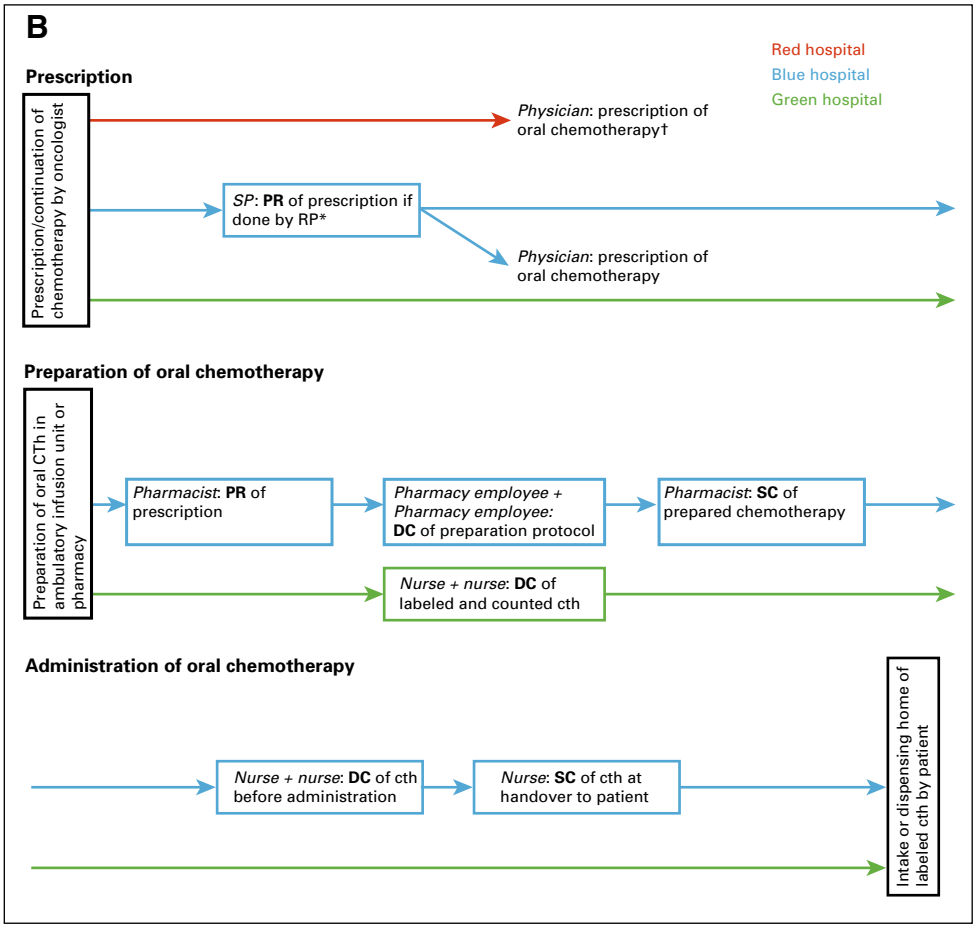


Fig 1. (Continued).

prescriptions of senior physicians were not cross-checked or reviewed in any of the participating units. Our analysis also showed that, there was no check in all three hospitals for the prescription phase of oral chemotherapy on wards (Fig 1D). Similarly, there were fewer checks for the oral route in the ambulatory infusion units. In the red hospital, there were no checks required at all for oral chemotherapy in some cases from prescription to administration (Figs 1B and 1D). The number of checks that nurses performed during the administration phase varied across different hospitals, even among the same routes and units (Figs 1A and 1D). The pharmacist production or preparation phase is the process that incorporated the most checks along the medication process. The number of nurse checks during administration phase varied according to collaboration with the pharmacy: In the ambulatory infusion unit of green hospital, the nurses produced the chemotherapy IV bags onsite. Here, the number of checks during production and administration was considerably smaller (three fewer checks) than in the other hospitals (Fig 1A). In the blue hospital, where the oral chemotherapy was prepared by the pharmacy, there were more checks for the oral route than when it was prepared by the nurses (Fig 1B).

In the green hospital, there was no standardized physician check before intrathecal administration. The nurses performed a double check; the physician was supposed to check the drug, but it was his or her own responsibility (Fig 1C).

Description of Checking Procedures in Internal Guidelines

The documentation of the pharmacy processes was thorough: all of the checks performed were documented. In contrast, we found no internal guidelines to describe any physician checks. For the nursing tasks, guidelines on checking drugs were rather general and not detailed enough to assess specifically which checks were performed.

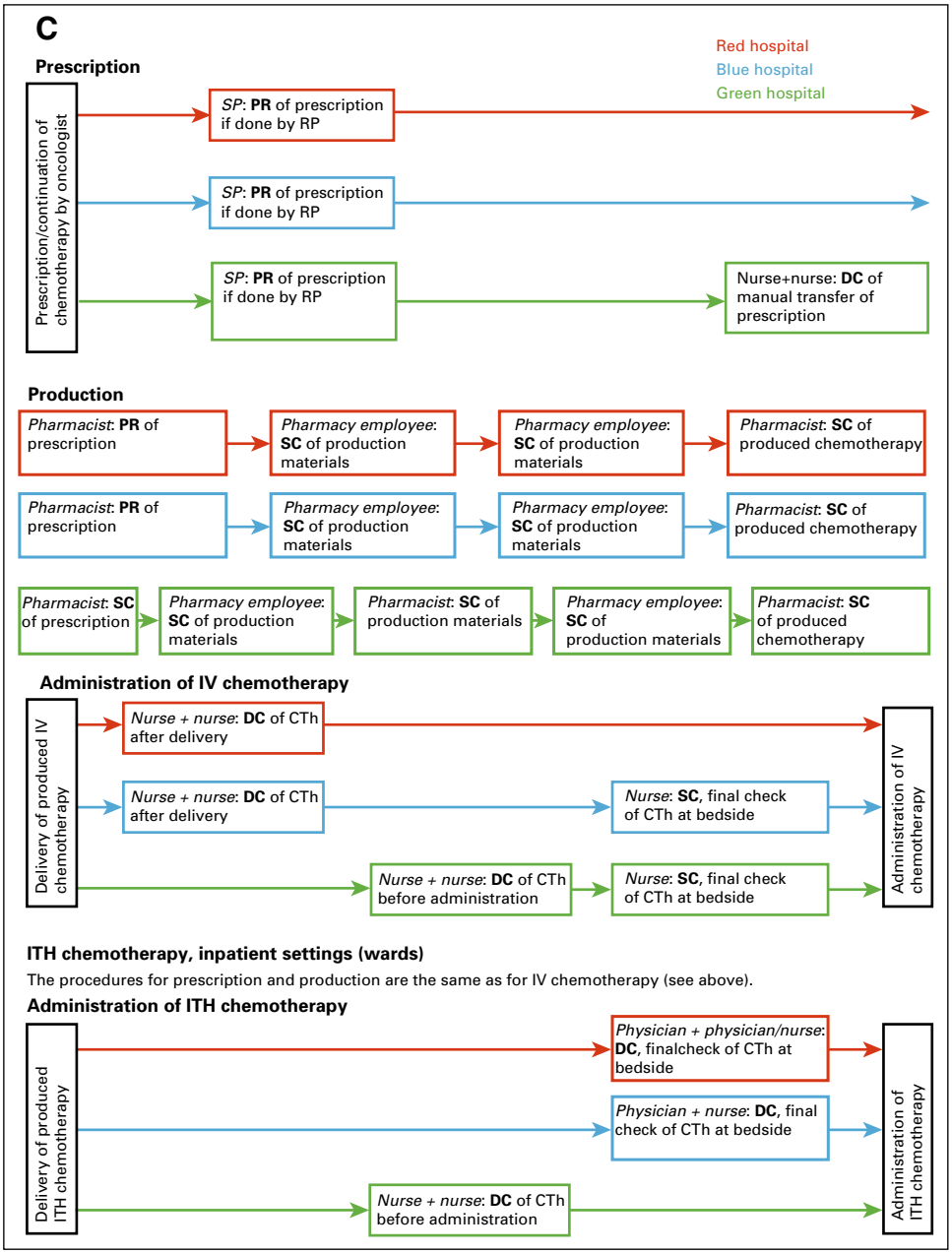
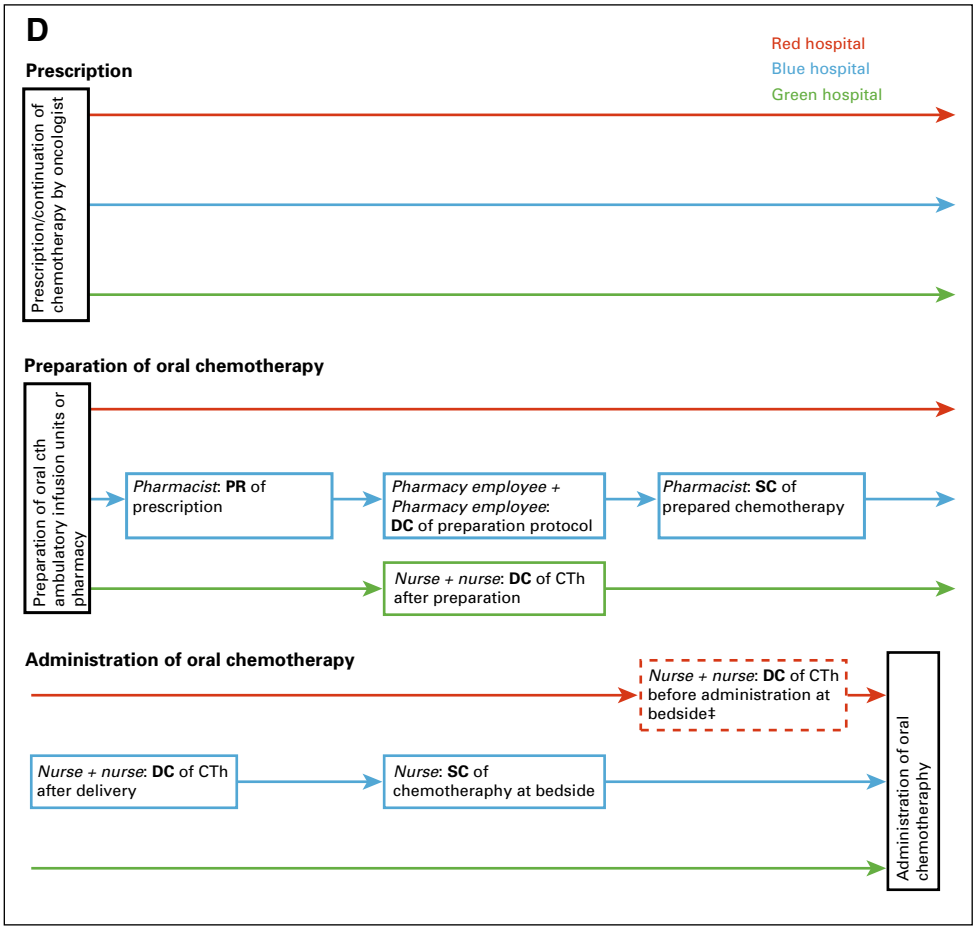


Fig 1. (Continued).

DISCUSSION

Checking chemotherapy before administration or during preparation is a reasonable action. It is deeply rooted in the professional self-concept of nurses and pharmacists.

However, our study showed that, for clinicians, there is a lot of variation and little consistency in the number and types of checks applied for the same medication phases across hospitals, among different administration routes, and between units and wards (even within a given hospital). The following examples illustrate this observation: (1) in the green hospital, a resident physician prescription was reviewed systematically by a senior physician when they worked on the ward but not when they worked in the ambulatory infusion unit. The resident oncologists worked in both places, so this means that their work was trusted in one place and reviewed in the other. (2) Given the severe consequences that intrathecal



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administration of a wrong drug may have, it is surprising that we found no standardized, systematic checking procedure that involved all participants. (3) The finding that there are fewer checks for oral chemotherapy is in line with prior research[7] and points to a need to raise awareness for the hazards in prescription, preparation, and administration of oral chemotherapy. The mapping approach we present is a feasible tool to identify the discrepancies among administration routes as a starting point for the design of safer processes. In our opinion, development of a checklist for intrathecal administration may be a viable way to make the checks before these administrations more systematic and reliable within and across hospitals. This would also improve collaboration between nurses and physicians in this checking situation, especially because physicians are not as familiar as nurses about the systematic medication checking procedures according to our study results. Furthermore, the results illustrate different checking habits of the involved professional groups: Pharmacists have the most standardized checking procedures; their checks are comparable in number and type across the two hospitals (for IV production), and they are transparently documented in guidelines. Pharmacists worked with the software program CATO (Becton Dickinson, Franklin Lakes, USA) for chemotherapy production, which provided technical safety barriers to avoid, for example, overdoses. For nurses, checking played an important role in the medication process, but there was a lot of variation in type and number of checking procedures applied among hospitals, units, and routes. Physicians applied checking procedures only rarely, which may reflect their autonomy-oriented professional culture and may be interpreted as a sign of their trust in the checks applied by other professions (eg, the nurses who administer the prescribed chemotherapy). These differences are important to take into account in the development of medication safety improvement projects.

The lack or deficiency of descriptions of checking procedures in the clinician guidelines was surprising to us. We

expected, for nurse administration of a drug in particular, a clear indication of what to check and how to perform a check. This lack of description may explain in part previous findings that the understanding of an independent check definition is limited.[4]

The little consistency of types and numbers of checks also is a sign that standardization in the design of medication processes and implemented checking procedures is low. Neuss et al[10] published standards for the administration of chemotherapy that were developed by bringing together literature and expert views to improve the safety of chemotherapy administration to support the design of safe medication processes. However, although the standard defines what items to check, it does not specifically describe the checking procedure itself (ie, how to perform a good double check). Our findings about the documentation of checks by clinicians also pointed to a lack of detail in the definition of checking procedures. We think that it is important to define and regularly train professionals about how to perform a double check (ie, do the two checkers perform a read–read-back procedure,[6] or do they check independently from each other?). Neuss et al[10] recommend use of standards as a basis for outcome research: when a unit or institution has defined, specific checking procedures, the effect on error rates can be monitored and evaluated regularly. In this way, it is possible to find out whether a specific check or check item, for example, helps reduce a certain type of medication error.

The nonexistent checks during the prescription phase are surprising in light of the hazards that are involved in this step: In their study on chemotherapy prescription errors, Mattson et al[11] found that, if the involved dosage computation was complex (eg, was based on glomerular filtration rate and body surface area), there were more prescription errors. In addition, a lot of information from different sources or systems (eg, laboratory results or treatment schemes) is used to take the decisions during the prescription phase. Furthermore, prior research on interruptions has shown that oncologists are interrupted frequently during prescribing, which increases the likelihood of an error.[12,13] These factors call for a better design of the work process to manage existing risks.

We draw as general conclusion from the presented results that checking procedures are not designed from a holistic overview of the whole medication process to match existing hazards. Rather, they seem to be added from individual professional groups in a fragmented way. For example, when the pharmacy is involved in production or preparation, there are considerably more checks than when nurses are in charge; thus, to fulfill the same tasks, the pharmacy applies more checks. Given that the pharmacy processes are less disturbed by interruptions (which is an argument for centralized chemotherapy production in the pharmacy) and that the hazards for the patients remain the same, it is not clear how these differences in checks are justified. We highlight the need to holistically analyze and design the oncologic medication process. For example, to identify areas for improvement in patient safety in radiation therapy, Chera et al[14] applied a safety theory[15] that allowed them to understand the whole work system better.

We focused on existing checks in the medication process, so our analysis does not allow firm conclusions about missing but potentially beneficial checks. However, we identified certain sensitive steps when a check may have been useful: for example, the patient's weight is important for accurate computation of the drug dosage. The weight is usually entered in the electronic medical chart by the physician without a check performed afterward, although nurses have reported incorrect weight entries by chance.

An analysis focused on the checks that are conducted along the process only allows for limited conclusions about the safety of the overall process, because other aspects that determine medication safety, such as information technology and work organization or cultural aspects, are not taken into account. Furthermore, we did not assess the actual checking behavior, so we cannot draw conclusions about compliance rates. The results are based on document analyses and on reports of health professionals who described their processes, and we may have misunderstood some of the descriptions. However, the fact that each interviewee validated our mapping results is regarded a sign of good data quality.

In addition, we did not include actual medication errors or near misses in our study. Linking the number, type, and quality of a check to actual error rates is subject to additional research (for example, that of Douglass et al[1]). In conclusion, application of a check uses valuable human resources, so adequate checking procedures should be defined that allow for the best possible identification of medication errors. The developed evaluation scheme is important to better understand and categorize checking activities in everyday practice. The mapping approach allows for visualization of the checks along the lifecycle of a prescription and for comparison of them among hospitals, hospital units, professional groups, and administration routes. The mapping supports a better understanding of the checks applied in the whole process, but it will not guide the decision about when to introduce checks. The medication hazards should be analyzed carefully, and the

checks should be located at points in the process that are most vulnerable to errors. Human checks have disadvantages discussed here, so decision makers in hospitals also should consider other safety improvement strategies, such as technologic support in checking or elimination of hazards by design.[16] For example, rather than implementation of more human checks to prevent lethal intrathecal applications of vinca alkaloids, abolishment of the syringe as an administration method and substitution with small-volume IV bags or use of specific connection systems that are mechanically incompatible with intrathecal connectors would be a more robust solution.[17] Assessment and comparison of the use of specific safety activities, such as checking procedures, generates useful results for practitioners and researchers alike. The proposed mapping approach makes the check processes visible to better understand and improve oncologic practices. JOP

Acknowledgment

Supported by Research Grant No. KFS-3496-08-2014 from Krebsforschung Schweiz (Cancer Research Switzerland) and by an unrestricted research grant from the Hanela-Stiftung. We thank all of the nurses, physicians, and pharmacists who participated in the study. We also thank Norman Ott and Delia Bornand (pharmacists) for support with practical experience in handling and producing chemotherapy and Chantal Zimmermann (research associate) for contributions to the analysis of the data.

Authors' Disclosures of Potential Conflicts of Interest

Disclosures provided by the authors are available with this article at jop.ascopubs.org.

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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

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No relationship to disclose

Stephan S. Gut
No relationship to disclose

David L.B. Schwappach
No relationship to disclose