
T H E S I S

Health Technology Assessment Perspective on
Prescription Writing



Stig Ejdrup Andersen, MD
University of Copenhagen, Denmark 2002

Section of Clinical Pharmacology, H:S Bispebjerg Hospital
Department of Clinical Pharmacology Q7642, H:S Rigshospitalet
Centre of Medicine, H:S Amager Hospital

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Thesis
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Initium est salutis, notitia peccati
Noticing error is the first step towards improvement



SENECA, EPISTOLAE 28.9

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Abbreviations

ATC	Anatomical Therapeutic Chemical classification system
CI	95% confidence interval
DDD	Defined daily dose
DKK	Danish krone
GP	General practitioner
HTA	Health technology assessment
OTC	Over-the-counter preparation
PCT	Percentage
POE	Physician order entry system

chapter one

Introduction

*“Han skal holde en ordentlig Dag-Bog over Syges Tilstand, Sygdommens Beskaffenhed, Af- og Tildragelser, samt de Medicamenter, som dem foreskrives og med særlig Accuratesse der ud i den anføre alle de selv samme Tildrageligheder, som forefalder,....Dagbog skal og naar han forlader Tjenesten forblive ved Hospitalet” **

PHYSICIANS INSTRUCTIONS, KGL. FREDERIKS HOSPITAL, FOUNDED 1757¹.

1.1 Clarification of concepts

The medication process denotes the totality of processes associated with the employment of drugs to patients (table 1.1). The medication process is indistinctly delimited from other routines in hospitals, and may vary between wards, specialities and hospitals. Any error occurring in the medication process is referred to as a medication error^{2,3}. Because the definition of medication errors remains somewhat controversial, comparisons of medication error rates across the literature are accompanied by significant uncertainty⁴⁻⁷. Moreover, differences in the medication processes make extrapolation from studies difficult⁸⁻¹⁰. Although many medication errors are caught in time by protective systems^{11,12}, or administered to patients, who do not experience any sequelae¹³, some are fatal¹⁴⁻¹⁶. Thus, an increasing number of deaths from medication errors have been reported¹⁷.

* He shall keep an orderly diary of the patients' condition, the nature of the disease, any occurrences, and the medicines, which are prescribed to them, and write down these very same occurrences with exceptional accuracy,....the diary is to remain in the hospital when he leaves the service.

For analytical purposes the medication process is often described as a linear series of repetitive and non-repetitive stages: prescribing; dispensing; administering; and monitoring^{7,18-20} (Table 1.1 and fig. 1.1). Medication errors, which are the broadest category, are classified by stages of the medication process. Errors occur in any of these stages^{7,12,18}.

Dispensing and administering refers to making up or preparing medications and distributing the medications to patients. Monitoring refers to the act of maintaining regular surveillance over a patient to detect intended or unwanted effects of the treatment. Dispensing, administering and monitoring will not be considered any further in this thesis.

Table 1.1.
The medication process

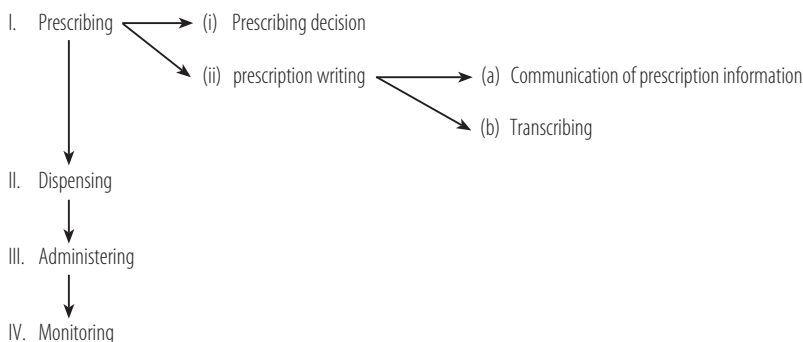
<i>Concept</i>	<i>Definition</i>	<i>Included in thesis</i>
I. Prescribing	The act of deciding to treat a patient with a drug and communicating the decision and the instructions for preparation and use of the drug	no
i. Prescribing decision	Determination of which drug or drug regimens, dose, dosage form etc. to prescribe	no
ii. Prescription writing:		
(a) <i>Communication of information prescription</i>	Transmission of prescription information, e.g. drug name, dose, and dosage form by writing	yes
(b) <i>Transcribing</i>	Copying information in writing from one document to another	yes
II. Dispensing	Making up or preparing medicine	no
III. Administering	Distributing medications to patients	no
IV. Monitoring	Maintaining regular surveillance over a patient to detect intended or unwanted effects of the treatment	no

Prescribing denotes the act of deciding to treat a patient with a drug and communicating the decision and the instructions for preparation and use of the drug. Prescribing errors, which are medication errors in the prescribing stage of the medication process, account for approximately half of medication errors^{12,21} and harm about 1% of all patients². In the literature, the rate of prescribing errors varies between 0.4 to 30% of the prescriptions²²⁻²⁷.

Prescribing includes two elements: (i) the prescribing decision (choice of drugs or doses appropriate for the individual patient) and (ii) prescription writing. Prescribing errors occur in both processes. Based on a Delphi process among clinicians, pharmacists and nurses Dean et al.⁶ classify prescribing errors in two main categories: (i) errors in decision making and (ii) errors in prescription writing. The prescribing decision is classed with the broader concept “clinical decision making”⁶ and will not be considered any further in this thesis.

Prescription writing comprises (a) communication of prescription information, which denotes the act of transmitting prescription information e.g. drug name, dose, or dosage form etc., and (b) transcribing, which is the act of copying information in writing from one document to another. Transcripts should be distinguished from direct copies such as carbon copies, photocopies or printouts from computer files. Although typewriting by secretaries technically is an act of transcribing, typewriting is included in the concept “prescription writing” in this thesis.

Figure 1.1.
The medication process



Errors in prescription writing are comprised of (a) failures to communicate essential information and (b) transcription errors⁶. Table 1.2 shows the errors in prescription writing reported in this thesis. These errors were studied because they indicate how successful prescriptions cross the gaps in care. In study II, ambiguous prescriptions were quantified. A prescription was ambiguous if form, route, dose, or schedule could be interpreted in more than one way. Ambiguous prescriptions are classified with the cate-

gory failures to communicate essential information⁶. In study II we quantified transcription errors attributable to incorrect transcription of prescription information from the medical record onto nurses' drug chart. Because the prevalence of one or more of this type error was 95% (128/135 patients), it was subsequently decided to quantify only the transcription errors that are attributable to incorrect transcribing of the generic drug name (I, III).

Table 1.2
Errors in prescription writing reported in this thesis.

<i>Error in prescription writing</i>	<i>Situation included as error in prescription writing</i>	<i>Study</i>
Failures to communicate essential information	Omission of prescription information (drug name, administration form, route, strength, dose, dosing, schedule, and duration of treatment)	II
	Writing ambiguous prescriptions	II
Transcription errors	On admission to hospital, unintentionally not prescribing medication that the patient was taking prior to admission	I
	Transcribing a prescription incorrectly from the medical record onto nurses' drug chart	II
	Transcribing prescription information incorrectly from the medical record onto nurses' drug chart	II
	Transcribing a prescription for discharge medication incorrectly from the hospital medical record onto the discharge letter	III

An example of prescribing is the physician who prescribes two tablets Digoxin of 62.5 microgram to be taken once daily against atrial fibrillation (table 1.3). First, the physician determines the drug, strength, dose, dosage form, quantity, and route to prescribe. This decision may integrate clinical and pharmacological knowledge, symptoms presented by the patient (fx breathing difficulties), clinical findings (fx oedema, perpetual arrhythmia), and results of examinations such as ECG and serum creatinine. When recording the prescription information, such as drug name (Digoxin), strength (62.5 microgram), dose (125 microgram), dosage form (tablets), dosage (125 microgram daily), and route (orally), the physician communicates the prescription information. If prescription information subsequently is being copied from the medical record onto the nurses' drug chart or the discharge drug summary, then an act of transcribing takes place.

Table 1.3

Types of error in prescription writing illustrated by the transcription from the medical record onto nurses' drug chart.

<i>Tape or rough draft (made by physicians)</i>	<i>Medical record (typewritten by secretaries)</i>	<i>Nurses' drug chart</i>	<i>Type of error</i>
Tablet Digoxin of 62.5 microgram each, two tablets once daily	Tablet Digoxin of 62.5 microgram each, two tablets once daily	Tablet Digoxin of 62.5 microgram each, two tablets once daily	No error
No prescription	No prescription	Tablet Digoxin of 62.5 microgram each, two tablets once daily	Transcription error
Tablet Digoxin of 62.5 microgram each, two tablets once daily	Tablet Digoxin of 62.5 microgram each, two tablets once daily	No prescription	Transcription error
Digoxin, 125 microgram once daily	Digoxin, 125 microgram once daily	Capsule <i>Dicillin</i> , 500 mg once daily	Failure to communicate essential prescription information Transcription error
Digoxin, 125 microgram once daily	Digoxin, 125 microgram once daily	Digoxin, 125 microgram once daily	Failure to communicate essential prescription information No transcription error
Tablet Digoxin daily	Tablet Digoxin daily	Tablet Digoxin of 62.5 microgram each, one tablet once daily	Failure to communicate essential prescription information Transcription error (quantified in study II, but not in study I or III)
Tablet Digoxin of 62.5 microgram each, two tablets once daily <i>(Based on ECG from wrong patient)</i>	Tablet Digoxin of 62.5 microgram each, two tablets once daily	Tablet Digoxin of 62.5 microgram each, two tablets once daily	Error in the prescription decision (Not quantified in this thesis)
Tablet Digoxin, two tablets once daily	Tablet <i>Dicillin</i> , two tablets once daily	Capsule <i>Dicillin</i> of 500 milligram each, two capsules once daily	Error in the prescription decision (Not quantified in this thesis) Transcription error (quantified in study II, but not in study I or III)
Tablet Digoxin of 62.5 microgram each, two tablets once daily	Tablet, two tablets once daily	No prescription	Transcription error (Not quantified in this thesis)

Understanding the magnitude of prescription errors and associated risk factors is essential to develop adequate strategies to control these problems. We decided to study the errors in prescription writing which are related to gaps in care that are aligned with distinct organisational boundaries, marking change in responsibility and authority, different roles of professionals, or formal division of labour.

1.2 Health technology assessment

The term technology assessment was first used in 1965²⁸. The concept was founded to cover the requirements of policy-makers for the identification of direct, intended and indirect, unintended or ignored consequences of technologies²⁸. Various definitions of health technology and health technology assessment (HTA) have been made²⁹. Health technology is the application of scientific or other organised knowledge to practical tasks in health care³⁰, and includes drugs, devices, equipment, medical and surgical procedures, support systems (patient records, clinical laboratories etc.), and organisational and managerial systems (clinical pathways, diagnosis-related groups, quality management programs etc.)²⁹. HTA denotes the systematic evaluation of properties, effects, and/or impacts of a health technology²⁹⁻³¹.

HTA is not defined by a set of methods but by its intent³². The intent of HTA is to provide input to technology-related decision making in health care^{29,32}. This characteristic distinguishes HTA from health related research³³, and orients HTA away from a primary object of increasing knowledge in the abstract towards applying knowledge in making decisions of practical significance. HTA is not a discipline or a field, but a process based on scientific evidence and information from different scientific traditions aside from health sciences, such as social, economic, and political sciences, collected to influence policy³²⁻³⁴.

At least three basic approaches to HTA are distinguishable²⁹: (i) a descriptive, technology-oriented assessment is intended to determine the characteristics or impacts of particular technologies; (ii) a comparative, health problem-oriented assessment focuses on solutions or strategies for managing a particular health problem for which alternative or complementary technologies might be used; and (iii) project-oriented (program-oriented) assessment fo-

cuses on a local placement or use of technology in particular institution, program or other designated project. These assessment orientations are not entirely exclusive and may overlap. A technology-oriented assessment is appropriate when, for example, assessing serotonin re-uptake inhibiting drugs in the treatment of alcohol abuse. Health problem-oriented assessment is appropriate when considering how drug treatment and non-pharmacological interventions should be used to decrease adverse health outcomes of alcohol abuse. Project-oriented assessment is applicable, should the county establish a new program for the prevention, diagnosis, and treatment of alcohol abuse.

Decision making in health care is complex and attempts to integrate many dimensions and values³⁵. To emphasise comprehensiveness and address the uncertainties of decision-makers the Danish Centre of Evaluation and Health Technology Assessment (DACEHTA) has developed a didactic, national HTA model^{30,36}. Technological, patient, organisational, and economic issues should be considered for inclusion in HTA-projects and any omission should be explained³⁷. This HTA model is specific to Denmark³⁷. HTA is established in most industrialised nations, but the programs, the type of technology assessed, the methodologies employed, the target groups, and the dissemination approaches are diverse^{33,34,38}. When put into practice, a partial approach to HTA is the most common³⁹.

The objective of the present analysis is not to conduct a thorough analysis of each of the four elements, but to address the elements where appropriate to answer the HTA questions about prescription writing. Applying the national HTA model to a non-embodied technology, we seek to explore the utility of this interpretation of HTA. Although the national model has been applied to specific medications, such as influenza vaccine, penicillin, and beta-interferon, the HTA model has not previously been applied to parts of the medication process.

Prescription writing is a widespread, non-embodied, established technology, which is regulated by statutes, regulations, and locally prepared guidelines (7.2). Although prescription writing is complex and may vary between specialities and settings, it is integrated in the day-to-day care of most patients. The use of drugs,

one of the main ingredients in modern medicine, has many beneficial outcomes. Seen as an organisational system, however, the gain from prescription writing is not calculable. Although the system is open to modifications, no true alternative technology exists. Therefore we decided to apply a technology-oriented approach²⁹, emphasising organisational aspects and errors in prescription writing (table 1.1), which are the undesired technical properties. The starting point was the organisation, and analyses of organisational diagrams (fig. 4.1) determined which studies to conduct in order to answer the uncertainties of the target group.

A substantial amount of methods can be applied to the various tasks of health technology assessment⁴⁰, including review and synthesis of existing evidence^{30,41,42}. Primary research for other than policy reasons is generally not classed as HTA⁴¹, but if sufficient rigorous evidence is unavailable as a main finding, HTA may either serve as a tool to identify clinical research needs⁴³ or give occasion for primary data collection³⁰. Besides compiling existing evidence we decided to include primary data collection, because the initial search of existing literature (1997) retrieved only two Danish studies of medication errors in hospitals^{44,45}. Foreign studies were available, though, but differences in health care systems and medication processes makes extrapolation difficult. No information about the organisational aspects of prescription writing was available.

Although only few studies were available, it was considered important to produce an HTA of prescription writing. This position was based on the experience, that in day-to-day clinic, misunderstandings frequently arise from errors in prescription writing. An HTA approach was chosen, because prescription errors are not simply a technical problem, which can be isolated from the organisational context in which they occur. Complexity, such as staff shaping the technology by creating or preventing errors, often makes it hard to pin down the causes of errors in prescription writing and find quick, straightforward solutions. The wide scope of HTA allows the addressing of this complexity. As a logical consequence, it was decided to focus on the technological and organisational issues of prescription writing, emphasising the structural and process quality. Errors in prescription writing may pose a threat to patients, but they may impede continuity of care

and waste skilled manpower as well. For example, physicians often need to process several documents to find out why a certain drug has been prescribed or discontinued⁴⁶. When trying to answer questions, like “What medications has the patient been taking recently” a lack of confidence in the accuracy of the answers is common⁴⁷.

A wide range of decision-makers in health can be identified, including government policy makers, insurance companies, other payers, industry, planners, administrators, clinicians, and patients³⁰. Managers, whether practitioners or not, are a prime target for information from HTA³³, but physicians are the end users of many health care technologies, and their practice patterns often shape the technologies. Study IV confirmed that this applies to prescription writing as well. The starting point, the organisation of day-to-day clinic on internal medicine wards, became determinant for the target group. This thesis is aimed at ward managers because the National Board of Health assigns ward managers to prepare instructions for the medication process⁴⁸. Although the choice of target group has influenced the organisation and contents of this thesis, the findings may apply to other target groups. For example, errors in prescription writing are frequent among surgical patients⁴⁹ and patients undergoing endoscopy⁵⁰.

To reduce uncertainties of the target group concerning planning of strategies to control errors in prescription writing we derived following HTA questions:

- What is the current quality of drug prescriptions on internal medicine wards?
- How can prescription writing be modified?
- How will modifications of prescription writing affect the organisation?

1.3 Organisation of thesis

This thesis includes eight chapters. The four elements of the national HTA model^{30,36} are discussed in separate chapters. Chapters 1 and 2 include the general introduction and aims of thesis. Chapter 3 deals with technology aspects of prescription writing and includes own studies of errors in prescription writing (I-III). Chap-

ter 4, which treats organisational aspects of prescription writing, includes own study of the difficulties identified by physicians and nurses when using medication charts (IV). Chapter 5 is about the economic consequences of prescription writing for patients and the ward. This chapter includes a secondary analysis of data derived from study III. A discussion of patients' perspective on errors in prescription is given in chapter 6. This chapter is entirely based on review of published papers. Chapter 7 includes the general discussion, which deals with legal aspects of the technology as well. General and specific recommendations are given in Chapter 8.

chapter two

Aims of the thesis

The overall objective of this thesis is to conduct a health technology assessment of prescription writing on internal medicine wards in order to support planning of strategies to control errors in prescription writing. The thesis addresses all four elements of the national HTA model, without postulating an exhaustive analysis of each of the elements. The thesis includes following intermediate aims:

TECHNOLOGY

- To assess the extra information about patients' pre-admission drug use, which can be obtained by a second drug interview and general practitioners' (GP) drug lists (I).
- To assess the accuracy of drug entries and to quantify errors in the transcription from the medical record onto nurses' drug chart (II).
- To test the hypothesis that the implementation of a medication chart reduces the prevalence of transcription errors in the discharge drug summary (III).

ORGANISATION

- To investigate the barriers that physicians and nurses associate with the application of medication charts in day-to-day clinic (IV).

ECONOMY

- To determine the cost of drugs of patients admitted to internal medicine wards from the patients' and the wards' perspective.

PATIENT

- To discuss patients' perspective on errors in prescription writing on the basis of published studies.

chapter three

Own studies of errors in prescription writing

This chapter includes three studies of errors in prescription writing (table 1.2). Overall, these studies quantify errors in prescription writing, related to admission (I), communication between medical and nursing staff (II), and discharge (III). Discussions of findings and study limitations are combined in section 3.5.

Three measures are applied to quantify errors in prescription writing: (1) the total number of errors in the sample of patients; (2) the prevalence of errors, which is the proportion of patients in the sample, who are affected by one or more errors; and (3) the rate of errors, which is the proportion of erroneous prescriptions in the sample.

3.1 Settings

The studies were conducted in one (II) and two (I, III) internal medicine wards. The hospitals are situated in two local regions of Copenhagen and serve 150,000 and 130,000 patients, respectively. Both wards have similar ward-based medication supply systems: All frequently used drugs are stocked in ward cupboards. Nurses make four to six drug rounds daily. With the exception of the statutory supervision of medicine cupboard⁵¹, pharmacy technicians or clinical pharmacist were not involved in the wards in the study periods. Generally, patients do not bring their medicines to compile an accurate medication history, and information is not routinely obtained from their general practitioners.

3.2 Admission (I)

3.2.1 Background

Hospital physicians depend upon complete medication histories to prescribe drugs safely. However, in any form of patient history there is a significant recall bias.

A transcription error occurs when physicians unintentionally do not prescribe a drug that the patient was taking prior to the admission⁶. Medication histories in the hospital medical records are often incomplete compared to questionnaire information^{52,53} or pharmacy records⁵⁴. Incomplete medication histories may impede the detection of drug-related problems and result in duplication of drugs, inadvertent discontinuation of medical treatment, unintentional changes in schedule or unwanted interactions⁷. Extra information can be obtained by a second drug interview⁵⁴⁻⁵⁸ or general practitioners' drug list (GP drug list)^{57,59,60}, but these sources are, however, often incomplete regarding medications that the patients are reporting to consume or medications that they actually keep^{57,59-62}.

Obtaining medication histories by combining information from different sources of pre-admission medications may reduce prescribing errors and provide a more comprehensive basis for in-patient drug therapy. The benefit of this approach in day-to-day clinic is not yet clarified.

3.2.2 Aim

The aim of this study was to assess the extra information about patients' pre-admission medication use, which can be obtained by a second drug interview and general practitioner (GP) drug list.

3.2.3 Material and methods

A cross-sectional study (I) was conducted in two internal medicine wards (3.1). On weekdays, consecutive patients were screened for inclusion. Patients over the age of 18 years who were able to communicate were eligible. Within the first 24 hours of admission each patient made a written informed consent and was randomised by drawing lots to a semi-structured interview performed by either a pharmacist or a physician. The patients were asked to mention all valid pre-admission medications. Requests for update drug lists were posted to the GPs.

Prior to the study we calculated a sample size of 71 patients, using a paired design. We wanted to be able to detect a difference of one drug, when comparing the result of a second interview to the medication history. We assumed a standard deviation of change of 3.0, chose a power of 0.80 and a significance level of 0.05. Because we expected a GP response rate of 70%, we decided to interview at least 50 patients from each ward.

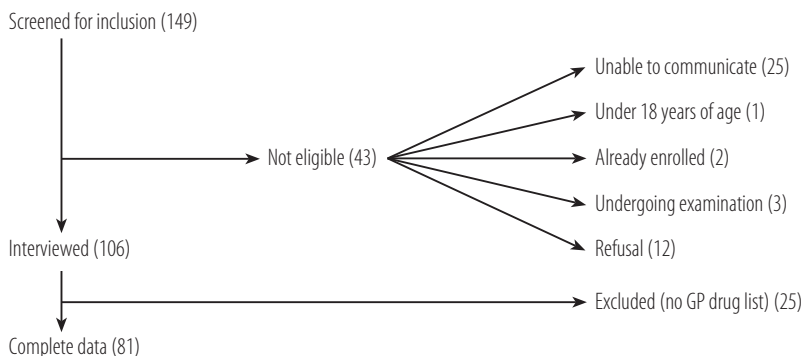
For each patient two investigators independently reviewed the interview form, the GP drug list, and medication history in the medical record and recorded all drugs by generic name. Nurses' drug charts were not reviewed. Medications to be administered by demand, vehicles, herbal medicines, diet and food agents, and unidentifiable preparations were excluded.

The rate of transcription errors was calculated by comparing drug entries in the medication history to the medications, which were obtained by a second drug interview and GP drug list. Comparisons were based on generic drug names. Medications, which were used currently according to second interview or GP drug list, but not recorded in the medication history, represented transcription errors.

All patients in the sample from one of the wards, who were affected by transcription errors in the medication history, were identified. Medications according to the medication history, the interview and the GP drug list were tabulated, and the content of the progress notes was summarised. A panel of clinicians (GP, cardiologist, internist and clinical pharmacologist) reviewed this material at four sessions lasting two hours each. The authors were not on the panel. The clinicians assessed eight statements concerning the potential clinical impact of transcription errors (appendix A) and rated their assessment of each statement on a five-category scale. Category one and five represented complete agreement and complete disagreement with a statement, respectively. Category one and two were subsequently merged and recorded as agreement.

Finally, the medical records were reviewed to verify the actual occurrence of any of the potential problems that the clinicians had identified.

Figure 3.1
Trial profile of study I. The numbers of patients are given.



Statistical analysis

We used Student t-test and Mann-Whitney U test, where appropriate. Frequency tables were analysed using the Chi square test with Yates correction for continuity. Cut-off level for statistical significance was taken at 0.05. All statistics were calculated with Statistica™ 5.1, StatSoft“.

3.2.4 Results

Overall, 106 of 149 patients were interviewed; GP drug lists were received in 81 cases (fig. 3.1). Complete data were available for analysis among 76% of the interviewed patients. The included (n=81) and excluded patients (n=25) were similar regarding age (median 73 vs. 73 years, p=0.96) and gender (f/m 55/26 vs. 20/5, p=0.36).

The medication history, second interview and GP drug list were identical in nine cases (11%, CI 6 to 20%). Regarding prescription drugs, the sources were identical in 11 (16%, CI 9 to 26%) of 69 cases. Regarding OTCs, the sources were identical in eight (11%, CI 6 to 20%) of 72 cases. The rate of drug entries, which were recorded identically on the lists were 108 of 278 prescription drugs (39%, CI 33 to 45%) and 47 of 172 OTCs (27%, CI 21 to 34%), respectively. Extra information was obtained by second interview in 56 cases (69%, CI 58 to 78%). This information included 54 prescription drugs (31 cases) and 72 OTCs (46 cases). Extra information was obtained by GP drug lists in 57 cases (70%, CI 60 to 79%). This information included 74 prescription

drugs (42 cases) and 26 OTCs (19 cases). Table 3.1 shows the distribution of transcription errors by number of drug entries in the medical record. Transcription errors occurred frequently at both ends of the spectrum and affected drugs from all Anatomical Therapeutic Chemical classification system (ATC) main groups⁶³.

Table 3.1

Distribution of transcription errors by number of drugs in the medical record. Number of patients and percentages of patients are given. Medications, which were used currently according to second interview or GP drug list, but not recorded in the medication history, represented transcription errors.

	<i>No. of drugs recorded in the medical record</i>	<i>No. of patients</i>	<i>No. of patients affected by transcription errors (PCT)</i>	
			<i>Second interview</i>	<i>GP drug list</i>
Prescription drugs	0	20	7 (35%)	7 (35%)
	1	14	3 (21%)	5 (36%)
	2	17	7 (41%)	10 (59%)
	3	11	5 (45%)	7 (64%)
	4	11	6 (55%)	7 (64%)
	5	2	1 (50%)	1 (50%)
	6	4	1 (25%)	3 (75%)
	7	1	1 (100%)	1 (100%)
Over the counter drugs	8	1	0 (0%)	1 (100%)
	0	33	20 (61%)	8 (24%)
	1	24	15 (63%)	6 (25%)
	2	16	7 (44%)	5 (31%)
	3	5	2 (40%)	0 (0%)
	4	2	2 (100%)	0 (0%)
	5	1	0 (0%)	0 (0%)

The pharmacist (n=35) and physician (n=46) interviews lasted on average 9.5 and 7.3 minutes, respectively, mean difference 2.2 minutes (CI 0.3 to 4.1 minutes, p=0.02).

A logistic regression analysis indicated that transcription errors (1=present, 0=absent) were not associated with age (below 65 years of age = 0, else 1), gender (0=male, 1=female), interviewer (0=pharmacist, 1=physician) or the number of drugs in medication history. The variables were eliminated backwards.

The prevalence of transcription errors was 56% (31 patients) in the sample of 55 patients from one of the wards. The panel assessed that if the extra information, which was obtained by second interview and GP drug lists, had been available during hospital stay,

then it might have had a beneficial effect on the course of ten patients (18%, CI 10 to 30%). Review of the progress notes indicated identified problems actually occurred in two cases.

3.2.5 Conclusion

This comparison of second drug interview and GP drug list to the medication history indicates that the prevalence of transcription errors in the medication history is 69 and 70%, respectively. Extra information, which can be obtained by second drug interview or GP drug list, may produce a beneficial effect on the course of 18% of the patients.

3.3 Communication between medical and nursing staff (II)

3.3.1 Background

Traditionally, drug entries are transcribed from the medical record onto nurses' drug chart. The medical record contains prescriptions entered by the physicians; the nurses' drug chart contains a transcribed interpretation of the prescribed medical treatment. In 1959 Trillwood⁶⁴ called attention to the risk arising from errors in the transcription from the medical record onto nurses' drug chart. Because nurses depend on complete prescriptions to administer drugs safely, failures to communicate essential information attributable to ambiguous or incomplete prescriptions may pose a risk to patients.

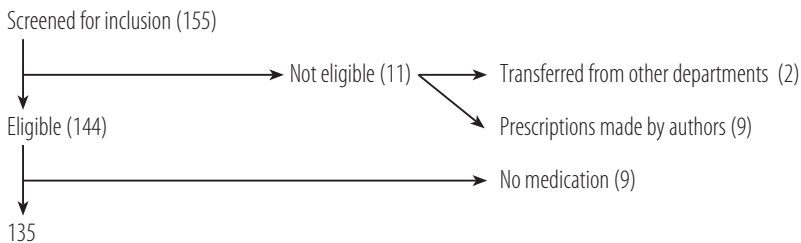
3.3.2 Aim

To assess the accuracy of drug entries and to quantify errors in the transcription from the medical record onto nurses' drug chart.

3.3.3 Material and methods

Figure 3.2

Trial profiles of study II. The numbers of patients are given.



This cross-sectional study (II) was conducted on a general internal medicine ward. On each of the five ward sections data were collected twice, with an interval of two weeks. All patients were screened for inclusion. The following patients were not eligible: patients under the age of 18 years, patients transferred from another department, and patients whose medical record contained prescriptions made by one of the investigators.

All valid drug entries were retrieved from the medical records and nurses' drug charts, and subsequently compared. Diet and food agents, vehicles, herbal medicines, fluids for intravenous administration, and unidentifiable drugs were excluded. Variability between nurses' drug chart and the medical record regarding generic drug name was recorded as a transcription error. A prescription was defined as ambiguous, if the prescription information (form, route, strength/concentration, dose, or schedule) could be interpreted in more than one way.

Statistical analysis

Mann-Whitney U test and the Chi square test with Yates correction for continuity were applied. The cut-off level for statistical significance was set at 0.05. All statistics were calculated with Statistica™ 4.5, StatSoft®.

3.3.4 Results

Overall, 135 of 149 patients were included, 79 women and 65 men (fig. 3.2). Median age 75 years (range 32 to 97); mean length of hospital stay was 11.6 days. The included and excluded patients were similar regarding gender and age.

Table 3.2

Summary of logistic regression analysis of data from study II. The dependent variable was discrepancy between medications in the medical record and on nurses' drug chart (present=1, not present=0). In brackets the 95% confidence interval for the odds-ratio is given.

<i>Parameter</i>	<i>Estimate</i>	<i>SE</i>	<i>t</i>	<i>p-value</i>	<i>Odds-ratio per unit change</i>
Slope	0.62	0.53	1.18	0.24	
Over 65 years of age (no=0, yes=1)	-1.11	0.51	-2.17	0.03	0.34 (CI 0.12 to 0.91)
No. of valid drug entries in the medical record	0.17	0.06	2.82	0.006	1.19 (CI 1.05 to 1.34)

The prevalence of transcription errors was 64.4% (87 patients). Overall, 808 prescriptions were retrieved. The rate of prescriptions recorded on both documents was 75.0% (606/808). The rate of prescriptions recorded only in the medical record or only on nurses' drug chart was 14.1% (114/808) and 10.9% (88/808), respectively. The rates of transcription errors in the medical record and on nurses' drug list were 15.8% (114/720) and 12.7% (88/694), respectively, $p = 0.11$. Transcription errors were distributed among all drug classes, except from sensory organ drugs (ATC main group⁶³ S), and affected medications with potential for injury, such as insulin (n=5), warfarin (n=3), furosemide (n=10), digoxin (n=4), sotalol (n=1), verapamil (n=1), antibiotics (n=11), strong analgesics (n=2), benzodiazepines (n=7), and disulfiram (n=1).

The following variables were included as predictor variables in a logistic regression model: patient age (below 65 years of age = 0, else 1), gender (m=0, f=1), length of hospital stay, and number of valid drug entries in the medical record. The dependent variable was variability between generic drug names in the medical record and on nurses' drug chart (present=1, not present=0). Variables were eliminated backwards, one at a time. The analysis unveiled that transcription errors were associated with age and the number of valid drug entries in the medical record (table 3.2).

Table 3.3
Prescription information.

	<i>Medical record</i>	<i>Nurses' drug chart</i>	<i>Odds-ratio (95% confidence interval)</i>
No. of prescriptions	709 (100.0%)*	684 (100.0%)*	
Unambiguous	428 (60.4%)	411 (60.1%)	1.00 (0.85 to 1.19)
Commercial drug name	664 (93.7%)	658 (96.2%)	0.97 (0.84 to 1.13)
Generic drug name+	65 (9.2%)	60 (8.8%)	1.05 (0.72 to 1.51)
Form	411 (57.9%)	476 (69.5%)	0.83 (0.70 to 0.99)
Route	71 (10.0%)	45 (6.6%)	1.52 (1.03 to 2.24)
Strength/concentration	44 (6.2%)	17 (2.5%)	2.50 (1.41 to 4.41)
Dose	614 (86.6%)	629 (92.0%)	0.94 (0.81 to 1.10)
Schedule	602 (84.9%)	595 (87.0%)	0.98 (0.86 to 1.14)
Dosing time	132 (18.6%)	638 (93.3%)	0.20 (0.16 to 0.25)
Duration	36 (5.1%)	31 (4.5%)	1.12 (0.69 to 1.83)

* Eleven drug entries in the medical record and ten on nurses' drug chart were to be administered by schedule. These entries are not included. +Generic drug name and commercial drug name were identical in 57 cases.

The rate of ambiguous prescriptions in the medical records and on nurses' drug charts was 39.6% (281/709) and 39.9% (273/684), respectively, $p = 0.96$. The rate of prescriptions where information was lacking (failures to communicate essential information (table 1.2)) varied between 3.8 and 97.5%, depending on the sort of prescription information (table 3.3). Unlike prescriptions in the medical record, the majority of prescriptions on the nurses' drug chart included dosing time. No difference between the medical record and nurses' drug chart regarding drug name, form, strength/concentration and schedule of all drug entries occurred in 7 cases (5.2%).

3.3.5 Conclusion

With the traditional medical record system, prescription information is lacking in 3.8 to 97.5% of the drug entries. Approximately 40% of the drug entries are ambiguous. The rate of transcription errors in the medical record and on nurses' drug list is 15.8% and 11.1%, respectively. One or more transcription error affects two-third of the patients. Transcription errors affect medications with the potential for injury.

3.4 Discharge (III)

3.4.1 Background

When a patient is discharged from hospital, a detailed discharge letter should be communicated to the general practitioner (GP)⁶⁵⁻⁶⁸. The GPs may not be aware of the medication their patients take^{57,59-61,69-71} and value a comprehensive discharge drug summary⁷². A comprehensive discharge drug summary should include: (i) an accurate list of medications on admission; (ii) a list of medicines added or deleted in hospital; (iii) reasons for giving or altering medications; and (iv) a list of medications with doses, frequency and proposed duration on discharge⁷¹.

Generally, clinicians encounter difficulties in retrieving the relevant drug entries with the traditional medical record system, because data are often scattered over several pages⁷³. When transcribing drug entries from the medical records, errors are virtually inevitable⁷⁴⁻⁷⁶. Consequently, prescriptions are frequently omitted from the discharge drug summaries^{65,66,77-79}.

Standardised record systems may facilitate accurate data retrieval⁴⁷. The introduction of a medication chart (3.5.2) may reduce

the rate of prescribing and administration errors⁸⁰⁻⁸³. The impact of a medication chart on transcription errors in the discharge drug summary, however, has not been investigated.

3.4.2 Aim

To test the hypothesis that implementation of a medication chart reduces the prevalence of transcription errors in the discharge drug summary. Secondly, to determine the number of consultations with health care professionals in the first month after discharge.

3.4.3 Material and methods

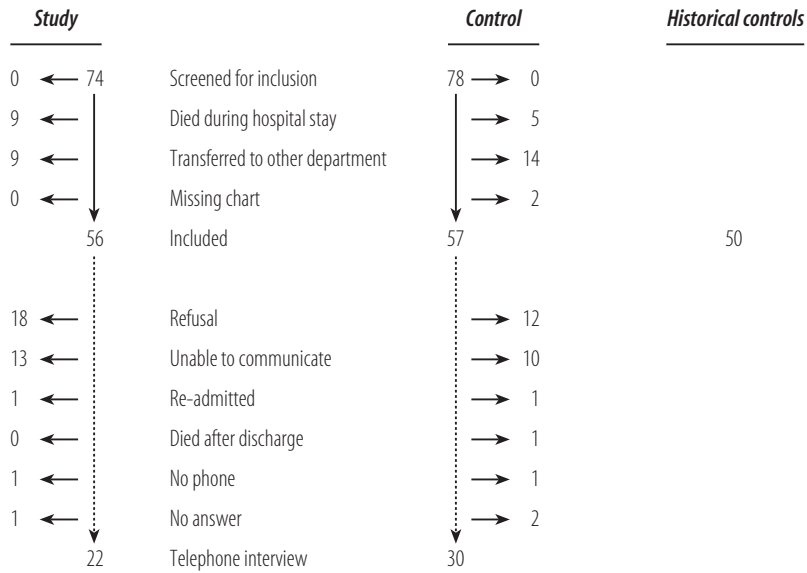
This non-randomised controlled study was conducted in two internal medicine wards (3.1). Prior to the study we calculated a sample size of 48 patients for each group. We wanted to be able to detect a reduction in the proportion of patients affected by transcription errors from 45% to 25%, using a two-sided Chi-square test with a power of 0.80 and a significance level of 5%. We decided to include at least 50 patients in each group.

Adults admitted to the wards on weekdays and hospitalised for 24 hours or more were eligible, if they were discharged directly to their home from the hospital. A group of 56 consecutive patients (study group) was included from a ward where a medication chart for prescribing and documenting drug dose administration (3.5.2) was implemented. Two control groups were selected. A group of 57 consecutive patients (control group) were included from another internal medicine ward, where drug prescriptions were recorded in the traditional medical record system. A sample of 50 patients (historical control) was drawn randomly among patients discharged directly home from the same medical ward as the study group, 6 to 18 months before the medication chart was implemented. Figure 3.3 shows the trial profile.

Valid drug entries of medications scheduled for regular use were collected from the medical records and the discharge drug summaries, and compared by generic drug name. Diet and food agents, vehicles, herbal medicines, fluids for intravenous administration, and unidentifiable drugs were excluded. Dose and regimen was not compared. A transcription error was recorded when a valid drug entry in the medical record was not retrieved from the discharge drug summary. Deliberate changes made by physicians and entered in the charts did not count an error.

Figure 3.3

Trial profiles of study II. The numbers of patients are given.



One month after discharge we phoned the patients from the study group and control group. Written informed consent was obtained from the patients during the hospitalisation. A prepared list of questions addressing post-discharge changes to medication and consultations with health care providers was used for the interviews. Telephone interviews with 22 study patients and 30 control patients were completed.

Statistical analyses

The mean number of drugs in each group was compared using analysis of variance. The analysis was based on square root transformed values. Transcription errors in each group were compared using Kruskal-Wallis analysis of variance. Chi-square test with continuity correction was used for dichotomous variables. The frequency of drug use according to the medical record and the discharge drug summary was compared by two sample confidence intervals for the difference of paired proportions 84. Cut-off level for statistical significance was taken at 0.05. 95% confidence intervals were calculated with CIA 2.084. All statistics were calculated with Statistica™ 5.1, StatSoft®.

3.4.4 Results

Clinical characteristics are summarised in table 3.4. The control patients were younger than the study patients were. The length of stay was shorter and mean number of medications in the discharge drug summary was lower in the historical control group.

Table 3.4

Clinical characteristics. In brackets the 95% confidence intervals for the means are given.

	<i>Study group</i>	<i>Control group</i>	<i>Historical control group</i>	
No. of patients	56	57	50	
Mean age (years)	76,4 (72,9 to 79,8)	68,4 (64,0 to 72,1)	70,6 (66,5 to 74,4)	p = 0.006
Gender (m/f)	21/35	24/33	26/24	p = 0.31
Mean length of stay (days)	8.7 (7.2 to 10.4)	8.0 (7.2 to 9.6)	5.4 (3.9 to 7.1)	p = 0.009
Mean no. of admission medications	3.3 (2.4 to 4.3)	3.4 (2.5 to 4.5)	2.5 (1.8 to 3.4)	p = 0.32
Mean no. of discharge medications	5.3 (4.6 to 6.2)	5.5 (4.7 to 6.6)	4.2 (3.4 to 5.0)	p = 0.04
Mean no. of medications in discharge drug summary	4.7 (3.9 to 5.7)	3.8 (2.9 to 4.9)	2.8 (2.0 to 3.7)	p = 0.01

In the study group the prevalence of transcription errors was 30% (17/56), compared to 54% (31/57) and 56% (28/50) (control and historical control group), difference 24% (CI 6 to 40%) and 26 (CI 7 to 42%). The median number of transcription errors was significantly higher among control patients (median 1) than among study patients (median 0), p=0.01. Regarding medications initiated during the index hospitalisation, 89% (study group), 71% (control group), and 58% (historical control group) were included in the discharge drug summary. No discharge summary was obtained in 3.6% (study patients), 7.0% (control), and 14.0 (historical control group) of the cases having valid discharge medications prescribed in the medical record (n.s.).

A logistic regression analysis unveiled that the presence of transcription errors was associated with the group and number of discharge medications (table 3.5). Following variables were included as predictor variables: Group of patients (study = 100, control = 101, historical control = 102), patient age (below 65 years of age = 0, else 1), gender (m=0, f=1), length of hospital stay, and number

of admission and discharge medications. The dependent variable was transcription errors (present=1, not present=0). Variables were eliminated backwards, one at a time.

Table 3.5

Summary of logistic regression analysis of data from study II. The dependent variable was errors of omission (present=1, not present=0). In brackets the 95% confidence interval for the odds-ratio is given.

<i>Parameter</i>	<i>Estimate</i>	<i>SE</i>	<i>t</i>	<i>p-value</i>	<i>Odds-ratio per unit change</i>
Slope	-78.86	30.66	-2.57	0.01	
Group	0.76	0.30	2.53	0.01	2.14 (1.18 to 3.89)
No. of discharge medications	0.29	0.08	3.87	<0.001	1.33 (1.15 to 1.55)

The frequency of medications by Anatomical Therapeutic Chemical classification system (ATC) main groups⁶³ is given in table 3.6. Transcription errors were associated with 90 different drugs. With the medication chart, significant differences in frequency of use between the medical record and the discharge drug summary was associated with haematological and central nervous system drugs: low dose aspirin (n = 2); folic acid (n = 3); anticonvulsant agents (n = 1); antipsychotics (n = 1); hypnotics (n = 1); narcoleptics (n = 2); narcotic analgesics (n = 1); nonnarcotic analgesics (n = 1).

A median 32 days after discharge telephone interviews were conducted with 52 (46%) patients. Compared to the 61 patients not interviewed, the interviewed patients were younger (median 69.5 vs. 78.0 years), p=0.01. Overall, 33 (63%) of the patients had consulted health care professionals in the first month after discharge. Twenty-three (44%) had consulted their GP. The frequency of consultations with health care professionals was similar among patients affected by transcription errors (n=25) and those who were not (n=27). Overall, 123 medications were omitted from the discharge drug summaries: 14 were scheduled to stop during the first month after discharge. Fifteen patients had taken 23 (21%) of the remaining 109 prescriptions into use again.

Table 3.6

Frequency of medications per 100 subjects according to the medical records (MR) and discharge drug summaries (DS) by Anatomical Therapeutic Chemical classification system (ATC) main groups⁶³. Only significant differences are shown.

<i>ATC system</i> <i>Main group</i>	<i>Study group</i>			<i>Control group</i>			<i>Historical control group</i>		
	<i>MR</i>	<i>DS</i>	<i>Difference</i>	<i>MR</i>	<i>DS</i>	<i>Difference</i>	<i>MR</i>	<i>DS</i>	<i>Difference</i>
A. Alimentary tract and metabolism	75	70	5 (-3 to 14)	67	60	7 (-2 to 16)	70	52	18 (5 to 30)
B. Blood and blood forming organs	46	36	11 (0 to 20)	35	30	5 (-2 to 12)	50	44	6 (-6 to 18)
C. Cardiovascular system	63	59	4 (-4 to 11)	56	46	11 (2 to 19)	62	50	12 (0 to 24)
N. Nervous system	61	54	7 (0 to 14)	61	51	10 (2 to 19)	44	24	20 (5 to 34)
R. Respiratory system	23	23	0 (-7 to 7)	37	26	11 (2 to 19)	18	16	2 (-7 to 11)

3.4.5 Conclusion

The study indicates that the discharge drug summary has become more accurate through the introduction of a standard medication chart. The potential for misinformation remains, as the prevalence of transcription errors is 30% with the medication chart.

3.5 Discussion of own studies

Study I (3.1) indicates that the prevalence of transcription errors in the medication history is approximately 70%. Study II (3.2) indicates that the prevalence of errors in transcription from medical record onto nurses' drug chart is 64%. Moreover, drug entries in the traditional medical record system are characterised by a high rate of failures to communicate essential information (II). Thus, the rate of ambiguous prescriptions is approximately 40%. Study III (3.3) indicates that the prevalence of transcription errors in the discharge drug summary is 54% to 56% with the traditional medical record system. The prevalence of transcription errors is significantly lower, 30%, with the medication chart. Transcription errors affect both prescription medications and over-the-counter preparations (OTC) from all Anatomical Therapeutic Chemical (ATC) main groups⁶³.

Study I and II are cross-sectional studies and study III is a non-randomised controlled study. Although the studies were conducted on one (II) and two (I, III) wards, located in the same city,

and may not be applicable to other settings, our findings are consistent with the literature (table 3.7, 3.9, 3.12).

The rate of errors in prescription writing is probably underestimated because we do not quantify all events that might be classified as transcription errors, such as illegibility, or writing “milligrams” when “micrograms” was intended⁶. Moreover, prescription information was only included in study II. This study showed that the rate of prescriptions where information was lacking varied between 3.8 and 97.5%, depending on the sort of prescription information (table 3.3). It follows, that the comparison of prescription information obtained from different charts is either impossible or leads to a very high yield of errors. Most of them are probably insignificant. Thus, it was decided to focus on the generic drug name and exclude prescription information from the comparisons (I, III).

Herbal products were not included, although miscommunication with herbal therapies is probably common, because patients often self-prescribe without consulting or informing their physicians. Adverse effects from herbal products are not necessary trivial^{85,86}, but the decision was based on the experience that physicians often do not consider these products to be drugs, and seldom if ever record use of herbal products.

Written drug entries were compared (I, II, III). This does not allow the distinction between discrepancies attributable to poor practice from discrepancies resulting from intentionally made changes in therapy, which are not recorded. For example, transcription errors in the medication history (I) include (i) poor quality of medication history taking, (ii) modifications made intentionally by the attending physician, but not recorded, and (iii) errors associated with type-writing. To distinguish between errors associated with these sub-routines, observation studies⁹⁰ are required. This distinction is important from an analytical or prevential point of view, but unimportant in day-to-day care.

3.5.1 Admission

Study I shows the utility of supplementing the traditional admission interview with extra information obtained by second drug interview and GP drug lists. Extra information was obtained in approximately 70% of the cases. This indicates that transcrip-

Table 3.7

Studies of transcription errors associated with admission to hospital.

<i>Author Year Country</i>	<i>Speciality</i>	<i>Design No. of pts. Included/ eligible</i>	<i>Reference</i>	<i>Types of drug Mean no. of drugs (medical record/ reference)</i>	<i>Match** (PCT of pts)</i>	<i>Prevalence of error: Drug(s) in MR, but not in reference/ drug(s) in reference, but not in MR/ combined (PCT of pts)</i>	<i>Drugs primarily affected by error</i>
Truitt ⁵³ 1982 USA	Gen. med. and intensive care	Cross-sectional study 186/207	Questionnaire	Prescribed drugs and OTCs Na.	25%	17%/58%/na.	Na.
Gurwich ⁵⁸ 1983 USA	Gen. med.	Cross-sectional study. 86/135	Interview	Prescribed drugs 2.4/5.6	Na.	Na.	Na.
Baum ⁵⁷ 1983 USA	Different specialities	Cross-sectional study 75/75	Hospital pharmacy drug profiles	Prescribed drugs and OTCs Na.	8%	Na.	Analgesics, sedatives, parasympatholytics, cathartics, anti-emetics
Beers ⁵⁵ 1990 USA	Different specialities	Cross-sectional study 122/na.	Interview	Prescribed drugs and OTCs 4.6-5.7/na.	17%	26%/78%/na.	Analgesics, vitamins
Van Hesse ⁿ * ⁵⁸ 1990 The Netherlands	Different specialities	Cross-sectional study 205/546	Community pharmacy drug profile	Prescribed drugs and OTCs Na./3.5	30%	Na.	Na.
Gonski ⁵⁷ 1993 Australia	Gen. med.	Cross-sectional study 64/113	Interview (Int) and GPs' drug lists (GP)	Prescribed drugs and OTCs Na./4.1	64% (Int) 37% (GP)	Na.	Na.
Akwagyiam ⁸⁹ 1996 UK	Accident and emergency	Cross-sectional study 33/na.	Interview	Prescribed drugs and OTCs (median) 2/3	Na.	9%/72%/na.	Na.
Cattell ⁵⁶ 1997 UK	Geriatric and respiratory medicine	Cross-sectional study 80/na.	Interview	Prescribed drugs Na./ 4.4	60%	Na.	Na.
Lau ⁵⁴ 2000 The Netherlands	Gen. med.	Cross-sectional study 304/840	Interview and community pharmacy drug profile.	Prescribed drugs 4.1/Na.	33%	12%/61%/na.	Analgesics, NSAID, benzodiazepines, oral cortico-steroids
Andersen (I) 2001 Denmark	Gen. med.	Cross-sectional study 81/149	Interview	Prescribed drugs and OTCs (median) 3/4 (Int)	(Int & GP) 11%	31%/69%/74%	Alimentary tract, cardiac, CNS, and respiratory system agents
			GPs' drug list	Prescribed drugs and OTCs (median) 3/3 (GP)		51%/70%/77%	

* Medication history as recorded in the hospital pharmacy file.

MR: Medical record.

OTC: over-the-counter preparation.

** Match: proportion of patients where all drug entries on the reference and in the medical record were identical.

tion errors in the medication history affect three out of four patients. Although no gold standard was established, such as home visits with review of all medication containers, the traditional admission interview appears insufficient, and the chance that drug information will escape the attention is obvious.

Patients unable to communicate, such as mentally impaired patients, were not eligible in the study (I) because they were unable to give consent. Because these patients are unable to present their medication during the admission interview, we may underestimate the prevalence of transcription errors.

Approximately 70% of older people in the population take OTCs regularly^{91,92}, and the range of obtainable OTCs is increasing⁹³. Our findings indicate that the medication history is incomprehensive regarding OTCs. This finding confirms a previous survey conducted by Batty et al.⁹⁴. Although computerised pharmacy data might be valid regarding prescription drugs, information about self-medication and adherence to treatment can only be obtained by an interview. It follows that electronic systems such as shared electronic medical records⁹⁵ or pharmacy files^{54,96} will not outdo the traditional medication history.

Although GP drug lists represent the GPs' best estimate of current drug therapy, the GP drug lists were incomprehensive when compared to the medication history and second drug interview. Some of these differences may originate from prescriptions made by practitioners out of our knowledge. Thus 31% of persons aged 75 years or more receive prescription drugs from two or more physicians⁹¹. Moreover, only 75 to 90% of the medicines prescribed by GPs are actually dispensed^{97,98}. When compared to home inventories, brought drugs, or medication charts GP drug lists are often incomplete (table 3.8). Despite these limitations GP drug lists provide much information, which does not appear from the medication history.

Cross-sectional studies make all measurements on a single occasion and do not follow subjects over time. It is difficult to predict the outcomes of errors in prescription writing from a cross-sectional study. First, the propagation of an accidental course of an error is shaped by the activity of people ("The Swiss cheese model of system accidents"⁹⁹). Secondly, errors do not necessarily harm

Table 3.8

Evaluation of general practitioners drug lists

<i>Author Year Country</i>	<i>Speciality</i>	<i>Design No. of pts. included/ eligible</i>	<i>Reference</i>	<i>Types of medication Mean no. of drugs on GP lists/reference</i>	<i>Match (PCT of pts)</i>	<i>Prevalence of error: Drug(s) on GP list but not in reference/drug(s) in reference but not on GP list/both (PCT of pts)</i>	<i>Drugs primarily involved</i>
Hulka ⁴² 1975 USA	Gen. practice and primary care internists	Cross-sectional study 357/372	Home visit	Prescribed drugs Diabetes.-pts (DM): 2.9/2.9 Congestive heart failure-pts (CHF): 4.7/4.7	DM.-pts: 40% CHF.-pts: 27%	DM.-pts: 21%/18%/21% CHF.-pts: 22%/22%/29%	Na.
Price ⁶⁹ 1986 UK	Gen. med.	Cross-sectional study 46/59	Brought drugs	Prescribed drugs and OTCs Na.	30%	26%/46%/Na.	Na.
Claoue ⁶⁵ 1986 UK	Ophthalmology	Cross-sectional study 76/100	Brought drugs	Prescribed drugs Na.	47%	5%/46%/1%	Eye agents, NSAID, sedatives
Gilchrist ⁶¹ 1987 UK	Geriatric	Cross-sectional study 675/675	Home visit	Prescribed drugs 1.9/3.0	38%	9%/53%/na.	Diuretics, analgesics, minerals and vitamins
Spagnoli ⁶⁹ 1989 Italy	Outpatient	Cross-sectional study 795/802	Home visit P	Prescribed drugs and OTCs 2.9/3.6	Na.	Na./44%/na.	Cardiovascular, diuretics, CNS agents, analgesics
Gonski ⁷ 1993 Australia	Gen. med.	Cross-sectional study 64/113	Hospital prescription chart	Prescribed drugs and OTCs Na.	37%	25%/16%/na.	Diuretics, digoxin, sedatives, inhalers, antibiotics
Atkin ⁷⁰ 1998 Australia	Primary care	Cross-sectional study 206/na.	Home visit	Prescribed drugs and OTCs Na.	Prescribed drugs:47% OTCs: 40%	Na.	Na.
Barat ¹⁰⁴ 2001 Denmark	Primary care	Cross-sectional study 348/793	Home visit	Prescribed drugs and OTCs 3.5/4.6		Na./55%/n.a.	Na.

Table 3.9

Studies of transcription errors based on comparisons of hospital medical records and onto nurses' drug charts.

<i>Author Year Country</i>	<i>Speciality</i>	<i>Design No. of pts. included/eligible</i>	<i>Prevalence of prescription errors</i>	<i>Rate of transcription errors in the hospital medical record</i>	<i>Rate of transcription errors on nurses' drug chart</i>
Watt ¹⁰⁵ 1973 UK	Psychiatry	Cross-sectional study 680/681	Na.	240/1339 (17.9%)	116/1215 (9.5%)
Senderowitz ¹⁰⁶ 1998 Denmark	Medicine and surgery	Cross-sectional study 57/95 and 61/95	35/57 (61.4%)* and 43/61(70.5%)*	Na.	Na.
Andersen (II) 1998 Denmark	Medicine	Cross-sectional study 135/ 55	87/135 (64.4%)	114/720 (15.8%)	88/694 (12.7%)
Schouboe ⁸¹ 1999 Denmark	Otorhinolaryngology	Before-after study** 100/na.	Na.	7/152 (4.6%)	182/363 (50.1%)

* Discrepancies in dose are included.

** Only "before data" are shown.

the patients because they are either intercepted^{11,12}, or administered to a patient who do not experience any sequelae due to resilience¹³. Thus, errors in prescription writing have probably no bearing on the course of patients where staff or patients are alert to diagnoses and complications. However, injury may develop if the established prevention systems are undermined¹¹.

In study (I) a panel of clinicians assessed each case individually. Because panel assessment demands considerable resources we decided to review only cases from one of the wards. This may affect the validity, and no general conclusions should be based on this small sample. We are, however, aware of only one study assessing the potential clinical impact of incomplete medication histories. Van Hessen et al.⁸⁸ established with the help of an expert panel that that inadvertent drug discontinuations of a serious nature occurred among 12 of 205 patients. The present study (I) supports this finding. With the applied methodology the specialist panel identified events that hold the potential to affect the course of patients. This is weak evidence and should be interpreted with great caution¹⁰⁰. Moreover, chart review in order to verify that any actual problems occurred is a subjective judgement open to bias. Recorded data allow only verification of events that arise, are detected, and are recorded during hospital stay.

Taking complexity of care into account, panel judgements might be the best source of estimating the potential impacts of errors¹⁰¹. Errors in prescription writing have consequences that are specific to each drug, to the disease, and to co-morbidity. Unintended stop of diuretic therapy prescribed for mild hypertension creates a low risk of problems, but if the diuretics were prescribed for severe heart failure, then therapy stop implies a risk of life-threatening fluid retention within a few days. If in the same patient, a laxative instead of the diuretic had been stopped, the consequences would probably be negligible.

The panel judged that a more comprehensive medication history might have prevented injury among 2 of the 55 patients (I). The average time spent on second drug interviews of 7 to 10 minutes per patient agrees with previous reports^{53,58,102}. It follows, that the number needed to interview to prevent one injury is 28 patients, which will last three to five hours. The actual time utilisation,

however, is difficult to predict, as we did not measure the time needed for contacting GPs, waiting, or going over medication lists. Considering a yearly admittance rate of approximately 1 Mio patients yearly to Danish medicine wards¹⁰³, the potential for injury resulting from errors in prescription writing appears substantial.

Although the accuracy of the medication history is not judged by a standard, our findings indicate that the medication history is incomplete in two-thirds of the cases. This may affect continuity of care and the counselling of in-patients (chapter 6). To the clinicians this finding has some practical implications. First, it should be recognised that even if the medication history does not support the hypothesis, an adverse drug reaction or an interaction generally is a probable diagnose. Secondly, physicians and GPs should bear in mind the risk of basing prescribing decisions on incomplete information. This is important in particular, when prescribing medications with a great potential for drug-drug interactions.

Obtaining an accurate medication history remains a problem. There seems to be no straightforward solution to this problem. Study (I) showed a high rate of variability between GP drug list and second drug interview. We suggest that both procedures should be performed. Alternative approaches are: questionnaires⁵³; second drug interview^{55,56,58,89}; GP drug list⁵⁷; community pharmacy drug profiles⁵⁴; and hospital pharmacy drug profiles⁸⁷ (table 3.7). No approach appears to be really superior to the other. Applying one or more of these approaches may reduce the rate of transcription errors on admission to hospital. The benefit on drug-related morbidity or mortality, however, is not substantiated by prospective studies.

3.5.2 Communication between medical and nursing staff

The rate of transcription errors in the medical record and nurses' drug list was 15.8% and 12.7%, respectively. The prevalence of transcription errors was 64% (II). Reports from psychiatric, surgical and medicine, and otorhinolaryngologic wards support our findings (table 3.9).

Data were collected just prior to nurses' morning drug rounds to reflect the conditions of drug dispensing and administration (II). Fewer discrepancies would probably have been detected if data

had been collected after the morning ward rounds. If staff or patients are not alert, then the risk that transcription errors either escape attention or are corrected with time lag is considerable.

We made no assessment of the potential risk associated with the transcription errors. The transcription errors involved medications from all ATC main groups⁶³, except S, and included medications with a high potential for injury. Approximately one-fifth of the errors involved medications to be administered by demand. Because no distinction between fixed scheduled and "on demand" prescriptions was made, some of the transcription errors are probably clinically insignificant.

The finding that transcribing errors are associated with the number of prescriptions in the medical record seems plausible clinically, but the finding that older age is associated with fewer errors is unexpected (table 3.2). To our knowledge, no studies have evaluated the influence of age on this type of transcription error. The finding may reflect that either staff is more alert or the patients less likely involved when medications are prescribed to older patients.

Transcribing connects the prescription decision with drug administration in the abstract. It seems evident, that to gain the expected benefits the patient should actually receive the prescribed drugs. Thus, preventing errors in the transcription from the medical record onto nurses' drug chart will benefit the patients. We are not aware of any empirical study that substantiates this assertion.

Entering prescriptions on a single document, a medication chart, which also serves as nurses' drug chart, will eliminate transcription^{46,81,82,107,108}. A medication chart is a pre-printed chart with spaces for prescription information (drug name, dose etc.). This system is based on the following principles: all prescriptions should be written by hand and signed by the physician; all dispensed and administered doses should be recorded and signed by nurses. If a patient misses a dose, it should appear from the sheet. A fixed location for specific data and a higher degree of structure distinguish the medication charts from traditional medical records. Better organisation of documents within the record and better organisation of data on document pages make patients'

data easier to find¹⁰⁹. Drug entries are physically separated from assessment and interpretation. The structured format and grouping of drug entries allow prompt access to data. The accuracy of retrieved information is higher with fixed-format record than with the traditional medical record⁴⁷.

When clinicians decide about patients' therapeutic programs, effective access to patients' data may help them to address inappropriate prescribing such as medications not indicated for the condition, polypharmacy, or drugs with similar effects. Thus, a non-randomised controlled study showed that the mean number of prescriptions decreased by 0.92 from admission to discharge when a written survey of patients' medication was provided to the physicians¹¹¹. In the control group the number of prescriptions increased by 1.65.

Table 3.10
Error prevention by the medication chart

<i>Methodology</i> ¹¹⁰	<i>Example</i>
Constrain	Abolishing the act of transcribing from the medical record onto nurses' drug chart
Reducing complexity	Reducing number of steps in the medication process (Figure 4.2)
Optimising information processing	Reducing reliance on memory; pre-printed boxes indicate which prescription information is required and where to write it. Extended recording; introducing the recording of drug administration

Several authors have appraised the clinical applicability of standard medication charts^{46,82,107,112}, but a search for controlled studies of the impact of medication charts on morbidity or mortality, however, was fruitless. Eight time-series and before-and-after studies were identified (table 3.11). With the medication chart, the prevalence of errors in the transcription from the medical record onto nurses' drug chart cannot be used to monitor the impact of medication charts. Various outcome measures have been included in the studies, which are all performed in single centres. The implementation of non-computerised medication charts may increase the rate of correctly written prescriptions and, if new procedures or a satellite pharmacy is implemented at the same time, reduce the rate of drug administration errors.

Approximately 40% of prescriptions are ambiguous with the tra-

ditional drug record system (I). If predefined boxes indicate where to write essential prescription information, then physicians make more complete prescriptions. Thus, evaluations of medication charts have reported rates of correctly written prescriptions of 76 to 96%^{22,46,81,112} (table 3.11).

Institution managers are allowed freedom to choose among record systems¹¹³. Medication charts are permitted, provided that physician name, and if necessary, date and hour appears on the charts. Moreover, notes in the medical records should refer to the medication chart^{114,115}. After the patient has been discharged, medication charts are to be enclosed the medical record and stored for 10 years or more^{113,115,116}.

3.5.3 Discharge

The study (III) indicates that the content of discharge drug summaries has become more accurate through the implementation of a medication chart in the hospital. The prevalence of transcription errors in the discharge drug summary is 30% with the medication chart.

Drug use at admission and at discharge is consistent with literature^{57,117-119}. Discharge drug summaries were present in 86 to 96% of the discharge letters. Studies have shown that no discharge drug summary is given in 25% to 80% of discharge letters^{77,120-123}. Presumably, our study failed to demonstrate an improvement, because there was practically no room for improvement. The power of this negative finding, however, is less than 35 pct (nQuery Adviser[®] 4.0).

Transcription errors were associated with 90 different drugs, most frequently with drugs used in gastrointestinal, haematological, cardiac, nervous system and respiratory diseases (table 3.6). No assessment of the potential clinical significance of the transcription errors was made. Transcription errors affected medications with a narrow therapeutic index or the potential for adverse effects, including warfarin, amiodarone, insulin, and narcotic analgesics. Injury caused by drug treatment is frequently associated with these drugs^{124,125}.

Transcription errors had no impact on patients' post-discharge contact pattern to doctors. Approximately half of the patients

Table 3.11

Evaluations of medication charts.

<i>Author Year Country</i>	<i>Speciality</i>	<i>Intervention</i>	<i>Design No. of pts. included /eligible</i>	<i>Rate of correctly written prescriptions</i>	<i>Prevalence of patients with correctly written prescriptions</i>	<i>Mean time per patient spent on nurses' drug handling</i>	<i>Rate of drug administration errors*</i>
Crooks ¹⁰⁸ 1967 UK	Different specialities	Medication chart	Time series. Incident reports Na./na.	Na.	Na.	Before: 161.1 sec. After: 80.2 sec. + 10.0 sec (recording)	Na.
Hill ⁸⁰ 1967 UK	Medicine	Medication and chart procedural changes	Time series. Incident reports Na./na.	Na.	Na.	Na.	Before: 15.3% After: 6.3% (incl. time errors)
Bergman ⁴⁶ 1979 Sweden	Haematology and medicine	Medication chart	Before-after study Before: na./na. After: 274 /286	Before: 58% After: 96%	Na.	Na.	Na.
Håberg ⁸² 1992 Norway	Medicine and surgery	Medication chart	Before-after study Before: 32/na. After: 42+36/na.	Before: 119/161 (74%) After three months: 196/204 (96%) After 12 months: 176/183 (96%)	Before: 11/32 (34%) After three months: 36/42 (86%) After 12 months: 29/36 (81%)	Na.	Na.
Olsen ⁴⁵ 1997 Denmark	Paediatrics	Medication chart and satellite pharmacy	Before-after study** Before: 64/na. After: 47/na.	Na.	Na.	Na.	Before: 12.9% After: 1.3% (excl. time errors)
Gardulf ⁶¹ 1998 Sweden	Medicine and surgery	Medication chart and staff training	Before-after study Na./na.	Before: 137/315 (43%) After six months: 171/226 (76%)	Na.	Na.	Na.
Schousboe ⁸¹ 1999 Denmark	Oto-rhinolaryngology	Medication chart	Before-after study Before: 100/100	Before: 105/152 (69%) After two to three months: 356/392 (91%)	Na.	Na.	Na.
Bourke ¹¹² 2001 Denmark	Medicine and surgery	Medication chart	Before-after study Before: 30/30 After: 60/60	Before: Na./na. After 12 months: 340/386 (88%)	Na.	Na.	Before: 77/640 (22%) After 12 months: 36/456 (5%)

* Administration of a drug incompatible with physicians' drug order.

** Only patients receiving parenteral therapy.

had actually consulted their GP. The results from the telephone interviews, however, should be interpreted with caution because the follow-up rate was low and the patients represented a younger sub-population. Moreover, recall-bias is likely to have influenced the results from the telephone interviews.

Comparability of study and control groups is an important limitation of this non-randomised study. Because the intervention (medication chart) took place in only one of the wards ("Hawthorne effect")¹²⁶ a bias was probably introduced. To minimise the influence from the implementation process, data collection was initiated 8 month after the implementation was completed. Two control groups were selected in order to overcome bias attributable to trends or organisational culture. The impact of these biases is likely insignificant because the results from the two control groups are comparable. In favour of the intervention speaks that the prevalence of transcription errors was significantly lower in the study group compared to both control groups. Although age and length of hospitalisation differed between the groups, the logistic regression indicated that transcription errors were not associated with age or length of stay. Thus, differences between groups seem unlikely to affect the overall results of the present study. This bias could have been controlled through appropriate adjustments, e.g. match by age and length of hospitalisation, but without randomisation it is impossible to know whether hidden bias exist.

Studies comparing discharge drug summaries to structured drug list such as hospital pharmacy drug profiles⁷⁶, hospital pharmacy discharge orders⁷⁵, and medication charts¹¹² support our findings. These studies show that the drug lists are identical among 57 to 74% of the patients (table 3.12).

House officers and general practitioners rate medication on discharge as the most important content of discharge summaries^{127,128}. Gradually, computerised prescribing systems are expected to replace manual systems and allow compilation of discharge drug summaries directly from prescription databases (7.1). The propagation of such systems, however, is generally not impending¹²⁹. Meanwhile, the medication chart may serve as a cheap, low technology solution. With the medication chart 30% of patients

Table 3.12

Studies of transcription errors associated with discharge from hospital

<i>Author Year Country</i>	<i>Speciality</i>	<i>Design No. of pts. included/ eligible</i>	<i>Reference</i>	<i>Types of drug. Mean no. of drugs (Discharge drug summary/reference)</i>	<i>Match (PCT of pts)</i>	<i>Prevalence of error: Drug(s) on discharge drug summary, but not on reference /drug(s) on reference, but not on discharge drug summary/combined (PCT of pts)</i>	<i>Drugs primarily involved</i>
Wilkin ⁷⁶ 1976 UK	Gen. med.	Cross-sectional study 56/na.	Hospital pharmacy drug profiles	Prescribed drugs and OTCs Na.	57%	Na. na./43%	Na.
Morrill ⁷⁴ 1988 USA	Different specialities	Cross-sectional study 121/121	Medication administration record	Prescribed drugs and OTCs Na.	Na.	Na./42%/na.	Na.
Siple ⁷⁵ 1992 USA	Nursing facility	Cross-sectional study 30/30	Hospital pharmacy discharge order	Prescribed drugs and OTCs Na.	60%	Na./na./na.	Na.
Bourke ¹⁷² 2001 Denmark	Gen. med. and surgery	Cross-sectional study 60/na.	Medication chart	Prescribed drugs and OTCs Na.	74%	Na./na./26%	Na.
Andersen (III) 2001 Denmark	Gen. med.	Cross-sectional study 50/50 (historical controls)	Medical record (historical controls)	Prescribed drugs and OTCs 2.8/4.2	37%	24%/56%/63%	Drugs for alimentary and neurological diseases
		Cross-sectional study 57/78 (controls)	Medical record (controls)	Prescribed drugs and OTCs 3.8/5.5	44%	11%/54%/56%	Drugs for cardio- vascular neurological and respiratoral diseases
		Cross-sectional study 56/74 (study group)	Medication chart (study group)	Prescribed drugs and OTCs 4.7/5.3	59%	14%/30%/41%	Drugs for blood forming organs and neurological diseases

are affected by transcription errors. This implies that initiatives should be made to improve the quality of the discharge drug summary. If a comprehensive discharge drug summary is available for follow up consultations, then the GP will not have to make assumptions⁶⁸ and misunderstandings in relation to prescribing are less likely to occur. With the medication chart, the prevalence of errors attributable to transcription from the medical record onto nurses' drug chart (II) cannot be used to monitor the quality of the medication process. The prevalence of transcription errors in the discharge drug summary combined with an assessment of failures to communicate essential information may serve as future quality indicators of prescription writing.

3.6 Conclusions

A second drug interview and GP drug list add information about pre-admission drug use to the medication history among 69 and 70% of patients, respectively (I).

On admission to hospital, obtaining extra information by a second interview and GP drug list produces a potential beneficial impact on the course of 18% of the patients (I).

With the traditional medical record system, the rate of transcription errors in the medical record and on nurses' drug list is 15.8% and 12.7%, respectively (II). One or more transcribing error affects 64% of the patients (II).

With the traditional medical record system, approximately 40% of prescriptions are ambiguous and open to interpretation (II)

The prevalence of transcription errors in the discharge drug summary is 30% with the medication chart, compared to 56 and 54% with the traditional medical record system, difference 26% (CI 7 to 42%) and 24% (CI 6 to 40%) (III).

chapter four

Organisational perspectives

*“I en så stor myndighed som den grevelige kan det en sjælden gang forekomme at én afdeling forordner noget, en anden afdeling noget andet, de kender ikke til hinanden, den overordnede kontrol er ganske vist yderst nøjagtig, men kommer ifølge sin natur for sent, og så kan der jo altid opstå en lille forvirring. Men det er vel at mærke altid kun de ubetydeligste bagateller, som f.eks. Deres tilfælde, i store sager har jeg endnu aldrig hørt om nogen fejl, men bagatellerne er også tit pinlige nok.”**

FRANZ KAFKA. SLOTTET P. 62 (GYLDENDAL 2001)

4.1 Introduction

The organisation of the medication process is outlined in section 1.1. This section includes flow sheets of the medication process and the presentation of a study of difficulties perceived by physicians and nurses when using medication charts. It is the intention to present organisational problems associated with change, not to provide a comprehensive analysis of the organisation of prescription writing in internal medicine wards.

* At rare intervals in such large count's estate authorities one department ordain something, another department something else, they do not know of each other, the superior control is exceedingly precise, indeed, but late by nature, therefore slight confusion may arise. Trivialities as in your case, of course, I have never heard of errors in significant cases, but trivialities are quite embarrassing though.

4.2 Thump nail sketch of the organisation of prescription writing

Although medication procedures are indistinctly delimited from other routines, and vary between wards, specialities and hospitals figure 4.1 and 4.2 show features of prescribing in outline, which likely are common to internal medicine wards. Analysis of these flow sheets provided background for our decision to study errors in prescription writing related to gaps in care that are aligned with distinct organisational or institutional boundaries, marking change in responsibility and authority, or formal division of labour.

4.3 Own study (IV)

4.3.1 Background

Gaining the benefits of a technical solution depends on implementation. Problems of implementation can arise for many reasons, including resistance from staff due to culture and interests, conflicts with existing routines, lack of resources, or training needs. As a consequence of study II, local ward managers decided to implement medication charts (3.5.2 and table 3.11). The adoption of medication charts implies the development of interdisciplinary collaboration and modification of established workflow patterns. In the pilot phase dissatisfaction with the new system emerged, e.g. staff moved amendments on background of their professional knowledge and experience.

Changing the organisation¹³ and the medication process (1.1) holds a potential for reducing drug related injuries^{4,12,27,130,131}. Although a wide range of interventions are available that could change the performance of health professionals, most interventions have modest

Figure 4.1 shows the traditional medication process in internal medicine wards. Processes associated with admission, ward rounds and discharge are shown separately. The processes are divided among professions, as well. Although often reiterated, ward rounds are only shown once. Bold-lined frames show procedures, thin-lined frames illustrate data sources, such as the hospital medical record and drug lists. Arrows indicate flow of information. Dotted lines illustrate alternative routes. The medication history is a narrative information about pre-hospital medication use that originates directly from the patient.

Fig. 4.1
Schematic presentation of the traditional medication process.
Details are given in section 4.2.

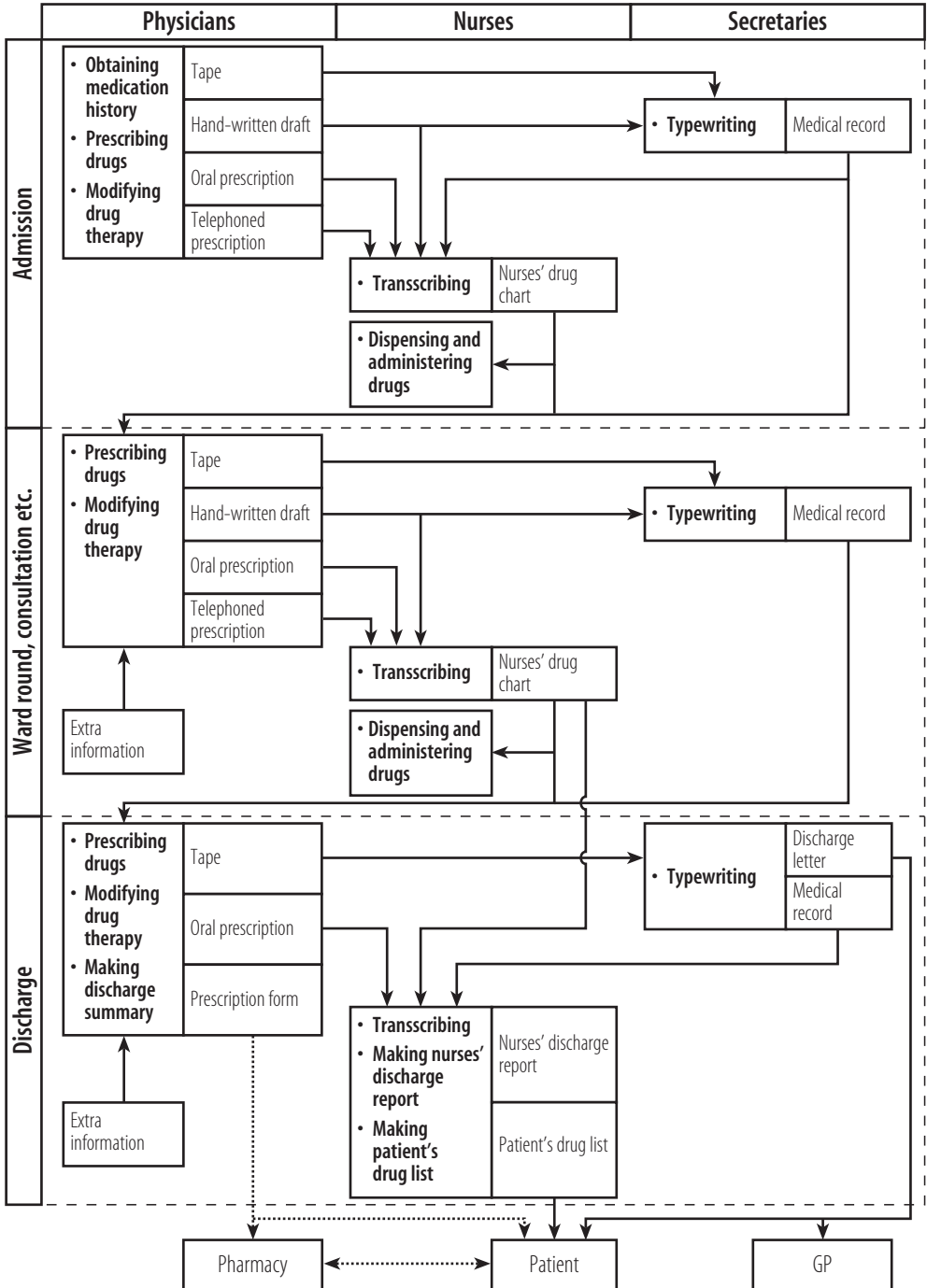
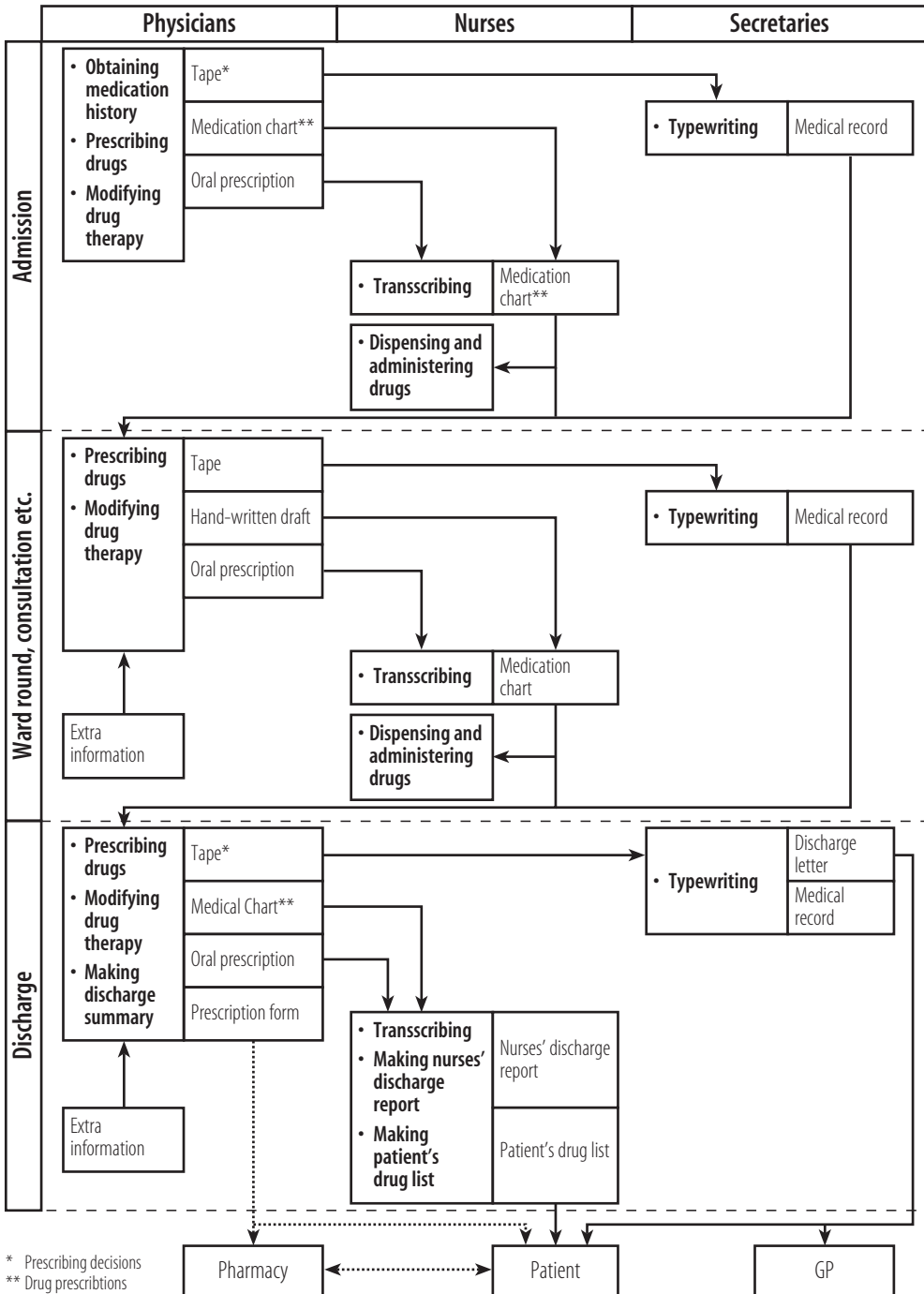


Fig. 4.2

Schematic presentation of the medication charts routines.

Details are given in section 4.2.



or negligible practical effect when used alone¹³². When coupled with other strategies the effects may be cumulative and significant¹³³. Interventions are more or less effective, depending on the changes sought, the target group, and the barriers found. Identifying specific barriers to change is necessary to tailor implementation strategies to the targeted clinicians and their working setting^{132,134-137}. In order to investigate these barriers it was decided to conduct a qualitative study (IV).

4.3.2 Aim

To investigate barriers that physicians and nurses associate with application of medication charts to day-to-day clinic.

4.3.3 Material and methods

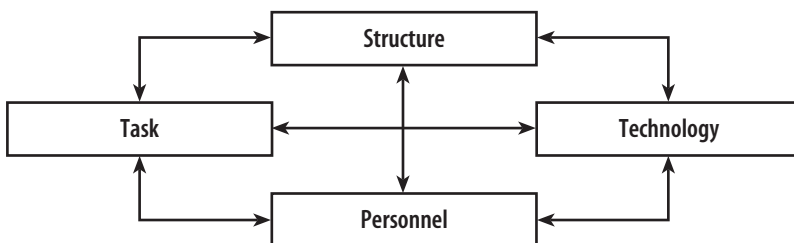
This qualitative study was conducted in two internal medicine wards (3.1). Semi-structured interviews with seven physicians and eight nurses were conducted, starting 8 and 16 month after the introduction of the medication charts (table 4.1). A chain sample approach¹³⁸ was used for locating information-rich informants who had gained experience with the medication charts. Demographic characteristics and occupation guided the sampling.

The interview schedule (appendix B) addressed the four elements of Leavitt's system model¹³⁹ (figure 4.3). Each interview lasted 25 to 85 minutes and was recorded directly into a laptop computer during the interview. New interviews were conducted until new themes no longer emerged. After each session a written summary of the author's interpretation was sent to the informants asking them to comment on the findings.

Figure 4.2 shows a schematic presentation of the medication process in the wards where staff uses medication charts (3.5.2). Compared to the traditional system, the medication process is less complex. For example, secretaries do not type write drug prescriptions, and less information is transcribed. Still, however, nurses transcribe oral or telephoned prescriptions.

Figure 4.3.

Leavitt's system model¹³⁹. This model describes an organisation as the relationship and dynamic interaction between four variables. Any changes of one variable affect the other variables.



Data were analysed according to Giorgi's phenomenological approach with Malterud's modifications^{140,141} through four stages: (i) obtaining an overall impression by repeated listening to sound files and review of written summaries; (ii) identifying units of meaning, representing different aspects of the interviewees' experiences and coding for these; (iii) condensing and abstracting the meaning within each of the coded groups, and; (iv) summarising the content of each coded group to gain descriptions. The analysis focused on difficulties explicitly identified by the participants during the interviews. The code-and-retrieve software¹⁴² package KIT version 2.0 (CVS Information System) was used, allowing codes to be attached directly to the sound files. Coded groups were subsequently transcribed. Findings were repeatedly compared to original sound files and written summaries. When possible the information was validated by comparing the perspectives of physicians and nurses¹⁴³. Information about the introduction and training policies was subsequently collected from the wards on enquiry. Moreover, information was collected from working parties on the medication charts and used for comparison during the analysis process. To verify alternative or erroneous use a sample of medication charts was reviewed.

Table 4.1
The interviewees.

	<i>Gender</i>	<i>Age (years)</i>	<i>Years since graduation</i>	<i>Duration of present appointment</i>	<i>Experience of using medication charts</i>
Ward 1					
Nurse	Female	25	1.5 years	1 year	8 months
Nurse	Female	26	2.5 years	1.5 years	8 months
Nurse	Female	28	3 years	3 years	8 months
Nurse	Female	47	25 years	8 years	8 months
Nurse	Male	26	2 years	1.5 years	9 months
Specialist registrar	Female	42	6 years	1 year	8 months
Staff specialist	Male	42	14 years	3 years	8 months
House officer	Female	28	9 months	5 months	5 months
Staff specialist	Female	42	16 years	11 years	9 months
Ward 2					
Nurse	Female	33	3 years	3.5 years	22 months
Nurse	Female	38	11 years	5 years	22 months
Charge nurse	Female	45	23 years	13 years	17 months
Senior house officer	Male	31	2.5 years	5 months	5 months
Staff specialist	Male	44	17 years	9 months	9 months
Senior house officer	Male	33	6 years	8 months	8 months

4.3.4 Results

The study identified nine barriers (table 4.2). The new procedures conflicted with existing structure, culture, and routines. Insufficient competence within the system made people create their own solutions to the problems they faced.

Lack of knowledge and competence

Uncertainty about how to use the medication charts was an important difficulty. Several nurses reported that the physicians filled in prescriptions inconsistently and erroneously. Four physicians supported this opinion. The physicians had been trained differently: two had not been trained, two had been offered a training program, and the remaining had briefly been introduced to the new procedures. All had felt prompted to take steps on their own to improve practice.

The participants felt that some of the physicians ignored sources of medication errors. They gave examples of procedures that might hamper drug safety. For example, prescriptions were recorded in the margin of completed charts and not transcribed to a new chart. Illegible prescriptions had become a widespread problem because

secretaries no longer typewrite prescriptions. The physicians explained illegibility and inconsistency by poor hand writing skills and pressures of work.

Conflicts with existing organisational structure and culture

Discussions between physicians and nurses arose frequently from unsettled responsibility towards completing the medication charts. Nurses from both wards described this as a principal problem. Although some regarded collaboration as frictionless, both physicians and nurses felt de-motivated from these discussions. The nurses expressed the view that they in particular experienced the inconveniences of errors in prescription writing because they were dependent on complete drug lists to administer drugs safely. They felt prompted to check up on physicians and roughly once daily each nurse had to call a physician to resolve drug problems. This caused delays or postponements of nurses' tasks.

Low community feeling was an obstacle to standardisation of the new procedures among physicians. Generally, the physicians worked individually. They were cautious in discussing the quality of care given by colleagues and preferably corrected errors without telling their colleagues. The physicians withheld justified critique if a colleague seemed overburdened. A junior physician expressed the opinion that physicians were more concerned about personal careers than issues of co-operation. In one of the wards rivalry and competition within the physician group was pronounced. Unlike the physicians, the nurses reported high cohesiveness and uniformity in attitude towards the charts.

Insufficient communication impeded the sharing of experiences and troubled harmonisation of the new procedures. Both physicians and nurses preferred trading opinions about the medication charts informally. Three physicians described incidences where the medication charts had been mentioned on ward conferences and the discussion had been brushed aside by wisecracks. There was a threshold determined by ideas of importance, which was more evident if topics were to be discussed on a regular basis.

Several participants reported a high degree of clinician autonomy and a low acceptance of change. They expected to be included in the decision-making processes and perceived that they had prac-

tically not been involved in the adoption of the medication charts. Some of the participants expressed the view that the implementation process was low management priority, because proposals of modification were generally not accepted. Several felt increasingly overburdened by workload created by their managers for administrative reasons and saw the medication charts as an example of bureaucratisation.

Both nurses and physicians had distinct perceptions of their professional roles and the tasks they were expected to undertake. They all expressed clear positions on the division of labour between nurses and physicians. Some of the nurses did not regard drug dispensing and administration as their task by right, but within the nurse group there was inconsistency on this topic. Some of the physicians felt that the task of completing the nurses' drug charts had been shifted to physicians.

Conflicts with existing routines

The participants said that the patient was the theoretical pivotal point for all activity. They agreed that medication errors were undesirable, but there were diverse views on solving the problem by introducing new drug-prescribing procedures.

Generally, the physicians on call had to prioritise urgent clinical assignments. They possessed diverse views on nurses' requests to clear up ambiguous prescriptions: some regarded these requests as unnecessary and annoying interruptions, while others considered them convenient precautions. Some of the participants felt that physicians generally gave priority to research and down-graded clinical work. Several physicians argued that the patients would benefit more if physicians spent time on professional specialisation instead of completing medication charts. Some of the nurses considered drug administration as dull routine work while others regarded it very important. One male nurse felt that at times nurses were prompted to exceed their powers by administering medications, which the physicians had not signed for.

In a few situations the medication charts were not accessible. For example, patients did not bring their drug chart when sent to the outpatient clinic. Consequently, the consultants made conditioned advice based on assumptions of the medication. On each ward section nursing staff stored the medication chart folder in

Table 4.2
Barriers identified by nurses and physicians

<i>Barriers</i>	<i>Example of meanings within the coded groups</i>	<i>Quotations</i>
Lack of knowledge and competence		
Insufficient knowledge and uncertainty about procedures	Low knowledge about procedures, procedure variability, lack of skills, poor or variable training, individual solutions	<i>"I have made some home-made solutions to the medication chart problems I have faced. At any rate, I find them reasonable"</i> (Senior house officer)
Ignorance of sources of error	Resuming or introducing risky procedures, carelessness, negligence, illegibility	<i>"I have resume the habit of entering the prescriptions in the medical record – for safety reasons"</i> (Staff specialist)
Conflicts with existing organisational structure and culture		
Unclear responsibility	Disagreements between professions, discussions about competence, uncertainty about responsibility, diverse views on responsibility	<i>"We have daily discussions about the medication charts. . . These charts are very annoying – we try to see it as some sort of joke. When they are completed, who is then supposed to transcribe the information to the new charts? The physician want us to do it, but we think they are supposed to do it."</i> (nurse)
Low solidarity	Rivalry and competition, strong hierarchy, individuality, cautious about advising colleagues, mistrust of colleagues	<i>"Community spirit is high only when we are opposing other staff groups, otherwise we are rivals."</i> (Staff specialist)
Insufficient communication	Informal communication, thresholds, restrictions, low opportunity of discussing the topic	<i>"If somebody refers to the topic, then what really matters is, whether you are for or against medication charts – not how to use them properly"</i> (Senior house officer)
Clinician autonomy and low acceptance of change	Resistance, deliberate deviation from procedures, obstructions, expectations of say, mistrust of managers	<i>"I haven't a clue, but one would think that people write illegibly because they are annoyed with the charts"</i> (Staff specialist)
Strong professional identity	Distinct perception of professional roles and tasks	<i>"When it comes to evaluation, then asking the managers is insufficient. You should ask the physicians, and you should address physicians and nurses very differently"</i> (Staff specialist)
Conflicts with existing routines		
Low priority task	Task disparagement, postponements	<i>"Some of the physicians might as well be looking out the window, when they sign for the drug entries"</i> (Charge nurse)
Logistic problems	Availability, supply problems, problems with sharing tools	<i>"If the ward round goes on at the same time, you need to search for the medication charts"</i> (Staff specialist)

different places and most physicians had met with the problem of finding the medication charts. To some physicians these were minor problems. To others, however, logistic problems contributed to the general view of a malfunctioning drug-prescribing system.

4.4 Discussion of own study

Development of local knowledge and acceptance of a technology is crucial to implementation, but the rapidity with which individuals take up new ideas varies¹⁴⁴. Widespread, long lasting resistance was a surprising finding. The first interviews were conducted 8 and 16 months after the adoption of the medication charts to avoid the temporary resistance associated with change¹⁴⁵. Greer developed a framework for diffusion of medical technologies¹⁴⁶: technologies run through an observation stage, which is characterised by controversy and rejection, followed by a consensus stage of evaluation and a potential take off in local adoptions. Dynamic technologies (still developing) remain longer in the observation stage than do formed technologies. If our finding indicates that medication charts are in the observation stage, then the implementation is unexpectedly prolonged.

People oppose change for many reasons, including self-interest, misunderstanding, lack of trust, different assessment of the problems and the solution, and low tolerance for change¹⁴⁷. To allow people to experience a sense of influence and cope with change, four main categories of need should be respected¹⁴⁷: (1) need for information; (2) need to develop new skills; (3) need for support to deal with new problems; and (4) need for empathy. The study unveiled that physicians and nurses perceived that these needs were not fully met.

Organisational culture includes e.g. routines, norms, and prevailing attitudes and values¹⁴⁸. Although it was beyond the scope of the present study to perform a complete cultural analysis, the study indicate that nurses and physicians have different positions within the department organisation, representing two different subcultures. This finding supports a study of professional cultures by Eriksen et al.¹⁴⁹. The authors reported substantial differences with potential for conflicts between physicians' and nurses' culture. The explanation for some of the identified problems includes the possibility that physicians and nurses differ in moti-

vation and their acceptance of routine tasks. Motivating factors may include: attention to personal needs; training and development; an accurate job description; feedback; and structures for support, complains, and assessment¹⁵⁰. Some physicians saw the new system as an exponent of a management style based on bureaucracy and control. This was expected, because freedom to order medications, and freedom to set volume of work and schedule priorities are related to perceived clinical freedom and physician satisfaction^{151,152}.

Unawareness of procedures, insufficient dissemination of knowledge, collegial difficulty and scepticism was common among those who put drug handling into practice. Clinical wards are examples of the type of organisation that Mintzberg classify as professional bureaucracy¹⁵³. Marked professional autonomy and relative independence of colleagues are characteristic features of the professional bureaucracy. Although professional specialisation and autonomy are appropriate when handling complex tasks, autonomy and lack of co-ordination result in low flexibility and hamper innovation. Although the identified problems were related to a specific task, they are likely impediments of a more universal nature. Similar problems have recently been reported as obstacles to the post-graduate training of Danish physicians, including problems related to the organisation of work, unsystematic and insufficient introduction of new staff, low group cohesiveness, and low exchange of experience¹⁵⁴. Only few problems, however, appear to have a strait forward solution. For example, problems regarding job identity do to some extent originate in issues outside the clinical setting because cultural values are gradually acquired during course and medical training¹⁵⁵.

The informants are not statistically representative of staff. Thus this study reports the spectrum of views rather than the frequencies of issues. The choice of in-depth interviews rather than a cross sectional survey may be justified by the detailed data collected. Interviews are more appropriate than quantitative methods when the aim is to study the complex phenomena of organisational and interpersonal issues¹⁵⁶⁻¹⁵⁸. Information, which cannot be reached by other research methods, on e.g. concealed and tabooed phenomena within an organisation may be unveiled by the interviews¹⁵⁶.

Generalisability, reliability, and validity describe rigour or quality of quantitative studies^{159,160}. In qualitative research relevance is an important quality indicator¹⁴¹. Although ultimately, the validity of qualitative studies is in the eye of the reader, the issue of quality in qualitative research is part of an ongoing debate and not clarified¹⁶¹⁻¹⁶⁴. The debate includes at least two opposing views¹⁶⁵: (i) qualitative research represents a distinct paradigm and should not be judged by conventional measures of generalisability, reliability, and validity; (ii) it is possible to assess the different perspectives offered by different research processes against criteria of quality common to quantitative and qualitative research, particularly those of validity and relevance. The means, however, may be modified. I adopt the latter view.

Through the entire study process the following methods of improving validity were applied: confirmatory questions (communicative validity¹⁶⁶), confirmation from informants (respondent validation^{141,165}), explicit and transparent methods of data collection and analysis¹⁶⁵, iterative comparison of findings against data, comparing interview findings to information obtained by other methods (source triangulation^{143,167}), incorporating a range of different perspectives (informant triangulation). Still, the disadvantage of a single researcher conducting the interviews and analysing the data needs to be considered^{143,156}.

4.5 Conclusions

This study indicates that more profound cultural and structural problems are crucial to the implementation of the medication charts. The medication chart should be considered an organisational entity. Since the system does not fit the organisation entirely, those implementing medication charts should monitor the implementation and be prepared to modify the organisation as well.

chapter five

Economical aspects

In 1999 the total sales of pharmaceutical products in Denmark were 10.7 billion DKK or approximately 5.70 DKK per capita per day¹⁶⁸, of this 19% were in the hospital sector. By amount the total sales of pharmaceutical products were 906 defined daily doses (DDD) per 1000 inhabitants per day, of this 4% were in the hospital sector. In the Danish health policy and health care sector there is an increasing awareness of costs and cost-effectiveness of different health technologies and therapies due to limited resources available in the Danish health care sector.

Because drug consumption and public drug expenditures reimbursed by the Danish the National Health Service are steadily increasing¹⁶⁹, issues of drug costs are of increasing significance. This is most pronounced regarding new expensive drugs. The Danish Ministry of Health has previously suggested that technology assessments, for example pharmacoeconomic analysis, should be conducted to assess, whether therapeutic benefits justify the use of expensive drugs when compared to the existing alternatives. Our initial considerations were to conduct a health economic analysis of the impact on society of errors in prescription writing. During the design phase it was concluded that it was not possible to collect sufficient data on costs and effectiveness to perform a health economic analysis in the given situation. The most important obstacle was the lack of studies establishing the impact on patients of errors in prescription writing. It was beyond the stated aim of this thesis to establish these data. The present technology-oriented assessment focus on the determination of the characteristics of the technology prescription writing (1.2) and the studies (I, II, III) do not allow e.g. a cost-effectiveness analysis^{170,171} to be carried out. Although numerous

economic analysis of prescription writing would be appropriate, we focus on a single problem. We report an analysis of drug costs on internal medicine wards, because these costs are important not only to ward managers meeting budget plans, but also to patients.

5.1 Analysis of drug costs

5.1.1 Background

Clinicians are not only involved in taking care of patients, but also in controlling of expenditures and meeting budget plans. Rational prescribing includes cost minimisation¹⁷², but economic considerations, however, often have low priority when hospital doctors prescribe medicine^{173,174}. Drug expenditures account for only a small proportion of total hospital costs, but there is an increasing pressure to consider drug costs in decisions about prescribing¹⁷². For patients, drug use represents one of the most conspicuous health care expenditures.

5.1.2 Aim

To determine the cost of drugs of patients admitted to internal medicine wards from the patients' and the wards' perspective.

5.1.3 Material and methods

An analysis of data derived from study III was conducted (3.4). Costs estimates were based on micro-costing¹⁷¹ and analysed from the patients' and the wards' perspective. Prescribing data from the study group (n = 56) and the control group (n=57) were obtained from the medication charts and medical records. Actual dispensing data were not recorded, because these data were not available from the control group.

For each patient the daily drug expenditures were calculated by multiplying the recorded daily dose of each drug by the drug price obtained from the Danish Drug Compendium (1999). The ward drug expenditures were calculated for each patient by multiplying the recorded daily dose of each drug by the duration of treatment and hospital pharmacy cost prices (AMGROS). Where different prices were available calculations were based on the lowest price per item.

The following dependent variables were analysed using linear regression models: average change in patients' daily drug expenditures and average ward drug costs per admission. The main ef-

fects of the following predictor variables were tested: ward (ward A = 0, ward B = 1), age (analysed as a function of grouping into 18 to 64, and 65 and older), gender, main diagnose, and patients' daily drug cost on admission. The variables were eliminated backwards. A variance component model (mixed model) was used to quantify changes in patients' daily drug costs. Patients were included as random effects in the model. Cut-off level for statistical significance was set at 0.05. SAS 6.2 was used for the analyses.

5.1.4 Results

Patients daily drug cost on admission was DKK 21.03 (95% CI 16.40 to 25.66 DKK) and increased significantly from admission to discharge by DKK 11.95 (95% CI DKK 5.41 to 18.49), $p=0.0004$. The linear regression analysis indicated that the change in patients' daily drug costs was inversely associated with patients' daily drug costs on admission, but not associated with ward, age, gender, or diagnosis (table 5.1). When prescriptions with explicitly given end date (time-limited prescriptions) were excluded from the calculations then the increment, DKK 1.44 (95% CI - 5.10 to 7.97), was not statistically significant.

The average ward drug cost per admission was DKK 302.72 (95% CI DKK 209.07 to 396.37). The linear regression analysis indicated that ward drug costs were associated with patients' daily drug costs on admission, duration of hospitalisation, and gender, but not influenced by ward or age (table 5.1).

Table 5.1.
Summary of the regression analysis

<i>Dependent variable</i>	<i>Predictor variable</i>	<i>Coefficient</i>	<i>SE</i>	<i>p</i>	<i>R2</i>
Change in patients' daily drug costs from admission to discharge (DKK)	Intercept	17.04	2.91	0.0001	0.04
	Daily drug costs on admission (DKK)	-0.20	0.01	0.04	
Ward drug expenses per admission (DKK)	Intercept	23.99	90.22	0.79	0.26
	Length of hospital stay (days)	22.74	6.59	0.008	
	Gender (male=0; female=1)	-178.51	84.96	0.04	
	Daily drug costs on admission (DKK)	8.79	1.82	0.0001	

5.2 Discussion of the analysis

This analysis shows that patients' daily drug costs increased 57% from admission to discharge, but the increment in patients' daily drug cost is attributable to prescriptions with explicitly given end dates. It follows that the cost increment is likely not lasting. Studies of the impact of hospitalisation on drug costs are few and conflicting. McCormack et al.¹¹⁷ reported a doubling of patients' daily drug costs (approximately £1) as a result of hospitalisation, primarily attributable to an increased number of drugs on discharge. The present analysis confirms this study. In contrast, studies of patients aged 65 or older indicate that the number of drugs and patients' drug costs decrease following admission to geriatric departments^{176,177}.

Muir et al.¹¹¹ studied the impact of delivering a written survey of patients' medications to physicians and reported that the mean number of medications in the intervention group decreased by 0.92 from admission to discharge compared to an increase by 1.65 in the control group. In study III all prescriptions in the study group were recorded on a medication chart, in the control group the traditional medical record system was used. The present analysis determines ward drug expenditures and change in patients' drug costs attributable to hospitalisation. The regression analysis indicates no association between the wards and these costs. Surprisingly, different record systems seem to have no impact on ward drug costs. No method allows calculation of power and sample size when data are to be analysed in regression models. When planning study III, sample size calculation was made to be able to detect a difference in the probability of omission errors between the two groups of patients (3.4.3), not a difference in costs. If differences between mean ward drug costs had been analysed using unpaired t-test after logarithmic transformation of data, then the power would have been 14% (nQuery Advisor® 4.0). Thus, a type II error is very likely the explanation for the negative finding of this analysis.

Medication charts may provide the requisite basis for economical prescribing and the information needed to make rational allowance for the individual case. Although not specifically studied, unawareness of drug costs might explain why this does not produce an impact on drug expenditures. The decisions whether

to prescribe at all, from which drug class to choose and which dose and schedule to choose are predominantly made by physicians. Although awareness of drug costs may affect physicians' prescription decisions¹⁷⁸, doctors generally show a high level of inaccurate cost awareness of medications and devices^{174,179,180}.

Study III is discussed in section 3.5.3. Patients from the two wards differed in age. The impact of this bias is likely to be negligible, because regression analyses indicated no influence of age on patients' drug costs and wards' drug costs. The influence of patients' daily drug costs and duration of hospitalisation on ward drug costs seems plausible, whereas the influence of gender lacks an explanation. Thus, gender is not associated with polypharmacy⁹¹, adherence to therapy¹⁰⁴, or discrepancies in the use of medications¹⁸¹. To our knowledge, prior studies have not evaluated the influence of gender on ward drug costs.

5.3 Conclusion

Patients' daily drug costs increase by 57% from admission to discharge, but the increment is attributable to prescriptions with explicitly given end dates. The average ward drug cost per admission is approximately DKK 300. The use of medication charts does not affect drug cost from either the patients' or the wards' perspective.

chapter six

Patient perspectives

6.1 Introduction

Good prescribing brings together the balancing of risks and benefits with the need to reduce costs and the right of the patient to make choices in treatment¹⁷². Patients are the final recipients of the medications that physicians prescribe. Approximately 1% of medication errors harm the patients², 62% of these errors occur at the stages of prescription or transcription¹². It is important to acknowledge the variability between the risk that patients and health professional are likely to accept. For example, patients with cancer are more likely to accept radical treatment with minimal chance of benefit than people who do not have cancer, including medical and nursing professionals¹⁸². Errors in prescription writing may appear indirectly and only to the alert patients. For example, transcription errors appear to the patients as a missing drug, wrong dose, schedule or duration, or incomplete information. Although patients may not encounter errors in prescription writing directly, they are exposed to potential consequences, such as withdrawal effects or unwanted drug interactions. Because no primary data were collected to investigate the patient perspective on prescription writing, this chapter is based on existing literature. The objective is to discuss patients' perspective on errors in prescription writing on the basis of published studies. Below, potential impacts of errors in prescription writing on biomedical outcomes, self-care and patients' satisfaction with care are discussed.

6.2 Errors in prescription writing: potential consequences for patients

6.2.1 Biomedical outcomes

Patients are concerned about efficacy and adverse effects of the medication they are expected to take¹⁸¹. They worry about specific drug interactions and potential adverse events such as impotence or liver toxicity, but more vague effects such as feeling dull give rise to concern as well.

Generally, medications are prescribed to cure, relieve or prevent diseases, disorders or symptoms. The prevalence of transcription errors in the medication history (I), the in-patient charts (II) and the discharge drug summary (III) is 69 to 70%, 64%, and 30 to 56%, respectively. Transcription errors may reduce the probability of reaching the desired objective due to missed detection of drug related problems such as unwanted drug interactions or unintended stop of medication. Study I indicates that clinical problems attributable to transcribing errors in the medication history actually do occur.

6.2.2 Self-care

Quantitative and qualitative changes in medications often follow hospitalisation^{57,117,119,176,183,184}. Within a very short time following discharge from hospital, patients may make additional changes of drug therapy by themselves or guided by GP or hospital¹⁸⁴⁻¹⁸⁶. Although patients are entitled to receive sufficient information¹⁸⁷, our findings raise the question whether physicians (I, II) or the GPs (III) have access to information, which allow them to advise on self-care. Lacking or conflicting information due to errors in prescription writing may affect the counselling of in-patients¹⁸⁸, patients' ability to manage self-care¹⁸⁹, and reduce the sense of being involved in own care¹⁹⁰. During post-discharge consultations misunderstandings between patients and GPs regarding prescriptions are associated with insufficient or conflicting information⁶⁸.

Patients want to understand the medication to take, the regimen to follow, and the danger signals to look for¹⁹¹. Information should be understandable and consistent¹⁹⁰. Incomplete medication history and insufficient information during hospital stay may contribute to unintended post-discharge deviation from the drug reg-

imen prescribed on discharge¹⁹². A common source of error is using medications or doses that had been operative before hospital admission^{192,193}. Thus, lack of continuity wastes resources spent on stabilising hospitalised patients on drugs¹⁹².

6.2.3 Patients expectations and satisfaction with care

The perceived technical quality of care seems to play a lesser role in affecting patient satisfaction than do access to care, continuity of care, and the interpersonal nature of care^{151,194}. Generally, when customers determine the quality of service, delivery is important¹⁹⁵. Attention to continuity in the design of organisational systems of care is likely to improve patient satisfaction¹⁹⁶. Patients value that the doctor knows their case and does not ask questions when the answers are in the notes¹⁹⁷. Communication and co-ordination is crucial when care is provided across different settings¹⁹⁰. Thus, errors in the communication between physicians and nurses (II), and between settings (I, III) is likely to affect continuity of care and patients' satisfaction.

Patients are concerned about how well the practitioners involved in their case co-ordinated their activities¹⁸¹, and they appreciate effective co-ordination of care between providers, consistent information from clinicians, and clear plans for continued care and treatment¹⁹¹. Patients often seek advice from other health professionals, when the information is perceived as inadequate¹⁹⁰.

Generally, the GPs are not aware of all the drugs their patients are taking^{57, 59-62, 104}. When discharged, the patients often worry about whether their general practitioner is being informed¹⁹⁷. Approximately 60% of patients had consulted practitioners during the first month following discharge (III). When discussing the hospital stay with their GP, patients are often disappointed because the GP has not received the discharge letter from the hospital¹⁹⁷. Discharge letters are the most important link between secondary and primary care¹⁹⁸, but approximately two-thirds of the GPs are not satisfied with the discharge drug summaries⁶⁷. Although house officers and GPs rate the discharge drug summary as the most important content of discharge letters^{127, 128}, no reference to medication is given in 25% to 80% of the discharge letters^{77,120-123}. The GPs request information about medication changes implemented by secondary care⁶⁷. If medication charts are adopted,

then this request is partially met through more accurate discharge drug summaries (III). Transcription errors in the discharge drug summary, however, remain a problem among one-third of the patients.

6.3 Discussion

Patients do not comprise a homogenous population and the discussion above does not pay attention to diversity. Moreover, mentally and physically impaired patients are not eligible in surveys or qualitative studies aimed to investigate attitudes. As indicated by study I and III (fig. 3.1 and 3.3) these patients make up a large proportion of internal medicine patients. These patients are likely more vulnerable, because they are unable to intercept and correct errors in prescription writing.

Quality of care can be seen from the perspectives of health professionals, managers, politicians or patients¹⁹⁹. Defining quality in terms of meeting the needs of patients might be an appropriate approach to quality of prescription writing. If quality becomes a subjective concept, assessed by individual patients¹⁹⁵, focus is on the overall aim, better patient care, not on individual parts of the system. Although none of the papers address the clinical outcome, other sides of care are brought to light, which are otherwise neglected by professionals working within the system¹⁹⁹.

6.4 Conclusion

Errors in prescription writing may appear to patients as drug-related problems or loss of information or coherence in plan of care. The challenge is to balance patients' wishes for information and continuity in care against staff's preferences (chapter 4) and considerations of benefits and risk.

chapter seven

General discussion

*“Det er et af myndighedens arbejdsprincipper at der overhovedet ikke regnes med fejlmuligheder. Det heles fortrinlige organisation gør dette princip berettiget, og det er nødvendigt, når den yderste ekspeditions hastighed skal opnås”**

FRANZ KAFKA. SLOTTET, P. 67 (GYLDENDAL 2001)

The overall objective of this thesis is to conduct a health technology assessment (HTA) of prescription writing on internal medicine wards in order to support the planning of strategies to control errors in prescription writing. To our knowledge, this is the first attempt to analyse drug prescribing within the framework of HTA. Focus is on the structural and processual quality of prescription writing. The thesis is based on two cross-sectional studies (I, II), a non-randomised controlled study (III) of errors in prescription writing and a qualitative study of the barriers explicitly reported by physicians and nurses when using medication charts (IV). Study II indicated that transcribing errors associated with transcribing from the traditional medical record onto nurses' drug chart affect 64% of the patients (II). If prescriptions are recorded in one single document, a medication chart, these transcription errors are impossible to make (3.5.2). Evidence of the impact of medication charts, however, originates from small, non-randomised studies (table 3.12) and the search for controlled studies of the impact of medication charts on morbidity or mor-

* Not considering the possibility of error is one of the principles of work of this authority. The excellent organisation legitimates this principle, which is requisite to forward with exceedingly speed.

tality was fruitless. The adoption of medication charts does not seem to affect patients' drug costs or ward drug expenses (5.1). Study IV unveiled that the implementation of medication charts may result in difficulties attributable to conflicts with existing structure and culture. It follows, that those implementing medication charts should monitor the implementation process in order to solve the conflicts and difficulties that will occur. Study I and III unveiled that the prevalence of transcription errors in the medication history and the discharge drug summary is 69 to 70% and 54 to 56%, respectively. Although with the medication chart, the prevalence of transcription errors in the discharge drug summary is only 30% (III), loss of information characterises the communication between primary and secondary settings. This may affect continuity of care and secondly, patients' satisfaction with care (6.2.3). Concerning information about pre-admission drug use, the extra information that can be obtained by a second drug interview and GP drug list contributes significantly to the medication history (I). Although this approach is time-consuming (minimum 7 to 10 minutes per patient) (3.2.4), it may have an impact on the course of one in five of the in-patients. When prescribing, physicians and GPs should bear in mind the risk of basing prescribing decisions on incomplete or erroneous information. This is important in particular, when prescribing medications with a great potential for interactions. When diagnosing, a side effect or drug interaction might be a probable explanation of a condition, even if the medication history does not support the hypothesis. Computerised prescribing, which is the next logical step towards preventing errors in prescription writing, is discussed below.

7.1 The computer

Computerised medication systems, which are not unambiguously defined, may embrace computerised physician order entry (POE), computerised decision support, robots for filling prescriptions, bar coding, automated dispensing devices, and computerised drug administration records²⁰. Computerised decision support, which is often linked to POE-systems, guides the prescribing decision (table 1.1) by checking aspects of prescribing and making suggestions, reminders, or alerts²⁰⁰⁻²⁰⁴. POE, which may support prescription writing (table 1.1), refers to a computer program in which physicians enter drug orders. POE is either sepa-

rate or integrated in computerised medical record systems. Evidence support the benefits of computerised decision support for drug dosing^{205,206}, preventive care²⁰⁶, and adherence to recommendations^{206,207}.

The potential of computerised prescribing lies in its power to create the infrastructure for a longitudinal patient record¹²⁹. In contrast to the traditional medical record or medication chart, paper dimensions does not restrict these systems⁷³. POE generates a database that contains the essential information of every drug prescription²⁰⁷, and built in constraints prevent failures to communicate essential information (table 1.2)²⁰⁸.

Exchange of data by electronic means between health care sectors hold the potential for reducing transcription errors in the medication history and discharge drug summary⁹⁵, but depend on the development of compatible systems²⁰⁹. Easy access to data reduces the time needed to gather drug information⁹⁵. On discharge, computer systems may reduce the time required to print patients' drug lists and information sheets, or generate discharge summaries²¹⁰. Medication data in computer-based records are, however, nor entirely complete neither entirely correct^{211,212}. Failure to gather and enter important information from patients may hamper the safety of computerised systems²¹³. Thus, physicians still depend upon a narrative medication history (I) to determine, which drugs and doses the patients actually consume.

Entering structured data requires more user time than entry of free text²⁰⁹. The challenge is to design a system and user interface (for example selection menus) that does not slow down the data entry process^{201,214}. Compared to the traditional system, using a computer for prescribing is more time consuming (mean 5.5 minutes per patient)²¹⁵. Like the medication charts (3.5.2), computerised systems may decrease the need to search for hidden or lost drug information¹⁰⁹ or repeat actions that otherwise have to be carried out for completion²⁰⁸.

Bates et al conducted a before-after study of a POE-system and reported a decrease in the rate of non-intercepted serious medication errors from 10.7 to 4.86 events per 1000 patient days²¹³. The frequency of non-intercepted serious medication errors decreased by 19% in the ordering stage and 84% in the transcription stage.

Although computers may give patients an impression of technical support²¹⁴ computers are interposed in the staff-patient relationship. For example, interrupted eye contact, beeps, mis-keys, and system break down may destroy the patients' trust and satisfaction with care.

A potential advantage of computer-based systems over paper records is simultaneous remote access. Although this may provide a high degree of flexibility, POE forces staff to modify established routines and workflow patterns²⁰⁸. POE forces strict and literal interpretation of policies, rules, and procedures. Staff has diverse views on the benefits of the computer²⁰². As with the medication charts (IV), organisational difficulties are brought to light by implementation of POE²⁰⁸.

Although the implementation of a POE system on a medical service may decrease average length of stay of 0.89 days and reduce charges by 12.7%²¹⁵, it requires substantial financial and human resources to purchase, implement, and maintain computerised systems. Guidelines or algorithms must be developed and incorporated into the computer system. Massive training of users are required²⁰⁸ and the digital infrastructure should be developed and maintained^{129,200}.

Technological changes may as a side effect create new potential for errors by creating new discontinuities in care or undermining established error prevention systems^{11,99}. This applies to computerised systems as well¹¹⁰. For example, errors in the structure of the POE-system may actually increase the rate of medication errors²¹⁶. The computer is no panacea. Uncertainty in terms of economical, organisational and ethical issues makes computerised prescribing a candidate for future health technology assessments.

7.2 Legal aspects

This thesis identifies several gaps between regulations and established practice. The following section includes a discussion of the legal aspects of errors in prescription writing.

Both legislation, authorisation statutes, and locally prepared administrative or technical instructions²¹⁷ specify the competence of authorised health care professionals and the interaction between professions, set boundaries for acceptable practice and

make explicit the responsibility for any violations (Appendix C). Physicians who make errors in prescription writing (I, II, III) may infringe the Physician Act section about conscientious performance¹¹⁶.

It is the prerogative of physicians and others with special warrant to prescribe prescription drugs^{116;217}, and physicians are generally accountable for the medication prescribed to in-patients^{116;217}. If some of the transcription errors (II) represent nurses' prescriptions, then this practice goes against the legislation. Drug administering is to be carried out in accordance with physicians' instructions²¹⁷, and nurses are only permitted to change drug prescriptions if arranged with physicians^{217;218}.

If some of the transcription errors (I, II, III) represent unrecorded prescriptions, then current practice is not in accordance with the rules. Physicians are committed to record all prescriptions that they make^{113;114;116}. This principle also applies when administering of drugs is left to nurses' discretion ('to be administered on demand' or 'to be administered according to schedule')²¹⁷.

The physicians expressed a general displeasure with calls from nurses, asking physicians to correct ambiguous prescriptions (IV). This practice, however, is in keeping with the legislation. Nurses who assist physicians are subjected to an independent responsibility²¹⁷ and are committed to make objections, if they judge that they cannot administer drugs safely²¹⁷. If a physician makes directions against local guidelines, nursing staff is committed to notify the physician²¹⁷.

Errors in prescription writing (I, II, III) may affect the information provided to patients (6.2.2). Physicians are expected to provide information about the medication that patients are expected to take²¹⁷, and patients are entitled to receive information^{113;116;187;219}. This information should form a sufficient basis for the patient to be able to decide on treatment options²¹⁹⁻²²¹.

Institutional managers are committed to develop guidelines needed for the correct use of medications^{48;217}, for identification of drug and patient¹⁸⁷, and for ordering and storage of drugs⁵¹. Written instructions specifying responsibility and control procedures of the medication process should be available in hospital wards¹¹⁵.

A widespread lack of knowledge concerning the medication charts was detected (IV). It follows that the guidelines are either insufficient or have been insufficiently implemented.

7.3 Risk management

Translation of a prescription into factual therapy depends on infallible prescription writing. Studies I, II and III visualise sources of variation and pin down weak points. Study IV presents an analysis of the problems faced by actors at the operative level when they are adapting to a new prescribing system. Overall, these studies indicate problems with the structure and process quality¹⁹⁹ of prescription writing. The need for initiatives aimed at bringing current practice in conformity with regulations and improve the quality of prescription writing is apparent.

Data on costs attributable to errors in prescription writing are required in order to judge the saving potential of any interventions. Because no Danish estimates of costs attributable to injury from errors in prescription writing is available, a rough estimate of these costs is calculated on the basis of a study by Bates et al.¹² and costs per bed day obtained from Danish databases. Bates et al. studied patients admitted to two hospitals in Massachusetts USA and reported a rate of 10.6 (95% CI 8.7 to 12.4) injuries per 1,000 patient days attributable to medications. Overall 28% of these injuries were ascribed to medication errors, of which 62% were associated with prescribing or transcribing. Each injury due to a medication error was associated with an extra length of hospital stay of 4.6 days²²². In 1999 the number of bed days in Danish medicine wards was 1,151,718¹⁰³ and the Danish Ministry of Health's basic free choice rate was DKK. 2,255 per bed day (www.sum.dk/frames/frame2.htm). Based on these data, the incidences of injury associated with prescribing and transcribing is added up to 2119 injuries per year in Denmark. The costs associated with an extra length of stay of 4.6 days due to prescribing and transcribing errors are added up to DKK 10,373 per injury or a total for the country of 22 million DKK per year.

Data from the USA are applicable to Danish health care system only with strong reservations. No Danish studies of these costs are available. A rate of injury attributable to the treatment in Denmark of 5.3 per 100 admissions has been reported²²³. This rate

is comparable with studies from the USA^{124,224,225}, Australia^{125,226}, and the United Kingdom²²⁷. Schiøler et al.²²³ conducted a retrospective chart review and reported that each injury due to the treatment was associated with an extra length of hospital stay of 7.0 days, but made no distinction between injuries caused by medication and injuries from other causes. It follows that the cost estimate calculated above is conservative and associated with considerable uncertainty. Although giving only a hint, this estimate might be useful when assessing the costs of technologies, such as the medication chart (3.5.2) or computerised order entry systems (7.1).

The multiplicity of mechanisms of error in prescription writing dictates that there cannot be a simple or universal means of reducing errors. The primary objective of the system should be to make it difficult to err¹³⁰, and to create systems that are better able to tolerate errors and contain their damaging effect⁹⁹. Because error cannot be reduced to zero, the aim of the system should be to reduce to zero the instances in which an error harms a patient¹¹⁰. Although preventable by definition, all errors should not necessarily be prevented. The challenge is to balance time-consuming safety procedures against effectiveness.

The causes of medication errors are often very complex^{4,11,228,229}. Accidents are typically judged to be caused by human error²³⁰ and errors are treated as a moral issue⁹⁹. Seeking to uncouple a person's unsafe acts from the institutional responsibility is in the interest of managers⁹⁹. Given the high rate of errors in prescription writing (I, II, III) it will be easy to find someone involved in the dynamic flow of drugs that has violated a formal rule by following established practice. The error leading to an accident is usually a human error, but the causes of error are often well beyond the individual's control¹³⁰. Errors are the result of both factors inside and outside of the individual, including distractions from the environment, workload, and sleep deprivation²²⁸. Prescription writing could not be isolated from other contingencies of the work context (IV). There is an increasing awareness that the most common cause of quality problems is the process itself, not the persons operating it^{4,99,130,231-233}. Seen from this perspective, errors are regarded as consequences rather than causes⁹⁹, having their causes in systemic factors. Analyses have supported the theory

that organisational issues influence the development of injuries from medical treatment^{27,131,234}. A medical example would be the physician on call informing the nurse about the prescriptions made, who is called in for an urgent assignment before the prescriptions have been recorded. When later on recalling and recording the prescriptions, the physician is likely to err. Another example is the nurse receiving a telephonic drug order and mix up sound alike drug names. A properly designed system would have prevented error by minimising disturbances and reliance on memory and by restricting use of medications with sound alike names. It follows that preventive efforts that focus solely on individual origin of error isolated from the system context have probably little impact. Experience gained from Danish wards indicates that a systems approach to medical errors is feasible²³⁵.

Systematic collection of reliable data on medication incidents precedes problem identification and assessment of progress²³⁶. Study I, II and III provide examples of retrospective chart review made for the purpose of analysing prescription writing. Although self-report is consistently unreliable²³⁷, this approach may focus on more significant errors and provide insight into the errors identified as such by staff. Voluntary incident reporting demands fewer resources than chart review but leads to underestimation of errors¹⁸. The combination of incidence monitoring and retrospective chart review will provide both baseline frequency of errors and knowledge about the nature of any injury that has occurred^{137,238}.

Providing sufficient training appears important to promote high quality prescription writing. Study IV unveiled that individual solutions to problems had evolved. Although this creativity may contribute to local development and adaptation of the medication chart, it frequently gave rise to misunderstandings and discussions. Actors do not see the whole system during their daily operational decision making. If left entirely to individual operators the behaviour will likely migrate towards the boundary of acceptable practice²³⁰.

Medications are prescribed in an interdisciplinary system, characterised by a high degree of interdependency where the customer and supplier roles alternate continuously. The introduc-

tion of medication charts tended to reinforce conflicts between the professions (IV). This finding indicates that standard medication charts will not be successfully implemented unless the interdependence is recognised and the antagonism reduced. Multi-disciplinary involvement is vital to the success of medication error prevention programs²³⁶. Disparity between medical and nursing staff in attitude towards teamwork was likely to influence the motivation of staff and the quality of prescription writing (IV). Recognising and understanding the different roles which professions adopt within the process is useful in settling conflicts²³⁹. Division of the medication process into separate functions is appropriate for analytical purposes^{18,236}, but understanding prescription writing from the point of view of a particular service or professional group, however, is apparently futile due to process complexity.

Many problems of prescription writing do not have a single answer that, once discovered and put into action, will provide a permanent solution. When improvements are made in a specific aspect, new problems are identified and changes to improve further should be considered. For example, the introduction of medication charts created problems with illegible prescriptions and introduced a risk of transcribing a medication order incorrectly when rewriting a patient's medication charts (IV). Compared to the traditional system, however, the prevalence of error is negligible¹¹².

7.4 The health technology assessment perspective

The results provide insight into important aspects of the Danish medication process, which have not been analysed previously. The most important findings are: (i) the prevalence of errors in the transcription from the medical record onto nurses drug chart of 64% (II), which can be reduced to zero by medication charts; and (ii) a demonstration of the structural and cultural difficulties perceived by the medical and nursing staff when adapting to medication charts (IV). Moreover, the quantification of errors in prescription writing (I, II, III) provides new knowledge about how the technology prescription writing (1.1) operates in day-to-day-care. The studies I, II, and III focus on prescription writing associated with gaps in care that are aligned with distinct organisational

boundaries. Errors in prescription writing appear as loss of information. Although loss of information is bound to affect the quality of treatment provided to patients, studying this outcome was beyond the stated aim of this thesis.

The objective of an HTA is to provide input to technology-related decision making in health care^{29,32}. The policy questions and the decision-makers were not given beforehand. The potential audience is large and dispersed and the desire for information is weak. Moreover the results might be perceived to interfere with doctor-patient relationship and alternative technologies and outcomes are less identifiable. These features are common to practice-oriented health technology assessments³³. Thus, several decisions were made in order to handle prescription writing within the framework of HTA.

To become assessable a technology should be defined and delimited. By defining drug prescribing as composed of decision making, and prescription writing (1.1), the concept becomes operational. An HTA denotes the systematic evaluation of properties, effects, and/or impacts of a health technology²⁹⁻³¹. To simplify the problem, focus was on errors in prescription writing, which are the unintended consequences. Thus, the disadvantage of excluding the intended effects of the prescription writing from the assessment should be considered.

The decision to produce a technology assessment of prescription writing was based on the experience that although staff takes great care in the task, misunderstandings regarding drug prescriptions are encountered on practically every round. To address complex procedures and multidisciplinary involvement it was decided to apply a technology-oriented approach²⁹, emphasising organisational aspects and undesired technical properties of prescription writing (table 1.1).

This HTA was intended for ward managers because the medication process on internal medicine wards is in the field of their responsibility. The identification of the decision-maker determines which elements of the technology to emphasise. If the HTA had been intended for e.g. the Danish Public Health Insurance or the clinicians, then it would have been appropriate to emphasise the economical aspects of the prescribing decision.

Prescription writing is a widespread, established technology, used for almost every in-patient and it is not possible to comprise all aspects within one analysis. While quality of equipment generally is easily described, a general definition of the quality of service is less obvious²³⁹. Restricting the analysis to prescription writing, which connects the prescribing decisions with the execution of the prescriptions, restricts the applicability of the results as well. On the assumption that prescription writing works infallibly, errors in the prescribing decision, dispensing, administering, or monitoring may still affect the medication process negatively.

An important element of an HTA is the review and synthesis of existing literature^{30,41,42}. Studies of prescription writing was searched in the Cochrane Library, PubMed and EMBASE databases, applying a combination of following MeSH-terms: "Drug"; "Drug prescription"; "Drug therapy"; "Medication errors"; "Medication systems, hospital"; "Risk management"; "Accident prevention"; and "Hospital". A supplementary snowball search was conducted. The literature search might not be fully comprehensive and the possibility of having omitted important studies should be considered.

Although several studies of the technology (errors in prescription writing) were retrieved, all were cross-sectional studies, time-series, or before-after studies (table 3.8, 3.10, and 3.13). These studies are likely context-dependent^{43,240} and a comparison of results across the literature is difficult due to various methodology and definitions⁴⁻⁷. How to balance trials of various quality in an HTA is unsolved²⁴⁰. Therefore it was decided to present relevant data in tables in order to increase transparency (table 3.8 to 3.13). Although studies were available from the literature, uncertainties concerning the generalisability indicates the necessity of study I, II, and III.

The context dependency is more pronounced regarding studies that take into account factors that go beyond efficacy, including ethics, preferences of the patients, education of staff, diffusion of information²⁴⁰⁻²⁴². Synthesising and appraising heterogeneous studies, including non-randomised studies of different methodology or qualitative studies, may cause problems, as methodology useful for amalgamating these studies has not been established^{243,244}. To overcome these difficulties, studies of economical, organisational, and

patient aspects were addressed within the less restrictive framework of the discussion.

Much HTA relies on a model in which the aim is to identify technology, evaluate it in a timely way to produce definitive results to be disseminated to the target audience who, if properly primed, will implement them²⁴⁰. Although planned initially, this model turned out to be inapplicable to the widespread, non-embodied technology, prescription writing. Prescription writing is a dynamic and developing technology. The major problems were blurred boundaries and emerging uncertainties in the study period (a moving target). Starting from the organisation by preparing and analysing flow sheet of procedures, the technology was characterised and defined. Study I, II, III, which were planned and conducted subsequently, quantified errors in prescription writing and formed the basis for the searching for solutions. Based on the uncertainties that emerged from the pilot testing of one of the identified solutions, study IV was planned and carried out. Finally, data from the studies (I-IV) determined which questions to address in the economic analysis and the discussion of the patient perspective. It follows that the present HTA does not assess the definitive technology, but a technology at one stage of development.

7.5 Conclusion

This thesis focus on gaps in care that are aligned with distinct organisational boundaries, marking change in responsibility and authority, different roles of professionals, or formal division of labour. The studies indicate how the technology prescription writing works in the day-to-day care and provides insight into the difficulties faced by the people who use the technology. Overall, loss of information characterises prescription writing. When creating systems that make it more difficult to err, modifying the organisational structure and culture appears important. Although there cannot be a simple or universal means of reducing errors, the adoption of medication charts may solve some of the problems in the secondary sector. When focus is on the whole system, however, this solution is insufficient. Rather than focus on individual parts of the system, approaches that cross the boundaries between primary and secondary care should be developed. With the existing system, therapy changes by chance affect the major-

ity of patients. All errors should not necessarily be prevented, but if current practice is accepted, then the appropriateness of the medical treatment that most patients actually receive is questionable.

7.6 Future aspects

The association between adverse events and errors in the medication process has been established from retrospective chart reviews and the evidence concerning interventions such as second drug interview, GP drug list, medication charts, comes from small, non-randomised studies. Whether these interventions actually reduce the rate of medication errors, and secondly adverse events should be investigated in longitudinal studies looking for relevant health outcomes.

Conducting an HTA implies the review and synthesis of existing literature. When it comes to studies that go beyond efficacy and address patient preferences, economy, ethics, legislation, organisation two major problems arise. First, results from studies conducted in one setting or health care system is probably not transferable to another. If included in an HTA, the conclusions and recommendations might not be transferable either. Secondly, the methods suitable for rating and amalgamating these studies are not available. Future efforts should be directed towards the development of methods to address these problems. One solution might be the development of an HTA-approach that consists of two steps. Step one, which addresses the efficacy, might be general and therefore transferable. Step two, which includes the appraisal of economical, organisational, and patient issues, should be conducted locally.

Recommendations

8.1 General recommendations

Generally, physicians and GPs should bear in mind the risk of basing clinical decisions on incomplete information about medication.

8.2 Specific recommendations

- On admission to hospital, extra information about pre-admission medication can be obtained in the majority of cases from a second drug interview and GP drug lists. Although this approach is labour-intensive, it may produce a beneficial impact on the course of one out of six patients. The evidence comes from cross-sectional studies and specialist assessments. The benefit has not been studied in longitudinal, controlled studies.
- Transcription errors attributable to transcription of drug information from the medical record onto nurses' drug chart affect the majority of patients. This procedure should be abandoned in favour of a unified medication record system. The evidence comes from cross-sectional studies.
- Use of medication charts eliminates errors attributable to the transcription of drug entries from the medical record onto nurses' drug chart. The implementation of medication charts may increase the rate of correctly written prescriptions and, if new procedures or a satellite pharmacy is implemented at the same time, reduce the rate of drug administration errors. This evidence is obtained from time-series and before-and-after studies. The benefit of medication charts on patient outcomes has not been addressed in longitudinal studies.

- Use of medication charts reduces the prevalence of transcription errors associated with transcription from the medical record onto the discharge drug summary. The evidence comes from cross-sectional studies. Because the prevalence of transcription errors with the medication chart is 30%, initiatives should be made to improve and monitor the quality of discharge drug summaries. A comprehensive discharge drug summary should include: an accurate list of medications on admission; a list of medicines added or deleted in hospital; reasons for giving or altering medications; and a list of medications with doses, frequency and proposed duration on discharge.
- Cultural and structural problems are crucial to the implementation of medication charts. The medication chart should be considered an organisational entity. This evidence comes from a qualitative study. Since the system does not fit the organisation entirely, those implementing medication charts should be in control of the implementation and be prepared to modify the organisation as well.
- Although not specifically assessed, computerised physician order entry combined with decision support systems appears to hold the potential for reducing errors in prescription writing. Uncertainties concerning the efficacy, economy, organisation, and patient issues make this technology a candidate for a future health technology assessment.

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Summary in English

The objective of this thesis is to conduct a health technology assessment of prescription writing on internal medicine wards in order to support planning of strategies to control errors in prescription writing.

Methodology and results: The thesis is based on two cross-sectional studies, a non-randomised controlled study and a qualitative study of prescription writing associated with gaps in care that are aligned with distinct organisational boundaries, marking change in responsibility, or formal division of labour.

This thesis indicates how the technology prescription writing works in day-to-day care and provides insight into the difficulties faced by the people who use the technology. The studies showed that a second drug interview and GP drug list add information about pre-admission drug use to the medication history in 69 and 70% of the cases, respectively. Obtaining this extra information on admission to hospital may produce a beneficial impact on the course of 18% of the patients. With the traditional medical record system, the rate of transcription errors in the medical record and on nurses' drug list is 15.8% and 12.7%, respectively. One or more transcribing error affects 64% of the patients. Approximately 40% of prescriptions are ambiguous with the traditional medical record system. The prevalence of transcription errors in the discharge drug summary is 30% with the medication chart, compared to 56 and 54% with the traditional medical record system, difference 26% (CI 7 to 42%) and 24% (CI 6 to 40%). Barriers to the implementation of medication charts originate from insufficient knowledge and competence, and conflicts with existing structure, culture, and routines.

Conclusion: Overall, loss of information characterises prescription writing. Adoption of medication charts may solve some of the problems in the secondary sector, but successful implementation of the system depends on organisational adaptation. When focus is on the whole system, however, this solution is insufficient. Rather than focus on individual parts of the system, approaches that cross the boundaries between primary and second-

ary care should be developed. With the existing system, therapy changes by chance affect the majority of patients. All errors should not necessarily be prevented, but if current practice is accepted, then the appropriateness of the medical treatment that most patients actually receive is questionable.

Dansk resumé

Formålet med denne Ph.D.-afhandling er at gennemføre en medicinsk teknologivurdering af lægemiddelordination på intern medicinske afdelinger til støtte for tilrettelæggelsen af lægemiddelordination, så fejl ved skrivning af lægemiddelordinationer begrænses.

Metoder og resultater: Afhandlingen er baseret på to tværsnitstudier, et kontrolleret, ikke-randomiseret studie og et kvalitativt studie af ordinationsskrivning. Undersøgelserne omfatter situationer, hvor grænser imellem primær og sekundær sektor og/eller faggrænser markerer en overdragelse af ansvaret for patienternes behandling.

Undersøgelserne viser hvordan skrivning af lægemiddelordinationer varetages i den daglige klinik og giver indblik i nogle af de vanskeligheder som læger og sygeplejersker møder, når de behandler patienter med lægemidler. Hos hhv. 69 og 70% af de indlagte patienter giver et ekstra interview og en medicinliste fra egen læge ny information om lægemiddelordinationer, som ikke er indholdt i den skriftlige medicinanamnese. Et panel af klinikere vurderede, at oplysninger om disse lægemidler ville have haft betydning for indlæggelsesforløbet hos 18% af patienterne. I alt 15,8% af lægemiddelordinationerne i journalen forekommer ikke i Medicinkardex og 12,7% af lægemiddelordinationerne i Medicinkardex er ikke dokumenteret i journalen. En eller flere af disse fejl forekommer hos 64% af patienterne. Ca. 60% af lægemiddelordinationerne er entydige. Hos 30% af patienterne stemmer medicinlisterne i udskrivningsbrevene ikke overens med de lægemiddelordinationer, som ifølge medicinarket er gældende ved udskrivelsen. Ved anvendelse af journal og Medicinkardex berører disse uoverensstemmelser over 50% af patienterne. Interviews med læger og sygeplejersker viser, at barrierer imod medicinark skyldes mangel på detaljeret viden om praktisk brug af medicinark, samt at anvendelse af medicinark er i konflikt med afdelingernes struktur, kultur og arbejdsgange.

Konklusion: Skrivning af lægemiddelordinationer er hyppigt forbundet med tab af information og tilfældige ændringer. Brug af

medicinark kan løse nogle af problemerne i sekundær sektoren, men anvendelsen af medicinark forudsætter en organisatorisk tilpasning. Hvis primær og sekundær sektorerne betragtes samlet, så er brug af medicinark ikke tilstrækkelig. Der er behov for at udvikle systemer, som beskytter imod tab af information ved overgangene imellem sektorerne. Alle fejl skal ikke nødvendigvis forhindres, men hvis den nuværende praksis accepteres, kan der stilles spørgsmål ved hensigtsmæssigheden af den behandling med lægemidler, som patienterne modtager.

Appendices

Appendix A

Statements presented to the panel of clinicians (I)

- This patient was admitted in a condition that impeded an admission interview.
- An adverse drug event attributable to one of the discontinued drugs might have been the reason for the admission.
- If the medication history had included the extra information obtained by second interview or GP drug list, then the physicians would have made different prescribing decisions within the first 24 hours of admission.
- If the medication history had included the extra information obtained by second interview or GP drug list, then the physicians would have made different prescribing decisions within the first 24 hours of admission.
- During admission, this patient was at risk of developing withdrawal or deficiency symptoms attributable to medications that were stopped inadvertently.
- After discharge from hospital, this patient was at risk of developing withdrawal or deficiency symptoms attributable to medications that were stopped inadvertently.
- If the discontinued drug(s) was/were re-dispensed after discharge from hospital, this patient was at risk of developing an adverse drug event.
- Information about essential medications was obtained by second interview or GP drug list.

Appendix B

Interview schedule (IV)

Introduction

- How do you use the medication chart in your daily work?

Technology

- What is your general view of the medication chart?

Tasks

- Has the implementation of the medication chart had any impact on your daily tasks?
- What differentiates completing medication charts from what you did previously?

Structure

- Which working procedures are related to medication chart?
- How does the interdisciplinary collaboration on drug-prescribing work?
- How is the interdisciplinary collaboration co-ordinated?
- Who is responsible for the medication chart in practice?

Personnel

- How much time do you spend daily on drug prescribing or drug administration?
- Has this changed?
- What is your role in drug prescribing or administration?
- In your opinion, is the time spent on drug prescribing or drug administration worth while?
- Do you have any idea of how your skills as health professional can be valued?
- How do you imagine the task of prescribing or administering drugs to be undertaken under optimum conditions?

Appendix C

Selection of Danish statutes, regulating prescription writing in hospitals.

Authority	Title
Laws The Danish Ministry for Health	Departmental order 1995-7-20 no. 632. The Physician Act ¹¹⁶ . Departmental order 1990-11-14 no. 759. The Nurse Act ²¹⁸ . Act 1998-7-1 no. 482. Act on Patients' Legal Status ²²⁰ .
Departmental orders The Danish Ministry of the Interior The National Board of Health	Departmental order 1937-7-26 no. 244 on physicians' duty to keep records ²⁴⁵ . Departmental order 1995-4-26 no. 270 on the medication process on institutions and wards providing therapy ⁵¹ . Departmental order 1998-9-14 no. 665 on information and delivery of health information et cetera ²¹⁹ .
Circulars The National Board of Health	Circular 1995-12-12 no. 184 on prescription of dependence producing drugs ²⁴⁶ . Circular 1996-12-19 no. 235 on physicians' duty to keep records orderly ¹¹⁴ .
Guidances The National Board of Health	Guidance 1996-12-19 no. 236 on physicians' record keeping ¹¹³ . Guidance 1998-2-6 no. 15005 on drug administering and patients' self-administering et cetera ²¹⁷ . Guidance 1998-5-1 no. 60258 on identification of patients and precautions against confusion in health services ¹⁸⁷ . Guidance 1998-9-16 no. 161 on information and on delivery of health information et cetera ²²¹ .
Other law sources The National Board of Health	Concerning the recording of drug prescriptions. Notice to Danish hospitals ¹¹⁵ .

Appendix D

Approvals and notifications

<i>Study</i>	<i>Commité</i>	<i>File no.</i>
I.	De Videnskabetiske Komitéer for Københavns og Frederiksberg Kommuner Registertilsynet Dansk Selskab for Almen Medicin. Udvalg vedrørende multipraksisundersøgelser	(KF) 01-320/98 1998-1200-490 MPU-30/1998
II	De Videnskabetiske Komitéer for Københavns og Frederiksberg Kommuner	(KF) 01-112/97
III	De Videnskabetiske Komitéer for Københavns og Frederiksberg Kommuner Registertilsynet	(KF) 01-127/97 1998-1200-560
IV	Datatilsynet	2000-41-0437

Appendix E

List of manuscripts

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- I. Andersen SE, Pedersen AB, and Bach KF. Medication History on Internal Medicine Wards: Assessment of information obtained by second interview and GP drug list. Submitted.

 - II. Andersen SE og Fog D. Skriftlig dokumentation af medicinordinationer. Overensstemmelse imellem lægejournal og Medicinkardex. *Ugeskr Læger* 1998; **160**(27): 4059-62.

 - III. Andersen SE. Improving the quality of discharge drug summaries. A controlled study. Submitted.

 - IV. Andersen SE. Implementing a new drug record system: a qualitative study of difficulties perceived by physicians and nurses. *Qual Saf Health Care* 2002; 11: 19-24.
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