Computer-based Shared Care

COMPUTER-BASED SHARED CARE

A STUDY ON ELECTRONIC DATA INTERCHANGE APPLIED TO DIABETES CARE

(COMPUTER-GEBASEERDE GEDEELDE ZORG

EEN STUDIE NAAR ELECTRONIC DATA INTERCHANGE
TOEGEPAST BIJ DIABETES ZORG)

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Geen schaartje

'Hé, dat lijkt wel een schaartje,
wat daar op de grond ligt', dacht ik,
'een stoffig, grijsgroen schaartje'

Maar toen ik beter keek zag ik
dat het geen schaartje was,
maar een elastiekje, ineengekringeld
in de vorm van een schaartje

C. Buddingh

CONTENTS

Chapter 1

Introduction

1.1 Introduction

The need for information for the delivery of good quality health care is growing rapidly. As in other areas of society, computer technology plays an ever-growing role in managing this information. Hammond [1], reviewing the development of Hospital Information Systems, indicates that health care has failed to keep pace with the rise in computing power and communications technology, possibly because of the complexity of health care and the large variety of individuals working with the systems. He underlines the importance of these systems for collecting, storing, processing, retrieving, and communicating patient-related data, not only between hospital departments but also between hospitals and other care providers. He concludes that "clinical information is not the property of a single facility but rather [..] part of a global resource which focuses on the patient-centered record". Buffone and Beck support this view: "Patient care typically requires that multiple providers share data and information in a facile and relevant manner" [2].

1.2 Chronic disease in general practice

In The Netherlands, the general practitioner functions as a gatekeeper between primary and secondary care. Typically, patients first consult their general practitioner. If considered necessary, the general practitioner refers the patient to a specialist who reports the results of the assessment (and possibly therapy) back to the general practitioner. For this reason the Dutch general practitioner is considered to be the central physician in the patient's medical history and the ideal person to coordinate shared care. This is especially true for patients with chronic illnesses. Hasler even goes so far as to stipulate the care for patients with chronic diseases as "The very stuff of general practice" [3]. This coordinating task puts high demands on the information-processing capacity of the general practitioner and the efficiency of communication with other care providers. A large number of studies have demonstrated that communication between physicians about co-treated patients is prone to be delayed, incomplete, or erroneous. A thorough literature survey on problems in communication between health care professionals, and possible solutions is presented in Chapter 2 of this thesis.

Especially for patients with chronic diseases, well-coordinated care is essential. Many of these patients are treated concurrently by different physicians. An example of a chronic disorder, requiring lifelong medical attention, is diabetes mellitus. Evidence exists that diabetes mellitus will become a more serious public health problem in the years to come. For The Netherlands, it has been estimated that the number of diabetes patients will increase from 191,000 in 1980 (1.35% of the population) to 355,000 (2.2% of the population) in 2005; this increase is partly due to the aging of the population, but also the result of an increasing incidence [4]. Furthermore, general practitioners are often confronted with comorbidity of their diabetes patients. Schellevis et al. [5] found that 40% of the diabetes patients aged over 65 suffered from one or more other diseases, such as chronic ischemic heart disease or hypertension; these patients are likely to be involved in more than one surveillance scheme, which may lead to improperly coordinated, and possibly inefficient care.

1.4 Computer-based patient records and electronic communication

Nowadays, developments in medical informatics are able to help physicians in overcoming a number of information-management problems. During the last years, Dutch general practitioners have rapidly turned towards computer-based patient records for the registration of medical data [6]. Presently, over half of the 6500 general practitioners use an information system during clinical encounters to record, retrieve, and review patient data. These systems assist the physician, for example, with problem-oriented storage of data, coding of diagnoses, and monitoring of drug interactions and contra-indications. Furthermore, computer-based patient record systems are in principle able to automatically receive, process, and store data in electronic form from other computerized sources (e.g., hospital laboratory computer systems). This communication is known as Electronic Data Interchange (EDI), and is defined as "*the replacement of paper documents by standard electronic messages conveyed from one computer to another without manual intervention*" [7].

1.5 Research objectives

The study reported in this Thesis focused on the potential value, development, and evaluation of a communication network by which general practitioners, specialists, and hospitals are able to exchange medical information using EDI. The leading questions were:

1. *What is the state of the art of electronic communication in health care; which options exist?*

2. *To what extent are patients confronted with more than one physician ordering laboratory test procedures and prescribing medications?*

3. *What type of communication problems do general practitioners encounter with respect to patients referred to internal medicine consultants?*

4. *Is it possible to implement an EDI network for data exchange between health care professionals; what are the benefits of such a network, especially with regard to the treatment of diabetes mellitus patients?*

1.6 Contents of this Thesis

Chapters 2-8 are written as scientific papers, which have either already been published, or have been accepted for publication or have been submitted for publication. This implies that these chapters can be read separately, but it also means that a certain overlap was inevitable.

Chapter 2 contains a review of current research issues in health care communication, using information technology. It highlights pros and cons of different methodologies, and describes experiments in which these methodologies were evaluated.

In order to determine the feasibility of using EDI in primary care, we performed a study in which general practitioners received laboratory test reports and admission/discharge reports via EDI. In **Chapter 3** we present the results of this study and the evaluation that we performed.

In order to evaluate to which extent EDI can solve existing communication problems in primary care, we studied the nature of the problems that general practitioners may experience. In **Chapter 4** we describe the results of a mail survey among general practitioners working in two regions in The Netherlands.

In **Chapter 5** we present a study on the usage of drugs in a large group of patients in The Netherlands. We especially looked at the role of the general practitioner in prescribing medications, and we also assessed the proportion of patients receiving prescriptions from more than one physician during a one-year period.

When more than one physician is involved in the treatment of a patient, duplication of diagnostic test procedures may occur. In **Chapter 6** we describe a study in which we assessed the percentage of repeat laboratory investigations for patients receiving care from more than one physician at the same time.

Fully integrated communication between computer-based patient records requires standardized electronic messages. Because such a standard was not available in The Netherlands, we designed one. This new standard (called MEDEUR), which is proposed to be adopted as a national standard, is described in **Chapter 7**.

Based on the communication standard that we developed, a communication project was started in which general practitioners and an internal medicine outpatient clinic were able to communicate electronically about co-treated diabetes patients. In **Chapter 8** we describe the evaluation of this project.

In **Chapter 9** we conclude the results of the study with a summary and a general discussion.

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Chapter 2

Communication in Health Care

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Abstract

For routine communication, care providers still mainly rely on paper documents and paper mail. Evidence exists, however, that this communication can be improved, both by a better content of information exchange and by a more timely deliverance of this information. At present, several alternatives to paper-based communication are available, such as the Fax, the Smart Card, electronic mail, and electronic data interchange. This paper describes existing communication problems, and examines the current state of development and research aimed at improving this communication using electronic communication techniques that are gradually replacing paper-based communication. Applicability and shortcomings of these new techniques are also discussed.

2.1 Introduction

The quality of communication between medical-care providers highly influences the quality of care. Communication is essential for those patients who are under the shared care of several physicians. Inefficient communication between these care providers may have undesired effects such as conflicting therapies or duplication of diagnostic tests, thereby wasting financial resources and negatively influencing quality of care.

At present, letters are the most common and in most cases the only means of communication between care providers. Previous research indicates that this way of communication is too slow for a progress follow-up, and often does not satisfy the information needs of the parties involved. Long and Atkins report that communication between GPs and consultants occurred in only 3% of the hospitalized patients, although 58% of the GPs and 67% of the consultants acknowledged the need for communication [1]. Penney found that of 104 hospitalized patients 26 (25%) discharge summaries never arrived: for the remaining 78 the average delay was 25.3 days, 20.8 days of this delay was taken by typing the summaries in the hospital [2].

Not only the content of a letter determines its usefulness. Tuloch et al. report that GPs preferred structured and well-designed summaries to narrative reports. They also found that the presentation style of the information, using headings, underlining, and capitals, added to the accessibility of the letter [3]. In a recent study, Newton et al. report that, although there exists a high degree of consensus among British clinicians about the content of referral communications, standardization of communication still is not widely accepted: when writing letters, physicians prefer to use their own phrasing [4].

Communication does not necessarily have to occur between physicians only. For example, Inada et al. [5] describe a system for home-care support which can measure, collect, and record biological information of patients at home, and subsequently send this information to hospital-based specialists for remote monitoring of these patients.

Nowadays, in addition to traditional means of communication, such as the telephone and mail delivery, several new possibilities for supporting communication have become available: the most well-known are the Facsimile (Fax), the smart card, electronic mail (E-mail) and Electronic Data Interchange (EDI). In this review article, we give an overview of the current techniques used for communication in health care. For each of the techniques the possibilities, limitations and developments are described.

2.2 Communication methods

During the process of transferring information electronically from one person to the other, the role of information systems in creating and processing the information may vary, dependent on the technique used. In this section we briefly review the different communication techniques used in health care. We also give examples of projects that make use of these techniques.

2.2.1 Fax

With the Fax it is possible to send documents via the telephone line to the receiver, thus speeding up communication considerably. The Fax has penetrated a large number of business areas, and is widely used by medical professionals. A large number of publications on Fax communication projects are available in MedLine. Harrison and Hall [6] report on an experiment in which the Fax was used for transmission of referral letters from a general practice to a dermatology department. Terae et al. [7] describe a project in which CT images were transmitted, using electronic communication, from a town hospital to a university hospital. At the university hospital, these CT images were judged by experts and the written report was sent back to the hospital, using the Fax. Van Casteren and Leurquin report on a European sentinel network, in which all the participating national coordinators used the Fax for reporting to the central facility in Brussels, where all national data were gathered and compiled [8]. Yasnoff [9] describes the so-called US HealthLink system, which offers online diagnostic decision support, information about drug interactions, and literature references. Fax delivery of this information is one of the options of the system.

The Fax is an easy-to-install and easy-to-use communication tool, relatively cheap and fits smoothly into organizational habits. Existing Fax communication protocols have been widely accepted. Disadvantages of the Fax are the low quality of the print-outs and, although Fax speeds up communication, it remains merely a sheet of paper: although a computer can be used for composing messages, the data cannot be used directly in computer applications.

2.2.2 Electronic Mail

When compared to the Fax, E-mail is a relatively old procedure. The basic principles have been used in Telex communication for many years. The use of E-mail in health care, however, is still not very widespread. We define E-mail as the delivery of mail in electronic form: this means that, when using E-mail, the sender composes a message on his computer, e.g., using a word processor, and sends it via a communication network (e.g., the telephone system) to the computer of the receiver. This can be done directly, from computer to computer, or indirectly via a so-called E-mail postbox. The receiver can read, print or edit the message because, unlike the Fax, the message is still in electronic form.

Several E-mail projects in health care have been implemented during the late Eighties. Buckingham [10] describes an experiment in the UK, using the so-called Merlin business system (British Telecom). Each user had a terminal, connected to the public telephone system via a modem. For every message, the sending terminal established a point-to-point telephone connection with the receiving terminal. Buckingham concludes that, for the system to be comprehensive, terminals need to be located in all health-care facilities, such as hospitals, health centers and general practices. Grundner and Garrett [11] describe an E-mail system, based on a computer-based postbox system. This system was originally designed to facilitate fast communication between care providers, located in five clinical units and scattered throughout the Cleveland metropolitan area (USA). Within a few weeks, however, members of the public found out about the project and began putting medical questions to the system. The authors describe how they adapted the technical and organizational structure of the system, in order to meet this unexpected demand. They conclude that telematics is a feasible option for the delivery of health care information. A similar system was also implemented by Vance Esler [12]. Cowie [13] reports on the implementation of an E-mail system for transmitting laboratory data between two hospital departments. Laboratory test reports were transmitted from a laboratory computer, via the telephone network and an E-mail system, to a laboratory computer in another hospital. Cowie reports that the system worked reliably, saved secretarial time, and eliminated transcription errors. In a project described by Gaunt, the Prestel Mailbox service was used for transmitting microbiology reports to GPs [14]. Gaunt reports a reduction in distribution delay of one to four days.

Working with E-mail offers fast message exchange. In addition, the receiver can edit and store the message in a computer-based database, because the message is in electronic form. To be able to work with E-mail, users obviously need to invest in a computer system. Furthermore, working with E-mail is often more complicated for the user than using a Fax machine. Also, E-mail messages are usually in free-text format. This impedes automated processing of data at the receiving computer system, for which standardization of messages is essential.

2.2.3 Electronic Data Interchange

A special form of electronic mail is known as Electronic Data Interchange. EDI can be defined as "*the replacement of paper documents by standard electronic messages conveyed from one computer to another without manual intervention*" [15]. The central, most important aspect of EDI is the use of widely supported message standards. These standards should describe syntax and semantics of the message. When standardized messages are used for transmitting data, this data exchange is system- and application-independent, thus reducing the costs of building interfaces between different computer systems. EDI reduces the amount of paper documents, it enables automatic handling of data, and consequently reduces the number of errors in data processing. Data, once entered into a system, do not have to be re-entered manually into another.

Outside health care, EDI has already been used for many years in several business areas, such as shipping, customs, and transportation. In health care, EDI is also in use, especially for financial, administrative and logistic activities. In an article by Sedor [16] it is stated that half of the hospitals in the USA are using EDI. Shafarman et al. [17] describe the experiences with implementing an EDI-based system for transmitting laboratory test reports from a laboratory system to a clinical database. Cahill et al. [18] report that the use of EDI proved to be beneficial because of shortening interface design efforts and providing common messages between various computer systems. Branger et al. [19] showed that the use of standardized letters, together with the use of E-mail, improved the speed of communication, decreased workload, and increased the general practitioner's understanding of the care delivered by other health care workers.

Similar to E-mail, EDI offers fast exchange of data but, in addition, it facilitates fully integrated data exchange between computer systems. Sophisticated computer hardware and software, and a well-organized, national message standardization body are necessary. Initial investments, therefore, are higher than for Fax or E-mail. Another difficulty is the shift in costs that occurs using E-mail and EDI. Using paper mail, the sender pays all, while using EDI the receiver is also charged. Especially organizations that have a considerable amount of outgoing mail (e.g., hospitals) might benefit from the use of EDI. General practitioners, on the other hand, receive more mail than they send out. This unbalanced situation will not stimulate the use of EDI, unless some ways are found to even the score.

2.2.4 Smart Cards

As health care becomes more complex and more care providers are getting involved, the question arises whether patients should carry their own medical record. Several options exist [20]. One of the possibilities is the use of a so-called Smart Card. A Smart Card is a card the size of a credit card, containing a microprocessor and a memory on a microchip. The Smart Card is essentially a compact, patient-held (part of a) medical record. In order to inspect data on the card or add data to the card, a special card-reading device is needed. This card reader is connected to a computer. In France, several projects are investigating the use of Smart Cards in health care [21]. In two separate papers, Benson [22] and Hopkins [23] report on the British Exeter Care Card project. In this project, family physicians, pharmacies and hospitals participate: around 8500 patients were issued a Care Card. Data are stored using the Read Clinical Classification [24]. The Care Card is protected by a code, only known to the patient. When a patient visits a physician, the card will reveal its content only after the patient has typed in his code on a terminal. In this way the patient can choose freely which physician to visit, without the risk of loss of information, or the need to tell his medical history all over again. The patient can inspect his own card if he wishes to. The authors state that the use of the Care Card offers physicians an up-to-date, accurate patient' history (including test results and medication). They report a reduction of time needed by the GP for gathering information and in carrying out investigations [25]. The average percentage of cards carried by the patients in the Exeter trial was over 80%. Not everyone is convinced, however, of the potentials of smart cards. Smith [26] argues that the Exeter Care Card project failed, because of imprecise aims and bad luck.

Ideally, the smart card offers a patient-held medical record so that patients, wherever they go for medical treatment, always carry their relevant data with them. There are, however, drawbacks to the use of smart cards. Apart from the fact that the use of smart cards is expensive, and that their storage capacity is still limited, patients may lose the card so that a backup will always be needed. And if this backup exists, why not simply link up the systems that contain the data [27]? Furthermore, Regan [28] argues that the heralded sovereignty of the patient over his own medical data is very questionable: refusing access to the data to some organization will probably rule out receipt of the service required.

2.3 Computer networks

In the process of decision making, health care professionals routinely use data originating from many different sources. Usually each hospital department, such as the laboratory or radiology has its own database and analysis programs. Ideally, a physician sitting at a workstation is able to access these data efficiently. Timely delivery of the correct information is crucial. This means that a workstation must be able to collect and present the data coming from different information systems without bothering the physician about how to access all these computers and how to transport and convert that data. To acchieve this goal, information systems are linked by computer networks.

In this section we briefly describe some of the most common used media. The intention is not to present a complete overview, but to give an idea of what is available today in terms of communication speed and standards. A more extensive discussion on this subject has been published recently [29].

2.3.1 ISDN

ISDN stands for Integrated Services Digital Network. The main principle of ISDN is to provide the user with a single interface to the existing telephone network to utilize the switching services of the network to establish multi-channel digital links [30,31]. A pre-requisite is the digitalization of the public telephone network, which is underway worldwide.

ISDN connections can be used for all kinds of digital data, such as voice, text, data, signals and pictures. This means that a connection made by simply dialing-up opens the possibility of multi-media communication. This requires of course standardization of the workstations used. An ISDN link contains several logical channels. The CCITT (Comité Consultatif International pour le Télégraphe et le Téléphonie) has specified two different interfaces [30]:

- Basic Rate Interface (BRI). This contains two information-bearing channels (B-channels) of 64 Kb/s each, and one signal channel (D-channel) for network control information. The data channel is used for network signalling and control (e.g., dialing, status, flow control, error control, etc.). It uses small data packages instead of dialing tones. The total bandwidth of 64 Kb/s is not needed for control, so it can also be used for a packet-switch type of data transfer. Each channel is designed for full duplex communication. All logical channels are time-multiplexed onto the same physical information carrier, which is for the short distance a pair of copper wires. Total maximum potential is 144 Kb/s.
- The Primary Rate Interface (PRI) is intended for larger numbers of channels. In the USA and Japan, 23 B-channels and one D-channel of 64 Kb/s each are used. In Europe, 30 B-channels, one D-channel, and a framing channel of 64 Kb/s each are used, which allow for 30 logical communication channels. The framing channel is needed because the D-channel is not sufficient for all the signal information of 30 B-channels. The total maximum transfer rate is 1.4 Mb/s.

2.3.2 Ethernet

At present, the Ethernet is the most common used medium for Local Area Networks (LANs). It consists of a simple coaxial cable that connects computer workstations with each other. Each workstation has (world-wide) a unique Ethernet address. Using Ethernet, each workstation can transmit data to other workstations. The data is transmitted as packets of bits, using a well defined frame which also contains the Ethernet address of the sending and receiving system. The bandwidth supported by Ethernet is 10Mbits/s.

2.3.3 Token-ring

The Token-ring technology also uses a simple coaxial cable of twisted pair cable. This cable connects computer workstations in a ring structure. A so-called *token package* is passed on from workstation to workstation. Only the workstation that is in possession of the token package is allowed to transmit data. If a workstation wants to transmit a package it waits fot the token package to arrive. It then temporarily keeps the token package, transmits it's own data and releases the token package afterwards. The bandwidth of tokenring is 16Mbits/s.

2.3.4 FDDI

The FDDI (Fiber Distributed Data Interface) is used to connect bridges or LAN segments. An FDDI backbone can operate on 100 Mbits/s. The capacity of the fiber optic technology enables transmission capacity in the multi Gbits/s ranges. The error rates in optical cables are very low. These means that most error checking protocols can be done by higher levels. Simple algorithms can be fully hardware implemented speeding up the effective transmission rate. B-ISDN uses a simplified packet switching protocol called ATM (Asynchronous Transfer Mode), which is compatible with the IEEE 802.6 MAN (Metropolitan Area network) standard. Bits are transmitted in fixed cells of 48 bytes with a 5 byte header. Another important feature of ATM is that routing is entirely done in hardware implying that the delay at each switch when a cell arrives is minimized.
On optical links this can result in transmission speeds between 50Mbits/s and 600 Mbits/s. With synchronous protocols much higher transmission rates can be obtained.

2.4 Communication applications in health care

The availability of the communication methods mentioned above has led to a large number of projects in which data collection and data communication is being done using computer systems. In this section we will give examples of such projects: we have divided these projects by subject. This division is not always definite; a number of projects could easily be appointed to other (related) subjects, dependent on the weight given to certain aspects of the project.

2.4.1 Telemedicine

It is not always possible that patients and medical specialists are at the same location. Medical data such as ECG tracings or radiographs are usually obtained by trained technicians. Especially in rural areas, centers can be equipped with data acquisition equipment, but the data will then have to be transmitted to a medical center where specialists are available to interpret the data. This situation, where patient and physician are at a different location, and medical data are exchanged between the two locations and interpreted by physicians elsewhere, is called *Telemedicine*.

Lear et al. [32] studied the possibility of using an ISDN network for the transmission of radiological images. The authors state that the limited usage of tele-radiology was caused mainly by the slow transmission rates of telephone-based systems, while the faster satellite communication systems were still too expensive. Banifatemi [33] describes a system where French physicians in rural areas can obtain diagnostic support from university hospital physicians for the interpretation of endoscopic and radiologic images. McDaniel et al. [34] underscore the need for a Wide Area Network (WAN) in rural areas in Canada to allow for communication between physicians.

2.4.2 Population surveillance

From a public health point of view, it is beneficial to have insight in prevalence and incidence of diseases, and the spread of diseases over different regional or global areas. Therefore, projects have been started in a number of countries, involving networks of physicians gathering disease data, which are compiled in a central database. These data are used for epidemiological studies, and for monitoring of, e.g., the spreading of an influenza epidemic.

Gathering data using paper-based documents may lead to transcription errors, thus endangering the validity of the database. Another problem, observed by Bean et al. [35], is that paper-based reporting is too slow for monitoring trends. The Centers for Disease Control, therefore, use a PC-based electronic reporting system for entering data locally, and E-mail for sending the data to regional or national offices. This has led to a faster availability of disease data and a reduction in paper handling. Salamon et al. [36] describe a similar telematics network, located in France. This network uses data, entered by GPs, for epidemiological surveillance. Another project, the French National Communicable Diseases Network, explored the possibility to detect and predict certain epidemics, such as influenza [37]. The authors conclude that monitoring of communicable diseases using telematics worked better than the original paper-based approach. The participating physicians especially liked the possibility to receive a quick feedback about the development of epidemics, and were probably more eager to participate than with the paper-based method, which did not supply this feedback.

2.4.3 Cost control

In business environments, one of the reasons for using telecommunication is cost control. When delivering care to individual patients, it is difficult to measure financial effects of improved communication. Several researchers, however, have argued that improved communication can decrease expenses in the field of logistics and the handling of mail. Parker [38] estimates that the use of the Fax in his surgical unit (six surgeons) would result in a net saving of UK£ 19,900 (approx. US$ 30,000) over a period of ten years. Neal et al. [39] describe the use of EDI for controlling a hospital pharmacy inventory. The use of EDI reduced the amount of time spent on placing daily orders to the wholesaler from 3 h to 1.5 h. Also, the drug turnover rate showed an increase from 10.8 to 12.5 in the first half year after the introduction of EDI. The authors conclude that EDI provides an efficient and effective way to control pharmacy inventory. Mahoney [40] describes the reorganization of pharmacy services in a 719-bed teaching hospital in Rhode Island, USA, by which substantial savings were established. The number of pharmacy dispensing offices were reduced from 12 to 2. Fax machines were installed for the transmission of medication orders.

2.4.4 Access to medical databases

In managing a patient's care, health care professionals routinely use large amounts of information. Part of this information comes from computerized medical databases. An example of such a database is the National Library of Medicine's MEDLINE literature system. In a prospective study, Klein *et al.* [41] showed that physicians performed more MEDLINE searches for handling severely ill patients than for patients with milder disorders.

Moreover, patients for which physicians performed MEDLINE searches, those whose searches were conducted earlier had statistically significantly lower costs, and lenghts of stay than those whose searches were conducted later.
Because computer networks are used to link up these databases, physicians are able to access remote information sources using their desktop computer. Nowadays many such network information sources are available. These sources may be document information sources, such as library systems, but also computational information sources, such as specialized statistical tools. An example of such an integrated resource and information sharing network is the Integrated Advanced Information Management System (IAIMS). The IAIMS program was initiated by the NLM in 1983. In his recent review article, Clayton mentions that through 1994, the NLM has donated to 21 institutions more than $34 million in funding for their IAIMS activities [42]. One of the oldest IAIMS initiaitives is located at the Columbia-Presbyterian Medical Center in New York [43].

Presently, the fastest growing network is Internet. Internet is a further development of ARPANET, which was started in 1969 as a military network experiment, linking together major research centers in the United States. Glowniak *et al.* estimate that, in Januari 1994, Internet connected approximately 2,217,000 computer hosts from 230 countries [44]. Using Internet, people all over the world can use electronic mail, log into any computer system, and retrieve documents, pictures, and executable programs. Finding that particular computer host which offers the desired information, however, can be a difficult task. Nowadays several software packages exist, based on client-server priciples, that help the user to find the desired information. Services available on Internet include *Gopher servers* (text-based, providing access to files or services), *Archie servers* (performs keyword searching of registered public file names on the Internet), and *World-Wide-Web (WWW) servers* (Hypertext-based servers offering multimedia information) [44]. An example of a WWW server offering medical information is OncoLink [45]. This multimedia server provides information about several aspects of oncology, not only for physicians and nurses, but also for the general public. Oncolink, available since March 1994, is being accessed on average 36,000 times each month. The authors express high expectations with regard to the use of the Internet for the dissemination of medical information.

2.4.5 Imaging and Picture Archiving Systems

The use of Picture Archiving and Communication Systems (PACS), also known as Image Management and Communication Systems (IMACS), opens the possibility to use a computer network to transport, store and use image information together with patient information. An IMACS system can be within one hospital but may also serve several hospitals. The connection of varied imaging modalities and patient information systems requires communication between the systems. A well-defined protocol, communication speed, and accuracy are the most important issues to be considered. Currently, the image information originates from a variety of imaging systems such as CTs, MRIs, and radiographs. Advantages of using IMACS are:

- a case can be viewed simultaneously at different locations,
- possibility of post-processing of images (e.g., possibility to compensate for incorrect exposure which will reduce the number of retakes),
- reduction of the number of images lost or misplaced.

Lear et al. [32] state that, depending on the imaging modality, 0.2 - 2 Mbyte is required per image. On normal telephone lines the capacity is limited to 10 Kb/s, resulting in transmission times ranging from 3 to 30 minutes. Satellite communication would be faster: channels are available that can operate up to 400 Kb/s but ground stations are expensive (US$ 50,000) and charges for transmission costs are on average $1 per image.

At Hokkaido University, Japan, a 9600 bps modem on normal telephone lines was used to transmit CT images from the Nakashibetsu Town Hospital to the university hospital (420 km away) for diagnostic interpretation [7]. Twelve CT images on film were digitized, compressed by a ratio of 5 - 10 and then sent to the university. The interpretation was returned as a written report using Fax. The transfer of the film took 7 to 20 min (7 min with the highest compression factor and with no re-transmissions). The 12 CT images were stored on a 14 x 17 inch film (4 rows x 3 columns) and digitized in a 2000 x 2000 matrix which resulted in 512 x 512 pixels per CT image.

According to Levine et al. [46] the requirement for the matrix size of the images and the number of colors or grey-levels for IMACS can vary from 512x512 to 2048x2560 with 10-12 bits for the grey-levels. Lear et al. [32]

reported that it was possible to transmit radiographs that were digitized into 1024x1024 pixels and non-destructively compressed by a factor of 2:1 in less than 2 min using only one B-channel of an ISDN link. They found that only in 7% of the cases a re-transmission was required.

Paakkala et al. used a 512x512 matrix with 8-bit grey-scale radiographs [47]. These images were transmitted from rural areas, where no radiologist was available, to Tampere University for diagnostic interpretation. A 64 Kb/s digital transmission line was used to transmit the images (2 min per image). Two radiologists evaluated the quality of the images and recorded all pathological findings independently. Three months later the original radiographs were interpreted by the same radiologists and compared with the results of the transmitted images. Questionable cases were reviewed by a panel. The image quality was considered satisfactory in 73% of the transmitted cases and in 90% of the original films. The sensitivity for diagnostic findings was about 5% better in the original films.

Meyer-Ebrecht [48] states that the wish for a digital alternative to the radiography filing room was the stimulus for PACS systems. Digital image archives, however, go hand in hand with the installation of digital communication systems. In case a physician wants to view and evaluate images, he first has to retrieve them from the archive via a communication link. At the Aachen university hospital, Meyer-Ebrecht measured the time needed by radiologists for interpreting radiographic images. He found that the time needed to analyze a set of 2 to 12 X-rays was 0.5-2 min, and for a sequence of 20 to 40 CT or MRI images 1-5 min. He estimated the size of an X-ray at 10 Mbyte, a CT at 0.39 Mbyte and an MRI at 0.1 Mbyte per image. This means for a reporting session, when images have to be retrieved from a digital archive to the computer system of the radiologist, an average data transfer rate of 3 Mb/s and in extreme situations up to 10 Mb/s. Radiologists judge that the latency time for retrieving an image should not exceed 2 s. This means that the required data transfer capacity should be between 57 and 335 Mb/s. At present, most hospital networks do not meet these requirements.

2.5 Standardization

2.5.1 What should be standardized

In medical informatics, communication is no longer restricted to dedicated point-to-point connections within one department or institution. Health care providers in different organizations and different locations exchange messages in either textual format or as special types of data, such as images, ECG signals, etc. This requires standardization on different levels, of which Mattheus [49] distinguished three:

1. Health-Care specific

Most communication deals with patient-related information. Health care providers have to agree on the protocols used for 'shared care'. This is a standardization activity that primarily belongs to the medical field, but the medical informatics discipline should provide the framework. The Medical Data Interchange standard (MEDIX standard P1157 of IEEE) [50] aims at developing models for the health care environment. Within CEN (European Standardization Committee), Technical Committee 251 (TC-251) is working on standards for health care terminology and medical concepts (semantics). Working Group 2 of TC-251 is concerned with health care terminology, semantics and knowledge bases.

2. Information-technology related

Standardization of, for example, information models, data models, and EDI messages, is needed to create an *Open Architecture for Medical Information Systems*. Within TC-251 three Working Groups (WGs) are responsible for this task:

WG1 : Health-care Information Modelling and Medical Records,
WG3 : Health-care Communications and Messages,
WG4 : Medical Imaging and Multimedia.

3. Telecommunication-related standards

Medical Informatics should not re-invent the wheel but make as much as possible use of existing standards.

2.5.2 Standardization activities

The EC has many activities going on in this field [51]. The latest one is the AIM project A2055 'TRILOGY' [52]. The mission of the TRILOGY project is *To establish an Open European Framework for the provision and exploitation of Health Care Telematics Services derived from and validated against the practical results of Operational Trials, building on the work of key AIM main phase projects.* The project will provide a framework for the implementation of Health-care Telematics Services, and the implementation of already developed telematics services, rather than carry out new research and will guide and monitor practical implementations based on some 15 regions in 5 domains.

Harrington et al. [53] describe the framework model for Health care IT as developed by the Medical Data Interchange (MEDIX) Committee of the IEEE in project P1157. This model has been reviewed and accepted by the HISCC (Health care Information Standards Coordinating Committee). P1157 also distinguishes three levels:

- Actual Health-care Environment,
- Information Model,
- Computational/Communication Model.

The long-term scope of the IEEE P1157 effort is medical data interchange for the entire field of health care. The initial phase emphasizes medical data interchange at the departmental level within the hospital setting. Standardization of the model is restricted to those aspects of the overall environment which are shared between multiple applications, and related to instances of information exchange between heterogeneous systems.

The HL7 Working Group is now working in cooperation with the IEEE P1157 in developing MEDIX [54]. HL7 stands for Health Level 7, which relates to level 7 of the OSI model (Open Systems Interconnect) of the International Standards Organization. Level 7 is the applications level, while levels 1 through 6 deal with hardware levels, data packages, networking, etc. The HL7 group started its work in 1987 and has developed standards for transmission and communication control structures as well as protocol formats for certain domains. HL7 defines transaction sets, which are specifications of data flows corresponding with so-called triggering events. Triggering events are, for example, admitting a patient, or ordering a laboratory test. For each transaction set the initiating messages and response messages are defined. A message is defined as consisting of a set of data segments in a specific sequence. A message segment consists of a structured group of related data elements. The standard also defines the structure of the messages, and the field delimiters used. HL7 assumes the presence of a network capable of exchanging the messages as described by HL7.

Closely related to HL7 is the EDIFACT standard [55]. EDIFACT stands for Electronic Data Interchange For Administration, Commerce and Transport. It defines the syntactical rules for the messages in a similar way as HL7. The European standardization Committee for Medical Informatics CEN/TC 251 has selected EDIFACT as one of the possible Interchange Formats (IF).

The standards activities described so far all relate to the health care sector as a whole. Standards relating to communication are also defined for special domains in health care.

2.5.3 Standards in image processing

Transport of images is needed for remote consultation of radiologists and in a hospital environment when the archiving of film images is replaced by a digital archive. In the first case, public communication facilities have to be used, while in the latter dedicated high-speed data links can be used. The acceptable latency time in transferring images is in the latter case significantly lower than in the first case. The requirements of the PACS systems exceed the capacity of existing networks. Meyer-Ebrecht [48] reports that Ethernet gave an effective transfer rate of 3 Mb/s (disk-to-disk), while a 100 Mb/s FDDI (Fiber Distributed Data Interface) resulted in 14.4 Mb/s. Therefore, he concluded that it will be unavoidable to develop networks specifically tailored to a PACS environment.

The generation, processing and management of information is achieved by distributed devices. In a PACS environment all these heterogeneous components have to exchange messages and data. The DICOM (Digital Image COMmunication) standard describes the logical and functional relations between images and non-image information by its data structures and protocol definitions. The DICOM standard is being developed by the American College of Radiology (ACR) and the National Electronics Manufacturing Association (NEMA) [56]. The DICOM standard describes the structure of the data sets in such a way that the data set itself describes the formats of its content. The content of a data set is contained in data elements which can be grouped in chains of data of the same type. Groups and data elements have a header describing the content format. For image data, the header contains information about, e.g., matrix size, encoding scheme, or exposure data. The DICOM protocol exchanges information by means of DICOM messages. A message is composed of the DICOM data set preceded by the command group. The command group controls the transmission of a data set and initiates the execution of PACS-specific functions by the addressed devices.

European standardization activities concerned with the specification of structures for medical images and related data created the CEN *MEDICOM* proposal which attempts conformity with ISO/IEC CD 12 087 IPI (Image Processing and Interchange), DICOM and other standards and pre-standards.

2.5.4 Standards in laboratory systems

The ASTM E1238 standard specifies the transfer of laboratory test requests and laboratory test reports, and care provider observations [57]. The EUCLIDES standard describes message syntax, transfer mechanism, and the coding systems used within the message [58].

2.6 Concluding remarks

Communication between health care providers attracts much attention, as is shown by the many articles published on the subject. The American College of Emergency Physicians even states that *use of facsimile (FAX) and electronic data transfer should be available to each emergency department* [59]. Several researchers have argued that replacing current paper-based communication with electronic communication holds potential benefits, both from a financial and a medical point of view. It is obvious, however, that investments and organizational changes may be needed to achieve these benefits.

Because of its easy operation and low cost, Fax technology has earned itself a place throughout society. It provides fast transmission of documents, and is especially suited for situations in which processing and interpretation of the documents by the receiver is not different from handling paper mail. This makes the Fax the ideal choice for a fast and uncomplicated implementation in medical practice. Examples of such situations are physicians working in rural areas, who can use the Fax to transmit, e.g., fetal heart rate recordings to hospital-based experts for treatment advice [60]. It is likely, however, that computer-based patient records will oust paper records from medical practice: in such an environment more sophisticated solutions than Fax technology can be applied

When care providers use computer-based patient records, communication between these systems can be highly automated, which offers several advantages. For a number of health problems, for example, shared care protocols have been developed, involving division of tasks between health care providers from different disciplines [61]. Optimal communication is considered to be a vital aspect of shared care, both from medical and cost effectiveness points of view [62], but physicians often lack the time to comply with the protocol. The use of computer-based medical records and electronic communication can facilitate shared care, by assisting physicians in maintaining high quality communication by automatically generating messages for co-treating physicians. Content and frequency of these messages are defined in the shared-care protocol, the information systems take care of timely exchange of the relevant data. To do so, standardization of messages is necessary, not only with respect to the syntax of messages, but also the semantics [63], and medical procedures.

Patient-held medical records (such as Smart Cards) may also be a good choice when patients visit different physicians, without one physician acting as coordinator of the delivered care. Using a smart card, the patient carries all his important medical data with him, so the physician will always have a clear overview of the patient's medical situation. This card can also be used for communication between physicians. Problems arise, however, when the patient forgets to bring the card with him or, worse, when the card gets damaged or lost. A backup system, therefore, will always be necessary. Regan expects physicians to be reluctant to add information to the card, because of the unknown future audience that will be inspecting his entries [28]. The question whether HIV-infected patients should carry an identity card suggests that Regan has touched a very important issue: as stated in a collection of letters by Srivastava et al. [64], "Medical gossip is more transmissible than any infection yet known in nature". It is feasible to use Smart Cards for storing data such as present medication, allergies, and blood type. Using these cards for complete medical records is in our view unnecessary and potentially harmful to the patient.

Communication links in health care can roughly be divided in intra-mural (within-hospital) and extra-mural communication. In extra-mural communication the Fax is more and more being replaced by EDI which allows a higher degree of automation of communication and guarantees a better privacy protection. Smart Cards can play a role in this situation but have a severe drawback that transportation of the information is still manual. Hospital-based physicians and nurses get their information from many places, such as laboratories, the pharmacy department, the X-Ray department etc. Fast communication of pictures and data is required. This requires standardization of message exchange protocols such as HL7 and standards to exchange graphical images such as DICOM. Suppliers of Hospital Information Systems and suppliers of Departmental Systems will have to provide these standard interfaces. Many efforts are currently being made to improve the communication structure in the hospitals.

As health care becomes more complex, with care providers from different disciplines involved in the delivery of care, the quality of communication influences the quality of care [65]. Protection of privacy of both patient and physician is an important issue in health care, not only in relation to information technology. From our own observations, however, we conclude that people tend to demand more preventive actions when information technology is involved, than with the original, paper-based storage and transmission of medical data. We believe that protective measures (for example passwords and encryption) guarantee privacy of patients at least as good as is the case with paper-based mail.

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Chapter 3

Electronic communication between providers of primary and secondary care

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Abstract

Objective-To study the effects of the introduction of electronic data interchange between primary and secondary care providers on speed of communication, efficiency of data handling, and satisfaction of general practitioners with communication.
Design-Comparison of traditional paper based communication for laboratory reports and admission-discharge reports between hospital and general practitioners and electronic data interchange.
Setting-Twenty-seven GPs whose offices were equipped with a practice information system, and two general hospitals.
Outcome measures-Paper based communication was evaluated by questionnaire responses from and interviews with care providers; electronic communication was evaluated by measuring time intervals between generation and delivery of messages and by assessing doctors' satisfaction with electronic data interchange by a questionnaire.
Results-Via paper mail admission-discharge reports took a median of 2-4 days, and laboratory reports 2 days, to reach general practitioners. With electronic data interchange almost all admission-discharge reports were available to general practitioners within one hour of generation. When samples were analysed on the day of collection (as was the case for 174/542 (32%) samples in one hospital and 443/854 (52%) in the other) the laboratory reports were also available to the general practitioner the same day via electronic communication. Fifteen general practitioners (of the 24 who returned the questionnaire) reported that the use of electronic admission-discharge reports provided more accurate and complete information about the care delivered to their patients. Ten general practitioners reported that electronic laboratory reports lessened the work of processing the data.
Conclusion-Electronic communication between primary and secondary care providers is a feasible option for improving communication.

3.1 Introduction

In the Netherlands, as in the United Kingdom, general practitioners functions as gatekeepers between primary and secondary care. Good communication between primary and secondary care providers is therefore essential for coordinating care for individual patients and providing continuity.

Previous research has highlighted the problems of communication between primary and secondary care providers. These studies have shown both the poor quality of information provided and the delays in receiving it [1-8]. In particular, some of these delays jeopardise continuing care, especially in elderly patients [5].

New technologies are now emerging that have considerable potential for improving communication. One such technology is *electronic data interchange*, defined as *"standard electronic messages conveyed from one computer to another without manual intervention"* [9]. In The Netherlands several organisations have cooperated to standardise messages in health care using the Edifact standard [10,11], which describes the syntax of messages. Several standardised messages are available, including a laboratory report and an admission-discharge report. Using such a standardised message a laboratory can, for instance, transmit test results electronically to a general practitioner's computer system, which can then manipulate and store the data automatically.

In the Netherlands the infrastructure required for electronic data interchange is emerging. Many hospitals already have had years of experience with information systems, and in primary care computer based patient records are gaining ground rapidly. At present half of all Dutch general practitioners (over 3000) are using an information system in daily practice, and 1300 of them are using computer based patient records.

In this paper we describe a project that studied electronic communication between hospitals and general practitioners. The aims of the study were (a) to introduce electronic data interchange in a health care environment, (b) to assess the gain in speed of delivery of reports achieved using electronic data interchange instead of paper mail, (c) to measure the influence of electronic data interchange on handling of data in daily practice, and (d) to evaluate its potential to support doctors in achieving continuing medical care.

3.2 Methods

In the city of Apeldoorn the communication project was started in 1988, with 27 general participating. Sixteen were single handed, eight worked in two person practices, and three worked in health centres and together they provided care for 50,000 patients. The two regional general hospitals (hospital 1 and hospital 2) participated in the project. All general practitioners were using the general practitioner information system Elias [12]. In addition to financial and administrative functions Elias provides a computer based patient record that is used by the general practitioner to maintain patient data.

Electronic Communication
In December 1989 three type of electronic messages were introduced: admission-discharge reports from hospital to general practice; laboratory reports from hospital to general practice; and free text messages between general practitioners. The free text messages were unstructured plain text, whereas the admission-discharge reports and the laboratory reports were transmitted as structured, standardised messages. The general practitioner's information system used the admission-discharge reports to create and update automatically an overview of admitted and discharged patients [13]. The general practitioner could obtain a printout of this computer based overview, optionally combined with relevant data from the computer based patient record, to be used as a memorandum for home or hospital visits. After verification by the general practitioner, data from laboratory reports were stored automatically in the patient record.
We used a commercially available communication network, on which each hospital and general practice had its own electronic mail address. The costs of this network were an entrance fee of Dfl 100, a monthly subscription of Dfl 15, and a charge of Dfl 1.50 per message of 225 lines.

Evaluation
The evaluation consisted of four phases.
Baseline study-Before the introduction of electronic data interchange we sent general practitioners a questionnaire that elicited practice characteristics, how long admission-discharge reports and laboratory reports took to arrive by mail, and the amount of communication among general practitioners. We also conducted personal interviews at the two hospital

patient administration departments and laboratories to assess the methods used to generate and send reports.

Message flow measurements-After electronic data interchange had been implemented we measured over 10 weeks (January-March 1990) the time between generation of all admission-discharge reports and all laboratory reports in the two hospitals and arrival of those messages at the general practitioners' offices. During the last three weeks of the study period we also measured the time between the arrival of the messages at the general practitioners' offices and reading of the message by the general practitioners. To perform these measurements we added programs to the hospital computer system and to Elias that recorded generation and use of the message, and, after removing data that could identify patient or doctor, automaically sent a copy of the message and the measurements to our research computer. We could not perform measurements on free text messages because it was impossible to eliminate the risk of violating privacy. At this time 21 general practitioners had started using electronic data interchange. The other general practitioners started two to four weeks later so they did not participate in this part of the study.

Efficiency study-We evaluated whether electronic data interchange increased the percentage of laboratory test results stored in Elias by the general practitioner and whether it reduced transcription errors. For three months before and three months after the introduction of electronic data interchange we collected laboratory test results from the hospital laboratory system and compared these data with the data held in the computer based patient records of seven general practitioners.

User satisfaction study-To assess the level of user acceptance we sent general practitioners a questionnaire after they had had three months' experience with electronic data interchange. We asked them whether electronic admission-discharge reports provided more accurate information on the care being delivered to their patients than paper reports; whether electronic laboratory reports demanded less work to process than paper reports; and whether the use of electronic mail for exchanging patient data had improved communication between general practitioners.

3.3 Results

Baseline study

Three times a week hospital 1 produced for each general practitioner an admission-discharge report, containing a list of admitted and discharged patients. This list was then mailed to the general practitioners. In hospital 2 each general practitioner had a mailbox in which a copy of the patient's identity card was placed at the time of admission or discharge; the general practitioner emptied this mailbox whenever he or she was in the hospital. The median time between the admission or discharge of a patient and delivery of the admission-discharge report at the general practitioner's office, as estimated by the 24 general practitioners who returned the questionnaire, was 2 days for hospital 1 and four days for hospital 2 (Table 1).

Table 1-Estimated time intervals for admission-discharge reports and laboratory reports when traditional mail delivery was used.

	No of GPs reporting an average time in days of							
	1	2	3	4	5	6	7	No answer
Admission-discharge reports								
Hospital 1	1	10	6	1				6
Hospital 2	4	3	2	2	5		2	6
Laboratory reports								
Hospital 1	3	11	6	3	1			
Hospital 2	7	11	5		1			

At both hospital laboratories sample taking and analysis were done throughout the day, whereas laboratory reports were generated only once a day (at about 4.00 pm). Results of emergency tests ordered by general practitioners were reported by telephone as soon as they became available. Sometimes general practitioners had to wait three days or longer for non-emergency results because the test was not performed every day - for example, thyroid function tests were performed only once a week; the sample was obtained shortly before the weekend and was reported on Monday; or the test was performed at a specialist laboratory at a different location. The median time between printing of the laboratory report and delivery of the report to the general practitioner's office, as estimated by the general practitioners, was two days for both hospitals (Table 1).

Communication between general practitioners about patients occurred most often when, during a night or weekend shift, one general practitioner saw another general practitioner's patient; the first would usually write a note describing this consultation and would put the note in the mailbox at hospital 2 or at the office of the general practitioner. In some cases the telephone was used.

Message flow measurements

During the 10 week period 1388 admission-discharge reports and 1396 laboratory reports were sent electronically. Admission-discharge reports were generated and transmitted twice a day and laboratory reports once a day. Almost all electronic admission-discharge reports were available to the general practitioners within one hour of generation (Table 2).

Table 2 - Time from generation of admission-discharge reports and its availability to the general practitioner when transmitted electronically.

	Time (hours)			
	1	2	3	>3
Number of reports	1269	78	20	21

Of all electronic laboratory reports, 174/542 (32%) from hospital 1 and 443/854 (52%) from hospital 2 were available to the general practitioners on the day that the samples were collected (Table 3). The remaining reports arrived later because analysis of the samples was delayed.

Table 3 - Time interval (hours) between generation and delivery of electronic laboratory reports. Results are numbers of reports.

	0-8	9-16	17-24	> 24	Total
Hospital 1	443	23	70	318	854
Hospital 2	174	3	33	332	542

The median time between the messages becoming available to the general practitioners and the general practitioners reading them was 0-4 hours for five general practitioners, 4-8 hours for four general practitioners, 8-24 hours for five general practitioners, 24-48 hours for four general practitioners, and more than 48 hours for three general practitioners. The time measurements were not adjusted for off duty hours and holidays, during which general practitioners did not work with Elias.

Efficiency study

All 7 general practitioners stored more test results with than without electronic data interchange (Table 4). We checked for errors 3635 test results entered in Elias manually and 5633 test results entered electronically. Among the results entered manually we found 19 errors (0.5%); in those entered electronically we found none.

Table 4 - Numbers of laboratory tests requested and stored in the computer based patient record by individual general practitioners without and with electronic data interchange.

	Without electronic data interchange		With electronic data interchange	
GP	No requested	No (%) stored	No requested	No (%) stored
A	1732	1139 (66)	1775	1266 (71)
B	1485	1324 (89)	1389	1286 (93)
C+D	3400	2239 (67)	4396	3191 (73)
E	735	616 (84)	1061	897 (85)
F	2030	1515 (75)	2003	1506 (75)
G	622	244 (39)	552	384 (70)

User satisfaction

Of the 27 general practitioners, 23 returned the questionnaire on user experience with electronic data interchange. All except one general practitioner used free text messages for exchanging patient information. When asked to rate the benefits of this type of message on a scale of 0 (useless) to 5 (very useful), 16 general practitioners scored 5, four 4 , one 3, and two 2. Fifteen general practitioners reported that use of electronic admission-discharge reports had provided more accurate knowledge on the care being delivered to individual patients. For the benefits of this type of message, 5 general practitioners scored 5, ten 4, four 3, three 2, and two 1.
The use of electronic laboratory reports has two possible benefits: increased speed of reporting and integration of tests in the computer based patient record. For speed of reporting, six 6 general scored 5, three 4, nine 3, four 2, and one 1. Integration of tests into the computer based patient record, however, was valued much higher: 17 general practitioners scored 5 and six 4. Ten general practitioners reported a decrease in workload.

3.4 Discussion

This first attempt to introduce electronic data interchange in Dutch health care was successful. Electronic communication between hospitals and general practitioners has led to shorter delays in transmission of admission-discharge and laboratory reports to the general practitioners; it improved the amount of information recorded in general practitioners' computer based patient records and its accuracy; and most general practitioners were satisfied with these results. The network has remained in operation after the completion of the study period, and the general practitioners have integrated electronic communication into their daily practice. Thirty four general practitioners in Apeldoorn now use electronic communication.

The aim of this study was to test the feasibility of electronic communication in Dutch health care in a representative health care region. We therefore designed the electronic communication system so that it would not depend on any local factors and used a nationally available communication network and standardised messages.

Our results suggest that using electronic data interchange creates new possibilities for improving communication: admission-discharge reports are now issued twice a day, and general practitioners thus have an up to date overview of their patients in hospital. Most of the general practitioners judged that their knowledge about the care being delivered to individual patients had increased with the use of electronic data interchange. This contrasts with the situation with paper based communications. Several studies have found poor quality information transmitted between general practitioners and hospitals [1,2,5,6] and delays in sending it [3]. Mageean, for example, found that half of discharged patients had contacted their general practitioner before the general practitioner had received any information from the hospital [4]. Doeleman has argued that improved communication leads to improved cooperation and quality of care [8]. We found that the general practitioners in our study greatly appreciated the use of free text messages for exchanging information on patients, especially for reporting patient encounters during night and weekend shifts.

The use of electronic data interchange for integrating laboratory test results into the computer based patient record led to a decreased workload for 10 out of 23 general practitioners. When test results are entered manually into the Elias system the program performs validity checks, thus presumably preventing most transcription errors. Even so we found that 0.5% of the test values entered manually into the computer based patient record were wrong. When the test results were entered electronically no such errors were observed.

We conclude that electronic data interchange has the potential to increase the efficiency of processing of information and to support continuity of medical care provided by general practitioners. Ament and L'Ortye report that a Dutch hospital spends Dfl 1000 to Dfl 1500 (£300 to £500) on communication per general practitioner per year and conclude that electronic communication will lead to substantial cost savings in hospitals [14]. General practitioners on the other hand, must pay for communication they previously got for free. In Apeldoorn the users of the communication network share the costs. How in the future people will pay for widespread use of electronic communication, however, is an issue to be negotiated by hospitals, care providers, and health insurance companies. This financial issue must be clarified before large scale introduction of electronic communication is possible.

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Chapter 4

Problems in communication between general practitioners and internal medicine consultants

Accepted for publication
Medical Informatics

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Abstract

Using a postal questionnaire, we studied the types of problems that general practitioners encounter in the communication with internal medicine consultants, and the consequences that occur as a result of these problems. Possible solutions to these problems were analyzed, especially the use of electronic mail.

The questionnaire was sent to 363 general practitioners in two regions in The Netherlands; replies were received from 144 (40%). Of these respondents, 47 (33%) reported a total of 82 communication problems with the internist concerning the patient described in the most recent letter received from an internist. The most frequently reported problems were: failure of the internist to report in good time when referring the patient back to the general practitioner (15; 10%); failure of the internist to provide sufficient detail in intermediate reports (15; 10%). In 39 of the 47 patients in which problems occurred, these problems led to a total of 58 consequences. The most frequently reported consequences were irritation caused to the general practitioner (15; 10%) and irritations caused to the patient (13; 9%). We conclude that communication problems mainly arise from too late delivery of information, and a lack of understanding by the internist of the information needs of the general practitioner. Personal contacts between co-treating physicians, and well-established protocols are key elements in providing good cooperation between physicians. Electronic mail may be a good option to assist physicians in maintaining protocol-based communication.

Keywords: Communication, Shared Care, Electronic Mail, Family Practice

4.1 Introduction

Exchange of patient information between care providers is essential for quality of care, especially when several physicians are treating the same patient independently. Previous studies have indicated that in such a shared care situation information exchange could be improved, by a better content of information exchange [1-4] and by a more timely deliverance of this information [5-7]. At present, communication between care providers is mostly done by means of paper mail, but interest for electronic information interchange is gaining ground. Several authors have emphasized the potential of electronic communication to facilitate the exchange of information in health care [8-13].

Fuelled by the introduction of computers in both hospitals and primary care [14], and by studies demonstrating the feasibility of electronic information interchange in health care [8-13], researchers have high expectations regarding the impact of electronic communication [15]. Little is known, however, about the extent to which specific communication problems, encountered by physicians, can be alleviated by electronic data transfer or whether additional measures are needed. Therefore, we performed a study to evaluate (a) the problems that general practitioners encounter as a result of insufficient communication with internal medicine consultants, and (b) the consequences arising from these problems. We categorized the encountered problems and analyzed the possible solutions to these problems, including electronic communication.

4.2 Methods

We designed a postal questionnaire aimed at obtaining an overview of communication problems between general practitioners and internists. We chose the general practitioner for this study because, in The Netherlands, the general practitioner functions as a gatekeeper between primary and secondary care. Typically, patients first consult their general practitioner. If considered necessary, the general practitioner refers the patient to a specialist who reports the results of the treatment back to the general practitioner. Therefore, the general practitioner is the central physician and the ideal person to coordinate shared care.

The first part of the questionnaire asked general practitioners about their type of practice (e.g. a single-handed practice, a two-person practice, or a group practice), and their years of practice in primary care.
The second part focused on the most recent letter received from an internist. For the patient described therein, the general practitioners was asked whether, during treatment of that patient, problems had occurred in the communication with the internist. If so, the general practitioner was asked to describe the problem by either selecting one or more problems from a predefined list, or adding problems to that list (Table 1). The general practitioner was then asked to indicate which consequences (if any) arose from that communication problem, by either selecting one or more consequences from a predefined list, or adding consequences to the list (Table 2). Further, we asked what medical problem the patient was suffering from and, finally, we asked the general practitioner to qualify the general contact with the involved internist on a four-point scale: poor, mediocre, fair, or good.
Ample space was available for the respondents to include their own remarks about the quality of the communication.

The postal questionnaire was sent to general practitioners in two regions in The Netherlands in March 1993. We selected at random 128 of the 256 general practitioners in the Apeldoorn region, a predominantly rural area, with 3 larger cities, 30 smaller cities and villages, 3 hospitals, and about 500,000 inhabitants. In addition, 235 of the 470 general practitioners were selected at random from the Rotterdam region; a highly urbanized area, with 3 large cities, 14 smaller cities, a university hospital, 9 periphery hospitals, and about one million inhabitants. A total of 363 questionnaires were mailed. After two weeks, the non-respondents received a reminder; two weeks after that, the outstanding non-respondents were sent a new copy of the questionnaire.

4.3 Results

A total of 144 valid replies were received (40%): 56 (44%) from the Apeldoorn region, and 88 (37%) from the Rotterdam region. Eight questionnaires (2%) were returned unanswered; these general practitioners stated they had insufficient time to participate.

Of the 144 general practitioners, 78 were single-handed, 33 worked in two-person practices, 28 worked in a health centre or group practice, and 5 general practitioners did not answer this question. The number of years the general practitioner had practiced in primary care ranged from 1 to 37 (median 13) years.

Of the 144 respondents, 47 (33%) experienced one or more problems in communication with the internist about the selected patient. These 47 general practitioners reported a total of 82 problems: 27 general practitioners reported one problem, 11 general practitioners 2 problems, and 9 general practitioners 3 or more problems. Table 1 shows the reported problems; the two most frequently reported problems are, failure of the internist to report in time when referring the patient back to the general practitioner, and failure of the internist to provide sufficient detail in intermediate reports.

Table 1 - Problems encountered by general practitioners in communication with internists about patients subject of the most recent letter from an internist.

Problem	Occurrences (% of patients)
Outcome of completed treatment not reported in time	15 (10)
Intermediate reporting from internist insufficient	15 (10)
Patient's discharge not reported in time	10 (7)
Referral to other specialist not reported	9 (6)
Name of internist in charge not reported	9 (6)
Unclear what the patient was told about the disease	8 (6)
Changes in therapy not reported	6 (4)
Question in referral letter unanswered	3 (2)
Death of hospitalised patient not reported	2 (1)
Internist difficult to contact by telephone	1 (1)
Disagreement on medical issue	3 (2)
Not classified	1 (1)
Total number of problems	82
Total number of patients	144

Of the 47 general practitioners that reported communication problems, 39 reported that the problems resulted in a total of 58 undesired consequences: 25 general practitioners reported 1 consequence, 9 general practitioners 2 consequences, and 5 general practitioners 3 consequences. In the remaining 8 cases the problems did not result in undesired consequences. Table 2 shows the reported consequences; the two most frequently are, irritation caused to the general practitioner, and irritation caused to the patient.

Table 2 - Consequences resulting from communication problems with the patient subject of the most recent letter from an internist.

Consequence	Occurrences (% of patients)
Feelings of irritation by the general practitioner	15 (10)
Feelings of irritation by the patient	13 (9)
Sub-optimal therapy	11 (8)
Doubling of diagnostic tests	9 (6)
Relationship general practitioner-patient disturbed	2 (1)
Relationship general practitioner-internist disturbed	2 (1)
Relationship patient-internist disturbed	-
Disagreement on a medical issue	4 (3)
Not classified	2 (1)
Total number of consequences	58
Total number of patients	144

The encountered medical disorders are listed in Table 3. In the category without communication problems, patients with digestive tract disorders were the most common (23%), followed by patients for whom no diagnosis could be made (20%). In the category in which communication problems occurred, however, patients with multiple disorders prevailed (36%).

Table 3 - Reported medical disorders, grouped by patients with and without communication problems.

Medical disorder	No communication problem (n=97) Occurrence (%)	Communication problem (n=47) Occurrence (%)
Digestive tract	22 (23)	5 (11)
Endocrine (excl. diabetes)	4 (4)	2 (4)
Diabetes mellitus	6 (7)	3 (6)
Malignancy	9 (9)	5 (11)
Multiple disorders	9 (9)	17 (36)
Blood/lymphatic system	4 (4)	1 (2)
Circulatory system	9 (9)	2 (4)
Respiratory tract	5 (5)	0 (0)
Psychiatric disorders	4 (4)	0 (0)
Other	6 (6)	1 (2)
No disease diagnosed	19 (20)	11 (23)

In rating the general contact with the internist involved, 35 of the 47 general practitioners (74%) who reported communication problems judged the contact as fair or good, and 12 (26%) as mediocre or poor; whereas 83 of the 97 general practitioners (94%) who did not report any communication problems judged the contact as fair or good, and 5 (6%) as mediocre or poor.

Of the 144 general practitioners, 35 commented that good personal contacts between physicians were vital for a high quality of communication. Eleven general practitioners stated that a better organisational structure of both general practices and clinics would result in faster communication and better coordination. One general practitioner reported that, after years of practice experience, he had reduced the number of specialists that he referred patients to, to those specialists that he trusted and who were easy to cooperate with: pre-existing communication problems were thus eliminated.

4.4 Discussion

To improve communication, researchers have investigated several methods. One approach relies on *formal and informal meetings* between general practitioners and consultants to improve understanding and cooperation between primary and secondary care. Emmanuel and Walter, for example, report that regular discussions between general practitioners and consultants to evaluate the appropriateness of referrals may result in more efficient referral behaviour [16]. In a survey, Roland et al. identified aspects of orthopaedic outpatient referral in which general practitioners', consultants', and patients' satisfaction could be improved [17]; the changes suggested by the authors include, among others, improved information from hospital to general practitioner about available services, and better communication between general practitioners and consultants via formal and informal meetings.

A second approach is to *standardise the content of referral letters and replies from consultants*. Using a postal questionnaire to canvass the views of general practitioners and consultants, Newton et al. found a high degree of consensus about the content of referral communications; they subsequently suggested the use of standardised letters for exchanging information [18].

A third approach involves replacing the usual paper-mail delivery with *electronic communication*. Cowie, investigating an electronic mail system for transmitting laboratory data between two hospital departments, concludes that the system worked reliably, saved secretarial time, and eliminated transcription errors [9]. Branger et al. showed that the use of standardised letters, together with the use of electronic mail, improved the speed of communication, decreased workload, and increased the general practitioner's understanding of the care delivered by other health care workers [13].

In the present study, 47 of the 144 general practitioners (33%) reported a communication problem with the internist, about the patient described in the most recent letter. Over-optimistically assuming that none of the non-respondents experienced a problem with their last patient, communication problems occur in 12% of the patients, referred to the internist. The most frequent consequences are irritation caused to the general practitioner or irritation caused to the patient, sub-optimal therapy, and a disturbed patient-physician relationship. Contacts between general practitioners and internists appears to be worse in those cases in which problems occurred. This is, of course, not surprising, because it can be argued that, when this contact is bad, problems are more likely to occur.

The problems, reported in our questionnaire, can be divided into four different categories (Table 4): problems dealing with *separation of care*, with *coordination of shared care*, with *timeliness of information*, and with *medical disagreement* on care given to the patient.

The first category of problems concerns *separation of care.* In The Netherlands, the general practitioner may refer a patient to a specialist for a specific problem without continuing the care himself: the specialist becomes responsible for treatment of the specific medical problem and, until the patient is referred back to the general practitioner, the general practitioner is not involved in making treatment decisions or execution of treatment. Typically, the specialist will keep the general practitioner informed by means of short intermediate reports. The patient, however, might still visit the general practitioner for other problems; these other problems, the resulting diagnoses and therapy might influence the medical procedures of the internist and vice versa. Consequently, although care has been separated, a minimum information flow is required to ensure integration of care.

The second category deals with *coordination of shared care* supplied by general practitioner and one or more specialists. Often, especially with elderly patients suffering from multiple health problems, one or more specialists and the general practitioner jointly treat the patient. One of the responding general practitioners reported about a patient who, suffering from breast cancer, was referred to internal medicine and, subsequently, surgery.

Table 4 - Classification of encountered communication problems.

1. *Separation of care*
   a. Information contents of intermediate reporting of internist to general practitioner is insufficient
   b. Questions posed by the general practitioner in the referral letter are not addressed or answered by the internist
   c. The internist does not notify the general practitioner of changes in therapy.
2. *Coordination of shared care*
   a. Referral by the internist to another specialist, without notifying the general practitioner of that referral
   b. The general practitioner has not received any information about what the internist told the patient about the disease
   c. Confusion as to which internist is in charge of the treatment of the patient.
3. *Timeliness of information*
   a. Information on the discharge of a patient from hospital reaches the general practitioner too late
   b. Information about the death of a patient in hospital reaches the general practitioner too late
   c. The patient is referred back to the general practitioner, but the internist fails to report in time about the results of his treatment
   d. The inability of the general practitioner to accelerate the exchange of information (for example, because it is difficult to contact the internist by telephone).
4. *Medical disagreement*
   a. Symptoms missed or wrongly diagnosed by the internist (in the view of the general practitioner)
   b. Disagreement about the therapy given by the internist.

The patient underwent a mastectomy, but the internal medicine department, unaware of this, also invited the patient, but for a breast-saving procedure involving chemotherapy. The general practitioner blamed inadequate communication between the involved physicians for this awkward situation. Coordinating such shared care requires the exchange of much more information as compared to separated care. Fletcher states: "*When many different providers are involved in a patient's care, it is possible that the process will not be integrated into a meaningful whole; such care is subject to failures of communication*" [19].

The third category deals with *timeliness of information.* Not only does the content need to be sufficient, but the information has to be available when the general practitioner needs it. Although the information may be forthcoming, the delay in delivery may disrupts care.

The fourth category deals with *medical disagreement* among the physicians involved. When different physicians treating the same patient fail to agree on how that patient should be treated, suboptimal treatment or even harmful interventions may occur.

In total, the general practitioners experienced 82 communication problems: 24 (29%) concerning separation of patient care, 26 (32%) concerning coordination of shared care, 28 (34%) concerning timeliness of information, 3 (4%) concerning disagreement on a medical issue, and 1 that could not be classified into one of the above-mentioned groups. The results of this study suggest that communication problems mainly arise from a lack of understanding by the internist of the information needs of the general practitioner, and from delayed delivery of information.
The possible contribution of electronic mail to improve communication between primary and secondary care is twofold. First, electronic mail is especially suited for an efficient and time-saving transportation of information that is available in computer systems. If different health care providers use computers to store information, these systems are able to exchange that information automatically without additional effort on the part of the provider. As providers increasingly use information systems, the potential impact of electronic mail increases. In a computerized environment, the physical location of a patient record becomes less important, and data can be shared.
Second, electronic mail can facilitate coordination of shared care. For a number of health problems, shared care protocols have been developed, involving division of tasks between health care providers from different disciplines [20]. Optimal communication is considered to be a vital aspect of shared care, both from medical and cost effectiveness points of view, but physicians often lack the time to comply with the protocol [21].
To improve communication, the most important aspect is that physicians reach agreements and define protocols on content and frequency of this communication. Personal contacts and well-established trust and cooperation between physicians, as was also stressed in our study, remain key elements for shared care. Once these agreements have been formulated, the use of computer-based medical records and electronic communication can help the physician in maintaining protocol-based shared care. At present, we are conducting studies in which internists and general practitioners use computer-based patient records, and share the information

they collect. Research in coming years may show whether this approach leads to better structured communication between physicians, without turning a shortage of information into an information overload.

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Chapter 5

Drug dispenses in the region of Apeldoorn-the Netherlands during a one year period

Submitted for publication

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Abstract

To gain insight in the medication consumption of the general population and to evaluate the physicians involved in medication prescribing to a single patient, we used data of a public health insurance fund, containing more than 1.2 million records of dispenses. The records cover the medication actually delivered and relate to 130,000 patients. The data were collected over a one year period (July 1991-June 1992) in the region of Apeldoorn, the Netherlands. They include information about the type and amount of drugs, the costs per drug, age and gender of the patient and specialty of the prescribing physician.

The mean number of dispenses increased with age. The mean number of dispenses per year amounted to 6.8. Women were prescribed more drugs than men in all age groups except in those below the age of 10. More than 50% of the patients received 5 or less dispenses in the year of observation. Few patients (3%) accounted for a large amount of dispenses (19%). General practitioners prescribed more than 80% of the dispenses. The overall mean number of dispenses prescribed by the general practitioner and specialist amounted to 7.9 and 1.5 respectively per patient who actually received medication during that year. More than 70% of the patients received their prescriptions from general practitioners only. About 30% obtained their prescriptions from two or more general practitioners.

We conclude that drug consumption varies widely in the general population and that the general practitioner plays a major role in prescribing medication. The high proportion of patients with multiple prescribers necessitates adequate coordination of care in order to prevent overmedication and drug interactions.

5.1 Introduction

Many consultations to general practitioners (GPs) result in drug prescriptions. In 1983, 59% of all consultations of Dutch GPs resulted in a prescription. Compared to other European countries, such as the United Kingdom (75%), France (78%), Belgium (93%), and Italy (96%) this is a low percentage [1].

Boethius studied the drug-prescriptions of 16,600 persons in Sweden. Fifty percent of the patients received prescriptions from one physician only, while 1% obtained drugs from 7 or more doctors. As the number of treating physicians increases, the chance of overmedication or drug interactions increases accordingly [2].

In the Netherlands two types of health insurance exist. A private health insurance for those with an income above a defined level (40%) and a public health insurance for low-income groups (60%). All health insurance funds patients are registered with one general practice and one community pharmacy.

Aims of our study were 1) to gain insight in the medication consumption of the general population; 2) to evaluate the number of physicians, involved in medication prescribing to a single patient.

5.2 Material and methods

All pharmacists in the Netherlands collect data of dispenses and supply these to the health insurance funds, where data bases of all pharmacists are compiled routinely.

We used data from a public health insurance fund named ANOZ. It covers the area of Apeldoorn, a rural area in the middle-east of the Netherlands. It contains about 355,000 inhabitants (2.4% of the Dutch population) of which some 50% is insured by this fund. The region is served by two hospitals and 137 general practitioners.

The data set contains about 1.2 million records of dispenses collected over a one year period (from July 1991 through June 1992). The records cover the medication actually delivered, and include information about patient number, age and gender of the patient, the type and amount of drugs dispensed, and the prescribing physician. Prescribing physicians were divided into GPs, specialists, dentists and midwives. Medication dispensed in hospital for admitted patients was excluded. All drugs prescribed were coded according to ATC categories [3].

5.3 Results

Of the 180,000 enrollees in the health insurance fund, 50,000 (30%) did not receive any prescribed medication during the one year period.
Of all 130,000 patients receiving drug dispenses 58.7% were female. Table 1 reveals close similarities in the age distribution of those who received medication, the sick fund population and the population of the Netherlands.

Table 1 - Age distribution of patients receiving medication, of all those insured with ANOZ, and of all inhabitants of the Netherlands.

Age category	Percentage receiving medication	Percentage of all insured by ANOZ	Percentage of all inhabitants of the Netherlands
0-9	10.9	10.8	11.5
10-19	9.7	11.6	14.4
20-29	20.2	20.3	19.7
30-39	15.6	15.5	15.7
40-49	12.9	13.0	10.9
50-59	10.2	9.9	9.6
60-69	10.0	9.5	8.6
70-79	6.9	6.1	6.4
80-89	3.1	2.9	2.8
> 90	0.5	0.4	0.4
Total	100.0 (n= 129,513)	100.0 n= 180,000)	100.0 (n=ca 16 million)

As indicated in figure 1 the mean number of dispenses clearly increased with age. The mean number of dispenses was higher for women than for men in each age group except in the group of 0-9 years olds. The mean amount among those receiving at least one prescription in the observation period was 9.5 dispenses. Among all insured people the mean number was 6.8. The mean amount for women was 10.4, for men 8.2 dispenses per

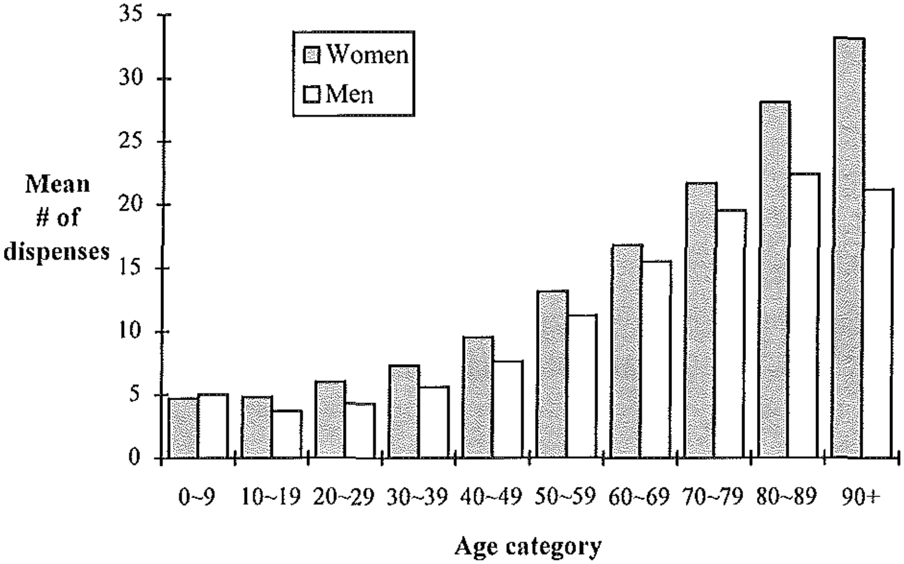

Figure 1 - Mean number of dispenses by age and gender during a one year period.

Table 2 - Dispenses according to ATC categories.

	ATC-category	proportion of dispenses (%)
A	Alimentary tract and metabolism	11
B	Blood and blood forming organs	3
C	Cardiovascular system	13
D	Dermatologicals	6
G	Genito urinary system and sex hormones	6
H	Systemic hormonal preparation, excl sex hormones	1
J	General antiinfectives for systemic use	5
L	Antineoplastics and immunomodulating agents	0
M	Musculo-skeletal system	6
N	Nervous system	21
P	Antiparasitic products	1
R	Respiratory system	14
S	Sensory organs	3
Various (including uncovered by ATC)		7
Total		100

year for those receiving medication. In men above 90 years of age a marked decrease in the number of dispenses is seen.
In our population more than 50% received 5 or less dispenses in the referred period. The category with the highest number of dispenses (3% of patients, having more than 45 dispenses in the one year period) accounted for 19% of the total number of dispenses.
Categorizing the dispenses by ATC groups (Table 2) revealed that the largest categories were formed by medication for the central nervous system (ATC group N), the respiratory system (R) and the cardiovascular system (C).
The physicians were divided into four types (Table 3). The general practitioner was involved in more than 80% of the dispenses.
In all age categories the general practitioners was the most frequent prescriber (figure 2). Involvement of specialists was highest in the group of patients 70 to 79 years of age (3.7 dispenses). The overall mean number of dispenses prescribed by general practitioners and specialists amounted to 7.9 and 1.5 respectively.

Table 3 - Dispenses according to prescriber.

Prescriber	Proportion of dispenses (%)
General practitioner	83.7
Specialist	15.7
Dentist	0.5
Midwive	0.1
Total	100 (n=1,226,310)

More than 70% of the patients received their prescriptions from general practitioners only. A small proportion of patients (3%) derived their dispenses from specialists only.
When patients received prescriptions from general practitioners, this concerned two or more general practitioners in about 40% of patients (i.e. about 30% of all patients receiving prescriptions).

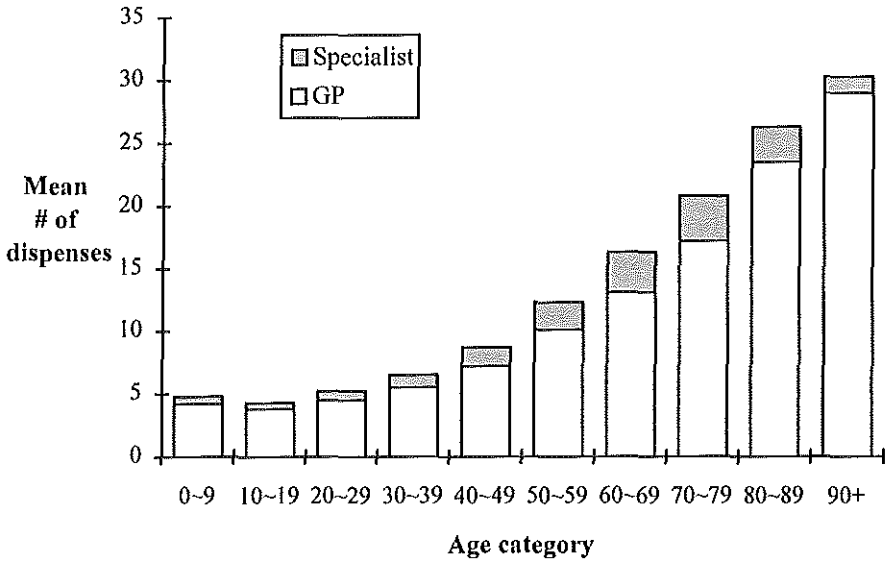

Figure 2 - Mean number of dispenses according to prescribing physician and age over a one year period.

5.4 Discussion

In the past, doubt has been cast on the accuracy of data on drugs prescription in the study of drug exposure [4]. Rashid showed that the proportion of prescriptions that are not cashed by patients may be as high as 20% [5].

In addition, we have to keep in mind that drug dispenses are not the same as drug consumption. It is not known to what extent the drugs obtained are actually used, and it would take an enormous effort to obtain this kind of information at a regional level.

A further drawback of these data is the lack of diagnosis related information, which is necessary when an in-depth analysis of prescriptions is asked for, as in the study of conflicting medication [6].

Because our data apply to one regional health insurance fund only and because coverage depends on income (all employed earning less than a defined level) the population is probably not representative for the total population of the Netherlands, although the age distribution was similar.

In this region 50% of the inhabitants are insured at the public health insurance fund. Compared to the whole country (60%) this is somewhat low.

In this study we examined dispenses of people who were insured by a public health insurance fund. We are aware of the fact that figures about the number of people enrolled in the public health insurance fund are not perfect. Some patients will have been registered for the whole period even when they were insured for only a part of the observation period. This will result in a slight over-estimation of people insured and consequently in an under-estimation of medication use.

In our study, men received less dispenses than women. Obvious explanations are the higher contact frequency of women with health care professionals and the use of contraceptives and other medicines relating to specific medical problems of women.

With increasing age people have more health problems. The decrease of the number of dispenses in men over 90 years can be explained by the known fact that women suffer longer from chronic illnesses than men before they die (selective survival) [7,8].

Specialists most often prescribe medication to patients aged 70-79 years old. Above this age this mean number of prescriptions decreases. A possible explanation for this phenomenon is the reduced mobility in very old patients, a reason why medical care is taken over by the GP.

As much as 40% of the registered people acquired their dispenses from two general practitioners. Group practices (46% of Dutch GPs practice in this type of setting) as well as locums during the nights, weekends and holidays can possibly explain this.

We conclude that drug consumption varies widely in the general population and that the general practitioner plays a major role in prescribing medication. The high proportion of patients with multiple prescribers necessitates adequate coordination of care [9] in order to prevent overmedication and drug interactions.

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Chapter 6

Laboratory services utilization: a survey of repeat investigations in ambulatory care

Submitted for publication

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Abstract

Earlier studies have shown that repeat investigations are a common cause of unnecessary duplication of laboratory test procedures. Most of the interventions aimed at reducing the number of repeat investigations have not resulted in long-term improvements. None of these studies, however, assessed utilization of laboratory services by physicians, co-treating the same patient. For a random sample of 1500 patients, we examined laboratory services utilization by physicians during an 8-month period. We measured the number of patients for whom more than one physician ordered laboratory test procedures simultaneously, and to what extent these procedures overlapped. We found that for 28% of the patients more than one physician had ordered tests. Of all 41,655 tests, 5,536 (13%) were repeated by another physician than the physician who ordered the initial test: 1,527 (4%) of the tests were repeated within 5 days. Patients between 70 and 90 years had the highest average number of tests, the highest number of involved physicians, and the smallest mean time between similar tests.
We conclude that there is a need for a better coordination of care. Improved communication among co-treating physicians may lead to a reduction of repeat investigations.

6.1 Introduction

Evidence exists that not all laboratory test procedures are always adding to adequate patient care [1,2]. In an early study, Dixon and Laszlo [3] showed that repeat investigations are a common cause of unnecessary requests: although 30% of the patients admitted to hospital had normal test results, most of these patients were re-examined twice during their hospital stay; in none of these cases did these repeat investigations provide information necessary for diagnosis or treatment.

Much effort has been invested to reduce the amount of inappropriate test requests. These efforts include: regular feedback of comparative laboratory usage data to clinicians [4]; on-call guidelines to junior staff [5]; memorandums circulated to medical staff on appropriateness of laboratory request procedures [5]; problem-oriented request forms [6], and financial incentives for laboratory supervisors who accomplish cost savings [7]. After an extensive literature study, Axt-Adam et al. conclude that most of these interventions only result in short-term effects [8].

Unnecessary duplication of diagnostic procedures may also result from delayed or incomplete communication among physicians co-treating ambulatory patients. Examples of patients receiving care from more than one physician are patients with severe and long-lasting diseases, such as cancer or diabetes mellitus. In such a shared care situation, optimal communication between the involved physicians is considered to be of vital importance, both from medical and cost effectiveness points of view [9]. Previous studies have indicated that a better content of information exchange [10-13] and a more timely deliverance of this information [14-16] could be useful in improving shared care.

Although a large number of studies have assessed utilization of laboratory facilities [8], these studies focused on inpatient care. To our knowledge, utilization of laboratory resources by physicians co-treating ambulatory patients has attracted little attention: there is no data available on how many physicians are simultaniously requesting laboratory tests for an individual, ambulatory patient. In order to gain insight in the magnitude of this problem, we performed a study to evaluate: (1) the number of ambulatory patients for which more than one physician requested laboratory test procedures; (2) the extent to which test procedures requested by co-treating physicians overlap; (3) the number of repeat tests which, theoretically, are unnecessary duplicates.

6.2 Research setting

During the diagnostic process and the treatment of patients, physicians make ample use of laboratory facilities [17]. In The Netherlands, laboratories are often situated inside a hospital: both hospital-based consultants and physicians working in their own offices (for example, general practitioners) have patients' specimens tested at that same location. Therefore, these laboratories form an ideal site for investigating usage of laboratory resources by physicians from different disciplines, who are co-treating the same patients.
We carried out our study in the Apeldoorn region where one general hospital (on two locations, with in total 750 beds) provides almost all care for the 180,000 inhabitants in this region. Only in case of diseases requiring highly specialized care, patients are referred to hospitals outside the region (e.g., University hospitals). The two laboratories of this hospital handle all test requests from the approximately 90 GPs and 90 hospital-based consultants in the region. To order a procedure, a physician usually fills out a request form during a consultation. On the request forms, tests can be ordered seperately, or in predefined combinations. After completion of the form, the physician hands it to the patient who then goes to the laboratory. Patients who are unable to go to the hospital laboratory are visited at home by a laboratory nurse.
Analysis of specimens is highly automated, all test result data are stored in a computer system, together with a code, indicating the requesting physician. Subsequently, a member of the laboratory staff validates and authorizes the test results: after the authorization process, reports are sent to the physician who requested the test. Test data are kept online for a period of 200 days, after which they are stored on a data backup device.

6.3 Methods

From the hospital laboratory systems a random sample of 1500 patients was drawn, for whom at least one test was ordered during the period from November 1992 to June 1993 (8 months). Patients who were hospitalized during this period were not included in the sample.
We defined every single result entry in this data set as a "test". The data set contained all tests performed during that period, indicating for every

procedure (1) an identification number of the patient, (2) the age of the patient, (3) the name of the test, (4) the result of the test, (5) the reference range, (6) the date on which the test was performed, (7) a code number of the physician ordering the test, and (8) the physician's specialization. The data set was anonimized with regard to patient- and physician-identifying data. The laboratory issues with each test the reference range of that test (valid for adults). Test results falling outside this reference range were termed abnormal. If a test procedure was repeated, the first occurrence of that test was termed the *initial test*, and the second one the *repeat test*.

6.4 Results

The mean age of the patients was 49 years (range 1-98). In total 41,655 tests were ordered (range 1-742, mean 27, median 16 per patient). The tests were ordered by 90 general practitioners and 91 hospital-based clinicians: general practitioners ordered 11,060 (27%), clinicians 30,595 (73%) tests. Of the 41,655 tests, 2419 (6%) were abnormal. Of the 39236 tests with a normal result, 14306 (37%) were repeated during the study period, whereas of the 2419 tests with an abnormal result 1389 (57%) were repeated. Although 412 different tests were ordered, 16 tests covered 50% of all performed tests, and 100 tests covered 95% of all performed tests. Table 1 shows the 10 most frequently ordered tests.

Table 1 - Ten most frequently requested tests.

Test	Frequency	(%)
Glucose	2177	(5.2)
Hemoglobin	2116	(5.1)
Leucocytes	1690	(4.1)
Carcinoembryonic antigen	1561	(3.7)
Erythrocytes Sedimentation Rate	1498	(3.6)
Creatinine	1403	(3.4)
Platelets	1352	(3.2)
Hemotocrit	1257	(3.0)
Mean Corpuscular Hemoglobin	1172	(2.8)
Mean Corpuscular Volume	1139	(2.7)
Total	15365	(36.9)

Shared Care

Of the 1500 patients, 1087 (72%) had only 1 physician involved in test ordering, 257 (17%) had 2, 89 (6%) had 3, 39 (3%) had 4, 16 (1%) had 5, the remaining 12 (1%) had 6 or more: one patient even had 9 different test-ordering physicians. Table 2 shows for different age groups the average numbers of tests, care providers, abnormal values, and time intervals between two identical tests. Patients between 70 and 90 years had the highest average number of tests, the highest number of involved care providers, and the smallest mean time interval between similar tests. The proportion of abnormal results in these elderly patients, however, was not much different from younger patients. We found the highest percentage of abnormal test outcomes in the youngest age group. When compared to the patients aged between 70 and 90, the group of patients older than 90 years showed a remarkable drop in average number of performed tests and care providers, and a larger average time interval between similar tests.

Time intervals between similar tests

Of the 41,655 tests, 15,695 (38%) were repeated during the 8-months period. Of these 15,695 tests, 6,748 (16% of all tests) within 5 days, 1,578 (4% of all tests) between 6 and 10 days, 1,145 (3% of all tests) between 11 and 15 days, and the remaining 6,224 (15% of all tests) after more than 15 days. Of the tests repeated within 5 days, Table 3 shows the 10 most frequently repeated ones.

Table 2 - Average number of requested tests per patient, involved care providers, abnormal values, and time between similar tests, divided per age category.

Age	Patients (%)	Average No. of tests	Average No. of physicians	Percentage of abnormal results	Average time between similar tests (days)
0-10	147 (9.8)	27	1.3	12	31
11-20	145 (9.7)	21	1.2	5	34
21-30	129 (8.6)	17	1.2	6	59
31-40	131 (8.7)	18	1.3	3	26
41-50	180 (12.0)	20	1.4	4	47
51-60	172 (11.5)	27	1.4	2	33
61-70	196 (13.1)	24	1.6	2	37
71-80	215 (14.3)	41	1.7	3	26
81-90	142 (9.5)	52	1.8	4	21
> 90	43 (2.9)	23	1.4	5	39

Table 3 - Number of tests, repeated by another physician within 5 days. The ten most frequently repeated tests are shown.

Test	Frequency	(%)
Hemoglobin	102	(6.7)
Leucocytes	74	(4.8)
Creatinine	73	(4.8)
Sodium	71	(4.6)
Carcinoembryonic antigen	70	(4.6)
Potassium	69	(4.5)
Glucose	66	(4.3)
Urea	61	(4.0)
Platelets	52	(3.4)
Aspartate aminotransferase	47	(3.1)

A repeat investigation may be ordered by another physician than the one who ordered the initial test. Of all 15,695 repeated tests, 5,536 (13% of all tests) were repeated by another physician than the physician who ordered the initial test: 1,527 tests (4% of all tests) were repeated within 5 days, 593 (1% of all tests) were repeated between 6 and 10 days, 592 (1% of all tests) between 11 and 15 days, the remaining 2,824 (7% of all tests) after more than 15 days.

Outcomes of repeated test procedures

In total, 1,527 tests were repeated within 5 days by another physician than the physician who ordered the initial test. Table 4 shows that of these 1,527 initial tests, 1,380 (90%) had a normal outcome and, when repeated, 1341 (88%) of these tests were still normal. In total, only 94 (6%) of these repeat tests showed a different outcome than the initial test.

Overall, the initial test procedures repeated within 5 days showed a larger percentage of abnormal results than the initial test procedures repeated after more than 5 days (10% vs 6%).

Table 4 - Result of the initial test, and result of the repeat test, ordered by another physician than the one who ordered the first test.

		Repeat test		
		Normal	Abnormal	Row total
Initial test	Normal	1341 (88%)	39 (3%)	1380 (90%)
	Abnormal	55 (4%)	92 (6%)	147 (10%)
	Column total	1396 (91%)	131 (9%)	1527 (100%)

6.5 Discussion

Our study shows that, to reduce inappropriate use of laboratory services for ambulatory patients, the aspect of coordinating activities among co-treating physicians requires further attention: We found that 28% of the ambulatory patients had more than one physician requesting laboratory investigations. The number of involved physicians was higher in the older age groups, and the time intervals between identical tests smaller. Of all investigations, 13% were repeated by another physician than the physician who ordered the initial one. We found that 4% of all tests were repeated by another physician within 5 days; moreover, the large majority of these initial tests as well as the repeat tests were normal (88%).

Repeat investigations may arise under several conditions. Firstly, the result of an investigation may be outside normal-value ranges, so that a re-evaluation, possibly after a therapeutical intervention, is part of the treatment. Secondly, an abrupt change in the condition of the patient (e.g., blood loss) may instigate repeat investigations. Thirdly, the physician ordering the repeat investigation may have incorporated certain professional rituals in patient management [18,19]. Fourthly, however, our study indicates that physicians may be unaware of the fact that a co-treating physician has recently performed a particular test as well; knowledge of this earlier investigation might have prevented the repeat investigation.
A major drawback of the data set we used is that it did not contain the reason why the involved physician ordered the tests; physicians do not supply this information to the laboratory department. We could, therefore, not distinguish among the different reasons for ordering a repeat investigation. The fact, however, that of the repeat tests ordered within 5 days only 6% showed a different test outcome when compared to the initial test, indicates that not all involved patients suddenly underwent a change in their clinical condition.

Coordinating shared care is a recognized problem that is not limited to laboratory use only, but also involves other areas of health care [20]. For other areas, studies have also identified problems in coordinating shared care. For example, Price et al. showed that for 70% of the patients, receiving medication from both general practitioner and hospital consultant, medical records were inaccurate: patients took more medication than was shown in their records, due to the fact that they received medication from different physicians [21]. The authors conclude that some of the drugs taken by the patients were inappropriate, and many seemed unnecessary.

Based on our study, and based on the results of other investigations [10-16,21], we argue that there is a need for improving the coordination of care and improving quality of communication.

Two recent developments in health care may facilitate the necessary improvements in communication among physicians. First, in several places (e.g., primary health care in The Netherlands [22]), computer-based patient records are gradually replacing paper records; physicians use these systems for storing medical data during consultations, for test ordering, and for prescribing drugs. Several studies have shown the potential of these computer-based patient records to support electronic communication among physicians. Tierney et al showed that using a network of computer workstations in a public hospital for inpatient order writing significantly lowered patient charges and hospital costs [23]. Furthermore, computer-based patient records enable transmural exchange of information using computer-to-computer communication. Branger et al, for example, showed that delivery of laboratory reports from hospital laboratories to general practitioners, using electronic communication, improved the speed of communication, decreased workload, and eliminated transcription errors [24].

Second, for a number of health problems, shared care protocols have been developed that involve a division of tasks between health-care providers from different disciplines [25]. In the United Kingdom, for example, a study was performed in which patients with diabetes mellitus were seen both in general practice and in the hospital clinic. Practice guidelines were issued, which defined division of responsibilities such as measurements and examinations [26], and computerized records were used to store the data from both general practice and hospital clinic. This integrated-care approach was then compared to conventional care, in which diabetes patients are treated only by hospital consultants. The minimum standards for screening for complications were met more effectively in the integrated care group.

We believe that efficiency of care for ambulatory patients may benefit from well-established communication among co-treating physicians, and hospital staff, e.g. clinical chemists: knowing of the result of diagnostic procedures performed by one physician may make repetition of this procedure by another physician unnecessary, especially for tests with a normal outcome.

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Chapter 7

A standardized message for supporting Shared Care

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Abstract

As health care becomes more complex, interest in the benefits of coordination of care has increased. Especially patients that are being treated jointly by more than one physician (shared care), are vulnerable to adverse effects resulting from inadequate coordination and communication. We describe a study in which care providers support shared care by using computer-based patient records for data storage, and structured electronic data interchange as a means of communication. In this study, we are aiming at the development and implementation of protocols for shared care.

7.1 Introduction

Shared care is a situation in which physicians jointly treat the same patient. Patients requiring shared care are, for example, patients suffering from chronic disorders, such as diabetes mellitus, obstructive pulmonary diseases, and cardiological disorders. To be effective, shared care requires coordination of activities. Fletcher states that: "*When many different providers are involved in a patient's care, it is possible that the process will not be integrated into a meaningful whole; such care is subject to failures of communication*" [1].

For a number of health problems, shared care protocols have been developed, involving allocation of tasks between health care providers from different disciplines [2]. Optimal communication is considered to be a vital aspect of shared care, both from medical and cost effectiveness points of view [3]. Previous studies, however, have indicated that paper-based information exchange between care providers needs to be improved, both in terms of content of information exchange [4] and in timely deliverance of this information [5,6].

Nowadays, new technologies are emerging that have considerable potential for supporting physicians in delivering shared care. Computer-based patient records, which in recent years have penetrated Dutch health care, are gradually replacing paper records: physicians themselves use these systems to store textual data during consultations. In addition to recording medical data, computer-based patient records also assist the physician in monitoring risk profiles, screening of patients, and conducting follow-up [7]. These systems are able to exchange information using computer-to-computer communication. This communication is known as Electronic Data Interchange (EDI), and is defined as "*the replacement of paper documents by standard electronic messages conveyed from one computer to another without manual intervention*" [8]. In the Netherlands general practitioners judged the use of EDI favorably for medical care [9].

Current EDI implementations, however, focus on small segments of the medical record. An example of such an implementation is the laboratory test report, with which laboratories can transfer test results electronically to general practitioners. To support shared care, not only limited subsets of the medical record may have to be transferred, but the whole medical record, including the structure of it.

In this paper we describe the implementation of a procedure for EDI-based communication between physicians jointly treating diabetes mellitus patients. We also describe the evaluation study that we are presently performing.

7.2 Design considerations

In this section we describe the present state of computer-based patient records in the Netherlands, message syntax standards used, and the user interface requirements of the EDI message handler.

7.2.1 Patient records

In the Netherlands, several computer-based patient record systems, designed using specifications formulated by professional organisations of general practitioners, are available [7]. These systems allow the general practitioner to replace the paper patient record with a computer-based patient record. The overall structure of such a computer-based patient record supports problem-oriented and episode-oriented recording of information, and SOAP coding [10,11]. Using SOAP-coding, the physician divides the information in Subjective information (the complaint of the patient), Objective information (findings like blood pressure), Assessment by the physician, and Plan (e.g. medication or referral). Using that overall structure, the physician may code detailed content of the patient record, such as reasons for encounter, diagnoses, medication, referrals, laboratory tests, and risk factors. The physician uses the system during patient consultations to inspect and record clinical data.

7.2.2 Message standards

Several message standards are available for electronic communication. The HL7 standard, used for example in the United States, provides common data segment and message definitions, for communication across various systems within hospitals [12]. In Europe, the ISO syntax standard EDIFACT has been adopted as the standard for defining messages [13]; each message consists of a number of segments. Each segment starts with a segment tag (e.g. UNH), contains a number of data-elements, and ends with an apostrophe. Segments that logically belong together may be grouped and

thus form a segment group. Data elements, segments, and segment groups may be conditional or mandatory.
In The Netherlands, coordination of the standardization of health care messages is performed by a national organization. At present, several standardized messages are available for a variety of purposes. One is a message for data exchange between physicians [14]; in this message, however, only physician-, patient- and hospital identifying data are structured, and all medical data is transferred as free text. Consequently, using this message, the receiving system is unable to integrate the data into the computer-based patient record. In order to support shared care, a message is needed that can also transfer the structure of the data in a computer-based record in order to allow integration of records from multiple sources.

7.2.3 User interface requirements

With EDI, messages can, in principle, be sent and received without human intervention. For patient-related communication, however, the physician has to match incoming messages with the patients in his practice, because in the Netherlands there does not exist a unique patient-identifying number. The computer-based patient record assists the physician by matching patient-identifying data (e.g. name, date of birth, gender) in an incoming message with known patient records; verification of the proposed match is subsequently performed by the physician.
In addition, fully automated data exchange is not desirable for several other reasons. First, in order to prevent an excessive growth of the amount of data in the computer-based patient record, the receiving physician needs to be able to select data from the message that can be discarded. Second, when composing a message, the sending physician may want to exclude from a message information that he considers to be irrelevant for the receiving physician, or a threat to the privacy of the patient involved.

7.3 Implementation

As discussed in section 2.2, currently available messages do not allow transferral of structured data. Therefore, we developed a new message, called MEDEUR, using the EDIFACT standard and already existing segment definitions. In this section we describe the structure of MEDEUR and the implementation of this message in the computer-based patient record system Elias.

Table 1 - Contents of MEDEUR message (version 1.0)

Segment group	Mandatory/Conditional	Description
1	M	Physician identification
2	M	Patient identification
3	C	General medical characteristics: sequence number
.. 4	C	.. Description
.. 5	C	.. Procedures planned
6	C	Patient encounter information - Type (e.g. consultation) - Date and time
.. 7	C	.. Free text lines
.. 8	C	.. Measurements (coded)
.. 9	C	.. Diagnoses (coded)
.. 10	C	.. Medication (coded)
.. 11	C	.. referrals (coded)
12	M	Authentication data

7.3.1 MEDEUR message standard (version 1.0)

MEDEUR, is designed for integrated patient data exchange between computer-based patient records. The message can contain both administrative and medical data. It can be used for transmission of a complete medical record, or sections of it. Table 1 shows the sequence number of the different segment groups (first column), whether it is mandatory or conditional (second column) and a short description of contents (third column). In total, 12 segment groups can be distinguished:

Segment group 1 contains identification (such as name, address, i.d. number) of sending physician (first occurrence) and receiving physician (second occurrence).
Segment group 2 contains identification (such as name, address, i.d. number, insurance data) of the patient involved (first occurrence). If required, identification of persons related to the patient can be included in the next occurrence(s) of segment group 2.
Segment groups 3, 4, and 5 contain general medical characteristics of the patient, such as risk factors (e.g. smoking), and medical problems (e.g. diabetes mellitus). It also specifies the procedures planned by the physician in relation to the risk factors or medical problems (e.g. kidney function checkup in case of a diabetic patient). Every medical characteristic has a

sequence number, described in segment group 3: segment groups 4 and 5 are nested within group 3 and describe the medical characteristic. The description may be coded, in which case also the identification of the code list used (e.g. ICPC or ICD-9) is included.

Segment group 6 contains the patient-encounter- oriented medical data. It specifies type of encounter (consultation, home visit, medical procedure), date and time of the encounter, and identifies (if needed) the physician involved in the encounter. The message contains one occurrence of segment group 6 for every patient encounter: each message may contain descriptions of up to 99 encounters. Segment groups 7 to 11 are nested within segment group 6: The data in these segment groups can be linked to a specific problem, already specified in segment group 3.

Segment group 7 contains that part of the data from the consultation that is in free text format.

Segment group 8 contains measurements that were performed (e.g. blood pressure, cholesterol etc.). Measurements may be specified with a code and the name of the code list used. Other data items include the date that the test was performed or the date that the test result became available, the result of the test, the unit, and the normal value range.

Segment group 9 contains diagnoses: these diagnoses may be coded, and the code list used (e.g. ICPC or ICD-9) can be specified.

Segment group 10 contains details about the medication prescribed by the physician during the consultation. It specifies identification of the medication (if desired coded according to e.g. brand name or chemical components), amount, dosage, for which diagnosis it was prescribed, and the specialism of the prescriber.

Segment group 11 contains details about other specialisms that the patient has been referred to, and data about outcomes of these referrals.

Segment group 12 contains information that can be used for authentication procedures.

Part	Contents
1	UNB+UNOA:1+500011774+500003170+940731:2127+108E'UNH+2100+MEDEUR:1:1:IT'BGM+UPD'DTM+137+1994:07:24'NAD+EMP+123456+Dr. Sending'NAD+EMP+654321+Dr. Receiving'PNA+PAT+999999+ Patient name'
2	SEQ+P+1'DTM+194+1989:10:22'CIN+DI+T90.1+ICP++Insulin dependent Diabetes Mellitus' SEQ+P+2'DTM+194+1991:03:27'CIN+DI+K86.0+ICP++Primary hypertension'
3	GIS+C'DTM+007+1994:08:08'INV+LM+102:LOC:Glucose'RFF+G3:1'RSL+N+17.2+mmol/l'RNG+NRM+:3.5:4.5'DLI+O+0'CLI+MED+13617893:KMP::Ins mixt 10/90 novolet 3M'RFF+G3:1'DLI+P+0'CLI+MED+13180789: KMP::Capoten 25MG Tablet'RFF+G3:2'DLI+P+0'
4	AUT+1234+4321'UNT+2100+27'

Figure 1 - Simplified example of a MEDEUR message, describing a patient consultation. The message can be divided into four parts: **part <1>** contains E-mail numbers (UNB), name and i.d. number of sender (NAD, first occurrence) and receiver (NAD, second occurrence), and patient and i.d. number (PNA); **part <2>** Contains problems the patient is suffering from, with a sequence number (SEQ), starting date (DTM), ICPC code, and a description (CIN); **part <3>** contains the data gathered during the consultation, such as lab tests (INV), the problem the test relates to (RFF, in this case to diabetes mellitus), the test result (RSL), and the normal value range (RNG); prescribed medication (CLI), the problem the medication relates to (insulin for the diabetes, and capoten for the high blood pressure); **part <4>** contains the authentication data and the message trailer.

Where possible, the use of code lists is supported: diagnoses, referrals, measurements, reason for encounter, and medication can be coded. In addition to this coded data, there is ample space to include free text. This free text can be used for data that cannot be placed in dedicated segments, or for additional data that is collected for research purposes. Figure 1 gives an example of a MEDEUR message.

7.3.2 MEDEUR message handler

The computer-based patient record system Elias already contains a communication module that allows it to exchange EDIFACT messages with other information systems, via telephone lines and e-mail services [9]. We designed a user interface that enables the physician to send and receive MEDEUR messages.

To send a MEDEUR message, the physician first specifies the patient and the period about which he wants to report. Elias then creates a MEDEUR message, based on the information stored in the computer-based patient record. The physician can, before the message is actually sent, edit the message by specifying what data to discard, and add text to the message.

The patient data in received MEDEUR messages can be stored directly into the computer-based patient record, with exactly the same structure as that of the patient record the data came from. Prior to storing the data, the physician can select and subsequently discard the data from the received message he considers to be irrelevant.

7.4 Present state

To evaluate the benefits of EDI for the support of shared care, we are conducting studies in which general practitioners and internal medicine consultants share data about patients with diabetes mellitus.

In the Netherlands the general practitioner functions as a gatekeeper between primary and secondary care. Typically, patients first consult their general practitioner. If considered necessary, the general practitioner refers the patient to a specialist. The specialist will report the results of the treatment back to the general practitioner. Therefore, the general practitioner is the central physician and the ideal person to coordinate shared care.

In a number of Dutch cities, we are introducing electronic communication between physicians. In the city of Apeldoorn, 64 general practitioners provide care for approximately 120,000 persons. Of these 64 general practitioners, 40 use the computer-based patient record system Elias. Apeldoorn has one hospital, with 10 internal medicine consultants. Two of these consultants provide medical care for 80% of all diabetics referred to the outpatient clinic. An electronic communication network is available, and is already used by physicians to transmit data, such as laboratory reports and admission/discharge reports [9].

We installed the MEDEUR message handler at the practices of 25 general practitioners. At the outpatient clinic of one of the two diabetes mellitus treating consultants, we installed an Elias system, tailored to the information needs of that consultant, and the MEDEUR message handler. Starting January 1994, this consultant and the 25 general practitioners exchange data about consultation outcomes, using MEDEUR messages. Code lists are used for coding reasons for encounter, measurements, diagnoses, referrals, and medication.

Using the implemented inter-physician communication, we are conducting studies to evaluate the benefits of EDI for shared care; these studies consist of two phases.

Phase 1: Prior to the intervention, we study 260 (randomly selected) medical records of diabetes mellitus patients that both treated by general practitioner and internal medicine consultant. We evaluated (1) the type of information routinely collected; and (2) communication frequency with the co-treating physician. Furthermore, we investigated patterns in laboratory test ordering and medication prescribing of general practitioner and consultant.

Phase 2: Starting after the introduction of the MEDEUR message handler, we receive a copy of each transmitted MEDEUR message. This copy does not contain patient or physician identifying data. From these message flow measurements we can deduct (1) which information is routinely collected by the physician; (2) which information is considered relevant for the receiving physician; (3) which information from a received message is considered relevant by the physician.

The results of these studies may lead to the definition of a communication protocol between primary and secondary care providers, specifying frequency and content of communication.

7.5 Discussion

Computer-based patient records, installed in general practices and used during consultations, have become a widely accepted component in the Dutch health care process [9]. These systems are able to assist the physician with recording medical data in a structured manner.

Using computer-based patient records and EDI, we have created an environment which enables the efficient exchange of information [9]. Moreover, using the standard message MEDEUR, it is possible to exchange patient information between computer-based patient records in such a manner, that the semantic structure of the information can be rebuilt in the receiving system. By doing this, physicians can share the information about patients that are jointly treated.

Previous studies have shown that existing paper-based communication is insufficient [4-6]. With the introduction of computer-based patient records and EDI, the opportunity to exchange *all* patient data is available. This could, however, lead to an information overload, especially when different care providers fail to agree on their role in the delivery of care and the information requirements of that role.

In the Netherlands, at present, no protocols exist that explicitly specify the role of co-treating physicians. Ideally, such a protocol should include a description of (1) the division of tasks; (2) guidelines for record-keeping; (3) guidelines for communication, both in terms of frequency, content, and a definition of consultation outcomes that should trigger communication activities. The use of these protocols should not only prevent medication conflicts and duplication of diagnostic tests, but should also guarantee that necessary procedures (like yearly checkup of the kidney function in diabetic patients) are being performed. We expect that EDI will facilitate the development of shared care protocols. Future studies will have to evaluate the impact of EDI and shared care protocols on the delivery of care.

7.6 References

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Chapter 8

Shared care for diabetes: supporting communication between primary and secondary care

Submitted for publication

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Abstract

Objective-To assess the effects on information exchange of electronic communication between physicians co-treating diabetic patients.
Design-Comparison of traditional paper-based communication for reporting and electronic communication.
Setting-General practitioners and an internal medicine outpatient clinic of an urban public hospital.
Subjects-A total of 275 diabetic patients, and the 32 general practitioners and one internal medicine consultant who cared for them.
Intervention-An electronic communication network, linking up the computer-based patient records of the physicians, thus enabling electronic data interchange.
Main outcome measures-Number of letters sent and received per year by the general practitioners, the number of diabetes-related parameters (e.g., results of laboratory tests) in the patient records, and HBA1C levels.
Results-Intervention GPs received more messages per year (1.6 per patient) than control GPs (0.5 per patient, $p<0.05$). Significant higher availability ($p<0.05$) was achieved for data on HBA1C levels, fructosamine levels, blood pressure measurements, cholesterol levels, triglyceride levels, and weight measurements. Intervention patients showed a slight but significant decrease of HBA1C levels in the second semester of 1994 (from 7.0 to 6.8, $p=0.03$), control patients also showed a slightly decreased group mean, but this change was not significant (from 6.6 to 6.5, $p=0.52$). The magnitudes of these mean differences, however, were not significantly different (intervention group: 0.21; control group: 0.12, $p=0.68$).
Conclusions-The electronic communication network for exchanging consultation outcomes significantly increased frequency of communication and the availability of data to the general practitioner on diagnostic procedures performed in the hospital, thus providing more complete information about the care that patients are receiving. A large-scale experiment over a longer period of time is needed to assess the effects of improved communication on quality of care.

8.1 Introduction

Diabetes mellitus still leads to large morbidity and mortality, although impressive improvements in the management of blood glucose levels have been achieved. In the United States, around 5.5 million patients suffer from this disease; diabetes is the underlying or contributing cause of approximately 323,000 deaths annually [1]. Evidence exists that during the past decades the number of diabetes patients has increased, independently of demographic changes [2-4]. This trend is expected to continue; for the Dutch situation an increase from 244,000 patients in 1990 to 355,000 patients in 2005 (an increase of 46%) is predicted [5].
In 1989, government health department representatives of all European nations formulated the St Vincent Declaration [6]. This Declaration sets guidelines to reduce morbidity and mortality from diabetes. Among the most important targets are the reduction of complications resulting from diabetes, such as blindness, and end-stage diabetic renal failure.

Previous studies have indicated that, in order to further improve the treatment of diabetes patients, several problems have to be solved. First, Hempel argues that , because early diagnosis and treatment of complications are key elements in managing these complications, well-kept medical documentation is essential [7]. A study by the same author, however, showed that the quality of this documentation was poor [8]. Deeb et al. also demonstrated that documentation of complications in primary care was poor, but that a multidisciplinary educational program could improve this situation [9]. Second, during the management of diabetes, more than one physician is often involved in the treatment of a patient: this may lead to fragmentation of medical records and discontinuous care [10].

In order to improve the documentation of medical activities and to facilitate the efficient communication between physicians, several studies have assessed the potential benefit of computer-based patient records. Tierney et al. showed that using a network of computer workstations in a public hospital for inpatient order writing significantly reduced patient charges and hospital costs [11]. In an earlier study, Branger et al. showed that using electronic communication to deliver laboratory reports from hospitals to general practitioners improved the speed of communication, decreased workload, and eliminated transcription errors [12].

In this paper we describe a project that evaluated the use of electronic communication between general practitioners and an internist working in an outpatient clinic. Our study attempts to assess the value of electronic data interchange in improving documentation of the total care that diabetes patients are receiving, and improving communication between physicians simultaneously treating a patient. We also studied whether changes in glycemic control occurred during the project.

8.2 Research setting

In The Netherlands, the general practitioner functions as a gatekeeper between primary and secondary care. Typically, patients first consult their general practitioner. If considered necessary, the general practitioner refers the patient to a specialist. The specialist will report the results of the treatment back to the general practitioner. In the case of diabetes patients, as a general rule, non-insulin dependent patients are treated by the general practitioner, and insulin dependent patients are treated by a hospital-based consultant. Recent research has shown that 40% of diabetes patients over 65 years suffer from one or more other diseases for which they also visit a specialist [13]. Thus, an important task of the Dutch general practitioners is to coordinate such shared-care situations. In order to meet this challenging task, general practitioners need to be aware of the total care that their patients are receiving, especially in the case of chronic disorders such as diabetes.

Our study was carried out in the Apeldoorn region, a region with approximately 180,000 inhabitants, one general hospital (on two locations, with in total 750 beds), and 65 general practitioners. Of the general practitioners, 32 used the same computer-based patient record system [14]. This system allows the general practitioner to fully replace the paper patient record with a computer-based patient record. The physician uses the system during patient consultations to inspect and record clinical data. The physician may code the content of the patient record in great detail, such as reasons for encounter, diagnoses, medications, referrals, laboratory tests, and risk factors. The system also contains an electronic communication module. This module enables electronic information exchange with other information systems. This technology is known as *electronic data*

interchange (EDI). Walker defines this type of communication as "*the replacement of paper documents by standard electronic messages conveyed from one computer to another without manual intervention*" [15]. Using a standardized message, a laboratory can, for example, transmit test results electronically to a GP's computer system. The GP's computer system can process and integrate the data automatically in the computer-based patient record. In The Netherlands, the National Board for Public Health (Nationale Raad voor de Volksgezondheid) has adopted EDIFACT as the standard for EDI between systems used in health care [16]. In 1989, the general practitioners in the Apeldoorn region started to use EDI for the exchange of messages among each other, for receiving admission and discharge reports from the hospital administration department, and for receiving laboratory reports from the hospital laboratory [12].
In the Apeldoorn hospitals, 2 of the in total 10 internal medicine consultants provide medical care for approximately 80% of all diabetes patients referred to the outpatient clinic. In the outpatient clinic of one of these diabetes treating consultants, we installed a system, similar to the ones in primary care, containing all the functions available to the general practitioners. We tailored this system to the information needs of the participating consultant.

8.3 Methods

We approached the 32 general practitioners who were already working with the computer-based patient record and EDI; all GPs agreed to participate.

8.3.1 Organization of EDI

The computer-based patient record system of the 32 GPs already contained a communication module that allows electronic data exchange with other information systems [12]. We designed an EDIFACT message standard that can be used for the electronic transmission of a complete medical record, or sections of it. The message can contain both administrative and medical data. This message standard, the so-called MEDEUR message, was described in detail in an earlier paper [17].
When initially referring a patient, a physician can send a referral message electronically using MEDEUR. To do so, the physician first specifies the patient and the period about which he wants to report. The system then creates a MEDEUR message, based on the data stored in the computer-

based patient record. The physician can, before the message is actually transmitted, edit the message by specifying what data to discard, or add free text to the message.
The physician receiving such a MEDEUR messages can directly store the patient data into the computer-based patient record, without the need to retype the data. Prior to storing the data, the physician can select and subsequently discard the data from the received message he considers to be irrelevant. The system keeps track of the diabetes patients who are also treated by another physician. At the end of a patient encounter, the system prompts the physician to compose a message, thus reminding the physician of the shared care aspects.

8.3.2 Formation of intervention and control groups

In order to try to assess the value of EDI for inter-physician communication, we divided the 32 GPs in two groups, using the following strategy: (1) at the participating consultant's outpatient clinic we counted, for every GP, the number of referred diabetes patients; (2) for a GP to gain sufficient proficiency in using the new module, regular use of the module was required, in order to avoid too long a learning period. We therefore
we selected the 20 GPs with the highest number of referred patients and called them the *intervention group*; (3) the remaining 12 GPs were called the *control group*. In January 1994 the intervention GPs were equipped with the newly developed inter-physician communication module [17], the control GPs continued to work as usual.

8.3.3 Data collection, measurements, and statistical methods

The assessment of the use of EDI for the support of shared care for diabetes patients was performed in two parts.
Firstly, on each information system of the 32 GPs, we ran a query procedure which analyzed the total number of patients enrolled in each practice, the average age of the patients, and the male-female ratio. The query also analyzed the number of contacts between physicians and patients, and the contents of the computer-based patient record of each diabetes patient. For each patient, we especially looked for laboratory parameters or comments considered to be important for diabetes care [18]. We counted the number of letters (either paper or electronic) sent and received by the general practitioner. We collected these parameters for two periods: the one-year period (1993) before the intervention study (i.e., the introduction and the

start of EDI between GPs and the consultant), and the one-year period (1994) of the intervention study. Outcome variables were the number of letters sent and received by the general practitioners, and the number of diabetes-related parameters (e.g., results of laboratory tests, for complete list see Table 3) in the patient records. Patients were nested within general practices, and general practitioners were nested within study groups (intervention or control). In order to compare intervention and control groups we performed an analysis of covariance. We used the values of the parameters in 1993 as covariate, thus assessing to what extent differences in outcome parameters were explained by baseline differences or by study group (intervention or control).
Secondly, we collected mean HBA1C levels for each patient in the intervention and in control practices during the first 6 months of the intervention study (January-June 1994), and compared these values with the mean HBA1C values collected during the second 6 months of the intervention study (July-December 1994). We performed a paired t-test to compare group means of the two periods. We used a t-test to compare intervention and control groups.
For the analyses mentioned above, we defined significance for p-values of less than 0.05.

8.4 Results

8.4.1 Study population

A total of 275 patients were included in our study; 215 patients were treated by the 20 general practitioners in the intervention group, and by the internal medicine consultant who was involved in the communication project; 60 patients were treated by the 12 general practitioners in the control group, and by the same internal medicine consultant involved in the communication project. Table 1 shows that the practices in the intervention group were larger, and that the average patient age was higher. The intervention group contained less type I patients (62; 29%) than the control group (24; 34%).

Table 1 - Patient population characteristics of control and intervention groups.

	General Practitioners	
	Control (n=12)	Intervention (n=20)
Total patient population		
Patients	26603	55910
Average practice size	2217	2796
Average age	35.2	39.5
Percentage of men	49.0	48.0
Diabetes Mellitus patients included in the study		
Patients	60	215
Average age	57.9	62.2
Percentage of men	47.0	47.0
Type I	24 (43%)	62 (29%)
Type II, diet	11 (20%)	26 (12%)
Type II, oral antidiabetics	11 (20%)	74 (34%)
Type II, insulin controlled	10 (18%)	53 (25%)

8.4.2 Patient management characteristics

The number of contacts between the patients and the general practitioners, both in the control group and the intervention group, increased from an average of 12 per patient per year in 1993 to an average of 14 in 1994 (Table 2). The number of contacts between the patients and the consultant remained constant at an average of 4 per year for both groups.

8.4.3 Frequency of communication

Table 2 shows the number of letters from GP to consultant and vice versa. There was a significant increase in the number of letters sent by the consultant to the intervention GPs when compared to the control group ($p < 0.01$). The number of letters from intervention GPs to consultant increased as well, but this increase was not significant.

Table 2 - Frequency of patient-physician contacts and document exchange between GP and consultant.

	Control GPs (GPs:12; Patients:60)		Intervention GPs (GPs:20; Patients:215)		
	1993	1994	1993	1994	P-value***
Patient contacts with					
the GP	12	14	12	14	NS
the consultant*	4	4	4	4	NS
Letters from					
the GP to consultant**	10 (0.2)	14 (0.2)	34 (0.2)	151 (0.7)	NS
the consultant to GP**	30 (0.5)	24 (0.4)	104 (0.5)	339 (1.6)	0.00

* Average number per patient per year.
** Absolute numbers are shown with average numbers per patient per year in parenthesis
*** P-values are based on F-tests in the analysis of covariance; significance for $p<0.05$.

8.4.4 Contents of patient records

Table 3 shows for 10 parameters the mean number of notes registered per patient during the one-year period preceding the intervention study (1993) and the one-year period after the start of the intervention study (1994). Using EDI, the patient records of the intervention group contained significantly more data on 6 of these 10 items (HbA1C levels, fructosamine levels, blood pressure, cholesterol levels, triglyceride levels, and weight) than did patient records of the control group. No significant differences were found for recordings of creatinine levels, proteinuria, outcomes of ophthalmological assessments, and glucose levels.

Table 3 - Medical record contents: recorded items per patient.

	Control*		Intervention*		
	1993	1994	1993	1994	P-value**
Kidney function					
Creatinine level	9 (0.2)	21 (0.4)	34 (0.2)	106 (0.5)	NS
Proteinuria	11 (0.2)	29 (0.5)	17 (0.1)	20 (0.1)	NS
Eye condition					
Assessment ophtalmologist	19 (0.3)	18 (0.3)	51 (0.2)	64 (0.3)	NS
Insulin control					
Glucose level	93 (1.6)	105 (1.8)	211 (1.0)	400 (1.9)	NS
HBA1C level	0 (0.0)	9 (0.2)	1 (0.0)	177 (0.8)	0.003
Fructosamine level	1 (0.0)	0 (0.0)	22 (0.1)	47 (0.2)	0.01
Other					
Blood pressure	78 (1.3)	81 (1.4)	128 (0.6)	417 (1.9)	0.000
Cholesterol level	6 (0.1)	25 (0.4)	22 (0.1)	149 (0.7)	0.03
Triglyceride level	1 (0.0)	7 (0.1)	6 (0.0)	52 (0.2)	0.02
Weight	12 (0.2)	27 (0.5)	71 (0.3)	448 (2.1)	0.000

* Absolute numbers are shown with average numbers per patients per year in parentheses. All statistics are analysis of covariance.
** Significance for $p<0.05$

8.4.5 Care parameters

As part of the usual checkup routine by the hospital consultant, HBA1C levels were measured during both the first semester and the second semester for 123 patients (57%) in the intervention group, and 32 (53%) patients in the control group. Table 4 shows the group means for both periods. Intervention patients showed a slight but significant decrease of HBA1C levels in the second semester of 1994 (from 7.0 to 6.8, p=0.03), control patients also showed a slightly decreased group mean, but this change was not significant (from 6.6 to 6.5, p=0.52). The magnitudes of these mean differences, however, were not significantly different (intervention group: 0.21; control group: 0.12, p=0.68).

Table 4 - Mean HBA1C levels

	1994, 1st half	1994, 2nd half	Mean difference (± 95% CI)*	P-value**
Control (n=32 patients)	6.6	6.5	-0.12±0.36	0.52
Intervention (n=123 patients)	7.0	6.8	-0.21±0.19	0.03

* Magnitude of this mean difference between control and intervention group was not significant (t-test, p=0.68)
** Paired t-test

8.5 Discussion

Diabetes mellitus is a chronic disorder that requires lifelong medical attention. The complexity of the disease leads to the involvement of many health-care professionals from various disciplines. In our study of the use of EDI for shared diabetes care we looked at three aspects: The frequency of communication between GP and consultant, the availability of data to the GP, and the clinical condition of the patient as indicated by HBA1C levels. We compared an intervention group for whom an EDI-link between general practitioner and consultant was established with a control group that communicated in the traditional paper-based manner. Comparing these two groups we found that the use of inter-physician communication resulted in significant changes in patient information management.
Firstly, previous research has pointed out that, when care is provided by more than one physician, discontinuous care may be the result [10]. Our study underlines that the frequency of communication about diabetic patients between primary and secondary care is low. The use of EDI has led to a significantly higher frequency of communication from consultant to general practitioner (from a mean number of messages per patient of 0.5 in 1993 to 1.6 in 1994, $p < 0.01$). Communication from general practitioner to consultant also increased (by a factor of 3.5) but, comparing the control and intervention group, this increase was not significant.
Secondly, our study showed that a higher availability of data to the GP about the care diabetes patients received in the outpatient clinic could be achieved by using EDI: a significant increase was found in the number of

entries in the computer-based patient records of the intervention GPs for HBA1C, fructosamine, blood pressure, cholesterol, triglyceride, and weight. During the project, no significant changes were found for items concerning kidney functions (creatinine level and proteinuria), data on ophthalmological examinations, and glucose.
Thirdly, evidence exists that good glycemic control reduces the risk of diabetic complications, such as blindness, lower extremities amputations, and renal failure [19]. In our study, patients in the intervention group showed a significantly decreased mean HBA1C level (from 7.0 in the first half of 1994 to 6.8 in the second half, $p = 0.03$). Because also in the control group a (not significant) decrease in mean HBA1C level was observed, and because the magnitude of the decrease in the intervention group was not significantly different from the changes in the control group, further research during a longer follow-up period is needed to confirm the effect of EDI on the outcomes of patient care.

The results indicate that EDI may prove to be a valuable method for improving communication between physicians. Assessing the contribution of this improved communication on the quality of diabetes care is difficult, especially since long-term effects of EDI on patient management could not be observed during our study. Furthermore, only limited numbers of physicians and patients were involved in the project. Finally, we could not establish randomized control and intervention groups: Because of the limited number of diabetic patients referred to the participating consultant, we selected the GPs with the largest practices, and the highest number of referred patients. This selection may have created a bias. On the other hand, if we consider the recognized importance of well-kept medical records of diabetes patients [7-10], it can be argued that the structured way of communication, implemented in our project, strengthens the coordination of care.

In order to successfully introduce EDI in clinical practice, a number of basic requirements have to be fulfilled. First, *participating care providers need to be using computer-based patient records*. In The Netherlands, especially in primary care, these systems are gaining ground rapidly, and it is expected that secondary care will follow suit in the next few years [14]. This will enable an extensive introduction of EDI in the future. Second, *guidelines for writing medical records may be of importance in maintaining high quality* *communication.* Several studies have shown that medical records are prone to be incomplete [7,20-22] and sometimes erroneous [23]. Part of these problems are caused by the fact that different physicians have different ideas about what patient data to record [24], and that physicians are seldom taught how to write medical records [25]. Because EDI uses the content of the computer-based patient record to build messages, the quality and completeness of the data in these records are essential. In addition, in The Netherlands, clinical guidelines for diabetes management in primary care have been developed that may prove to be helpful in improving the quality of documentation and thus in facilitating EDI [26]. Third, *EDI may lead to an information overload.* In our project we focused on diabetes patients only. Using EDI for all patients, however, would require firm provisions for managing this flow of information: One of the possible drawbacks of EDI is that it makes communication so easy that an information shortage may be replaced by an information overload. This problem may arise especially in situations where different physicians co-treating the same patient, fail to agree on each other's contribution to that treatment and on the information requirements of that contribution. Reaching this agreement on the division of tasks may be difficult, especially because financial issues will play a part in this matter.

Diabetes is one example only of a chronic disorder, requiring a lifelong, close cooperation between patient, general practitioner, and specialist [27]. Although many issues connected to the use of EDI still have to be resolved, the results of this study indicate that EDI may prove to be a powerful tool in managing patient information and improving the quality of care.

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Chapter 9

Summary and Conclusions

9.1 Summary

The purpose of this study was to gain insight in the level to which patients are concurrently treated by more than one physician, to analyze the problems that may occur in such shared-care situations, and to assess possible merits of electronic communication between physicians. Now that the majority of Dutch general practitioners use computer-based patient records in daily practice, many hospital departments store data in electronic form, and hospital-based consultants are expected to follow suit in using electronic records in the next few years, replacing paper-based information exchange with electronic communication seems a logical step.

Different electronic alternatives for paper-based information exchange are available: In **Chapter 2** we give an overview of currently available electronic communication techniques, and of studies assessing their value in improving health care delivery. These techniques range from cheap and simple to implement (e.g., the Fax) to expensive and more complex (e.g., Electronic Data Interchange). The structure of health care in a particular country or region may make one alternative more suitable than another. In The Netherlands, the general practitioner functions as a gatekeeper between primary and secondary care. Ideally, the general practitioner's (computer-based) medical record reflects the medical history of a patient, and can be used as a basis for communication with other health care professionals, using electronic messaging in one form or another. This methodology may not suffice in other countries (e.g., the USA) where such a central physician is often missing; in such a setting, patient-held electronic medical records (so-called SmartCards) may prove to be a better alternative.

In **Chapter 3** we report on a study which shows that Electronic Data Interchange in Dutch health care is a feasible instrument for improving communication between hospital departments and general practitioners. We first studied the traditional paper-based communication of admission-discharge reports and laboratory test reports. We subsequently introduced Electronic Data Interchange (EDI) for these two types of messages, to 27 general practitioners and 2 hospitals. We studied changes in speed of communication, efficiency of data handling, and satisfaction of general practitioners with EDI. Via paper mail admission-discharge reports took a median of 2 days in one hospital and 4 days in the other, and laboratory

reports took 2 days to reach general practitioners. With EDI, almost all admission-discharge reports were available to general practitioners within one hour of generation. When laboratory test samples were analyzed on the day of collection (as was the case for 32% of the samples in one hospital and 52% in the other) the laboratory reports were also available to the general practitioner the same day via electronic communication. Fifteen general practitioners (of the 24 who returned the questionnaire) reported that the use of electronic admission-discharge reports provided more accurate and complete information about the care delivered to their patients. Ten general practitioners reported that electronic laboratory reports lessened the workload of processing the data.

The results of this study were encouraging, and strengthened our expectation that the availability of EDI may motivate physicians to start using computer-based patient records. The study described in Chapter 3 only demonstrated the feasibility of EDI in daily practice; it merely replaced existing paper documents with electronic ones. In order to use EDI for inter-physician communication, it is important to gain a thorough understanding of existing communication pitfalls in this area. In the Chapters 4, 5, and 6 we report on studies investigating possible problem areas.

In **Chapter 4** we present the results of a mail survey which aimed at assessing the types of problems that general practitioners encounter in communicating with internal medicine consultants, and the consequences that occur as a result of these problems. Possible solutions to these problems were analyzed, especially the use of electronic mail. The most frequently reported problems were: failure of the internist to report in good time when referring the patient back to the general practitioner, and failure of the internist to provide sufficient detail in intermediate reports. The most frequently reported consequences were irritation caused to the general practitioner, and irritations caused to the patient. We conclude that communication problems mainly arise from a too late delivery of information, and a lack of understanding by the internist of the information needs of the general practitioner. Personal contacts between co-treating physicians, and well-established protocols are key elements in providing good cooperation between physicians. Electronic mail may be a good option to assist physicians in maintaining protocol-based communication.

Prescribing medication is one of the most important and expensive activities a general practitioner can undertake. The results of the study presented in **Chapter 5** underline the important role of the Dutch general practitioner in prescribing, but the study also shows that not all patients receive their medication from just one physician. To gain insight in the medication consumption of the general population and to evaluate the number of physicians involved in medication prescribing to a single patient, we used data of a public health insurance fund, containing more than 1.2 million records of dispenses. The records cover the medication actually delivered and relate to 130,000 patients. The data were collected over a one-year period (July 1991-June 1992) in the region of Apeldoorn, the Netherlands. They include information about the type and amount of drugs, the costs per drug, age and gender of the patient, and specialty of the prescribing physician.

The mean number of dispenses increased with age. The mean number of dispenses per year amounted to 6.8. Women were prescribed more drugs than men in all age groups except in those below the age of 10. More than 50% of the patients received 5 or less dispenses in the year of observation. Few patients (3%) accounted for a large amount of dispenses (19%). General practitioners prescribed more than 80% of the dispenses. The overall mean number of dispenses prescribed by the general practitioner and specialist amounted to 7.9 and 1.5, respectively, per patient who actually received medication during that year. More than 70% of the patients received their prescriptions from general practitioners only. About 30% obtained their prescriptions from two or more general practitioners, 3% even from 4 different physicians.

We conclude that drug consumption varies widely in the general population and that the general practitioner plays a major role in prescribing medication. The high proportion of patients with multiple prescribers necessitates adequate coordination of care in order to prevent overmedication and drug interactions.

In **Chapter 6** we focus on the ordering of laboratory test procedures. Earlier studies have shown that repeat investigations are a common cause of unnecessary duplication of laboratory test procedures. Most of the interventions aiming at reducing the number of repeat investigations have not resulted in long-term improvements. None of these studies assessed utilization of laboratory services by physicians, co-treating the same patient.

For a random sample of 1500 patients, we examined laboratory services utilization by physicians during an 8-month period. We counted the number of patients for whom more than one physician ordered laboratory test procedures simultaneously, and to what extent these procedures overlapped. We found that for 28% of the patients more than one physician had ordered tests in the 8-months period. Of all 41,655 tests, 5,536 (13%) were repeated by another physician than the physician who ordered the initial test: 1,527 (4%) of the tests were repeated within 5 days. Patients between 70 and 90 years of age had the highest average number of tests, the highest number of involved physicians, and the smallest mean time between similar tests.
We conclude that, also with regard to test ordering, there is a need for a better coordination of care. Improving communication among co-treating physicians may result in a reduction of repeat investigations.

Several studies, mentioned in Chapter 2, have argued that communication between physicians could be improved. The studies described in the Chapters 4-6 point in the same direction. In Chapter 3 we demonstrated that EDI may be an option to improve this communication. To implement inter-physician communication based on EDI principles, however, a message standard was needed that could transfer data from one computer-based patient record to another in such a manner that integration of the data from multiple sources is possible. Although in The Netherlands standardization of electronic health-care messages has made much progress over the past years, none of the available message standards provided enough functionality to enable EDI between computer-based patient record systems. In **Chapter 7** we describe a new message standard, called MEDEUR, that we designed for integrated patient data exchange between information systems. It can contain both administrative and medical data, and allows for electronic transmission of data in a structured manner. The structure of the message fits in with the structure currently offered by information systems available to primary and secondary care. We implemented the new message in a primary care information system, and a system specifically tailored for storing data on diabetic patients treated at a hospital outpatient clinic. We conclude that, using the message standard MEDEUR, it is possible to exchange patient information between computer-based patient records in such a manner, that the semantic structure of the information can be rebuilt in the receiving system. In this way physicians can share the information about patients that are jointly treated.

To evaluate the benefits of the communication infrastructure described in Chapter 7, we conducted a study, described in **Chapter 8**, in which general practitioners and an internal medicine consultant in the region of Apeldoorn share data about diabetic patients. Diabetes mellitus is a chronic disorder that requires lifelong medical attention. Because early diagnosis and treatment of complications are key elements in managing these complications, well-kept medical documentation is essential. Furthermore, the complexity of the disease requires the involvement of many health-care professionals from various disciplines (e.g., general practitioner, internist, ophthalmologist, dietician). This may lead to fragmentation of medical records and discontinuous care. Other researchers found that the quality of documentation of diabetes care is far from optimal. For these reasons, diabetic patients form a representative group for a study which aims to assess the value of EDI in shared-care situations, delivered to chronically ill patients.
In the region of Apeldoorn, already described in Chapter 3, we performed an experiment in which 32 GPs and one internal medicine consultant participated. The GPs already used an information system during consultations to inspect and record clinical data. The system also contained an electronic communication module. This module enables electronic information exchange with other information systems, such as hospital laboratories and hospital patient administrations. In the two regional hospitals, 2 of the in total 10 internal medicine consultants provide medical care for approximately 80% of all diabetic patients referred to the outpatient clinic. In the outpatient clinic of one of these diabetes treating consultants, we installed a system, similar to the one used in primary care, containing all the functions available to the general practitioners. Furthermore, we tailored this system to the information needs of the participating consultant.
Starting January 1994, 20 of the GPs (the intervention group) and the consultant were equipped with the inter-physician communication module described in Chapter 7, thus enabling EDI about diabetic patients. The other 12 GPs (the control group) continued to work as usual. After one year (in January 1995) we ran a query procedure on each information system of the 32 GPs which analyzed the contents of the computer-based patient record of each diabetic patient. We especially looked for laboratory parameters or comments concerning diabetes-related medical activities. We counted the number of letters (either paper or electronic) sent and received by the

general practitioner. We collected these parameters for two periods: the one-year period (1993) before the intervention study (i.e., the introduction and the start of EDI between GPs and the consultant), and the one-year period (1994) of the intervention study. Outcome variables were the number of letters sent and received by the general practitioners, and the number of diabetes-related parameters (e.g., results of laboratory tests) in the patient records. We collected HBA1C levels for patients in intervention and in control practices during the first 6 months of the intervention study (January-June 1994), and compared these values with HBA1C values collected during the second 6 months of the intervention study (July-December 1994).

In total, 275 diabetic patients were involved in the study, 60 treated by GPs from the control group, and 215 by GPs from the intervention group. All 275 patients, however, received their care in the hospital from the same consultant. The results of the measurements showed that intervention GPs received more messages (1.6 per patient) than control GPs (0.5 per patient, $p<0.05$). A significantly higher availability ($p<0.05$) was achieved for data on HBA1C levels, fructosamine levels, blood pressure measurements, cholesterol levels, triglyceride levels, and weight measurements. No significant differences were found for recordings of creatinine levels, proteinuria, outcomes of ophthalmological assessments, and glucose levels. Intervention patients showed a slight but significant decrease of HBA1C levels in the second semester of 1994 (from 7.0 to 6.8, $p=0.03$), control patients also showed a slightly decreased group mean, but this change was not significant (from 6.6 to 6.5, $p=0.52$). The difference between these mean changes, however, was not significant (intervention group: -0.21; control group: -0.12, $p=0.68$).

In conclusion, the study demonstrated that the electronic communication network for exchanging consultation outcomes significantly increased the frequency of communication and the availability of data to the general practitioners on diagnostic procedures performed in the hospital, thus providing them with more complete information about the care that patients were receiving. A large-scale experiment over a longer period of time is needed to assess the effects of improved communication on the quality of care.

9.2 Concluding remarks

1 Shared Care

A substantial number of patients are at some point in time co-treated by two or sometimes more physicians. This may lead to duplication of diagnostic procedures and problems in coordinating the delivered care. These problems can be alleviated by a more timely information exchange between co-treating physicians, and by a better understanding of each other's communication needs. Especially for patients with chronic disorders or multiple diseases, well-established communication may be of vital importance. Apart from good personal contacts between physicians and other health care personnel, timely and integrated communication, such as electronic data interchange, is of great value.

2 Electronic communication

Now that computer-based patient records are gradually replacing paper records, the next step is to start using this electronically available data for more purposes than was common and feasible with written data. Electronic communication between health-care professionals is one such purpose.

3 Quality of care

As demonstrated in this study, computer-based patient records can be used as a basis for electronic data interchange, allowing the physician to create messages based on data already present in the system. However, this in fact entails the reuse of patient data originally entered for other purposes than communication. Bearing this in mind, physicians may feel restrained in writing their records in the way they prefer to write them. On the other hand, knowing that other physicians will eventually receive the data from the medical record may encourage the physician to further improve the quality of his or her records.

4 Coding and standardization

When exchanging data between information systems, the syntactical structure of the electronic messages used and the semantics of the data are of crucial importance. Widely accepted code lists for elements such as laboratory procedures, diagnoses, medications, and referrals are needed to facilitate large-scale implementation of integrated data exchange. At present, such code lists are under development but not always already available.

5 *Future research*

The communication network described in this study resulted in an increased speed and volume of communication, a decreased workload of handling data in the general practitioner's office, and a better understanding from the part of the general practitioner of the care patients are receiving from other health-care professionals. It is likely that these combined effects positively influence the quality of care. Further development of electronic communication in health care should build on these experiences and should try to assess the benefits of electronic communication when applied to subgroups of potentially vulnerable patients, such as the chronically ill, cancer patients, patients with complex, multiple disorders, and -in general- elderly patients.

Chapter 10

Samenvatting en conclusies

10.1 Samenvatting

Het doel van de studies samengebracht in dit proefschrift was te onderzoeken in welke mate patiënten tegelijkertijd te maken hebben met meer dan één behandelend arts, welke problemen kunnen ontstaan in situaties waarin sprake is van gedeelde zorg, en of elektronische communicatie dergelijke problemen kan voorkomen of reduceren en tot verbeterde zorgsituaties leidt.
Momenteel gebruikt de meerderheid van de huisartsen een Elektronisch Medisch Dossier, en de verwachting is dat ook specialisten de komende jaren daarop zullen overgaan. De vervanging van de huidige papieren berichtuitwisseling door elektronische communicatie is dan een logische volgende stap.

De elektronische alternatieven voor papieren communicatie zijn legio. In **hoofdstuk 2** geven wij een overzicht van de huidige stand van zaken op het gebied van elektronische gegevensuitwisseling. Wij beschrijven daarbij een aantal studies waarin de bruikbaarheid van deze technieken voor het verbeteren van de zorg werd onderzocht. De mogelijkheden lopen uiteen van goedkoop en eenvoudig te implementeren (bijvoorbeeld de fax) tot relatief duur en meer complex (bijvoorbeeld Electronic Data Interchange). De organisatiestructuur van de gezondheidszorg kan overigens (mede)bepalend zijn voor de bruikbaarheid van een specifieke techniek. De Nederlandse huisarts heeft bijvoorbeeld een poortwachtersfunctie tussen eerste- en tweedelijns gezondheidszorg. Idealiter is het (elektronisch) dossier bij de huisarts een goede afspiegeling van de totale zorg die een patiënt ontvangt. Dit dossier kan dan dienen als basis voor elektronische communicatie met andere zorgverleners. In landen waar een dergelijke centrale zorgverlener ontbreekt (zoals bijvoorbeeld in de Verenigde Staten) is een door de patiënt bij zich gedragen elektronisch dossier, zoals bijvoorbeeld een zogenaamde Smart Card, mogelijk een meer voor de hand liggende keuze.

In **hoofdstuk 3** beschrijven wij een door ons uitgevoerd onderzoek dat aantoont dat Electronic Data Interchange (EDI) in Nederland een haalbare techniek is om communicatie tussen ziekenhuizen en huisartsen te verbeteren. We vergeleken het gebruik van papieren post voor de verzending van opname- en ontslagberichten en laboratoriumuitslagen met het gebruik van EDI. Bij dit onderzoek waren twee ziekenhuizen en 27 huisartsen betrokken. Via de post was de mediaan voor opname- en ontslagberichten 2 dagen voor één ziekenhuis en 4 dagen voor het andere; laboratoriumberichten hadden 2 dagen nodig om de huisarts te bereiken. Met EDI waren alle opname- en ontslagberichten binnen een uur nadat ze in het ziekenhuis waren gegenereerd elektronisch beschikbaar voor het informatiesysteem van de huisarts. Laboratoriumbepalingen die op dezelfde dag werden uitgevoerd dat het patiëntmateriaal werd verzameld (32% van de bepalingen in het ene ziekenhuis en 52% in het andere) waren via EDI ook op dezelfde dag beschikbaar bij de huisarts. Vijftien huisartsen (van de 24 die een toegestuurde enquête retourneerden) oordeelden dat het gebruik van EDI opname- en ontslagberichten had geleid tot meer accurate en complete informatie. Tien huisartsen rapporteerden een verminderde werkbelasting bij het verwerken van laboratoriumuitslagen. De tijdwinst bij de verzending van laboratoriumuitslagen oordeelde men van minder belang, in tegenstelling tot de tijdwinst bij opname- en ontslagberichten die wel gewaardeerd werd.

De resultaten van onze studie waren bemoedigend, en ondersteunden onze overtuiging dat de beschikbaarheid van EDI voor artsen een motivatie zou kunnen betekenen om het Elektronisch Medisch Dossier te gaan gebruiken. Echter, de geïmplementeerde berichten behelsden slechts een elektronische vorm van een reeds bestaande papieren berichtgeving. Om EDI zinvol in te kunnen zetten voor de verbetering van de communicatie tussen artsen is inzicht nodig in de bestaande problemen bij die communicatie. In de hoofdstukken 4, 5 en 6 beschrijven wij de resultaten van studies die tot doel hadden dit inzicht te verwerven.

In **hoofdstuk 4** beschrijven wij de resultaten van een enquête die tot doel had de verschillende problemen te inventariseren die huisartsen ontmoeten in hun communicatie met internisten, en de consequenties die voortvloeien uit deze problemen. Wij beschrijven een aantal mogelijke oplossingen voor deze problemen, waaronder elektronische communicatie. De meeste door de huisartsen gerapporteerde problemen betroffen: te late berichtgeving door de internist bij het terugverwijzen van de patiënt en een niet voldoende gedetailleerde tussentijdse rapportage door de internist. De consequenties voortvloeiend uit deze problemen waren met name irritatie bij de huisarts en irritatie bij de patiënt. De conclusie van het onderzoek is dat problemen met name ontstaan als gevolg van een te late berichtgeving en een gebrek aan inzicht bij de internist ten aanzien van de informatiebehoefte van de huisarts. Goede persoonlijke contacten tussen medebehandelaars en breed geaccepteerde samenwerkingsprotocollen vormen de basis voor een goede samenwerking. Elektronische communicatie kan daarbij een goede optie zijn voor het onderhouden van geprotocolleerde communicatie.

Het voorschrijven van geneesmiddelen is één van de belangrijkste en duurste activiteiten die een arts kan ondernemen. **Hoofdstuk 5** onderstreept de belangrijke rol die de huisarts hierbij heeft, maar onze studie toont ook aan dat niet alle patiënten hun medicijnen van slechts één arts voorgeschreven krijgen. Om inzicht te krijgen in de medicijn-consumptie in Nederland en het aantal verschillende artsen waarvan een patiënt medicijnen ontvangt, bestudeerden wij de prescriptiegegevens zoals deze beschikbaar waren bij een ziekenfonds. De gebruikte dataset bevatte van 130.000 patiënten uit de regio Apeldoorn de gegevens over door de apotheek afgeleverde medicatie. Deze gegevens bevatten leeftijd en geslacht van de betrokken patiënt, het specialisme van de voorschrijver, en het type, de hoeveelheid en de prijs van het voorgeschreven medicijn. De dataset dekte de periode juli 1991-juni 1992 en bevatte in totaal ruim 1.2 miljoen records.

Het gemiddeld aantal voorschriften over alle leeftijdsgroepen bedroeg per jaar 6.8. Het aantal voorschriften nam toe met het stijgen van de leeftijd. Vrouwen van alle leeftijdsgroepen, met uitzondering van de groep jonger dan 10 jaar, ontvingen meer medicijnen dan mannen. Ruim de helft van de patiënten ontving vijf of minder voorschriften; een klein deel van de patiënten (3%) nam een relatief groot deel (19%) van het totaal aan medicatie voor zijn rekening. Huisartsen schreven 80% van alle recepten voor: gemiddeld 7.9, specialisten 1.5 recepten per patiënt per jaar. Ruim 70% van de patiënten ontving de medicijnen alleen van de huisarts. Ongeveer 30% van de patiënten ontving de medicijnen van meer dan één huisarts, 3% van de patiënten had zelfs te maken met vier verschillende artsen.

Op basis van deze resultaten concluderen wij dat het medicijngebruik sterk varieert, en dat de huisarts een hoofdrol speelt bij het voorschrijven ervan. Het grote aantal patiënten dat te maken heeft met verschillende voorschrijvende artsen benadrukt de noodzaak tot een goede coördinatie van medicatiebeleid. Hiermee kunnen overmedicatie en ongewenste interacties worden tegengegaan.

Stond in hoofdstuk 5 het medicijngebruik van patiënten centraal, in **hoofdstuk 6** proberen wij een soortgelijke vraag te beantwoorden, maar dan voor laboratoriumdiagnostiek. Andere onderzoekers hebben aangetoond dat herhaal-aanvragen vaak onnodig zijn. De meeste interventies die gericht waren op het bestrijden van deze dubbeldiagnostiek hebben op de lange termijn geen effect gesorteerd.
Uit de literatuur zijn ons geen studies bekend die zich richtten op het optreden van dubbeldiagnostiek in het geval van gelijktijdige behandeling van een patiënt door meer dan één arts.
Wij onderzochten bij 1500 random geselecteerde patiënten de door de behandelende artsen gedurende 8 maanden aangevraagde laboratoriumdiagnostiek. Wij telden het aantal patiënten waarvoor meer dan één arts laboratoriumdiagnostiek aanvroeg, en onderzochten in hoeverre er sprake was van overlap.
Wij vonden dat voor 28% van de patiënten meer dan één arts diagnostiek had aangevraagd. Van alle 41655 tests werden er 5.536 (13%) binnen de studieperiode van 8 maanden herhaald door een andere arts dan degene die de initiële test had aangevraagd: 1527 (4%) van alle tests zelfs binnen 5 dagen. Patiënten in de leeftijdsgroep 70-90 jaar ondergingen de meeste diagnostiek, hadden het grootst aantal betrokken artsen, en een gemiddeld kortste tijdsduur tussen twee identieke tests.

Wij concluderen dat, ook waar het gaat om laboratoriumdiagnostiek, de noodzaak bestaat tot een betere coördinatie van zorg. Het verbeteren van communicatie tussen de artsen betrokken bij de behandeling van één bepaalde patiënt kan resulteren in terugdringing van het aantal onnodige dubbelbepalingen.

Uit diverse studies, genoemd in hoofdstuk 2, blijkt dat de communicatie tussen artsen voor verbetering vatbaar is. Ons onderzoek beschreven in de hoofdstukken 4 tot en met 6 wijzen in dezelfde richting. In hoofdstuk 3 gaven wij een voorbeeld van een door ons uitgevoerd experiment waarin de mogelijke waarde van EDI ter verbetering van de communicatie werd aangetoond. Voor elektronische communicatie tussen artsen, gebaseerd op de principes van EDI, is een berichtstandaard nodig. In Nederland is de laatste jaren grote vooruitgang geboekt bij het standaardiseren van elektronische berichten voor de gezondheidszorg. Geen van deze bestaande berichten bood echter de gewenste functionaliteit zodat een nieuwe berichtstandaard nodig was.

In **hoofdstuk 7** beschrijven wij een nieuwe EDI standaard, genaamd MEDEUR, speciaal ontworpen voor geïntegreerde gegevensuitwisseling tussen medische informatiesystemen. MEDEUR kan zowel administratieve als medische gegevens bevatten en maakt een gestructureerde, elektronische verzending van deze gegevens mogelijk. De structuur van MEDEUR sluit aan op die van bestaande informatiesystemen in eerste en de tweede lijn.
Wij pasten MEDEUR toe in een reeds bestaand informatiesysteem voor de eerstelijn, en in een soortgelijk informatiesysteem dat speciaal was aangepast voor gebruik bij de behandeling van diabetespatiënten op een polikliniek interne geneeskunde.

Wij concluderen dat de berichtstandaard MEDEUR geïntegreerde uitwisseling van gegevens tussen elektronische medische dossiers mogelijk maakt. Daarbij kan het ontvangende informatiesysteem de oorspronkelijke semantische structuur van die gegevens reconstrueren, zodat artsen die gezamenlijk dezelfde patiënt behandelen de gegevens over die patiënt kunnen delen. In het volgende hoofdstuk beschrijven wij een veldexperiment waarbij EDI met behulp van MEDEUR werd gebruikt.

In **hoofdstuk 8** beschrijven wij een studie waarin, met behulp van de infrastructuur beschreven in hoofdstuk 7, huisartsen en een internist in de regio Apeldoorn elektronisch gegevens uitwisselden over diabetespatiënten. Diabetes mellitus is een chronische ziekte die levenslang medische zorg behoeft. Omdat vroege herkenning en behandeling van diabetische complicaties van groot belang is, is een optimale documentatie van het medisch handelen essentieel. Daarnaast maakt de complexiteit van de ziekte een multidisciplinaire aanpak noodzakelijk, waarbij onder anderen de huisarts, de internist, de oogarts en de diëtist betrokken zijn. Deze situatie kan leiden tot fragmentatie van medische gegevens en discontinuïteit in de geleverde zorg. Uit ander onderzoek is gebleken dat de kwaliteit van de medische verslaglegging over diabetespatiënten verre van optimaal is. Om bovengenoemde redenen vormen diabetespatiënten een representatieve groep voor een studie naar de waarde van EDI bij transmurale zorg voor de chronisch zieken.

Wij voerden het onderzoek uit in de regio Apeldoorn, met de participatie van 32 huisartsen en een internist. Al voor de aanvang van het onderzoek gebruikten alle huisartsen een Elektronisch Medisch Dossier en waren zij in het bezit van een communicatiemodule. Met deze module waren zij in staat laboratoriumuitslagen en opname- en ontslagberichten te ontvangen.
In het Apeldoornse ziekenhuis (met twee lokaties) zien twee van de in totaal tien internisten ongeveer 80% van alle door de huisartsen in deze regio verwezen diabetespatiënten. Bij één van deze twee internisten installeerden wij een informatiesysteem met een Elektronisch Medisch Dossier, aangepast aan de eisen van een polikliniek voor diabetespatiënten. In januari 1994 werden de systemen van 20 huisartsen (de interventiegroep) en de internist uitgerust met de communicatiemodule beschreven in hoofdstuk 7, waardoor de artsen in staat werden gesteld met behulp van EDI patiëntgegevens uit te wisselen. Bij de overige 12 huisartsen (de controlegroep) bleef de communicatie ongewijzigd. Na een periode van één jaar analyseerden wij van iedere patiënt de inhoud van het Elektronisch Medisch Dossier, waarbij wij speciaal letten op diabetes-gerelateerde parameters. Wij telden het aantal brieven (papieren of elektronisch) verzonden en ontvangen door de huisarts. Wij voerden deze tellingen uit over twee perioden: het jaar (1993) voorafgaande aan de studie, en het jaar (1994) waarin de EDI communicatie werd gebruikt. Uitkomstvariabelen waren het aantal verzonden en ontvangen brieven, en de aantallen diabetes-gerelateerde parameters (zoals uitslagen van laboratoriumdiagnostiek). Voorts verzamelden wij van alle patiënten in de interventie- en controlepraktijken de uitslagen van de HBA1C-bepalingen gedurende de eerste zes maanden van 1994 en vergeleken deze met de uitslagen over de laatste zes maanden van 1994.

Bij het onderzoek waren 275 patiënten betrokken, 60 patiënten van huisartsen uit de controlegroep en 215 van huisartsen uit de interventiegroep. Alle patiënten waren onder behandeling bij dezelfde internist.
Ten aanzien van de berichtgeving en dossiervorming bleek uit het onderzoek dat, de huisartsen in de interventiegroep meer brieven per jaar ontvingen (1.6 per patiënt) dan de controlegroep (0.5 per patiënt, $p<0.05$).

Significant hogere aantallen gemeten waarden voor HBA1C, fructosamine, bloeddrukbepalingen, cholesterol, triglyceriden en gewichtbepalingen waren beschikbaar bij de interventiegroep dan bij de controlegroep. Geen significant verschillende aantallen meetwaarden werden gevonden voor kreatinine, proteïnurie, resultaten van oogheelkundig onderzoek en glucosebepalingen.
Patiënten in de interventiegroep vertoonden een lichte maar significante daling van het HBA1C in de tweede helft van 1994 (van 7.0 in de eerste helft van 1994 naar 6.8 in de tweede helft, p=0.03). Een daling trad ook op bij de patiënten in de controlegroep, maar was niet significant. Het verschil tussen de grootte van deze veranderingen in HBA1C-gehalte in de interventiegroep en de controlegroep was niet significant (interventiegroep: -0.21; controlegroep: -0.12, p=0.68).

Concluderend stellen wij vast dat deze studie aantoonde dat het gebruik van EDI voor het rapporteren van medische gegevens tussen artsen heeft geleid tot een verhoogde communicatiefrequentie en een grotere beschikbaarheid van gegevens bij de huisarts over de zorg verleend in het ziekenhuis. Het is aannemelijk dat deze aspecten de kwaliteit van zorg positief beïnvloeden. Verder onderzoek naar deze invloed op de kwaliteit van zorg dient in een grootschaliger experiment gedurende een langere periode plaats te vinden.

10.2 Conclusies

1 *Transmurale zorg*

Een substantieel deel van de patiënten wordt op een bepaald moment behandeld door meer dan één arts. Deze situatie kan leiden tot dubbeldiagnostiek en problemen bij het coördineren van de aangeboden zorg. Een tijdige informatie-uitwisseling tussen medebehandelaars, en een beter begrip van elkaars informatiebehoefte kan helpen de coördinatie te verbeteren. Met name bij chronisch zieken en bij patiënten met multiple aandoeningen kan een optimale communicatie van vitaal belang zijn. Naast goede contacten tussen de betrokken zorgverleners is een tijdige, geïntegreerde communicatie zoals EDI, van grote waarde.

2 *Elektronische communicatie*

Nu het Elektronisch Medisch Dossier geleidelijk de plaats in begint te nemen van het papieren dossier is de volgende stap het gaan gebruiken van die in elektronische vorm beschikbare gegevens voor meer doeleinden dan gebruikelijk en mogelijk was met geschreven gegevens. Elektronische communicatie tussen zorgverleners is daarvan een voorbeeld.

3 *Kwaliteit van zorg*

Deze studie toont aan dat het Elektronisch Medisch Dossier gebruikt kan worden als basis voor EDI, zodat de arts berichten kan opstellen samengesteld uit gegevens die reeds beschikbaar zijn in het systeem. In feite worden de gegevens op zo'n moment gebruikt voor een doel waar ze oorspronkelijk niet voor waren bedoeld. Met deze kennis in het achterhoofd is het mogelijk dat artsen terughoudend kunnen zijn bij het schrijven van het medisch dossier zoals ze dat gewend waren. Aan de andere kant, de wetenschap dat medebehandelaars uiteindelijk de ingetypte tekst te zien kunnen krijgen kan ertoe leiden dat de arts de kwaliteit van zijn of haar medisch dossier verder verbetert.

4 *Codering en standaardisatie*

Bij elektronische uitwisseling van gegevens tussen informatiesystemen met behulp van elektronische berichten is de syntactische en semantische structuur van deze berichten van cruciaal belang. Algemeen geaccepteerde codelijsten voor onderwerpen als laboratoriumonderzoek, diagnoses, medicatie en verwijzingen zijn noodzakelijk om geïntegreerde elektronische communicatie op grote schaal te kunnen implementeren. Op het moment zijn dergelijke codelijsten slechts beperkt beschikbaar.

5 *Vervolgonderzoek*

Het in ons onderzoek gebruikte communicatienetwerk leidde tot een verhoogde snelheid en toegenomen omvang van communicatie, een verminderde werkbelasting in de huisartspraktijk bij de verwerking van die gegevens, en een beter inzicht van de huisarts in de zorg die patiënten in de tweedelijn ontvangen. Het is aannemelijk dat deze effecten een positieve invloed hebben op de kwaliteit van zorg. Verdere ontwikkeling van elektronische communicatie in de gezondheidszorg kan voortbouwen op onze ervaringen. Vervolgonderzoek dient zich te richten op het evalueren van de waarde van elektronische communicatie bij de zorg voor kwetsbare patiëntengroepen, zoals chronisch zieken, kankerpatiënten, patiënten met complexe, multiple aandoeningen en -in het algemeen- oudere patiënten.

ABOUT THE AUTHOR

Peter Johan Branger was born in Haarlem, The Netherlands, at 03:10 on the 3rd of december 1960.

He received his undergraduate education at the Gemeentelijk Gymnasium in Hilversum. He attended medical school at the Free University in Amsterdam ("artsexamen" 1988).
In 1988 he started his work with the Department of Medical Informatics at the Erasmus University Rotterdam. During the period 1990-1994 he held a joint appointment with this department and the Department of General Practice. The work reported in this Thesis is based on the work done in the period 1988-1994.

Peter Branger continues research at the Department of Medical Informatics.

NAWOORD

De titel van dit proefschrift geeft het al aan: hoewel mijn naam op de omslag staat is de voltooiing van het werk te danken aan de inspanningen, aandacht en *Shared Care* van velen. Laat ik dicht bij huis beginnen.

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Johan van der Lei heeft een belangrijke bijdrage geleverd aan de zeggingskracht van mijn publikaties. Van hem heb ik geleerd hoe de boodschap aan de lezer over te brengen, zwakke plekken in redeneringen te ontmaskeren en *run-on sentences* te voorkómen.

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Hans van der Wouden heeft mij de methodologische bril opgezet en de valkuilen getoond waar een beginnend onderzoeker in terecht kan komen.

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Het leukste werk is het veldwerk. Om de ideeën over communicatie in de praktijk te kunnen testen is het echter nodig om mensen bereid te vinden tijd en energie te steken in die activiteiten. Aan dergelijke mensen heeft het gelukkig niet ontbroken.

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Ook in de Apeldoornse ziekenhuizen is veel werk verzet om elektronische communicatie te realiseren, en onderzoek te verrichten naar de effecten ervan. De klinisch chemici en de medewerkers van de Dienst Automatisering hebben regelmatig bijgedragen aan het welslagen van de projecten. Rob Verhoeven heeft in het Mare-project een sleutelrol vervuld. Als 'Witte Raaf' onder de medisch specialisten heeft hij de stap gezet naar het gebruik van het elektronisch patiënt dossier, en daarmee de realisatie van gestructureerde communicatie tussen eerste- en tweedelijn mogelijk gemaakt.

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