The Introduction of Computer-based Patient Records in the Netherlands

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■ **Computer-based patient records, although an area of active research, are not in widespread use. In June 1992, 38% of Dutch general practitioners had introduced computer-based patient records. Of these, 70% had replaced the paper patient record with a computer-based record to retrieve and record clinical data during consultations.**

Possible reasons for the use of computer-based patient records include the nature of Dutch general practice and the early and active role of professional organizations in recognizing the potential of computer-stored patient records. Professional organizations issued guidelines for information systems in general practice, evaluated available systems, and provided postgraduate training that prepares physicians to use the systems. In addition, professional organizations successfully urged the government to reimburse general practitioners part of the expenses related to the introduction of computer-based patient records.

Our experience indicates that physicians are willing and able to integrate information technology in their practices and that professional organizations can play an active role in the introduction of information technology.

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The potential value of computers in medicine has long been recognized, and medical informatics has emerged as an important interdisciplinary research field (1–4). A particularly challenging problem has been the development of computer-based patient records (5, 6). Despite more than two decades of research in the United States, use of computer-based patient records by physicians is not widespread (7). A survey done in 1988 showed that, although almost 50% of the general practitioners in the United States had a computer in their practice, fewer than 1% used computer-based patient records (8). The Institute of Medicine recently urged that computer-based patient records be developed, implemented, and disseminated (9).

In contrast, many Dutch general practitioners have started to use computer-based patient records in daily practice. Our purpose is to describe the introduction and use of computer-based patient records in general practice. We briefly describe the role of the general practitioner in the Dutch health care system and discuss reasons why use of computer-based patient records in the Netherlands appears to be increasing.

The Health Care System in the Netherlands

In the Dutch health care system, nearly every citizen is enrolled in the practice of a general practitioner. Patients are free to change from one practice to another, which occurs infrequently and nearly always because the patient moves out of the area. When a patient transfers, so does the patient record. When seeking advice or treatment, the patient usually contacts his or her general practitioner, who acts as a gatekeeper in the health care system. The general practitioner may refer patients to other specialists, who report their findings to the general practitioner. Approximately 90% of the patients' presenting problems are addressed by the general practitioner; the rest are referred to a specialist.

In the Netherlands, just more than 6400 general practitioners provide primary care; the average size of a practice in January 1991 was 2350 patients. More than 75% of the Dutch population will see their general practitioner at least once a year, and more than 90% at least once every 3 years. A general practitioner will see, on average, 35 to 45 patients per day. Approximately 60% of the patients are insured through sick funds, a compulsory insurance for any citizen with an income less than 54 000 Dutch Florins (about $30 000). The remaining patients have private health care insurance. The general practitioner is reimbursed a flat fee per year for each sick-fund patient in his or her practice, independent of the number of visits by that patient; for privately insured patients, the general practitioner is reimbursed on a fee-for-service basis (10).

Use of Computer-based Patient Records

The information systems used by general practitioners have been designed specifically for use in primary care (11, 12). They consist of different modules, each performing a specific set of functions. For example, one module is for billing and another module is for recording clinical data. These modules, however, are not independent; data from the module that records clinical data also may be used for billing. We use the term information system to denote all interrelated modules, and the term patient-record module to identify the specific module that enables replacement of the paper-

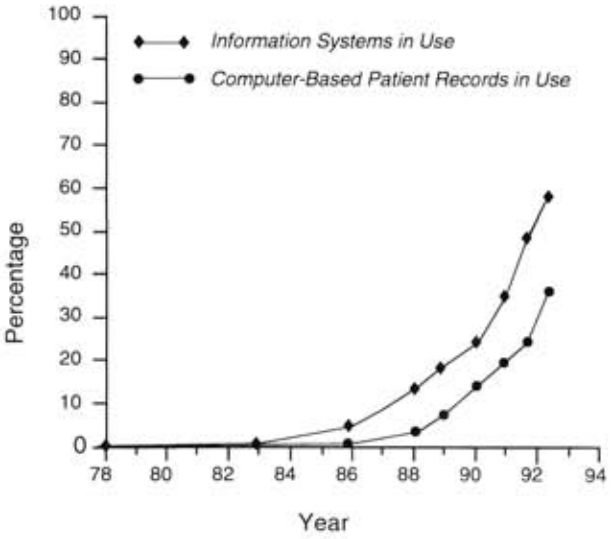

Figure 1. The number of general practitioners using information systems. The top curve shows the percentage of Dutch general practitioners who used an information system in their practice from 1978 to 1992. The lower curve shows the number of physicians who had purchased and installed computer-based patient records.

based patient record with a computer-based patient record.

Figure 1 shows the use of computers by Dutch general practitioners. After the first Dutch general practitioner installed a computer in 1978, few followed suit. By 1983 only 35 general practitioners were using a computer (13). However, by July 1990, the Dutch Association of General Practitioners reported that 1465 general practitioners (23%) were using an information system; 2 years later, in June 1992, 58% of general practitioners had installed an information system (14).

The general practitioner, however, is free to decide which modules of an information system to install. The introduction of an information system into a practice is stepwise, usually beginning with the system's administrative and financial modules. As the general practitioner automates his or her practice, additional modules are added. The computer-based patient record is typically the last module installed; the time between the introduction of the financial modules and the computer-based patient record is usually at least 1 year. Figure 1 also shows the percentage of Dutch general practitioners who had installed the patient-record module. In June 1992, 38% of general practitioners had purchased and installed a patient-record module (14).

Because a general practitioner purchases and installs a patient-record module does not guarantee that the module is used. The Dutch Association of General Practitioners reported in June 1992 that of the 38% of Dutch general practitioners who had purchased and installed a computer-based patient record, 70% used the computer-based record instead of a conventional paper record (14).

Elias System

In the Netherlands, the physician can choose among several competing information systems based on the requirements formulated by the professional organizations of general practitioners (11, 12). (Two major associations are the Dutch College of General Practitioners, which has a predominantly scientific focus, and the aforementioned Dutch Association of General Practitioners, which promotes the interests of its members.) As a result of these guidelines, all systems provide the same basic functions. They allow the general practitioner to replace the paper record with a computer-based record and they support a problem-oriented medical record. None of the available systems, however, allow storage of nontextual data such as images.

The guidelines of the professional organizations are based on the principle that physicians themselves must use the computer-based patient-record module: The physician uses the system during patient consultations to inspect and record clinical data. Therefore, all available systems capture data directly from the physician. The systems do not support initial recording of data by the physician on paper followed by transcription of the physician's notes by clerical personnel; that is, the systems do not print paper forms such as progress notes or encounter forms on which the physician can record clinical data. Although all available systems capture data directly from the physician, significant differences are evident in the user interfaces and in the sophistication of additional features (such as the ability to conduct clinical research using the system).

In the Netherlands, Elias (Cendata B.V., Nieuwegein, the Netherlands) was one of the systems that pioneered computer-based patient records in general practice (15). Its first version was developed at the same time (1983–1985) the first professional organizations' requirements were formulated. The research team that developed Elias played an active role in both formulating the requirements and evaluating their feasibility (11). Developed in an academic setting, Elias continues to be a focus of research and is available commercially (16–19). By December 1992, Elias was used by more than 900 (14%) general practitioners.

Overview of Elias

Elias consists of five modules: the basic module, the financial module, the pharmacy module, the patient-record module, and the communication module. The basic module contains administrative data for the patients and employees of the practice and data on the persons or organizations with whom the practice may correspond (for example, a ledger of specialists to whom the physician may refer patients). In addition, this module contains functions for scheduling patient appointments, for recording the data necessary for billing, and for actual billing. The financial module contains functions for financial administration of the practice; for example, it includes a ledger for recording incoming and outgoing payments. The pharmacy module provides functions that support drug dispensing, such as billing and stock control.

Patient Record

The computer-based patient record of Elias replaces the paper patient record; the only exceptions are non-

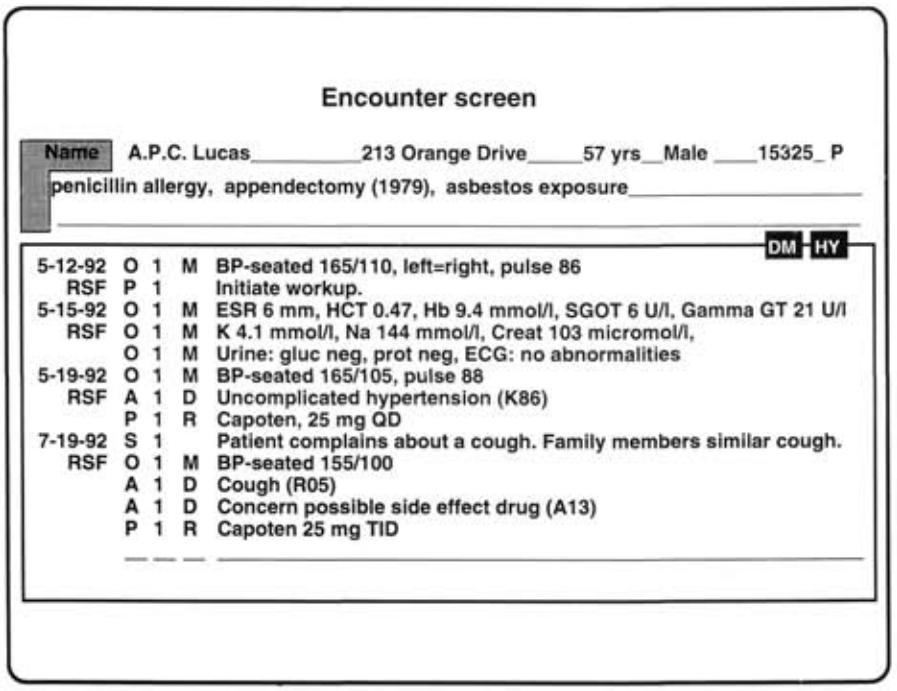

Figure 2. Encounter screen from Elias. Elias, an information system for primary care, supports a computer-based patient record. Shown here is the encounter screen used by the general practitioner to enter data during a consultation. At the top of the screen, name, address, age, and sex are shown, followed by a few lines containing pertinent events from the patient's history (for example, known allergies). Markers identify chronic diseases (DM = diabetes mellitus, HY = hypertension). In the lower part of the screen, the first column lists the date of the encounter and the physician's initials. The next column refers to SOAP coding: S = subjective, O = objective, A = assessment, P = plan. The third column identifies a problem from the problem list in this example, only the entries associated with a single problem, hypertension, are shown. The fourth column identifies the specific coding resource that has been used to code data: M = coded measurements, D = diagnoses coded according to International Classification of Primary Care codes (such as K86, R05, and A13), and R = coded prescriptions.

textual data such as roentgenogram images. General practitioners use the computer-based patient record to retrieve, review, and record data during consultations; paper copies of the patient record are only produced for circumstances in which the computer is not available (for example, when making house calls). The physician inputs the data using a keyboard; Elias does not print paper progress notes or encounter forms for the physician to use during consultations.

The medical-record module of Elias provides the physician with functions that use or augment the data in the computer-based record to, for example, monitor drug interaction and contraindications, access practice guidelines, summarize patient histories, monitor risk profiles (for example, cardiovascular risk profiles), screen patients (for example, identify women eligible for Papanicolaou smears), or conduct follow-up (for example, identify patients who did not return for an additional Papanicolaou smear after an initial abnormal result). For Elias to use these functions, the physician must code the patient data. Elias can generate reimbursement claims based on the patient record only when data such as the type of visit or procedures done are coded. Similarly, Elias can monitor drug interaction and drug doses only when the prescribed drugs and their doses are coded.

Elias also provides the physician with resources to code the medical data. These resources can be divided into two broad categories: those that provide the overall structure of the patient record, and those that allow coding of detailed content. For the overall structure, Elias supports Weed's coding, which uses the categories subjective, objective, assessment, and plan (SOAP), and the problem-oriented patient record (20, 21). When a physician uses SOAP coding, Elias divides the medical data into the above-mentioned broad categories, each of which is recorded separately: the subjective description of the patient's complaints, the objective findings of the physician, the assessment by the physician, and the plan for further action. To structure the patient record further, the physician may use the problem-oriented mode, which enables him or her to define problems and then to assign clinical data to those problems.

To code detailed content, Elias provides the physician with additional resources. For coding the reason for the encounter and the diagnosis, Elias supports the International Classification of Primary Care (ICPC) (22). A database of all drugs available in the Netherlands, maintained by the Royal Dutch Association for the Advancement of Pharmacy (23), enables the physician to code prescriptions. Another resource contains descriptions of available laboratory tests (including normal values), and allows the entry of results. Other resources allow the coding of numeric data obtained during physical examination (for example, vital-sign measurements), referrals to other health care providers, or enrollment in studies (for example, intervention studies or postmarketing drug surveillance).

Figure 2 shows an encounter screen used by the general practitioner to enter data during a consultation. Elias displays the entries in the patient record in chronologic order. At the bottom of the chart, Elias displays an empty line, the data-input line. At this line, the

physician enters new data. If the physician does not use any coding resources, Elias assumes that the physician is about to enter free text; in this mode, Elias behaves like a word processor. To structure the data, the physician must inform Elias about the type of data that are to be entered. For this purpose, the data-input line is preceded by command fields; by first issuing commands in these command fields, the physician controls the behavior of the system. The first two command fields reflect the overall structure of the patient record: The first command field is reserved for SOAP coding and the second command field is reserved for the problem list. Using the third command field, the physician may activate specific coding resources, such as the drug database when he or she is prescribing a drug, or the ICPC when he or she is coding the reason for the encounter. In addition, the physician may use this third command field to issue commands that cause Elias to display selected parts of the patient record in alternative modes—for example, a graphic display of laboratory data over time, an overview of the medication history, a history of referrals, or, when the physician is using a problem-oriented registration, a display of only those entities that belong to a specific problem (for example, the chart shown in Figure 2 contains only the lines associated with a single problem, hypertension).

Although consultation data are captured directly from the physician, nonconsultation data such as laboratory data or data received from specialists are typically entered by clerical personnel. In addition, when the computer-based patient record is introduced in a practice, clerical personnel will enter summaries of the existing paper-based record before these records are archived.

Communication

Elias also contains a communication module that allows communication with information systems outside the practice. Increasingly, general practitioners working in the same city or region of the country and acting as covering physicians have jointly introduced information systems into their practices. Using electronic mail, they can use their information systems to communicate with one another; often, connections to other health care institutions are also established (18). The most common connections are between the general practitioner and pharmacies (for example, when the physician transmits a prescription), between the general practitioner and laboratories (for example, when the laboratory transmits the results of tests), and between the general practitioner and hospitals (for example, when the hospital information system reports to the general practitioner an admission or discharge of one of his or her patients). Electronic mail enables the exchange not only of free text but also of coded data; a laboratory can, for example, transmit the results of laboratory tests so that Elias can, after inspection of the data by the physician, include these results automatically in the patient's computer-based patient record.

Technical Implementation

Elias is written in the M language (formerly called Mumps). The hardware platform most frequently used by general practitioners is a PC 386 with the operating system MS-DOS (Microsoft Corp., Redmond, Washington). The use of electronic communication among general practitioners, other health care providers, and third-party payers requires standardization. In the Netherlands, the National Board for Public Health (Nationale Raad voor de Volksgezondheid) has adopted Edifact as the standard for electronic data interchange between systems used in health care (24). By using Edifact, a national standard is defined for each type of message exchanged (for example, admission of patients to a hospital, discharge from hospital, results of laboratory tests, referral letters, or invoices to third-party payers). Elias uses Edifact for electronic communication (25).

Discussion

Researchers have called computer-based patient records a potentially major catalyst for change in health care (5, 6, 9). Application of information technology to the patient record, however, has not resulted in the wide-scale use of computer-based patient records (7–9). A recent study by the Institute of Medicine claims that technology no longer constitutes a major barrier to the development and introduction of computer-based patient records (9). The increasing use of these records and electronic communication in primary care in the Netherlands supports this claim. Why, then, does the use of computer-based patient records appear to be increasing more rapidly in the Netherlands than in the United States? Lacking a controlled trial, we cannot say with certainty. However, we believe the difference is related to the nature of general practice in the Netherlands, the role of professional organizations, and the existence of government incentives promoting the use of computer-based patient records.

Nature of General Practice in the Netherlands

General practice can be envisioned as providing population-based services responsive to both individual and collective needs of people; this contrasts with specialized medical practices in which institution- and physician-based services deal with overt demand for curative care. For example, general practitioners developed the ICPC because the existing classifications (most notably the International Classification of Diseases) did not correspond with problems identified in their population-based approach (22). The ICPC allows the coding of the reason for encounter, for example, and enables the collection of episode-oriented data.

In the late 1970s and early 1980s, professional organizations of Dutch general practitioners emphasized that the role of the general practitioner in the health care system is to provide population-based services responsive to both individual and collective needs (26). This also applies to the requirements imposed on patient records: The patient record must be able to provide and coordinate care for an individual patient (for example, the patient record describes both care provided by the general practitioner and by other health care providers), and should also support population-based services (for example, active case finding for issues such as doing

periodic cervical smears, vaccinations, or population-based cardiovascular risk management) (26, 27). Conventional paper-based patient records are unable to provide such population-based services: For example, searching a practitioner's paper records for more than 2000 patients is a tedious and time-consuming task. The diverse requirements inherent to Dutch general practice are more easily met when the practitioner has the patient data available in a computer-based format (28). This format allows documentation and coordination of care (for example, the system can provide different reports, including referral letters, in response to requests for information by other health care workers), as well as active case finding (12). Many Dutch researchers working in general practice view automation of medical records as an essential tool that allows analyses of patterns of disease and care in a general-practice population (13).

The addition of electronic communication with hospitals, laboratories, and pharmacists provides added support to the general practitioner. Branger (18, 29) reported that general practitioners integrated such electronic communication into their daily practices (18, 29). A subsequent survey of general practitioners showed that electronic communication had decreased their workload (for example, electronic transfer of laboratory data allowed the results to be automatically included in the patient record) and had increased their knowledge of care delivered by other health care providers (18).

Role of Professional Organizations

Recognizing the potential benefit of computer-based patient-record systems and the danger of uncontrolled proliferation of such systems, the Dutch professional associations of general practitioners established in 1984 a task force that organized hearings with the software industry and in 1985 published their first software requirements (11, 28). They subsequently announced that they would evaluate the available systems and would urge their members to purchase only systems that met these requirements. In 1986, the first vendor submitted software to be evaluated; the results became available in 1987.

The software requirements are revised and published regularly; the latest revision further defined the criteria for the communication module (12). As new requirements become available, vendors submit or resubmit their products to the professional organizations for evaluation. These evaluations are important for disseminating the information systems, for providing potential buyers with criteria for judging available products, and for giving vendors concrete guidelines on the functions to be included in their systems.

An important issue in the introduction of information technology involves the expectations of the potential users of the system. If they are too high, the users will be disillusioned. If expectations are too low, the introduction of the technology will be impeded. Aware of the need to educate potential users, in 1987 the Dutch College of General Practitioners introduced postgraduate training on computers in general practice. This 2-day course conveyed a realistic set of expectations for the automation of their practices. It covered potential benefits (such as reduced administrative workload, increased income because of optimal billing, and more accurate follow-up of patients) as well as costs (financial, changes in the organization of the practice, and time required to introduce the system). Because computer-based patient records require the physician to interact personally with the system to inspect and record clinical data, the course included practical sessions on how to use these systems in routine practice. The course also provided detailed practical scenarios describing how to introduce an information system to the physician's practice.

Parallel to the postgraduate training, a debate on information systems for primary care was carried out in the leading journals of Dutch general practitioners. In this debate, the participants weighed the advantages and the disadvantages of information systems in general practice. As a result, the general practitioner who decides to introduce a system in his or her practice is now aware of the consequences of that decision and is able to plan it carefully.

Government Incentives

Until recently, the general practitioner was not reimbursed for expenses related to practice automation. In the fall of 1991, however, the National Association of General Practitioners and the government reached agreement on a plan to stimulate the use of computer-based patient records. The general practitioner will be reimbursed 60% of the expenses incurred, with an annual maximum of 5900 Dutch Florins (approximately $3600). To qualify, the general practitioner must 1) use an information system that passed evaluation by the professional organizations, 2) introduce computer-based patient records within 2 years, and 3) provide data for health policy planning. Details of the arrangement, such as what data the general practitioner must provide, are being negotiated.

Future Developments

The professional organizations' guidelines will continue to evolve; the next major revision is scheduled for 1995. Additional requirements will be formulated for the integration of computer-based patient records with decision-support modules (such as those that support protocol-based care) and research modules (such as those for epidemiology, postmarketing surveillance of drugs, and execution of clinical trials). The complete patient record may have to be transferred from one system to another when the patient moves from one practice to another, or when the practitioner decides to purchase a system from another vendor. The professional organizations, therefore, are developing standards that allow such a transfer. Using computer-based patient records and electronic communication, we are doing studies in which physicians (both general practitioners and specialists) who see the same patient have access to each others' patient records; the goal is to improve the continuity of care by sharing data, possibly leading to a single shared patient record.

As physicians start using computer-based patient records and electronic communication, data security and privacy (of both patients and physicians) become important concerns. Dutch law prohibits unauthorized use of data from communication networks. A more stringent law, including more severe penalties for violations, passed the lower chamber of parliament in 1991; final acceptance in the higher chamber is expected soon. Data from computer-based patient records can be aggregated in large observational databases. For example, the postmarketing surveillance of drugs is one area in which such large, aggregated databases derived from computer-based patient records are under development in the Netherlands. In a study of security and privacy issues related to such a database, the Dutch Health Council argues that privacy is best ensured if the clinical data are anonymous, but that total anonymity may not be possible (30). For example, a report of a potential side effect may require tracing the individual patient to collect additional clinical data. The Health Council recommends that consent from the patient be obtained before clinical data from the computer-based patient record are transmitted to an aggregated database, and that tracing of an individual patient can be done only through the physician who recorded the initial clinical data (30).

Although increasing numbers of Dutch general practitioners are replacing paper-based patient records with computer-based records, little is known about the influence of this trend on the quality and cost of health care. Research in coming years must evaluate changes in health care that are precipitated by the large-scale introduction of information technology in primary care.

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