Communications of the Association for Information Systems

Volume 20 Article 59

December 2007

Information Systems and Healthcare XXIII: Exploring Interoperability of Electronic Healthcare Records by Studying Demand and Supply in the Netherlands

Ton AM Spil
University of Twente, a.a.m.spil@utwente.nl

Christiaan P Katsma
University of Twente

Robert A Stegwee
Capgemini Consulting

Communications of the Association for Information Systems

INFORMATION SYSTEMS AND HEALTHCARE XXIII: EXPLORING INTEROPERABILITY OF ELECTRONIC HEALTHCARE RECORDS BY STUDYING DEMAND AND SUPPLY IN THE NETHERLANDS

Ton AM Spil
Christiaan P Katsma
Information Systems & Change Management
University of Twente
a.a.m.spil@utwente.nl

Robert A Stegwee
Capgemini Consulting

ABSTRACT

Every year, the Dutch Minister of Health promises that by the following year, all citizens in the Netherlands will have an Electronic Health Record (EHR). Until now this promise has not been met. One of the main requirements for realizing a national EHR is an interoperability framework, agreeable to the government, vendors and users.

This paper first studies the demand side using the results of twenty two interviews with physicians, asking them about their core processes and their expected value of an EHR. This provides us with the adoption perspective on the EHR market. Next we look at the current EHR market, investigating the suppliers and their achievements and market share. Finally we take a look at the government side with an overview of the interoperability requirements dictated by the national IT-agenda for healthcare. The contribution of this paper is twofold:

- First, our main conclusion is that success in the EHR market in the Netherlands is not yet motivated by interoperability requirements.
- Second, from a detailed analysis on micro level the following result stands out: A majority of the end users (demand side) do not get support in their relevant working processes.

Keywords: e-health, electronic health record, interoperability, supply, demand

I. INTRODUCTION

The nearly 20-year-old promise of an Electronic Health Record (EHR) solving all major problems in healthcare [Ellingson et al. 2003]] has been renewed by the promise of an interoperable open EHR capable of integrating all existing EHR's [Beale et al. 2002]. This latest promise itself seems to be emerging now, but in actuality it too has been around for over a decade [Kilsdonk et al. 1996]. Creating an EHR is definitely an evolutionary process [DeWar 2006], requiring

professionals to become skilled in the different uses of an EHR, which range from accessing a patient's information on the computer and documenting their findings and actions, to using the EHR's decision support capabilities to determine issues pertaining to diagnosis and treatment plans

Adoption of new innovations is highly dependent on the relative advantage that end users perceive in the new product [Rogers 1995]. Delone and McLean [2003] would call this the "net benefits" of the EHR, and Venkatesh et al. [2003] would call this "performance expectancy." In qualitative studies, Schuring and Spil use the relevance concept, which in their definition is the net value of performance expectancy and effort expectancy [Spil et al. 2004]. They all agree that the expected value of the system to the end user plays an important role in both adoption and diffusion. In addition to the end user perspective and its influence on adoption, Earl and Sampler [1998] conclude that a distinguishing characteristic of IT is that two sides need to be adjusted: both demand and supply.

In this paper we investigate both sides to explore the reasons why the adoption of a national EHR in The Netherlands seems to be failing continuously. The next section defines and describes EHR from the demand and supply perspectives and theoretically explores the interoperability perspective. Section III shows the research method. In Section IV an analysis is given of interviews with 22 physicians, 12 suppliers (focusing on the main five plus one in-house development) are investigated, and finally the interoperability aspects are studied. Section V presents our conclusions.

II. THE ELECTRONIC HEALTH RECORD

EHR BACKGROUND

The number of scientific publications on EHR has increased every year since 1991 [Moorman et al. 2003]. The EHR is a central component of an integrated health information environment. It is conceived as a distinct service, having its own models and dynamics.

There are many names and acronyms for computer-based systems in healthcare, such as Electronic Medical Record, Patient Care Information System, Electronic Care Record, Electronic Health Record, Computer-based Patient Record and Electronic Patient Record. This difference in nomenclature often reflects the different points of view of the authors or refers to different levels in functionality of the system [Michel-Verkerke 2003].

The most commonly used definition of an EHR is the one from the medical records institute: "a computer stored collection of health information about a patient linked by a person identifier" [Waegemann et al. 2002]. The International Standards Organization has devoted a whole discussion to the definition, scope, and context of an EHR [2005], but these definitions take some time to become mainstream. They distinguish between the EHR — the virtual collection of health data pertaining to a patient — and an EHR-System — the computer system used for storage, retrieval, and maintenance of the health data of many patients.

Although the term *Patient Care Information System* best expresses its function, i.e., supporting patient care, the term *EHR* will be used in this paper, because it is the most complete term. The definition of an EHR that is used in this research is based on the definition of a computer-based patient record of the Institute of Medicine [Dick et al. 1997]: *An Electronic Health Record (EHR) is a patient record that resides in a computer system specifically designed to support care providers by providing accessibility to complete and accurate patient data, medical alerts, reminders, clinical decision support systems, links to medical knowledge and other aids.*

EXPECTED VALUE OF AN EHR—THE DEMAND SIDE

In the IT diffusion literature, relevance was originally defined by Saracevic [1975] as a measure of the effectiveness of contact between a source and a destination in a communication process.

This is somewhat abstract wording of what we would call the degree to which the user expects that the IT-system will solve his or her problem or help to realize their goals. We use the word "expects" since we want to make more explicit that relevance is an important factor not only for evaluation, but also for the adoption process.

Many researchers of diffusion have sought to explain differences in diffusion patterns. Venkatesh et al [2003] propose a synthesized model of user acceptance, which they call the UTAUT (Unified Theory of Acceptance and Use of Technology). In this model, they propose four constructs that play a significant role as determinants of user acceptance and usage behavior. Of these four, the performance expectancy construct is the strongest predictor of use intention. Chismar and Wiley [2003] confirm this in the healthcare industry. Performance expectancy is a concept that evolved over time. It resembles Rogers' [1995] relative advantage, Davis' [1989] perceived usefulness, Thompson's [1967] job-fit, and usefulness and outcome expectations [Compeau et al. 1995]. Schuring and Spil [2003] call the factor relevance, which is in fact the net value [DeLone et al. 2002] of performance expectancy and effort expectancy. Their USE IT model [Spil et al. 2004] and, specifically, the relevance part of it is used to analyze the expected value of EHR for 22 physicians. The main focus in these interviews was on the expected value, which is defined as "the degree to which IT-use helps to solve the here-and-now problem of the user in his working process" [Spil et al. 2004]. Even if an innovation is valuable for the organization or for the society, however, it might never come to actual use, simply because the "right moment" never arises.

In a previous study [Spil et al. 2005], five criteria were identified which the end-users find relevant for an EHR:

1. Availability
2. Less administrative work (letters, search activities and redundancy)
3. Analyses (information for research and information for management)
4. Uniformity of working processes
5. Reliability

Especially in hospitals with multiple locations, availability was an important issue. Specifically, desire for availability from home was mentioned. Physicians said that greater availability enabled better preparation for patient consults. Insufficient availability during clinical visits, however, was still a problem, and some suggested mobile solutions. Some interviewees sought the possibility of "access anywhere, anytime."

Some physicians that were experienced with EHR actually decreased their secretarial staff and many thought it might be possible to do so in the future. The use of an EHR lengthened consultation time, but this was more than offset by time savings in the later processing of administrative data. One physician actually said "We've got a happier administration now," after implementing an EHR.

Using an EHR, data can be analyzed on a higher level using a uniform way of capturing data. This gives the professional information for his or her medical research. It can also enable the sharing of data for medical research on an (inter)national level.

One of the physicians was very negative about uniformity: "Writing in an EHR is like writing your own guilty verdict." Another physician agreed with him: "Every patient is different." Most nonphysicians were in favor of uniformity.

None of the physicians mention reliability as relevant for an EHR. Maybe they assume that it "just is" reliable. In some interviews we specifically asked if they favored availability or reliability and in both interviews the doctors were in favor of availability.

EXPECTED SOLUTIONS—THE SUPPLY SIDE

From the EHR background it can be argued that an EHR is not only a computer-stored version of the paper data, but an active system supporting healthcare professionals in the care process

[Michel-Verkerke 2003]. Gartner distinguishes five different generations of Computer-Based Patient Record Systems [Handler 2004], of which the first three can actually be found on the market right now. We broadly transform these generations into the following grades of an EHR:

- A first-grade EHR contains all information that is gathered about a patient in back-office processes and makes this information available to the clinician;
- A second-grade EHR contains all information of a first-grade EHR and adds to this the clinical documentation as entered by the individual clinicians for reference and accountability purposes;
- A third-grade EHR contains all information of a second-grade EHR and adds to this the possibility to actively support the clinical work processes, in terms of care planning, workflow, and clinical decision support.

Many solutions have been proposed for building an EHR [Bisbal et al. 2003; Grimson et al. 2001]. Staroselsky (et al) show that the new breed of EHRs have the potential to improve the active component by providing decision-support, which has been demonstrated to improve the provision of preventive services [Staroselsky et al. 2006] . However, “EHR implementations often fail because the implied views of medical work do not fit with the real nature of that work” [Faber 2003]. This paper therefore studies the working process of the end users, tries to uncover the real nature of medical work by investigating the relevance of EHR and studies how the suppliers support this.

The development of EHR solutions started about twenty years ago as an extension to the existing hospital information systems by their respective vendors. Because these systems were administrative in nature, the EHR remained administrative and mostly just the modules with clear financial consequences were used by the professionals.

The expected value of the supply side is difficult to measure. On the one hand a commercially available EHR should satisfy the requirements of the user and hence realize the expected value of the healthcare professional on a micro level. Also, on a macro level, one would expect the value of the supply side to be demonstrated by the degree of openness. The use of standards can be used to determine whether a system is open or not. In terms of Enterprise Application Integration (EAI) this would mean the level of integration that is achieved by the vendor.

INTEROPERABILITY PERSPECTIVE

From the discussion of different grades of EHR in the previous section, the need to bring together information from many different sources clearly stands out (grade 1). Within hospitals, such sharing of information has been common practice for a large number of years. Interoperability requirements for information systems for medical support functions in hospitals, such as patient administration, laboratory, and medical imaging, are well understood. A number of interoperability standards have been developed to facilitate this exchange of information. An extensive review of these types of healthcare standards has been carried out by Klein [2002]. However, sharing of information between healthcare providers has not evolved as rapidly, mainly because of the lacking uptake of electronic clinical documentation (grade 2 EHR). More advanced interoperability, in terms of seamless integration of workflows across functional boundaries (grade 3 EHR), is even less well developed. The interest in the interoperability of EHRs has increased as a result of a number of reports on the role of information in relation to medical errors and patient safety, such as the Institute of Medicine report of 1999. This, in turn, has led to efforts to realize a regional or national infrastructure for the exchange of health data, leading to an EHR that crosses the boundaries of individual healthcare institutions. On a national level, the National Information and Communication Technology Institute for Healthcare in The Netherlands (NICTIZ) has produced the architecture specifications for a national health information infrastructure, called AORTA, and has laid out the standards for nationwide interoperability toward a national EHR. Similar initiatives can be found in many other countries.

In order to understand the interoperability requirements of a (national) EHR, we need to better understand the definition of interoperability within the healthcare industry. To this end we adopt the notions developed by one of the authors in a publication on domain specific interoperability [Stegwee et al. 2003], which are summarized here. The starting point is the interoperability definition by IEEE: “The ability of two or more systems or components to exchange information and to use the information that has been exchanged." Taking from this definition the notion of the *systems or components* to exchange and use the information and the separate notion of *use the information* a model is developed identifying different kinds of communication and different levels of interoperability.

The different kinds of communication arise from the fact that the (implicit) definition of system is enlarged from a purely technical system to a socio-technical system. Building upon Warboys et al. [1999], three different subsystems of the socio-technical system are identified: the human subsystem, the process subsystem, and the technology subsystem. In terms of a healthcare system, doctors and nurses work together toward a number of shared clinical goals, using agreed upon protocols and procedures, to carry out and coordinate their tasks. Technology is available to support them in accomplishing parts of these tasks.

Different levels of interoperability are identified by taking the semiotic perspective, defined by Stamper [1996], to analyze each of the different kinds of communication. The semiotic perspective differentiates between syntactic, semantic, and pragmatic levels. The pragmatic level of interoperability means that in addition to preserving the content (syntactic) and meaning (semantic) of the data exchanged between the organizational subsystems, the subsystems are able to act in concert on the basis of this data. As such, this level of interoperability provides the end user with the impression of a single integrated system.

The evolution of interoperability in industry has been studied extensively. This domain-specific knowledge can be taken as an example and on the macro level be compared with the situation in the healthcare domain. We can discern three different stages of integration from the socio-technical perspective, as introduced previously and further elaborated by Stegwee et al. [2003]:

1. The transfer from functional toward integrated information systems, realized by the development from Material Requirement Planning (MRP I and II), via Enterprise Resources Planning (ERP) towards Enterprise Systems, or the adoption of EAI as a system-independent alternative to achieve integration.
2. The subsequent transfer from these integrated information systems towards information systems or standards that support entire supply chains or processes over the formal borders of organizations. Examples are Supply Chain Management (SCM) systems [Tarn et al. 2002] and Extended Enterprise Applications (EEA) [Búrca et al. 2005; Loh et al. 2006].
3. The recent development of platform- and technology-independent services like Web services or Service Oriented Architectures [Frandji et al. 1994] for further support of so-called loosely coupled systems in process chains or even business networks [Loh et al. 2006].

Interoperability from the macro perspective can be unraveled in two perspectives: level A for information integration across the entire supply chain; and level B for process integration across the entire supply chain. These two integration levels can be illustrated for the healthcare domain and the developments in industry (Table 1). Outside the healthcare domain, new developments have increased information integration and process functionality along entire supply chains or business networks. It is especially the developments in 2 and 3 that combine information integration and process support (right column in Table 1; based on [Búrca et al. 2005; Loh et al. 2006; Österle et al. 2001; Tarn et al. 2002]). The middle column shows some examples of the application of these concepts to the healthcare specific domain. As early as 2000 some of these concepts were operational in the healthcare domain, based on standards (e.g. HL7), messaging (e.g. CorbaMed) and EAI. Nevertheless only the integration level A was supported and often with mere vendor-specific systems [Grimson et al. 2000]. To successfully introduce an open EHR in

the healthcare domain, both integration levels A and B (see Table 1) should be supported simultaneously across entire healthcare chains. In our exploration of the recent Dutch supply *and* demand situation we investigate both the information *and* process perspective of the offered applications. Analogous with Khoumbati et al. [2006], our research ambition is to investigate the specific progress since 2000 in the healthcare domain.

Table 1. Interoperability Unraveled In Two Perspectives

	Integration level	**Examples in the healthcare domain in 2000 [Grimson et al. 2000]**	**Recent existing solutions outside the healthcare domain [Búrca et al. 2005; Loh et al. 2006; Österle et al. 2001; Tarn et al. 2002]**
A	Information integration across the entire (healthcare) chain	HL7, CorbaMed, HISA Vendor specific solutions in one system (SAP, Peoplesoft, Cerner)	• Business Bus (RosettaNet, CFPR) • Business port (Tibco, SAP BC), • SCM, EAI, EEA • Web Services and SOA's (WSDL, J2EE)
B	Support for Process logic across the entire (healthcare) chain	Not available	

III. RESEARCH METHOD

Twenty-two physicians were interviewed about their operational process and the expected value of an EHR within their own situation. The USE IT interview model was used [Spil et al. 2004]. The interviews took place in 11 different hospitals (10 percent of the total in the Netherlands) and took more than one hour each. The professionals were deliberately chosen from 13 different disciplines because homogeneous groups of the end users were very difficult to construct. Recommendations by Miles and Huberman [1994] were followed to analyze the interviews on relevance issues. In this study we concentrate on the main end users, the 22 physicians, whose support is crucial for adoption of the EHR.

From the 12 suppliers identified by a previous study of the Dutch EHR market [Ernst&Young 2003], five were chosen for in-depth study. From the original list of 12 EHR suppliers, one has since been taken over and the others were excluded because each had less than 3 percent of the market share. Because more than 12 percent of the hospitals have developed a system themselves, one in-house application was studied as well (Intrazis). Three analysis methods were used for each supplier. Data on the suppliers and their products was gathered by first studying the documentation made available by the supplier. Then demos were given and finally a discussion between one of the authors and the supplier was held. Based on the information gathered in the previous steps, the general issues related to interoperability and openness were studied and categorized. Further information about the offerings of the EHR suppliers was gathered through our participation in two conferences of the Dutch Association of Medical Administration. During both of these conferences a clinical documentation challenge was held, comparing the capabilities of different vendors. The first assessed the general documentation capabilities of the software, whereas the second time the vendors were asked to demonstrate for a specific case.

IV. ANALYSIS

DEMAND PERSPECTIVE

Based on our interviews with 22 physicians, we need to add an additional five criteria to those identified in the study reported in Section II:

1. Direct contact with the patient
2. Quality of care
3. Collaboration with colleagues
4. Time
5. “Just being a good doctor”

Direct Contact with The Patient

This criterion was mentioned as most important in the working processes and as being simply indispensable for the physicians. One of the doctors specifically voiced his concern about the computer "getting in between" him and his patients.

Quality of Care

Seven of the 22 doctors began the relevance part of the interview by stating specifically that good care or the quality of care is most relevant to their working processes. One even said that “although it will increase costs, the quality of care will make the introduction of EHR worthwhile."

Collaboration with Colleagues

Communication inside and outside the healthcare institution was found to be important to seven of the 22 physicians. One physician recalls an extreme situation when an emergency patient with a severely cut wrist was referred to him without any forewarning. Another physician says: “We hardly have time to communicate."

Time

This factor is mentioned in many guises but mostly as “we just do not have time." Some think that paper offers a quicker working process. Although an EHR is supposed to shorten consulting time, which is not confirmed in this study, one of the physicians makes a plea for longer consulting time. This would be in line with the importance of direct contact with the patient

“Just Being a Good Doctor"

Six physicians spontaneously stated that they “just want to be a good doctor.” According to the sighs heard during the interviews, the organization does not always help them in dealing with bureaucracy. Apparently the EHR is not perceived as being helpful to this end either.

SUPPLY PERSPECTIVE

The Dutch healthcare market is small (about one hundred hospitals) but the number of suppliers of EHRs is comparatively large (about 20 suppliers). The supply is also very concentrated, with nearly 60 percent of the market in the hands of only two suppliers, who also happen to be suppliers of (administrative) hospital information systems (HIS) as well. Based on HIS installations Isoft is the market leader overall, with an overwhelming presence in academic hospitals (eight out of nine), while Chipsoft is quickly becoming the market leader in the general hospitals. This does not necessarily mean that these hospitals also use the EHR solution provided. For instance, three of the academic hospitals have an EHR that was developed in-house. Still, the strong position of these two suppliers in the HIS market translates into a 60 percent EHR market share. The other 40 percent of the market is divided among the remaining suppliers, among which only two suppliers (SAP and McKesson) provide a hospital information system as well.

For each of the vendors we have assessed their interoperability in terms of the integration levels described in Section II. In addition, we have included compliance of the EHR system provided with the national infrastructure AORTA. The only type of AORTA compliance available for hospital EHR systems, so far, is the Medication Prescription compliance [www.nictiz.nl]. Other compliance

requirements will be published by NICTIZ in the future. The condensed results of our analysis are presented in Table 2.

Table 2. Condensed Results of the Analysis of the Five Largest Dutch EHR Suppliers and One In-House Application; Market Shares Based on [Ernst and Young 2003] for 2003.

Supplier	**Package**	**Information integration towards other systems**	**Process logic support towards other systems**	**National Infrastructure (AORTA) compliance**	**Market share 2003**	**Market share 2007 Indication**
Isoft	Mirador	Dedicated interface. Needs customization	Not available	Not available	37%	<37%
Chipsoft	CS DDR	Dedicated interface. Needs customization (based on Hl7v3)	Dedicated interface-protocols, need customization	Medication Prescription	18%	>26%
Various	e.g. Intrazis, PoliPlus, Eridanos	In general dedicated interface	Probably Not available	Medication Prescription (just Eridanos)	12%	>12%
SAP	i.s.h.med	Connectivity module (customization necessary for external systems other than SAP)	Connectivity module (customization necessary for external systems other than SAP)	Not available	5%	8%
McKesson	X/Care module EHR	Partly possible (raw data transfer, no standards), but mainly focused on "own *Horizon* EHR standard"	Passport and horizon but not visible in techniques.	Not available	3%	8%
MI Consul-tancy	Norma 2000	Dedicated interface	Not available	Not available	3%	5%

In addition to the description of the hospital EHR market in Table 2, it is worthwhile to note that in several regions in the Netherlands (e.g. Leiden, Utrecht and Twente), regional EHR initiatives are underway. Per definition a regional EHR cannot be a closed system. In the case of Leiden this has led to a new supplier entering the market which can be considered to provide an open system. The Intrazis solution, considered an in-house EHR, was developed in Utrecht, with the aim to connect the hospital with primary care providers in the region. The approach taken in Twente resembles the national EHR initiative. A regional server has been developed to provide an interoperability platform. So far this has been implemented only for the EHRs used by general

practitioners, and no hospitals have been connected yet. These initiatives suggest that the current supply of EHRs does not meet the needs of a regional EHR. Given the lack of openness, most of the systems are best used in combination with a hospital information system from the same supplier. The support for operational processes is rather disappointing. The systems are much more descriptive than prescriptive.

INTEROPERABILITY PERSPECTIVE

In this section we analyze EHR interoperability by considering together both the demand and supply requirements. Table 3 summarizes the main findings from an interoperability perspective.

Table 3. Overview Main Findings Demand and Supply

	Information Integration	Process Integration
Demand	*1.* • Communication • Availability • Time	*3.* • Quality of care • Patient contact • Being a good doctor
Supply	*2.* • Current state	*4.* • Not available

Spil et al [2005] showed that, for hospitals that had already implemented an EHR, availability was the most relevant factor. Yet, many Dutch professionals in healthcare do not use any form of EHR, and the net benefits of existing EHRs do not seem to be enough to lead to adoption. In this study, only 6 out of 22 physicians thought availability to be relevant to their working process. In addition, business value of EHR is not yet fully proven. The results of this study show that the EHR can save time because it results in less administrative work. It can be realized because there is less searching for data, data does not have to be re-entered multiple times and letters can be generated easier. There are important differences in who can save time. For example, a secretary or physician's receptionist can save time and effort with an EHR, but for physicians, consultation time tends to increase. During the first period after the implementation, the so-called shakedown phase, the medical specialists and administrative staff have to insert all the data, and this takes time. During consultation, specialists say that they can return to the old consultation length after half a year to a year. After the shakedown phase, physicians report time savings, but no data was available to substantiate these claims. Mitchell and Sullivan [Mitchell et al. 2001] conclude that in five of six cases the consultation length was increased, with increases ranging from 48-130 seconds. Finally communication with colleagues is found to be very important by the professionals but most of this communication takes place by phone, fax, and paper letters. At a recent Dutch conference showing the current unsatisfactory situation of EHR development, automated output of paper letters is still considered to be the main output and source of value of the EHR.

Research into interoperable EHRs has evolved during the past decade but a significant gap between research and practice remains. In the Netherlands two research groups have studied interoperable EHRs but their work has not progressed beyond pilot systems. Numerous suppliers in The Netherlands have shown willingness to or have already created the required information integration to support EHR implementations, which in most cases have been successful in cases where the EHR supplier is also the HIS supplier. In light of the national infrastructure AORTA, we can see the first movements toward providing information integration in an open, standardized way [Graaf et al. 2007]. However, these are very limited first steps only.

Maintenance of or improvement in the quality of care will be essential in convincing physicians to use an EHR. The drive for interoperability on a regional and national scale is addressing that issue, in terms of reduced medical errors and improved patient safety. Payments to physicians for proper input of data might also help accelerate diffusion of EHR, but intrinsic motivation by supporting the patient contact and the quality of the working process (i.e., "just being a good doctor") would be much preferable. Open and interoperable EHRs might be able to create quality improvements. On the other hand, increased interoperability can also improve communication between healthcare providers and make it easier to provide information to the patient.

Currently, none of the EHR market leaders seem open to the creation of a regional or national EHR. Without their involvement, the burden of the integration of existing and non-existing patient records will fall to the relatively new players in the market. Even with the backing of large international organizations the risks seem high. Another possibility would be a Web-based system backed by groups of patients (like CVA and Diabetes) or suppliers where the patient can create his or her own medical record on the Internet. This last group of systems is out of the scope of this study.

It remains surprising to see that the healthcare sector is substantially under pressure, but apparently is unable to obtain what it needs. In 2000 Grimson et al. [2000] showed the main deficiencies of interoperable EHRs. At that time they showed the possibilities of BPR and EAI and expected a substantial improvement of Web technology. Our review shows that suppliers have failed to deliver the necessary solutions that can support healthcare professionals and institutions. The argument that the technology is new seems less persuasive, as there are plenty of successful examples of comparable solutions available from outside the healthcare domain. As these domains move on to Web services and SOA, healthcare-specific suppliers are still struggling with rudimentary integration aspects.

V. CONCLUSIONS

The enhanced availability of information is an expected value of an EHR whose design is agreed upon by all end users. We conclude that from the physician's point of view the EHR is not yet viewed as necessary, but that the benefits from an administrative point of view, in the form of time savings and availability, are clear. We therefore think the physicians should be incentivized for using the EHR.

At this moment EHR suppliers fail to demonstrate the value of an EHR in terms that are important to users. Many professionals state that the welfare of the patient, communication with colleagues and the quality of care are the most important aspects of their working processes. However, at the moment the EHR's offer improvements in information availability and administrative time savings. Communication goals, as well as increased quality of care and hence improved welfare of the patient, could be achieved through a more open regional and national approach toward the EHR. Striving for true interoperability, not just on the technical level might provide the badly needed breakthrough to support the early majority of users.

EHR's with external process integration are currently offered only by suppliers with a small market share. Only if the main suppliers are stimulated (by government and by customers) to open up, can a national EHR arise. And for the end users (demand side), current EHRs do not yet provide support for their important working processes. Greater focus should be laid on the potential for EHR to enhance the quality of care and communication with patients and colleagues.

ACKNOWLEDGEMENTS

We like to thank our colleague Jeff Hicks for his advice.

REFERENCES

Beale, T., S. Heard, D. Kalra, and D. Lloyd. (2002). "Open EHR," www.openehr.org

Bisbal, J., J. Grimson, W. Grimson, D. Berry, and L. Hederman. (2003). "From Passive to Active Electronic Healthcare Records," *Methods of Information in Medicine* (42:5), pp 535-543.

Búrca, S. D., B. Fynes, and D. Marshall. (2005). "Strategic Technology Adoption: Extending ERP across The Supply Chain," *Journal of Enterprise Information Management,* (18:4) 2005, pp 427-440.

Chismar, W. G., and S. Wiley-Patton. (2003). "Does the Extended Technology Acceptance Model Apply to Physicians?" 36th Hawaii International Conference on System Sciences, Hawaii.

Compeau, D. R., and C. A. Higgins. (1995)."Application of Social Cognitive Theory to Training for Computer Skills," *Information Systems Research* (6:2), pp 118-143.

Davis, F. D. (1989). "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly*, September, pp 319-340.

DeLone, W. H., and E. R. McLean. (2002). "Information Systems Success Revisited," in: *35th Hawaii International Conference on System Sciences*, Hawaii.

DeLone, W. H., and E. R. McLean. (2003). "The DeLone and McLean Model of Information Systems Success: A Ten-Year Update," *Journal of Management Information Systems* (19:4), pp 9-30.

DeWar, C. (2006). "Bring the EHR to Life," *Nursing Management*:January), pp 31-35.

Dick, R. S., E. B. Steen, and D. E. Detmer. (1997). *The Computer-Based Patient Record: An Essential Technology for Health Care*, (Revised edition ed.) National Academy Press, Washington, DC.

Earl, M. J., and J. L. Sampler. (1998). "Market Management to Transform the IT Organization," *Sloan Management Review*), Summer, pp 9-17.

Ellingson, G., and E. Monteiro. (2003). "Big Is beautiful: Electronic Patient Records in Large Norwegian Hospitals," *Methods of Information in Medicine* (42:4), pp 366-370.

Ernst and Young. (2003). "*Electronische Patienten Dossiers in Nederlandse Ziekenhuizen*."(in Dutch).

Faber, M. G. (2003). "Design and Introduction of an Electronic Patient Record: How to Involve the Users? " *Methods of Information in Medicine* (42:4), pp 371-375.

Frandji, B., J. Schot, M. Joubert, I. Soady, and A. Kilsdonk. (1994). "The Riche Reference Architecture," *Medical Informatics* (19:1), Jan-Mar.

Graaf, J. C., A. E. Vlug, and G. J. V. Boven. (2007). "Dutch Virtual Integration of Healthcare Information," *Methods of Information in Medicine* (46), pp 458-462.

Grimson, J., W. Grimson, and W. Hasselbring. (2000)."The SI Challenge in Health Care," *Communications of the ACM* (43:6) 2000, pp 49-55.

Grimson, J., G. F. Stephens, B. Jung, W. Grimson, D. Berry, and S. Pardon. (2001). "Sharing Healthcare Records over the Internet," *IEEE Internet Computing* (5) 2001, pp 49-58.

Handler, T. J. (2004). "The 2004 Gartner Computer Based Patient Record System Generation Model," R-21-6592, Gartner, Inc.

Khoumbati, K., M. Themistocleous, and Z. Irani. (2006). "Investigating Enterprise Application Integration Benefits and Barriers In Healthcare Organisations: An Exploratory Case Study," *International Journal of Electronic Healthcare* (2:1), pp 66-78.

Kilsdonk, A. C. M., B. Frandji, and A. van der Werff. (1996). "The NUCLEUS Integrated Electronic Patient Dossier Breakthrough and Concepts of an Open Solution," *International Journal of Bio-Medical Computing* (42:1-2), pp 79-89.

Klein, G. O. (2002). "Standardization of Health Informatics - Results and Challenges," in: *Yearbook of Medical Informatics,* R.C.K. Haux (ed.), Schattauer Verlagsgesellschaft mbH, Stuttgart, pp. 103-114.

Loh, T. C., S. C. L. Koh, and M. Simpson. "An Investigation of the Value of Becoming an Extended Enterprise," *International Journal of Computer Integrated Manufacturing,* (19:1), pp 49-58.

Michel-Verkerke, M. B. (2003). *What Makes Doctors Use the Electronic Patient Record?* University of Twente, Enschede.

Miles, M. B., and A. M. Huberman. (1994). *Qualitative Data Analysis (2nd ed.).* SAGE, Thousand Oaks, CA.

Mitchell, E., and F. Sullivan. "A Descriptive Feast But an Evaluative Famine: Systematic Review of Published Articles on Primary Care Computing during 1980-97," *British Medical Journal* (322:279-282).

Moorman, P. W., and J. V. D. Lei. (2003). "An Inventory of Publications on Computer-Based Medical Records," *Methods of Information in Medicine* (42:3), pp 199-202.

Österle, H., E. Fleisch, and R. Alt. (2001). *Business Networking: Shaping Enterprise Relationships on the Internet*, (2nd ed.) Springer, Berlin.

Rogers, E. M. (1995). *Diffusions of Innovations* The Free Press, New York.

Saracevic, T. (1975). "Relevance: A Review And Framework for the Thinking on the Notion In Information Science," *Journal of the American Society for Information Science* (26:6), pp 321-343.

Schuring, R. W., and T. A. M. Spil. (2003). "Relevance and Micro-Relevance for the Professionals as Determinants of IT Diffusion and IT-Use In Healthcare," in: *ERP & Datawarehousing in Organizations: Issues and Challenges,* G. Grant (ed.), IRM Press, Hershey.

Spil, T. A. M., C. Katsma, E. Ligt, and D. A. Wassenaar. (2005). "IT Based Innovation Success in Healthcare: The Art of Implementation and Use of an Electronic Patient Record," International Conference of Healthcare Technology and Management, Aalborg.

Spil, T. A. M., R. W. Schuring, and M. B. Michel-Verkerke. "Electronic Prescription System: Do The Professionals Use It? " *International Journal of Healthcare Technology and Management* (6:1) 2004, pp 32-55.

Stamper R.K. (1996). "Signs, Information, Norms and Systems," In Holmqvist et al. (Eds.), *Signs of Work, Semiosis and Information Processing in Organizations*, Walter de Gruyter, Berlin, NY, 1996.

Staroselsky, M., L. A. Volk, R. Tsurikova, L. Pizziferri, M. Lippincott, J. Wald, and D. W. Bates. (2006). "Improving Electronic Health Record (EHR) Accuracy and Increasing Compliance with Health Maintenance Clinical Guidelines through Patient Access and Input," *International Journal of Medical Informatics* (75:10-11), pp 693-700.

Stegwee, R. A., and B. D. Rukanova. (2003). "Identification of Different Types of Standards for Domain-Specific Interoperability," *MIS Quarterly* Special Issue Workshop on Standard Making: A Critical Research Frontier for Information Systems, pp. 161-170.

Tarn, J. M., D. C. Yen, and M. Beaumont. (2002). "Exploring the Rationales for ERP and SCM Integration," *Industrial Management & Data Systems* (102:1), pp 26-34.

Thompson, J. D. (1967). *Organization in Action,* McGraw-Hill, New York.

Venkatesh, V., M. G. Morris, G. B. Davis, and G. F. Davis. (2003). "User Acceptance of Information Technology: Toward a Unified View," *MIS Quarterly* (27:3) 2003, pp 425-478.

Waegemann, C. P., C. Tessier, A. Barbash, B. Blumenfeld, J. Borden, J. Brinson, M. Robert, T. Cooper, P. L. Elkin, J. M. Fitzmaurice, S. Helbig, Milholland, K. Hunter, B. Hurley, B. Jackson, J. M. Maisel, D. Mohr, K. Rockel, J. H. Schneider, T. Sullivan, and J. Weber. "Healthcare Documentation: A Report on Information Capture and Report Generation," Medical Records Institute, Newton.

Warboys, B., P. Kawalek, I. Robertson, and M. Greenwood. (1999). *Business Information Systems: A Process Approach,* The McGraw-Hill Companies.

ABOUT THE AUTHORS

Ton AM Spil (1964) is researcher at the capacity group Information Systems & Change Management at the University of Twente in the Netherlands. He did his Ph.D on the effectiveness of IT governance, and after that he specialized in the application area healthcare and professional organizations. He was project manager on a big e-health research project on electronic prescription systems for general practitioners. He edited several books on e-health and started the iNet group on interorganizational information strategy. He chaired the healthcare track on several major conferences on information systems (ECIS, HICSS, IRMA). The main subjects of research now are the governance and interorganizational aspects of information strategy and the User Satisfaction of IT in Healthcare (USE IT). He published in major international journals on both subjects.

Christiaan P. Katsma (1970) is assistant professor in the capacity group Information Systems and Change Management at the University of Twente, in the Netherlands. His main research interest is organizational change and the implementation of information systems. His research includes enterprise system implementation and organizational change, the adoption of healthcare information systems and enhancement of IS implementation methodologies with specific change interventions.

Robert A. Stegwee (1962) is principal consultant for IT in Healthcare with Capgemini Consulting and professor of E-Health Architectures and Standards at the University of Twente. A Masters degree in Computer Science and a Ph.D in Business Administration prepared him well for a combined academic and practical career in the field of information management. His work in healthcare has focused on the use of high-level architectures to achieve an evolving integrated health information environment. He is author of a large number of both scientific and professional publications, including a book on strategies for healthcare information systems.

Communications of the Association for Information Systems

ISSN: 1529-3181