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Intra-organizational Communication in Healthcare

Considerations for Standardization and ICT Application

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Summary

Objectives: Intra-organizational communication is mostly interpersonal. Synchronous interruptive communication is recognized as a primary source of inefficiency and error in healthcare, and there is much potential for information and communication technology (ICT) to improve such communication. As recently suggested, however, due to communication failures ICT can also compound medical errors. In this paper we analyze factors that restrict the role of ICT in improving interpersonal healthcare communication and suggest solutions.

Methods: We critically analyzed the literature from a selection of diverse scientific disciplines. These were related to interpersonal communication, to the role and place of standardization and computerization in its improvement, and to reducing medical errors.

Results: Four possible scenarios were defined on how ICT can serve healthcare communication. Two differing conceptual frameworks about communication in healthcare were discussed. Considering "information space" as a part of "communication space" allows the recognition and control of the source of the semantic gaps in conventional standardization and an enhancement of the role of ICT in improving intra-organizational communication. Moreover, cognitive, social, and organizational dimensions of complexity in interpersonal communication can be managed. Three approaches to control the variability in those dimensions and to promote the role of ICT in intra-organizational communication were discussed.

Conclusion: A multi-dimensional approach is required to promote the role of ICT in intra-organizational communication in healthcare. Parallel to conventional standardization, at least three dimensions need to be addressed: controlling the effect of the social context, developing standard information processing skills, and most importantly, controlling variations in care practices' performance.

Keywords
Interpersonal communication, interoperability, standardization, patient safety, ICT, healthcare communication

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1. Introduction

Mounting evidence indicates that errors in healthcare intra-organizational communication are accompanied by a rise in medical errors that result in morbidity and mortality [1-3]. Communication failures, particularly those due to an inadequate exchange of information between healthcare providers, remain among the most common factors that contribute to the occurrence of adverse drug events [4]. In a retrospective review of 14,000 in-hospital deaths in Australia [5], communication errors were found to be the leading cause, and were twice as frequent as errors due to inadequate clinical skills [5-7]. In another study, 37 percent of errors in a critical-care unit were found to be the result of problems in the verbal exchange of information between nurses and physicians [8].

Information and communication technology (ICT) has considerable potential to improve communication in healthcare [4]. As recently suggested, however, ICT can also increase medical errors due to problems apparently caused by ICT in intra-organizational communication [9-11]. Nevertheless, little has so far been learned about the reasons for these side-effects of information systems. Therefore, it is crucial to determine just how ICT applications might or might not be beneficial. To examine this question more deeply, one needs to understand problems in the current healthcare intra-organizational communication, the potential improving roles for ICT, the current approaches to using ICT in healthcare communication, and the probable pitfalls. Basically, standardization precedes every successful computerization [12]. One of the central issues to be addressed is standardization and its effect on successful communication through ICT channels. Through this focus, we will be able to elucidate how and how not to draw upon ICT to improve intra-organizational communication.

This article is a critical appraisal of the published literature about empirical studies, points of view, and theories from linguistics, cognitive psychology, sociology, medical informatics, quality and organization in healthcare, and Computer Supported Co-operative Work (CSCW). We examine several of the problems inherent in healthcare communication and elaborate upon the source of errors due to communication problems. Next, we evaluate the possible roles that ICT can play in improving healthcare intra-organizational communication. Theoretical frameworks relating to improving communication in healthcare and their impact on standardization approaches and ICT application are then appraised. Finally, we discuss the limitations that hinder effective standardization in healthcare communication and make suggestions regarding other approaches.

2. Background

Communication in highly specialized and collaborative healthcare work is both essential and critical [13]. Tasks in healthcare environments are information-intensive, and to be performed properly a specific task requires a precise set of information, which is obtained mainly through direct interaction[a] with colleagues but also through using Patient Care Information Systems

[a] The word "interaction" here means communication either between people or between humans and machines [14].

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(PCISs) [7, 15, 16]. Interpersonal communication constitutes the greatest part of intra-organizational communication in healthcare [17, 18], and the more that healthcare workers play a role in direct patient care, the more they are involved in communication [15]. Studies, for example, show that among the care providers medical and nursing staff are the main communicators in healthcare organizations [7, 16]. In this paper interpersonal communication is frequently used to represent intra-organizational communication.

In the literature, interpersonal communication is categorized as synchronous vs. asynchronous [18, 21]. Technically, when the message of a communication is broadcast and received simultaneously, it is called *synchronous*[b]. In healthcare, *synchronous* channels have been identified as the main interpersonal communication channels [7, 18-22]; among them, verbal[c] communication is recognized as the most prevalent [18]. Verbal communication is almost always synchronous and potentially interruptive in its nature [7, 19, 20]. Studies have reported that verbal interruptive communication comprises 11-35 percent of all healthcare communication [7, 15]. However, researchers who studied conventional conversation in the workplace reported that communication regarded by one person as intentional was perceived as interruptive by the person being addressed [24]. Whether verbal communication is interruptive appears to be a subjective issue, and the frequency of interruptions reported may therefore be underestimated.

In healthcare, *asynchronous* communication is less prevalent. It is, however, an important part of interpersonal communication, since communicators are able to organize their message or the information that they intend to exchange. Communication through PCISs, such as a patient's medical records, notes written on boards (e.g., white-board notes), e-mail, faxes, and communication through web-based applications, are among the most common forms of asynchronous communication. In daily healthcare work, care providers exchange much registered information in PCIS via synchronous interactions. Communication between a physician and a nurse during a ward round, for example, includes not only an exchange of structured data (e.g., found in patient charts) but also a discussion about unstructured information (e.g., what nurses have to say about a patient's emotions, and so forth).

3. Source of Errors in Interpersonal Communication

In the literature, synchronous channels are considered a primary source of inefficiency and errors in interpersonal communication in healthcare [7, 18-22]. These channels can hamper healthcare practice for at least two reasons. First, for most synchronous communication in healthcare, especially face-to-face interactions, interruption is unavoidable. The introduction of synchronous interruptive channels in such a healthcare environment has a negative impact on the working memory and performance of care providers [21, 22, 25]. Interruption can lead to distraction and forgetfulness, and if it happens frequently it can lead to cognition overload and to errors [7, 25-27]. Therefore, to contribute to a more efficient performance on the part of healthcare professionals, unnecessary synchronous interruptive communication should be reduced.

Second, the information exchanged via synchronous channels either is not registered in PCIS or is registered with a delay, which results in a negative effect on the institutional memory. It is suggested that the biggest information repository in most organizations resides within the heads of staff members, and the most updated information can be found with individuals rather than elsewhere, for example in patient dossiers or information systems [6, 28]. Such claims denote the fact that communicators fail to register the important exchanged information in PCIS appropriately and timely. Cooper et al. [29] observed how a maternity ward staff in an interruption-driven environment failed to enter patient data into an electronic medical record (EMR) at appropriate times. The failure to register patient data in PCIS has a detrimental effect on the work of others who rely on documented data in their work process [4]. Therefore, decreasing synchronous interactions and increasing asynchronous ones can help to improve organizational memory and thereby the quality of healthcare.

Nevertheless, despite the disadvantages of synchronous interactions at the organizational level, they are valuable at the individual and interpersonal level. They facilitate mutual understanding among healthcare professionals, allowing them to make instant corrections that prevent misinterpretation, to give feedback and to update instantly, and to synchronize their work activities [1, 30]. For these reasons, synchronous communication is considered important in avoiding errors and providing qualitative care. Therefore, to improve healthcare interpersonal communication, a trade-off has to be sought between the intention to reduce interruptions and to improve organizational memory (by reducing synchronous interruptive communication) on the one hand, and to support the mutual intelligibility of care providers (by giving room for synchronous interruptive communication) on the other. The optimal trade-off point will be that at which ICT provides the maximum benefit for intra-organizational communication. Later in this article we demonstrate that the trade-off point also reveals the restrictions under which ICT should be expected to play a role in interpersonal communication. To identify the trade-off point, however, we first need to know how information systems can be useful and how this synchronous communication can be substituted by an asynchronous method or be managed properly through information systems.

4. Role of ICT in Refining Interpersonal Communication

We argued that synchronous communication is the most problematic aspect of

[b] In healthcare, an interaction is considered to be synchronous when two parties interact simultaneously.

[c] When spoken language is used as a symbol system for a message exchange, the interpersonal communication is called verbal communication [23].

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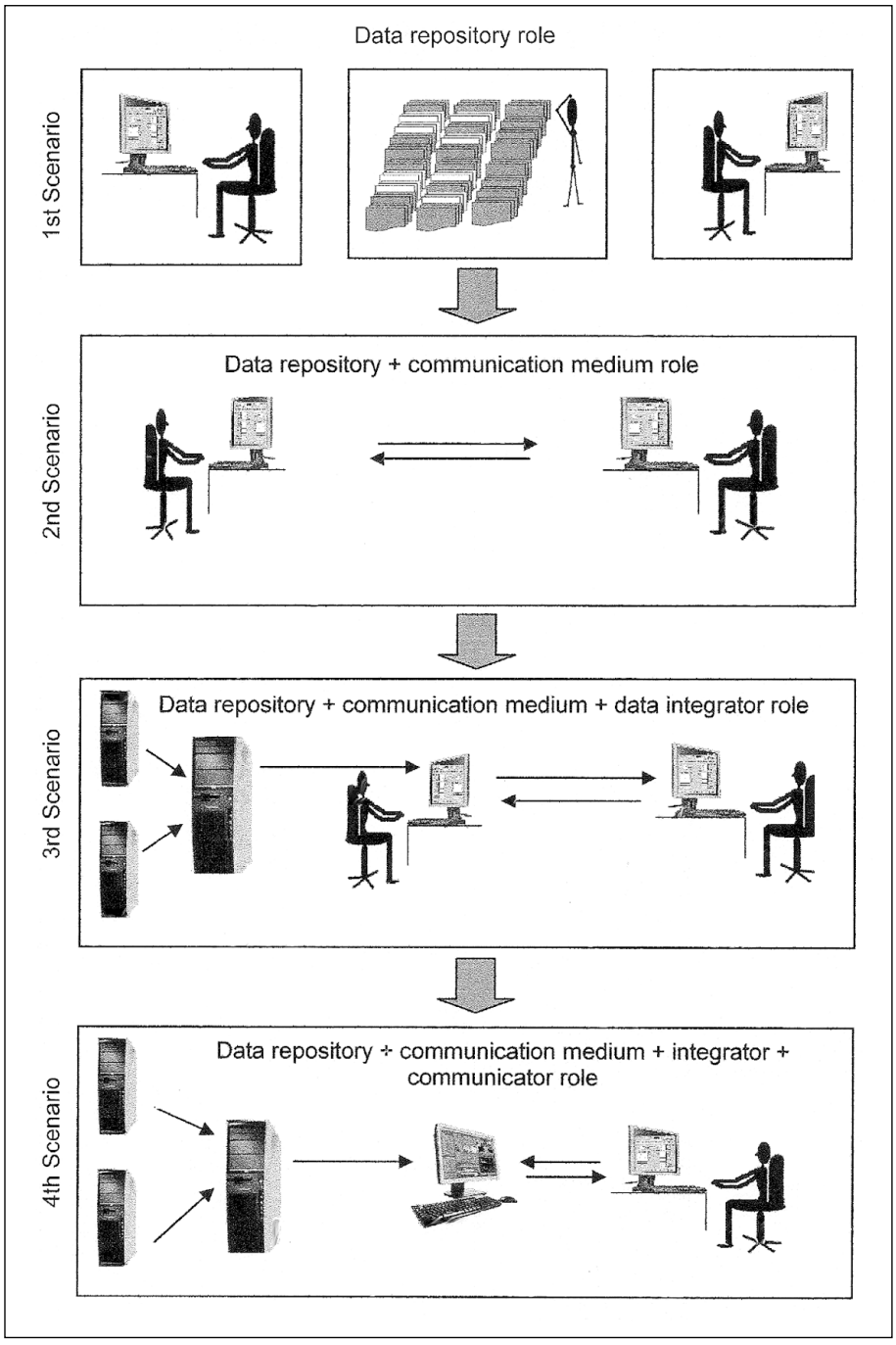

Fig. 1 Four scenarios represent how the role of IT has been promoted in healthcare communication.

healthcare interpersonal communication, although it is necessary to promote interoperability. Thus, in order for an information technology to improve healthcare intra-organizational communication, it needs either to shift information-exchange processes from synchronous to asynchronous mode or to prevent care providers' interruptions by providing necessary information and interpretations for their instant needs.

At least four scenarios can be defined in terms of how information technology has been adopted in healthcare communication. Each scenario is built upon the previous one and complements the next one. The role of information system has gradually been promoted in each scenario and each IT system falls into one of these scenarios based on the role it plays in the communication process (Fig. 1). In the first scenario, information technology is used to store and to retrieve patient data for different purposes; its role is that of *data repository.* In the second scenario, information technology serves as a *communication medium* through which certain healthcare interactions can be performed asynchronously. This scenario has been widely adopted in healthcare communication; Electronic Data Interchange (EDI), Internet, and e-mail fall into the second scenario as they are mainly used for data communication in healthcare. In the third scenario, information technology acts as the *integrator* to help care providers to acquire metadata and to integrate different pieces of patient data asynchronously. For example, a central EMR that is accessible at multiple locations in a hospital can reduce the number of communication processes (e.g., telephone calls) to access separate bits of single patient information produced by various care providers and stored in different databases. In the fourth scenario, information technology can take over the role of *human communicators* and participate in a synchronous interaction with humans. In other words, information technology is able to interpret information and to generate appropriate feedback or reactions. Decision Support Systems (DSS), for example, can act as acknowledged professionals that have access to different sources of information and act upon the received information by providing healthcare professionals with necessary advice and without interruption in their work or that of their colleagues. In that sense, information systems can be considered to play the role of communicators.

In literature, one can distinguish two general conceptual frameworks that represent two different approaches to communication improvement in healthcare. Some researchers view "communication space as a part of healthcare information space", while others consider it to be "larger than the healthcare information space".

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5. Two Different Conceptual Frameworks

In the first conceptual framework, which is a common notion in medical informatics, the "communication space" is considered to be a part of the "information space". Communication is considered as "the process by which information is exchanged between individuals or computers through the use of a commonly accepted set of symbols" [12]. Three dimensions are considered for every communication: communicator(s), communication media, and the exchanged information. In practice, the focus is on the *informative aspect* of communication processes: information and the methods by which it is transacted between computer systems. Successful communication is defined as leading to *interoperability* between the systems. In the course of communication, syntactic interoperability refers to the ability to maintain the syntax of the exchanged information. Whenever the transaction is on the basis of "shared, pre-established and negotiated meaning of terms and expressions", semantic interoperability will also be established [31]. The role of communication space is considered to comprise only part of the total information-exchanging processes [1, 6] (Fig. 2), and the environment within which communication takes place does not play a central role [1, 12, 22, 32]. Therefore, in this conceptual framework an improvement in communication is sought through standardization of information registration, transaction, and integration procedures.

In the second conceptual framework, communication space is not considered to be a part of healthcare information space: rather, it is seen to be larger (Fig. 2). In this framework, which is a common notion in cognitive and social sciences, communication is not viewed merely as an information-transaction process but is considered one that always centers on coordination and on establishing, testing, and maintaining relationships [9, 33, 34]. In other words, the focus is on the results of communicative exchange. Therefore, in the complex healthcare environment a successful communication amounts not only to *interoperable systems* but also to *interoperable people.* Since information space is a part of communication space, the interoperability is not considered only for information system communication. It also includes gaining "mutual intelligibility" or "shared understanding" between human communicators [14].

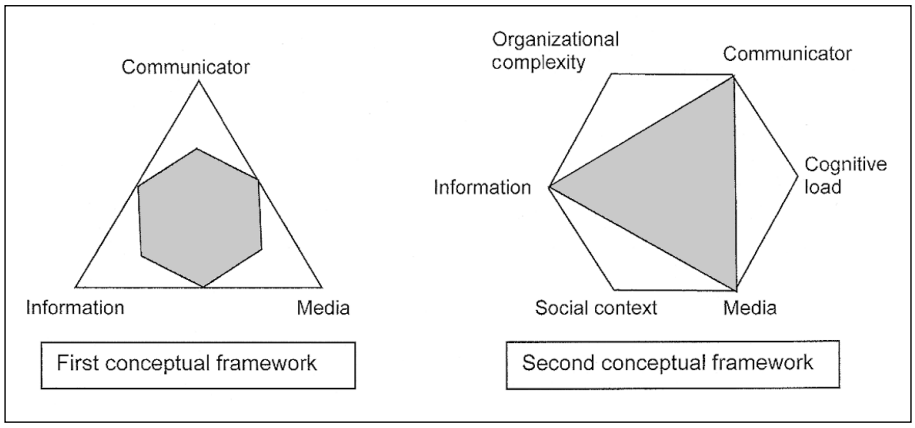

Fig. 2 The triangle represents information space and its triple dimensions, while the hexagon represents communication space and its six dimensions. The first conceptual framework considers information, communicator, and media as the triple dimensions required for achieving communication objectives; however, in the second conceptual framework, social, organizational, and cognitive dimensions are also equally important.

The mutual intelligibility of the communicators, on the other hand, is greatly complicated by their communication environment. Besides the communicator, media, and information, three other important dimensions can be recognized for interpersonal communication: cognitive, social, and organizational. The intricacy that exists along these three dimensions gives rise to the complexity of healthcare interpersonal communication. Improvement measures according to the second conceptual framework thus need to generate ways to cope with these complexities. This can only be achieved through jointly organizing the environment within which the information is produced, exchanged, and interpreted.

5.1 Complexity at the Cognitive Level

One main reason for the complexity in interpersonal communication is the *cognitive load* that the decoding of communication messages imposes on the communicators. The semantics of a message are largely dependent on factors that influence the encoding-decoding process [35, 36]. Two types of factors, internal and external, are at play here[d], and any variations in them impose a heavy cognitive burden on communicators [23]. The external factors are related to the communication environment and will be evaluated in the following topics. The most important internal factor is related to the "knowledge ground" that is essential for interoperable communication [39].

The perception of a patient's condition and the state of medical treatment in general are determined by several sources of distributed information that together can be seen as one body of knowledge [28]. In order to use this knowledge it is not sufficient to have all of the necessary information from different sources aggregated in one place (e.g., an EMR). To render disparate pieces of information useable for care purposes, they have to be integrated. This integration is a cognitive process of building semantic relationships and links.

On one level of this integration the semantic links are built between items of in-

[d] Based on the mechanical-mathematical model of communication, proposed by Shannon and Weaver [37], a sender encodes a message, for example, by putting an idea into words. This message is then broadcast to a receiver. The person or the device that receives the message decodes the signals to formulate meaningful content. Finally, the receiver may send feedback to the sender to indicate whether the message was understood [38].

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formation, while on another level the links are also to be built between perceived information and the background knowledge of communicators. The first level of integration can be achieved by ICT in an integrator role. However, the second level of integration is the product of the mutual effort between communicators to implement an encoding-decoding process in a manner that results in more or less the same understanding about a subject [14, 35]. Synchronous interactions allow communicators to learn how to encode messages, taking into consideration each other's immediate knowledge and perspectives. Such a mutual learning mechanism in interpersonal communication reduces the cognitive demands for the production and comprehension of communication messages [23]. This level of interaction remains a challenge for ICT application in interpersonal communication, especially for its communicator role. Hayes and Reddy [40] argue that the central difference between interpersonal communication and existing interactive computer systems is robustness: the ability to respond to unanticipated circumstances and to detect and remedy troubles in communication.

5.2 Complexity at the Social Level

Healthcare is a social environment that determines a context for care providers communication: *social context* [41]. The immediate impact of the social context is a "social dimension" for every communication and for every item of exchanged information. This social dimension plays an important part in understanding the core message and in gaining interoperability during interpersonal communication. Moreover, it affects the productivity and effectiveness of communication [42]. Hartly [41], for example, explains the effect of this social dimension in distinguishing the role that a communicator may take in different circumstances: e.g., that of a friend vs. that of a boss.

Communication channels vary in their ability to convey different levels of the social dimension. Face-to-face communication facilitates the richest level, followed by audio/visual, audio-only, and written or Computer Mediated Communication (CMC) [43-45]. If the social dimension of a communication is damaged, for example by standardizing its message or changing its communication channel, the semantics of the message will be hampered accordingly. Therefore, in applying ICT for healthcare communication, maintaining the social dimension of exchanged information is necessary for gaining mutual intelligibility between communicators.

5.3 Complexity at the Organizational Level

Healthcare systems are dynamic organizations in which not only the actors but also objects and information sources move around [17, 28] and tasks are more or less interrelated and contingent. In such a situation, tasks are carried out by "a collaborating ensemble of actors engaged in a dynamic teamwork characterized by continuous synchronization of the many actions and actors involved" [30, 46]. Healthcare systems are inherently constrained by time and resources at the same time that healthcare personnel are required to coordinate frequently with each other [6, 46]. The dynamic coordination results in an ongoing process of synchronous negotiations among care providers to align and adjust their work trajectories, to determine how to use shared resources, and to remedy contingencies, urgent problems, and unforeseen conflicts [14, 46].

In healthcare systems, interpersonal communication is the prevailing method of acquiring information, both for task performance and for continuous coordination [7, 21, 46]. Since asynchronous channels fail to meet these needs, healthcare personnel frequently turn from applying asynchronous IT channels to ad hoc synchronous interruptive communication [6, 47]. Reducing the conditions and controlling the factors that necessitate continuous coordination between healthcare personnel can help to reduce the ad hoc synchronous interactions between them. This way, the possible interactions between healthcare personnel can be predicted and be considered in ICT design and applications in order to substitute interpersonal interactions.

6. Standardization Approaches

Standardization is fundamental and precedes communication through information systems [12]. The level of the required standardization, however, varies for the different communication scenarios. For data repository and communication medium roles, standardization must entail data registration and communication messaging methods. For these purposes, a wide range of data coding, data transactions, and terminology systems exist in the healthcare domain [48, 49]. However, to some extent for the role of data integrator and mainly for the role of communicator in the information system, standardization has to include the semantics of the exchanged information. Among the conceptual frameworks mentioned, the first tries to establish semantics of the exchanged information through terminology systems, agreed modules of communication, and clinical concepts: ontological models. These models are representative of clinical concepts in terms of the formal and computer-processable specifications of the clinical contents [50]. Once these ontological models are shared between different information systems, semantic interoperability between them becomes possible [33].

The first conceptual framework will inherently have a limited impact on the standardization of communication in healthcare. In practice, the semantic aspect of the communication is minimal. Though this standardization possesses many advantages for information sharing (syntactic interoperability), it carries no assurance that the communicators can reach an agreed level of interpretation of the shared information (semantic interoperability) [33]. As a result, in many instances, where for example the information systems and the standards are the same, the intervention of an intermediary human agent is still necessary to interpret the exchanged messages and to fill the semantic gaps [51].

Moreover, although ontological frameworks can facilitate building semantic interoperability in communication between information systems [50], they have three intrinsic limitations. First, ontological models are designed only for specific domains (e.g.,

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for internal medicine) and organizations (e.g., for solo-practice specialists). This specificity in design, which is necessary for semantic standardization and interoperability, jeopardizes generalization to other domains and to other organizations. Second, the development of ontological models requires a sharp line to be drawn between the developing area of medical practice, which is called "knowledge domain", and "information structure". In the constantly evolving science of healthcare, this is often difficult, if not impossible, to achieve [52]. Third, in defining ontological models, only formal communication is considered and informal communication is usually ignored [50]. Although no exact statistics represent the frequency of informal interactions in healthcare organizations, direct and indirect empirical evidence suggests that most synchronous communication consists of informal interactions [18, 32]. Therefore, standardization based on the first conceptual framework will only support to a limited extent the application of ICT as communicator.

In standardization based on the first conceptual framework, there will be *semantic gaps* that the current standards cannot cover [49]. For example, in a research project focusing on the development of a reference architecture for an inter-institutional health information system, Lenz et al. [49] identified concurrent standards in use. The group then categorized and distinguished standards with respect to their ability to cover technical vs. semantic integration on the one hand and data vs. functionality integration on the other. By mapping and putting all the standards into place, a semantic gap was revealed that could not be covered by any of the standards. Thus, to fill the semantic gaps and to address the issue of mutual intelligibility in formal communication, complementary methods of standardization are necessary.

The complementary methods must address ways to control the factor variations that affect healthcare interpersonal communication; to change interactions from informal to formal; and to promote the impact of current standards in healthcare. In the second conceptual framework, it is argued that to maintain semantic interoperability, the standardization domain needs to extend into the communication environment and include, for example, the role, behavior, and language of the communicator. For instance, in order for a user to interact successfully with an information system, he or she has to follow the standard rules and to work in a manner conceptualized by the system's designer [14]. Moreover, it is possible to design standard methods for information processing and transaction within which semantic relations and links for every potential step are already defined. The compliance of healthcare personnel with such standard procedures is expected to reduce the effect of the variables from cognitive, social, and organizational domains of healthcare communication space and to improve the mutual intelligibility of their formal interactions. Three standardization approaches are discussed in the following sections (Table 1).

6.1 Controlling the Social Dimension

The missing social dimension of communication has been evaluated substantially in asynchronous CMC. Early studies of CMC proposed that this method filters out cues from the social context of communication [53] and distorts the communication [54]. More recent studies, however, suggested that the CMC communicators can actually communicate successfully, but it takes more time than via face-to-face communication [55]. Therefore, the basic difference between CMC and face-to-face communication is the rate at which communicators can establish interoperability [55]. This difference in speed was also found to be relevant in a recent study of applying CMC to enable committees to meet virtually to agree upon the priorities and commission projects in healthcare [56]. Studies, moreover, suggested that missing contextual factors in CMC is mainly a socio-technical interaction matter than only a technical matter (media bandwidth) [54]. There are many socially determined variables that affect how, why, when, and where such media are used. Controlling the dynamic effects of social context, therefore, can create a situation where media richness is less important to the effectiveness of communication, irrespective of media bandwidth [54].

Moreover, it has been argued that a method of dealing with the social character of communication can be taught to and cultivated among communicators through asynchronous IT channels [57]. Studies, for example, have indicated that CMC users develop the ability to express in written form the missing values of direct communication [45]. Such a notion can be adopted in order to improve semantic interoperability in IT applications in healthcare, especially where an information system is used as a medium (Table 1).

It is also possible to design and to use a system of *standard meta-signs* that are not central to the message of a communication but that reflect communicators' ideas, feelings, and thoughts about the information transacted through IT channels. Such standards can promote social presence and improve interoperability by controlling the effect of social context on interpersonal communication. We could not find anything in the literature that reports on applying these kinds of standard meta-signs in interpersonal communication. However, it is rational to imagine that semantic interoperability could utilize standard meta-signs. For example, a laboratory specialist could use them to indicate the extent of certainty about a test result. This would avoid the need for the person who requested the test to make a phone call to confirm the result. Another example would be the use of a standard meta-sign indicating the reason for issuing an unusual prescription; this could render it unnecessary for a pharmacist to phone and inquire about it. Moreover, an application such as openEHR (open Electronic Health Record) has the potential to support the use of standard meta-signs. With a dual-model approach (i.e. Reference Model and archetypes), openEHR can relate every standard meta-sign with a definition and domain-specific constraint to promote communicator interoperability [50, 58]. By improving semantic interoperability, these standard meta-signs can help to reduce synchronous interactions around asynchronous communication.

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Table 1 Standardization approaches to control variation at the cognitive, social and organizational dimensions of healthcare communication

Standardization approach	Objective	Example
Controlling the social dimension	To promote social presence in asynchronous communication through IT channels	A standard meta-sign that explains the reason of an unusual prescription for a pharmacist
Controlling the cognitive dimension	To promote developing standard information processing skill by healthcare staff	How to record information so that it is understandable for other care providers
Controlling the organizational dimension	To promote aligning, and integrating a set of practices, actors, and situations	Guidelines and standard care paths

6.2 Controlling the Cognitive Dimension

Many interoperability problems in communication through IT channels are potentially due to nonstandard information processing routines, like inappropriate coding of data. Such inappropriate routines develop if care providers have not been instructed about the coding purpose or have no clear idea about it. Winthereik [59] observed how Danish, Dutch, and British GPs coded patient diagnoses into their information systems, and realized that they used coding systems differently and according to their local conditions. They were confused about how to code diagnoses in cases where they were not told the purpose of the coding process, whether their coding was for billing or research purposes, or for communication with other colleagues.

The rate of synchronous interactions will be reduced, time will be saved, and collaboration will be improved if healthcare professionals learn how to process (i.e., acquire, record, and communicate) necessary information effectively and efficiently [60, 61]. A recent review article about the information-seeking behavior of doctors suggested the lack of search skills is a common barrier to using information sources [62]. An important way to improve this is to implement training programs that instruct healthcare professionals about where and how to find the information they need (e.g., when working with EMR) and how to record information so that it is understandable for other professionals [62-64]. Studies showed that coding accuracy is improved for residents following a coding and documentation training program [65, 66]. Educational programs, therefore, have to aim at improving care providers' understanding of coding purposes and at applying appropriate methods in working with ICT (Table 1).

6.3 Controlling the Organizational Dimension

Procedural standards, such as guidelines, are able to construct new links between work practices and to transform their functions, capacities, and properties within a care process. They standardize, *align*, and *integrate* a set of practices, actors, and situations. By determining what to do when, and in what sequence (for example, how to evaluate patients, to perform diagnostic and therapeutic procedures, and to report patient data and findings), these standards can control variations in performing healthcare practices. By coordinating the various tasks within and between different work practices, these standards can greatly reduce unexpected variation that is amenable to more synchronization and coordination [67] (Table 1).

At healthcare organization level, standardized care pathways built upon the trajectories of most patients describe *interdisciplinary* steps that care providers need to take for certain types of patients. It has been argued that in a standardized care path 70-80 percent of the steps and decisions can be delineated beforehand, thereby avoiding the need to configure the care trajectory repeatedly for each patient [63, 68]. This would potentially mean avoiding many unnecessary and routine activities that result in a great deal of ad hoc interruptive synchronous communication and coordination. Moreover, in most cases, considerable communication among healthcare personnel in a standardized care path can be predicted and replaced by IT channels [69].

Standardizing highly collaborative care processes has to include implementing feedback mechanisms. By informing and updating fellow care providers in the same process, these feedback mechanisms can prevent many of the synchronous interactions concerning coordination. Feedback mechanisms, moreover, can reduce the cognitive overload in asynchronous interactions. Dahl [70] studied location-based virtual notes that allowed hospital workers to leave short digital messages linked to relevant physical locations (e.g., by a patient's bed), so that intended colleagues could pick them up later when entering those locations. One of the main user concerns in this study was the lack of feedback about the posted virtual notes that made users uncertain about whether someone had received the note or had acted upon it.

After care processes are standardized, one can speak of defining role-based communication within and between task structures. The knowledge and information needed to fulfill the intended roles in standard care processes are predictable, and an information system in which this basic knowledge has been modeled can promote interoperability in ICT application based on the fourth scenario [39]. ICT would be able to provide healthcare personnel with the necessary information related to specific tasks, in a specific time and place, and in a specific sequence. By integrating other sources of patient information, for example from laboratory systems, ICT can be expected to work as a communicator in the loop of acquiring, integrating, and interpreting patient data to offer appropriate advice for care providers.

7. Discussion

We have argued that the optimal value of ICT application for healthcare intra-organizational communication will be at the point where changing synchronous interactions to

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asynchronous ones does not hinder care providers' interoperability. Four scenarios were presented whereby ICT improves healthcare communication; each is built upon the previous one and complements the next one and each one requires a different level of standardization. Two conceptual frameworks were discussed and their impact on the standardization of communication events in healthcare were elaborated upon. The first conceptual framework has been applied as the basic platform for a standardization process in several systems and in a number of IT applications for information repository, media, and integrator roles. We argued that these standards could mainly cover the syntactic component of healthcare communication and leave gaps in the semantic aspect [49]. To reduce these gaps, standards are also needed to maintain the semantics of the exchanged information. To develop such standards, the standardization process needs to go beyond the syntax of communication messages and to include those aspects of communication that influence the interpretation and understanding of the communication message: namely, cognitive, social, and organizational. This level of standardization enables ICT to assume a communicator role. The second conceptual framework can be a platform for this level of standardization and to support ICT application in the communicator role.

The contribution and maintenance of information in healthcare are collaborative activities performed by various members in the organization. An EMR, for example, is not a simple aggregate of every individual's contribution. Instead, every contribution has to be written, collected, completed, assessed, and accepted or rejected, as well as frequently updated [71]. Rigorous standardization then may necessitate more synchronous interactions to resolve the ambiguities and complexities that appear in exchanged information via asynchronous channels [67]. Therefore, the collaborative nature of information processing in healthcare poses restriction to standardization based on the first conceptual framework; this restriction has to be considered in applying information systems to substitute healthcare personnel communication based on the first conceptual framework [71, 72]. Wherever this restriction was not considered, problems arose due to difficulties in semantic interoperability. For example, empirical studies demonstrated that the volume of synchronous communication rose, relationships among healthcare staff were disrupted, cooperative work was undermined, and medical errors increased [11, 72]. Hence, the successful standardization of interpersonal communication needs another mechanism to help the current standards to meet the requirement for ICT in communicator role.

If the semantics of information processes could be standardized, improvements in mutual intelligibility through asynchronous interactions would be expected. We have argued that many factors affect the semantics of communication processes. In practice, it is not possible to control all of them. Nevertheless, at least ways exist to reduce ambiguities and to improve mutual intelligibility through asynchronous interactions. This means that standardization is necessary for both the information contribution of care providers and for those aspects of the communication environment that produce complexity at the organizational, cognitive, and social dimensions.

In this study, we critically analyzed literature from different scientific disciplines related to improving healthcare interpersonal communication. Whereas much ICT work has focused on the standardization of communication in healthcare, empirical studies show that standardization may actually hamper effective communication [67]. Rather than argue against standardization as such, or against standardization for only limited communication processes, we discussed the form that it has taken within healthcare ICT, and we suggested alternatives. Based on the information from different scientific disciplines, we suggested that promoting the role of ICT in healthcare interpersonal communication requires a multi-dimensional approach. Such an approach – as well as explicit standard systems for data storage, data transaction, terminology, and ontology – must address at least three dimensions: social context, the information processing skills of healthcare personnel, and most importantly, standardizing care process. In fact, any IT implementation effort that substitutes interpersonal communication in healthcare must – one way or another – deal with the social, cognitive, and organizational dimensions of communication space.

Communication problems contribute to many IT implementation failures and to patient safety concerns in healthcare. However, to our knowledge, few studies thus far have evaluated the effect of IT systems on cognitive, social, and organizational dimensions of healthcare interpersonal interactions. Even fewer studies have evaluated the effect of combining IT implementation with the improvement measures we proposed in this study. We analyzed literature from diverse scientific disciplines in order to bring new insights into IT applications to improve interpersonal communication, and realized that many research topics concerning the role of ICT in improving healthcare communication are still open. The suggested improvement measures in this paper, for example, represent ideas that need to be confirmed by further empirical studies. The scope in this review might have missed certain relevant issues or failed in some cases to present a deeper analysis. However, we believe that it has raised a number of important foci for future in-depth studies.

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