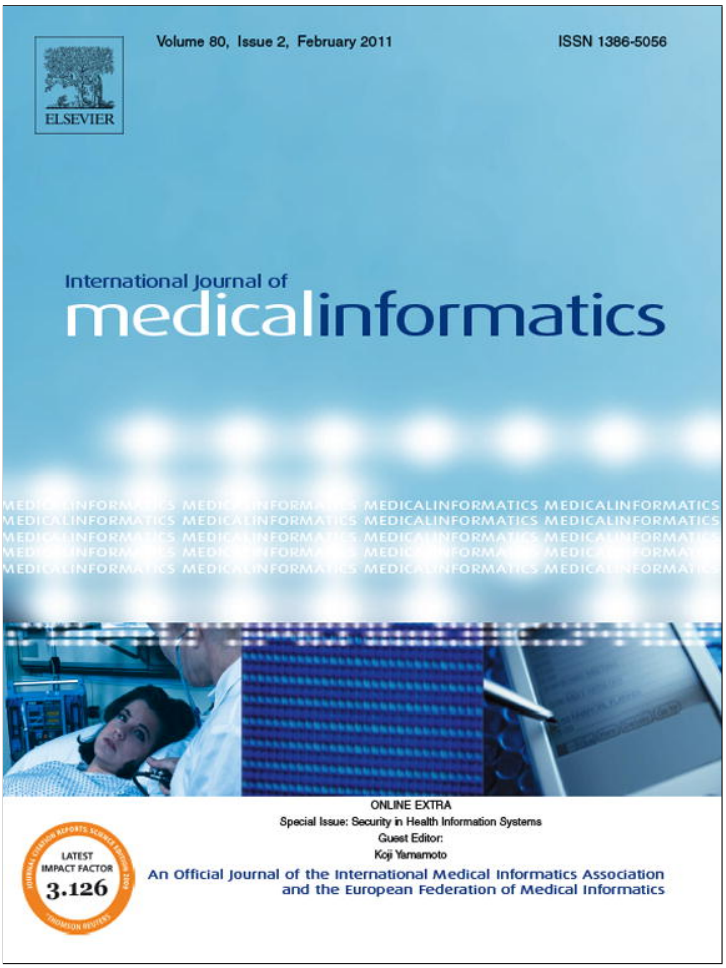

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# The IT productivity paradox in health: A stakeholder's perspective

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ABSTRACT

*Purpose:* While information technology (IT) investments in healthcare are higher than ever, there are contradictions in the literature regarding their ability to improve productivity, quality of care and/or healthcare system efficiency. Using theories that can help make sense of these contradictions, we propose a new framework to assess the actual impacts of health information technology (HIT) implementation.

*Method:* Following an exhaustive literature review, we build upon the 'productivity paradox' and 'stakeholder' theories to improve the evaluation of IT impacts in healthcare. Interview data from three case studies of HIT implementation in different hospitals were used to develop our proposed framework.

*Results:* The empirical data analysis suggests that it is important: (1) to identify, account for and accurately measure the appropriate impacts (beneficial/adverse, expected/unforeseen effects); (2) to consider the context of implementation; (3) to adopt a multi-level perspective (individual, group and organization); and (4) to take into account the various stakeholders' perspectives (managers, health professionals and patients).

*Conclusions:* An assessment framework was developed to provide general guidance on how to assess HIT impacts. The proposed framework will be useful for researchers and practitioners as it takes into account the underlying reasons for the HIT productivity paradox and identifies the salient outcomes of interest linked to HIT implementation.



## 1. Introduction

Investments in information technology (IT) in healthcare are greater than they have ever been, and in most countries, not less than 2.6–6% of health budgets are dedicated to IT [1]. In the United States, as part of the February 2009 economic stimulus package, Congress appropriated more than U.S. $20 billion for health information technology (HIT). In Western Europe, the healthcare sector modernization will generate a growth in IT spendings from U.S. $9 billion in 2006 to U.S. $12 billion in 2011 [2]. In the healthcare sector, HITs are being presented as a means to improve productivity, quality of health and/or system efficiency [3,4]. However, there is growing concern about the lack of actual positive outcomes that can be directly tied to HIT implementation [5].

On the one hand, the reasons cited in favour of the implementation of new HITs are numerous and diverse, both in the scientific literature and in government reports [6–8]. HITs are presented as one of the principal ways to improve quality

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of care [6,7,9,10]. It can improve medical practices, assist the decision-making process by facilitating access to good practice guidelines, simplifying the prescription of diagnostic procedures, and producing reminders [7,11,12]. Also, the use of IT in health is said to translate into lower rates of medication errors and adverse drug events [13–15]. Finally, some studies show that it can lead to greater productivity among professionals, and lower costs [6,7,16].

On the other hand, some findings on the actual effectiveness and efficiency of HIT remain inconclusive [5,17,18]. Some studies have even suggested that, in some cases, HIT implementations appear to be counter-productive [19]. Moreover, according to the literature in information systems and health informatics, not many HIT implementations have been successful [13,20–23].

Faced with contradictory evidence, some researchers, health professionals and hospital administrators have expressed doubts about the actual value of investing time, money and energy in the implementation of new HITs [17,24–26]. Being able to explain these contradictions and finding a way to determine the actual impacts of IT on health has therefore become a crucial endeavour that stands to benefit both research and practice.

In this paper, we seek to make sense out of the contradictory findings reported in the literature by providing a comprehensive framework that can be further used to improve the evaluation of IT impacts in healthcare. In the following sections, we review the literature on the impacts of HIT in healthcare and introduce the productivity paradox [27] and stakeholder theory [28]. From these, and based on empirical evidence from three case studies of HIT implementations, we propose our HIT Comprehensive Assessment Framework. Finally, we discuss the implications of our paper and its limitations.

## 2. Background: the real impact of information technologies in health

A growing number of studies seek to determine the real impacts of HIT. A review of the literature on HIT impacts [19] found that between 1995 and 2004 (a 10-year period), 257 studies were published. This number is growing exponentially. Our literature review has allowed us to determine that in the past five years alone (2005–2009) more than 1300 articles have been published on this very issue. A close examination of these studies allowed us to identify three emergent themes: (1) the impact of IT on quality of care; (2) the impact of IT on costs and efficiency; and (3) the impact of IT on professionals' tasks and roles.

*Quality of care:* While HIT is often presented as a means to improve healthcare outcomes [29–31], its actual effectiveness is deemed difficult to measure and interpret [17,32]. On the one hand, reviews and systematic reviews have reported many studies that show a positive impact through better adherence to good practice guidelines [12,19], improved clinical monitoring [19], fewer prescribing errors and adverse drug events [19,33,34], fewer cases of inappropriate service utilization (over, under and poor service utilization) [35], and even positive results in terms of health status [12]. Patients are generally satisfied with HIT [35–37] and find that it improves the accessibility of healthcare services [38] and continuity of care [39]. On the other hand, the same reviews and systematic reviews have nevertheless revealed that some studies have shown no impact on the quality of care indicators measured [12]. There is some evidence suggesting that the implementation of HIT may, on the contrary, foster medical errors and even lead to higher patient mortality rates [7,10,12,35,40].

*Costs and efficiency:* Many studies indicate that HIT may lead to savings through: improved prescription of medications [11,41], prevention of treatment side effects [11], optimization of prescriptions for tests (radiological and blood tests) [11,41,42], avoidance of costly medical errors [35,41], better use of nurses' time [11], decreased time spent charting [43], shorter hospital stays [35], and reduced printing costs [42]. Other studies however suggest that the use of HIT may rather augment health costs by increasing time spent charting [43], justifying a greater intensity of services (higher provider billings with no increased productivity) or inducing new types of costly medical errors [7]. Some authors even argue that we lack the data needed to assess the real costs and return on HIT investments, so it is actually impossible to truly assess their real cost-efficiency [7,19].

*Professionals' tasks and roles*: Systematic reviews of the literature [12,19,35] have suggested that investigators have rarely analyzed the impact of HIT on tasks. The rare studies that have focused on analyzing the impact of HIT on tasks and/or professionals' roles [44–50] suggest that a wider set of impacts should be considered. First, these studies show that HIT implementations have an impact on hospital physicians' work practices (rapid response, error prevention, and data management and accessibility) [46,47]. Second, the implementation of HIT may change the nature of the tasks performed by a group of healthcare professionals: for instance, the time saved by nurses in performing some routine tasks may be redirected to other tasks that require a greater focus on patient-centered care [44]. Some tasks that previously required professional input (such as approval of prescriptions by pharmacists) are being partially automated, significantly modifying professional roles [48]. Third, the implementation of HIT can modify professionals' respective roles and responsibilities [45,48,49] in a planned way or in unexpected manners. Indeed, the use of HIT may lead to a voluntary delegation of tasks, such as physicians delegating vaccination management to nurses [49], effectively increasing nurses' autonomy and responsibilities in the care process. Some unexpected migration of tasks may also occur, such as tasks transferred between laboratory technicians and assistants or between clinicians and secretaries [48].

In conclusion, despite investigators' growing interest in the phenomenon of HIT in healthcare and despite significant financial and human investments made to develop and implement IT in health, the evidence in terms of the actual impacts of HIT is still inconclusive.

## 3. Theoretical foundations

Over the last decade, IT research has identified and helped us understand what is called the *productivity paradox* [27]. In the fields of management and finance, another stream of research

based on *stakeholder theory* has helped explain contradictions in evaluations of outcomes. Both theories are described below and their application with regards to HIT implementation is reviewed.

### 3.1. *The productivity paradox theory*

The "productivity paradox" is the observation made by Nobel Prize laureate Robert Solow that it is impossible to prove that IT has an influence on firm productivity [27,51]. In the 1990s, many writers, economists and specialists in the study of information systems established that although the number of computers had more than tripled between the 1970s and the 1990s, productivity seems to have stagnated [27]. Indeed, the enormous investments made by businesses in IT did not appear to have had a positive effect on their productivity [27,52,53], and this has led to disillusionment and frustration with the technology. More recently, Carr [54] argued that it is impossible to draw any conclusions about the competitiveness and profitability of organizations following their investments in IT.

Four types of explanations have been offered for this IT productivity paradox: measurement error, time lag, redistribution of profit, and mismanagement of IT. *Measurement errors* are linked to the fact that inputs and outputs may not be properly measured. Mismeasurements are at the core of the "productivity paradox," and measurement problems seem particularly acute in the service sector and in the knowledge industry. Recently it has been proposed that investments in IT should be measured specifically in the context in which the investment that has been made [55]. *Time lag* refers to the fact that the actual impacts of IT might not have an immediate effect. In other words, a period of learning, adjustments, and reorganization may be necessary in order to reap the full benefits of IT investments. IT will have an impact on productivity, but its impacts could be delayed, hence rendering it difficult to identify or assess them. *Redistribution of profit* means that there are effects linked to the introduction and use of IT, but these are sometimes positive and sometimes negative, with an overall sum effect of zero. For example, IT may be beneficial to some individual firms, but unproductive from the standpoint of the economy as a whole. Finally, *mismanagement of IT* means that the absence of effects might be linked to the fact that the IT was not properly managed. Investments in IT might be made without a sound rationale, because decision-makers are pursuing personal objectives or using outdated criteria in their decision making, or not properly adjusting work organization and incentives.

### 3.2. *The HIT productivity paradox*

In healthcare research, very few published studies have used the productivity paradox perspective [6,16,48]. Considering the results of these studies and including those of the literature review presented above, we can apply the productivity paradox to the health care context to better understand some of the contradictions found in the results of studies analysing the impact of IT in health (see Table 1) for each explanation drawn from productivity paradox theory.

*Measurement error*: This dimension of the productivity paradox has been the one most studied in the field of health care and indicates that the selection of variables has probably not always been appropriate, leading to errors in our measurements of the impacts. Most of the studies have been quantitative, measuring occasional indicators of quality of care (such as the number of medications) [35] or partial costs [6,7,11,19,56] without examining the overall inputs and outputs of an IT implementation.

In terms of inputs, the measure must be as broad as possible and take into account the human resources, equipment and organizational capital invested, yet these inputs are rarely seen in studies of IT in health [6]. In addition, studies of IT in health should also consider other factors that influence productivity, such as re-engineering and change management, but this has rarely been the case [6]. In terms of outputs, studies have rarely considered them all, and have usually only measured a single or a very limited set of indicators, thus providing only a partial view of reality [6]. The impact of IT cannot be limited to cost reduction, and it has been argued that the IT potential for improving the outcomes of health services (including outcomes for patients, such as changes in or maintenance of quality of life and well-being) should also be taken into account [6].

*Time lag*. Studies in health have not focused much on the importance of time lag in assessing HIT impacts. There is evidence, however, that the existence of a lag may help explain the problems encountered assessing the value of HIT. The time lag effect vis-à-vis the investment in IT and the timing of the resultant gains may be the result of two factors: first, because of the delay in IT adoption in the health care industry and second, because evaluation studies are typically done too soon after HIT implementations, before any real impacts can actually be measured [16].

*Redistribution*. Little consideration has been given to the effects of redistribution. Given the variety of professionals involved, the literature suffers from a lack of studies of the impacts of HIT on tasks and role redistributions between professionals. Some rare studies have shown task redistribution effects among professionals following HIT implementation [48]. Others also suggest that HIT implementation can change the nature of medical errors [35,40,57]. It is therefore possible that HIT fosters quality care in some sectors while contributing to a deterioration of care in other areas.

*Mismanagement of IT*. Most HIT implementation "failures" are failures to properly apply managerial wisdom that has been substantiated by research and experience [21]. As the adoption rate has an impact on benefits of HIT [35,58], the fact that studies have shown that HIT use varies widely [59] raises concerns regarding the assessment of actual impacts. Finally, given that HIT implementation studies rarely associated the findings on quality of care or costs with technology utilization variables, it is difficult to know if the lack of impacts is due to non-utilization or to an inappropriate utilization of the technologies [12].

Our literature review therefore suggests that the productivity paradox is relevant to the study of IT impacts in healthcare. When associated with the use of IT, measures of productivity tend to be biased. Too often, the measures used do not take all the inputs into account and, given their variety and the need to

**Table 1 – Explanations for the productivity paradox.**

| Categories | Explanations for the productivity paradox | Sources in IT research | Evidence in healthcare research | Sources in healthcare research |
|---|---|---|---|---|
| Measurement error (*inputs and outputs*) | Conventional approaches are not properly measuring the inputs and outputs of the industries using the information. | Brynjolfsson, 1993 [27] | *Inputs:* Measures do not take into account human resources, equipment and organizational capital invested. | Bodell, Covvey and Fader, 2004 [6]; Kuperman and Gibson, 2003 [35] |
| | | Brynjolfsson and Hitt, 1998 [52] | *Outputs:* Measures are based on a single or a very limited set of indicators, thus providing only a partial view of reality. Most of the studies are quantitative and measure only occasional indicators of quality of care. | Chaudhry et al., 2006 [19]; Sidorov, 2006 [7]; Kaushal et al., 2006 [11]; Frisse, 2006 [56] |
| Time lag | There is a lag between the investment in IT and the timing of the resultant gains, and the approaches used are not taking this lag into account. | Brynjolfsson, 1993 [27] | The lag may be generated by: (1) the delay in IT adoption in the health care industry, and (2) studies that are conducted too soon after the IT implementation. | Thouin, 2008 [16] |
| | | Dehning et al., 2004 [62] | | |
| Redistribution and dissipation of profits (outputs) | Profits associated with investments are in fact being redistributed and do not appear in the outputs. | Brynjolfsson, 1993 [27] | Evidence suggests potential redistribution (e.g., task redistribution effects among professionals). | Hebert, 1998 [48] |
| Mismanagement of IT: Poor management practices, poor implementation | The absence of a financial return following an investment in IT may simply be the result of poor implementations. | Stratopoulos and Dehning, 2000 [63] | Quality of care/costs are not studied in association with technology utilization variables, so we do not know if the lack of demonstrated impact is due to non-utilization of IT or an inappropriate utilization of IT. Indeed, the IT use rate varies widely and has a direct impact on the benefits. | Ash, 2004 [40]; Kuperman and Gibson, 2003 [35]; McNutt, 2002 [57]; Delpierre et al., 2004 [12]; Lindenauer et al., 2006 [59]; Rothschild et al., 2006 [58], Kuperman 2003 [35]. |
| | The lack of an explicit measure for the value of information makes it particularly vulnerable to poor management practices. | Brynjolfsson, 1993 [27] | | |

take into account both the quantity of what is produced and its quality and production value, outputs are difficult to measure [6,60]. In addition, the fit between a given IT and related tasks may vary according to how individuals define their work as well as their individual characteristics and preferences [46,61]. Depending on the type of professional, productivity may be affected differently by HIT, as the impacts on tasks and task redistributions differ from one type of professional to another.

### 3.3. *The stakeholder theory*

Stakeholder theory originated from management studies and was initially used to describe how managers work. For Freeman [28], who originally developed the theory, stakeholder theory is based on two major key questions. First, "What is the organization's goal?" This question leads to consider the value created by the organization from the point of view of all its stakeholders. The significance of stakeholder theory lies in the fact that the resulting description of the organization's environment is unique and based on the points of view of different parties. More specifically, a stakeholder is described as "any group or individual who can affect or is affected by the achievement of the organization's objectives" [28]. The second key question is: "What is management's responsibility to stakeholders?" This question is posed to gain a better understanding of what type of relationship exists between business managers and the various stakeholders and to decide how much consideration should be given to each.

Although the use of stakeholder theory is recent in IS research [64] the pluralist approach afforded by stakeholder theory is highly appropriate in the field of IT [65]. Pouloudi [64] argues that in order to reflect the multi-faceted concerns of the IT development process, a more holistic view of stakeholders is required. She calls for the study of multilateral stakeholder relationships in IS research. Vidgen [65], observing that the failure rate for IT implementations is still in the order of 75%, states that this may be due to the fact that an IS can affect many different stakeholders and requires their participation during its implementation, even though these parties will clearly not have the same interests in the implementation or voice the same opinions.

### 3.4. *The stakeholder theory in the context of HIT implementations*

The stakeholder theory has not been formally used to study HIT implementations and their impacts. Nevertheless, in one of the few studies identified, Burke and Menachemi [66] used a stakeholder perspective to develop a theoretically specified measure of IT capability. They argue that IT can be used as a strategy to provide information to the many and diverse types of hospital stakeholders. Their results indicate that IT munificence accounts for both internal and external IT capabilities.

Surprisingly, even the very concept of stakeholders has received little attention in the context of IT implementations in health [67,68]. Some papers have however acknowledged the importance of taking into account a plurality of stakeholders in regards to HIT implementations. According to Kazanjian and Green [69] and Kaplan and Shaw [61], the HIT stakeholders are the various interest groups, which fall into four main categories: the producers of an HIT, its users, the recipients (patients), and the administrators/payers, which include society and experts. Lyons et al. [70] have identified three stakeholder groups affected by the implementation of HIT: administrators, physicians and nurses. In these papers, the importance of considering the opinions of these different groups is highlighted. Indeed, each stakeholder group has a different point of view: clinicians will be more motivated by issues of clinical effectiveness, administrators will be interested in financial issues and the management of other resources that have an impact on quality of care, governmental agencies will focus on efficiency, and patients will be concerned with quality and safety.

The extant literature therefore suggests that different types of actors are affected differently by HIT and do not perceive the same impacts of the technologies. Stakeholder theory has been advocated as a useful framework for better understanding healthcare delivery [71]. Indeed, stakeholder capitalism implies that human beings are required to be at the center of any process of value creation and trade. The authors claim that applying the four basic principles of stakeholder capitalism to healthcare provides a better understanding of the complexity of healthcare delivery. First, according to the principle of stakeholder cooperation, value creation and trade is not a zero-sum game; value is created because stakeholders can jointly satisfy their needs and desires. Second, the principle of continuous creation suggests that individuals are multifaceted and capable of acting on the basis of many different values. In healthcare, it thus suggests a need to determine the "fundamental value questions that may bind together a particular healthcare institution" [71]. Third, based on the principle of continuous creation, organizations are a source of the creation of value. In healthcare, most value can be gained by cooperating with stakeholders as they can represent sources of innovation. Finally, according to the principle of emergent competition, competition emerges in relatively free societies where stakeholders have options. In healthcare, it can be argued that competition stems from the cooperation among stakeholders and not from the 'primal urge to get the other guy.' This means that some forms of cooperation may better satisfy some stakeholders' needs. It is therefore important to begin by identifying the different stakeholders affected by the introduction and use of IT in health.

### 3.5. *Theoretical insights for HIT implementation research*

The foundations of the productivity paradox and stakeholder theory indicate a need to go beyond simple financial assessments of return on investment and take into account the nature of the stakeholders involved, the specific nature of the implementation context, and the wide range of outcomes resulting from the introduction and use of IT in health. Like Panko [72, p. 201], we believe that: "**How** one uses IT would seem to be far more important than simply **how much** one spends" on IT.

In assessing the value of IT in health and HIT impacts, using the above-mentioned theories lead to acknowledge the importance of including a wide range of impacts from the introduction and use of HIT, in terms of costs, care accessi-

bility, efficiency, quality and safety of care, health outcomes, changes to professionals' roles and tasks, etc. With few exceptions, the studies we reviewed tend to rely on a very small number of indicators of pre-conceived impacts and do not consider the wider range of impacts that can be associated with the implementation of IT in healthcare settings. Yet, whether they are foreseen or not, beneficial or even adverse, the impacts are numerous. Our review of extant literature in health, management and IT also showed that impacts can be performed at the individual level (e.g., patient information privacy), at the group level (e.g., changes in the respective roles of healthcare professionals), and at the organizational level (e.g., variations in medication errors in a given setting).

Our literature review has further highlighted the wide variety of technologies implemented, the diversity of the healthcare settings studied, and the multiplicity of the rationales for investing in HIT. Finally, it has showed how important it is to give consideration to the numerous stakeholders involved in the process.

## 4. Research methods

Our research approach was based on a multiple-case design study [73]. As indicated in Table 2, the three sites varied in terms of the type of hospital (teaching vs. general), the type of HIT (Alpha vs. Delta) implemented and the overall outcome (success vs. failure). In each setting, three distinct groups of stakeholders were identified: physicians, nurses and administrators. Data were collected as part of a larger research program on CIS implementations [74–77].

At each site, semi-structured interviews (the interview guide is presented in Appendix A) were conducted with members of these three stakeholder groups (see Table 2) following a snowball sampling procedure [78,79]. More precisely, in each site, the first respondent was the person identified as a key actor in the HIT implementation. He or she had a thorough knowledge of the HIT project and its implementation. At the end of the interview, this first respondent was asked to identify other key actors who could provide additional insight about the HIT implementation project, making sure that different point-of-views would be considered. All interviews lasted one hour on average and were conducted at the workplace of the respondent (care unit or office). The data gathering process finished at the point of redundancy that is when additional interviews did not allow eliciting any new information.

**Table 2 – Cases and respondents.**

| Cases | Respondents |
|---|---|
| *Case 1* | |
| General hospital | Physicians: 7 |
| System= Alpha | Nurses: 4 |
| Outcome = Failure | Administrators: 5 |
| *Case 2* | |
| Teaching hospital | Physicians: 4 |
| System= Alpha | Nurses: 4 |
| Outcome = Success | Administrators: 5 |
| *Case 3* | |
| Teaching hospital | Physicians: 4 |
| System= Delta | Nurses: 6 |
| Outcome = Failure | Administrators: 4 |

From the interviews it was possible to obtain a narrative of the implementation of the HIT in each hospital, from software selection to project termination. The several hundred pages of transcripts that resulted were rich and diverse. QSR NVivo 8 was used to code the data. The coding process was iterative, using both the initial coding scheme and open codes [80,81]. Given our chosen theoretical foundations, we first used categories and codes important in the productivity paradox and stakeholder theories such as: impact nature, valence, impact measure, context, level of analysis, stakeholder identity, and stakeholder perspective.

We then proceeded to a second round of coding in which we remained open to new codes and categories when appropriate [82, p. 62]. Indeed, to build our proposed framework for assessing impacts of IT in health, a grounded theory analytic strategy [80–82] was deemed appropriate. Following an axial coding strategy, codes with the same content and meaning were grouped in categories. Through selective coding, patterns were analyzed and a core process emerged. The most revealing quotes were selected to illustrate the results of our analysis. The analysis process was carried out until theoretical saturation.

## 5. Empirical evidence: three case studies

In order to develop our framework, we use evidence from three case studies of HIT implementation in hospitals [23,74]. The first case is set in a new general hospital that was never intended to process any paper documents. With this in mind, a multidisciplinary committee at the hospital chose the Alpha software package to support both clinical and administrative processes. In fact, two years passed before the HIT was actually implemented. The first module to be introduced – Test Requisition/Results – changed how the physicians used and consulted patient records. A year and a half later, a second module was launched – the Computerized Care Plan, and it radically altered the hospital's recordkeeping process. Originally, the physicians had written prescriptions through verbal instructions to nurses, but now the new system required that they enter the data themselves. As a result, major conflicts arose between the physicians, the nurses and the hospital's administrators. In contrast to the nurses, the physicians did not like the new system, complaining that it was inappropriate. They began taking radical measures, doing anything that might result in the module being withdrawn. At the time of our study, the second module had been removed, and the CEO dismissed. The system was running at 25% of capacity, and the new administration showed no interest in implementing any new module.

The second case involves the implementation of a HIT that integrates patient care with the teaching needs of a university hospital. As in the first case, a multidisciplinary committee selected the Alpha software package. The implementation of a first module – Admission, Transfer, and Discharge – was quickly followed by another – Test Requisition/Results. These

implementations were met with relatively little resistance, but the third module – Pharmacy – was received very differently. It was perceived as inappropriate for making prescriptions, a threat to patient safety and an obstacle to providing quality care. Hospital administrators decided to withdraw the module. At the time of this study, the project was widely viewed as a success; 75% of the system's functionalities were in use, and the others were to be introduced in the near future.

The third case involves the implementation of a HIT in a university hospital where it would replace obsolete systems in the Admissions, Radiology, and Pharmacy departments, as well as in the laboratories. The Delta system was selected by a committee of physicians and nurses. A pilot project was begun in the surgery unit, which had volunteered for it. The surgeons' initial enthusiasm was short-lived; when the Requisition/Results module was introduced, they soon began expressing concern about the system's ability to meet their real needs. Their concerns were inflamed with the introduction of the Computerized Care Plan, which created conflicts between the physicians and the nurses to such an extent that hospital administrators had to intervene. At the same time, the Delta system was being implemented in the Pediatrics and Geriatrics departments, where the response was quite favorable. The launch of the Pharmacy module several months later would prove to be the source of a new conflict, this time between the hospital's surgeons and pharmacists. The surgeons then demanded that the HIT be withdrawn, and this placed them in direct conflict with the administration. At the time of our study, the system was being used in Pediatrics, but it was no longer used by the geriatricians, who chose to side with the surgeons. It had also been withdrawn from Surgery, with no plans for a reintroduction in the near future.

## 6. Data analysis results

Based on our empirical data analysis, as evidenced by the quotes provided below, a **wide diversity of impacts** have been experienced in all three cases, from impacts on clinical processes and quality of care to security and privacy, as well as on organizational climate and power distribution:

***Case 1*** *I thought that it was a good idea... If it can simplify our work and give us more time with patients, that's great... You could take someone's blood pressure and enter it right away, you stayed with the patient. I found that worthwhile.* (Nurse, Case 1).

*In fact it was a terrible scrap to have over a work tool. It was terrible because the scars are still with us today. (...) In addition, it was very expensive. It cost the hospital a million dollars, and we're still trying to figure out how to finance it.* (Administrator, Case 1).

***Case 2*** *There was just so much in that system. People who liked that kind of thing really got into it, they saw more advantages. Those who don't, complained; it was always more complicated.* (Nurse, Case 2).

*We hadn't realized that it would be helpful in terms of preventing unauthorized changes in a patient's records. In order for someone to do something in a file, they had to enter their key and password, and it was registered. We discovered that there were people occasionally making changes in records that were none of their business. We let them know that we knew it. That was enough; it stopped.* (Administrator, Case 2).

***Case 3*** *With the system, we said that it would be great if we could have lab results in the department without having to go and get them, have the results directly in the departments. We thought it was a good idea.* (Physician, Case 3).

*Before, there were things that the nursing units slipped under the rug, in the sense that they knew that they shouldn't hold onto a ton of medication. But they keep it for a rainy day, things like that. And sometimes the pharmacy doesn't know that they're holding on to medication. But with the system, it was more difficult to get away with this kind of thing.* (Nurse, Case 3).

Data from all three cases therefore indicate that there exists a wide range of impacts – foreseen or unexpected, positive or adverse – that are related to the introduction and use of IT in healthcare settings.

The analysis of our empirical data further highlights the importance of taking into account **contextual factors** when studying the impacts of IT in health, be it the specific nature of the technologies implemented, the healthcare settings studied, or the rationales for investing in IT. For example, our data shows that in all three cases, while the software package purchased had officially been designed to fit the practices of the health professionals, in fact it mostly reflected policies, laws and regulations, and this did not always reflect the unique characteristics of the day-to-day practices of the healthcare professionals in these particular hospitals.

***Case 1*** *With a computer, the vision of the patient had changed. As doctors, we examine people and we perceive people; we have a comprehensive view, it's holistic. When we treat someone the heart isn't really independent of the abdomen, it isn't independent of the lab tests. (...) But now the patient has become a bunch of tunnels, and I've lost my overview.* (Physician, Case 1).

***Case 2*** *One day we had incredible problems with system response time. At one point, when you have to download a list and it takes 5 or 10 minutes (...) I can wait that long when I'm at home making a cup of coffee, but not while I'm treating a patient.* (Physician, Case 2).

***Case 3*** *The professional organization of a hospital, it isn't like a company selling nails. All of a sudden you have this system that is black and white, no shades of grey. Well, that's when things went off the rails. There are people who used to have privileges, real prima donnas, and that doesn't work anymore with a computer system.* (Administrator, Case 3).

*In all three cases, there is also evidence that implies the importance of adopting* ***a multi-level perspective*** *that takes into account the individual, the group and the organization when studying the impact of introducing and using HITs. For each case, we include below quotes that summarize well issues that were identified at each level.*

***Case 1*** Organization: *When the hospital obtained credits to open and build here, the approach adopted by just about everyone, on the board of directors, even before we had a general manager, was that the hospital's philosophy included a computer system. They said that there would be computer systems because that's the future.* (Physician, Case 1).

Group: *The crux of the problem was that the administration, with the support of the board of directors of the time, believed in self-financing and said: "The doctors are just a small group that isn't pleased, we just need to carry on." And that's when the whole thing exploded. That's when it caused incredible problems in the hospital. Frictions between groups, nurses going against the doctors.* (Administrator, Case 1).

Individual: *Sitting down in front of a keyboard isn't something that disgusted me; I didn't hate it. I liked it, then I saw it as a challenge, to get involved. I saw it as something positive, but I was quickly seen by colleagues as a computer expert.* (Physician, Case 1).

***Case 2*** Organization: *Here . . . they said, it'll be wonderful. Since we're in a hospital where we have a lot of teaching, research, and what are called tertiary care beds, we often have to look back in the records and plan care, managing spreadsheets and so on. We'll have the system, it'll have everything in it, we'll just press a button and it'll be extraordinary. They bought it, seeing the benefits in terms of better quality care, teaching and research.* (Physician, Case 2).

Group: *We began by group, and simply by the group's attraction. In one department, the managers – because we were working with the managers – well, we tried to convince them that the plan had merit. As long as they hadn't bought in, we couldn't do anything for the group.* (Administrator, Case 2).

Individual: *I've been using it for five years now–I know the shortcuts, but I know people who don't, and it slows them down a lot. Your behaviour towards the system depends a lot on your knowledge of it. Not everyone has the same facility with it.* (Physician, Case 2).

***Case 3*** Organization: *As I just told you, a certain interest, since people felt that it would be coming in the normal course of events, and here at Hospital ABC we've always thought that our hospital should lead in all areas, and we just saw another opportunity to show that, in a way, we're at the cutting edge.* (Physician, Case 3).

Group: *When the surgeons jumped ship, it lasted three months. Interminable meetings, letters, residents who resigned. Of course the nurses were furious, since they found it incredible having patient care plans, with everything that came with it.* (Administrator, Case 3).

Individual: *The reactions varied form one person to the next. Overall, things are going well. Some people were slower than others, some were just crazy about using it, and some weren't as thrilled.* (Nurse, Case 3).

In each case, there is therefore evidence of the importance of taking each level into account (e.g., the hospital philosophy at the organization level, the power at the group level, or the skills and needs at the individual level) when assessing the value of HITs.

Finally, in the cases that we studied, we noted clear indications that the impacts of the systems were perceived differently from one type of **stakeholder** to the next and that the grounds for adoption and use were sometimes very different:

***Case 1*** [One] *major problem faced by a hospital that is computerizing is the wide range of professionals who will be using the system, and their wide range of expectations. The needs of the physiotherapist, the respiratory therapist or the nurse, or the needs of the physician, psychologist or radiology technician, are vastly different.* (Administrator, Case 1).

***Case 2*** *That's what we tried to do, because since there are many types of users among the staff, what we tried to do was make it useful to everyone such that everyone could benefit.* (Administrator, Case 2).

***Case 3*** *In any event, if we had to do it all over again, we wouldn't begin the same way. But we were in a hurry because the project was self-financing. (. . .) I remember saying, what if we had begun with the laboratories (. . .). Maybe it would have been different. On the care units, we're not dealing with the same people, the same needs. It's different.* (Administrator, Case 3).

Hence, our evidence also suggests the importance of taking stakeholders' perspectives into account when studying the impacts of the introduction and use of IT in health.

## 7. A framework for assessing impacts of it in health

Based on our theoretical foundations and considering our empirical data, we propose the following assessment framework of the impacts of IT in health (see Fig. 1). The productivity paradox and stakeholder theory are combined here with our case analyses to provide a new lens for studying IT phenomena in healthcare, as illustrated by our framework. From productivity paradox theory, we learned that the absence of visible signs of success following an IT implementation could be related to four categories of explanations: measurement errors, time lag, redistribution and dissipation of profits, and mismanagement of IT (poor management practices, poor implementations). In light of our empirical results, we see that the benefits of an IT implementation will be experienced differently at several levels and by several types of stakeholders (physicians, nurses and administrators in our cases), thus illustrating that there is indeed a redistribution of the profits and that if they are not measured at the right place and for the right stakeholder, they could pass unnoticed. We also illustrate that it is essential to have the right IT in the right settings: if the IT is not designed to fit the practices of the various stakeholders (through appropriate selection and implementation processes) and if the practices of the stakeholders are not themselves appropriate (good management practices), then again no benefits will result from the implementation. We also found that each level of the hospital (individual stakeholders, groups of stakeholders, and the organization as a whole) has to be taken into account, since the benefits to be measured will be different for each of them. Finally, as suggested by the stakeholder theory, in order to properly measure the benefits of an implementation, each type of stakeholder (in this instance, physicians, nurses and administrators) should be included, since the impacts of a same system can be very different for each.

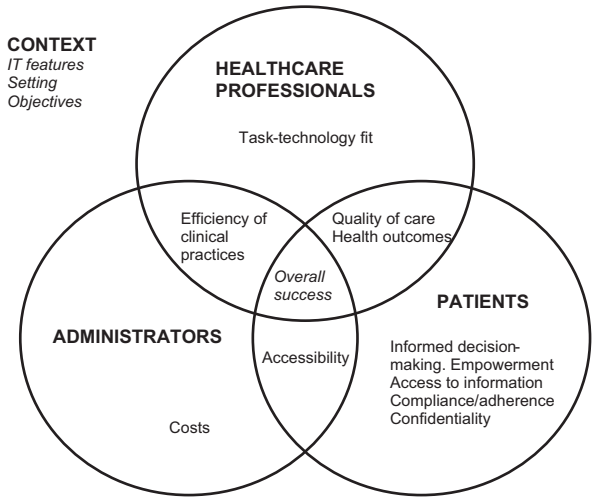


**Fig. 1 – HIT impacts assessment framework.**

In our framework above (see Fig. 1), the context is represented by the external border; it sets the boundaries of the environment and allows taking into account its particular characteristics. The context would include, for example, the features of the IT implemented, the time frame, the nature of the setting and the objectives pursued. Within these boundaries, the framework consists of three circles. Each circle represents one of the three most important groups of stakeholders identified: administrators, patients and healthcare professionals. At the intersection of the three circles, overall success represents the conjunction of impacts for all three groups. Within each circle and within each area of overlap, salient outcomes of interest – or impacts – have been identified as illustrations. Only the most salient impacts are represented, and they are by no means exclusive or exhaustive. We do recognize that, to a point, all stakeholders do value quality of care, health outcomes and efficiency—to name only a few. Rather, our framework is designed to highlight the most influential impacts for each group of stakeholders.

This framework is applicable to a wide range of ITs and types of settings. It provides overall guidance on how to assess actual HIT impacts, taking into consideration both the actual context and the stakeholders. Depending on the nature of the IT, the setting being considered, and the objective pursued, it is possible to refine and tailor each circle. For instance, in a specific setting such as ambulatory settings, the stakeholder group "healthcare professionals" could include a variety of care providers (primary care providers, pharmacies, homecare services, etc.). For a specific objective, such as an IT implementation aimed at improving communication between nurses and physicians, the impact on physicians and nurses could be assessed separately. In the case of a specific technology, such as a smart home, the stakeholder group "patients" would include not only the patient but also family caregivers. Moreover, the salient indicators of impacts have to be selected in accordance with the objectives pursued. For instance, if a HIT such as telecare is implemented, accessibility can become one of the most significant impacts considered.

## 8. Discussion and conclusion

Our article has underscored how difficult it is to draw any conclusions about the actual impacts of IT in health based on the extant literature, given that findings often contradict each other. Evidence from three empirical case studies suggest that a true assessment of HIT impacts require: (1) to identify, account for and accurately measure a wide range of impacts (beneficial/adverse, expected/unforeseen effects); (2) to consider the context of implementation; (3) to adopt a multi-level perspective (individual, group and organization); and (4) to take into account the various stakeholders' perspectives (managers, health professionals and patients).

In light of our case results and by transposing the productivity paradox and the stakeholder theory to the study of impacts of HIT, our proposed framework allows for a different reading of the contradictions found in the extant literature and explains why the impacts of a given HIT might be evaluated very differently depending on the indicators chosen and the nature of the stakeholders. When reconsidering these studies in light of our framework, we see that, in association with the implementation and use of IT, patients are mostly concerned with confidentiality, informed decision making, access to health information, quality of care, health outcomes, and the patient-physician relationship [83–85]. For their part, healthcare professionals are more concerned with task-technology fit, quality of care, health outcomes, efficiency of clinical practices, quality of clinical decision, information quality, timely access to information, education, and training [83,86–89]. Finally, managers are mostly concerned with costs and organizational, financial and operational performance [90].

We should acknowledge that our literature review was constrained by the fact that there are only a handful of studies in healthcare that have taken into account the patient's point of view, and we do not have patient interviews. Our empirical data are also limited to the impacts of the implementation of clinical information systems in hospital settings. Though there are differences in terms of outcomes, technologies and settings in our data, future studies will need to explore a wider variety of HITs and settings. Moreover, it will be important to empirically verify what are appropriate indicators and measures of outcomes, depending on the context where the HIT assessment is performed.

Despites the limitations of this study, we believe that our HIT impacts assessment framework will be useful for both research and practice. For researchers, it will help identifying the boundaries of the evaluation and help plan the design of the assessment studies. Depending on the nature of the HIT implemented, the objectives that are pursued and the stakeholders involved, the research design (choice of indicators, populations, time frame, primary and secondary outcomes, level of analysis, setting, etc.) should be framed appropriately if one wants to accurately assess the actual value of HIT. For practitioners, the proposed framework highlights the importance of properly defining the boundaries of an HIT implementation. On the one hand, in the case of a wide-scale implementation, the framework suggests that many different perspectives will need to be taken into account and that it will be important to understand that, in the end, a wide variety of objectives will need to be met. Overall success will depend on the capacity to satisfy the salient needs of the various stakeholders involved. On the other hand, the framework may also help practitioners to actually set limits on what needs to be achieved, and to set objectives in light of the most important needs of appropriate stakeholders, given the context of the HIT implementation. Doing so will foster better utilization of scarce resources.

## Authors' contributions

All three authors contributed to the design of the study. The first author conducted the semi-structured interviews and analyzed the data. The authors interpreted the results together. IV and LL developed the assessment framework. All three wrote the paper as a team; all approved the final manuscript.

## Statement on conflict of interest

The authors declare that they have no conflict of interest.

**Summary points**

What was already known on the topic:

- IT investments in healthcare are greater than they have ever been.
- HITs are being presented as a means to improve productivity, quality of health and/or system efficiency.
- Current study results are however contradictory.
  - Some studies present HITs as a means to greater productivity and/or efficiency.
  - Other findings remain inconclusive. Some studies even show that HIT can be counter-productive.

What this study added to our knowledge:

- The productivity paradox and stakeholder theories can help making sense of the contradictions found in the extant literature.
- Our empirical study revealed that a wide range of impacts, the context of implementation, a multi-level approach and the various stakeholders' perspectives must be taken into account when assessing the value of HIT.
- By taking the different stakeholders into account and identifying the boundaries of an HIT implementation, our framework will help researchers and practitioners to better assess HIT impacts and, in turn, foster better utilization of scare resources.

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## Appendix A. Interview questions

**Initial Open-ended Questions**

- To begin with, could you describe the "story" of the clinical information system (CIS) project, from the time it was only an idea till it was actually implemented?
- Can you, from your personal experience, tell me more about your organization, the CIS implementation and its impacts?
- Could you please tell me, in your opinion, how the different stakeholder groups (physicians, nurses and administrators) experienced the CIS implementation?

**Prompts (used as needed to elicit additional insights)**

- How did you learn that a clinical information system would be implanted in the hospital?
- How did you react to this announcement?
- Have you been prepared/trained to use this system? If so, how?
- How have you experienced the first days of implantation?
- Were you satisfied with the system?
- Has the implementation of this system changed your work? If yes, how?
- Did you get any support from the organization?
- Has your perception of the system changed over time? In what way?
- Do you still use the system?
- How would you rate the system today?
- Would you be willing to go back to a "paper system"?
- Generally, how have your colleagues reacted to the news that a CIS would be implemented?
- How would you describe the way that your colleagues lived through the implementation of the system?
- Has the implementation/system been experienced similarly by the different stakeholder groups?

- In the presence of problems or conflicts, how have doctors/nurses/administrators reacted?
- Has the implantation of the system changed the way you work with doctors/nurses /administrators?
- Can you describe your hospital to me and explain "how it works"?
- How was the system selected and purchased?
- How was the system funded?
- How do you foresee the future?

**Conclusion**

This concludes the questions that we have planned to ask you today.

a. Is there anything else that you feel is important to mention relative to the CIS implementation?

b. Is there anything else we did not raise that you think is relevant to mention in the context of this study?

**Socio Demographic Questions**

This socio demographic information is being collected solely for the purpose of data analysis in the context of this study. This data will be kept anonymous and strictly confidential. Unless you explicitly allow us to do so, there will be no way to identify respondents.

1. Gender: ☐ Male ☐ Female
2. Age: ____
3. Profession / background: _____Since? _ _ _ _(yyyy)
4. Place of employment / industry? : _____Since? _ _ _ _(yyyy)
5. Position(s) occupied(s)? : _____

We thank you for your participation. Please note that the time you spent with us is much appreciated and that your comments are of great importance for the success of our study.

## REFERENCES


[1] J. Conn, Still taking small steps. IT spending to grow, but don't expect large increases, annual survey says, Mod. Healthc. 38 (8) (2008) S1–2.

[2] IDC Report. Western Europe Healthcare Sector IT Spending Forecast Update, 2007–2011. 2008 February 2008 Contract No.: #IDC04024.

[3] E.S. Berner, Implementation challenges for clinical and research information systems: recommendations from the 2007 Winter Symposium of the American College of Medical Informatics, J. Am. Med. Inform. Assoc. 15 (3) (2008) 281–282.

[4] P.M. Kilbridge, D.C. Classen, The informatics opportunities at the intersection of patient safety and clinical informatics, J. Am. Med. Inform. Assoc. 15 (4) (2008) 397–407.

[5] R. Meyer, P. Degoulet, Assessing the capital efficiency of healthcare information technologies investments: an econometric perspective, Yearb. Med. Inform. (2008) 114.

[6] R. Bodell, H.D. Covvey, C. Fader, Achieving a "Therapeutic Dose" of IT, Stud. Health Technol. Inform. 107 (Pt 2) (2004) 1348–1351.

[7] J. Sidorov, It ain't necessarily so: the electronic health record and the unlikely prospect of reducing health care costs, Health Aff. 25 (4) (2006) 1079–1085.

[8] J. Øvretveit, T. Scott, T.G. Rundall, S.M. Shortell, M. Brommels, Implementation of electronic medical records in hospitals: two case studies, Health Policy 84 (2–3) (2007) 181–190.

[9] Committee on Quality of Health Care in A, Institute of M. Crossing the Quality Chasm: A New Health System for the 21st Century, National Academy Press, Washington, DC, 2001.

[10] R. Koppel, J.P. Metlay, A. Cohen, B. Abaluck, A.R. Localio, S.E. Kimmel, B.L. Strom, Role of computerized physician order entry systems in facilitating medication errors, Am. Med. Assoc. (2005).
[11] R. Kaushal, A.K. Jha, C. Franz, J. Glaser, K.D. Shetty, T. Jaggi, B. Middleton, G.J. Kuperman, R. Khorasani, M. Tanasijevic, Return on investment for a computerized physician order entry system, J. Am. Med. Inform. Assoc. 13 (3) (2006) 261–266.
[12] C.L. Delpierre, J. Cuzin, M. Fillaux, P. Alvarez, Lang. Massip, A systematic review of computer-based patient record systems and quality of care: more randomized clinical trials or a broader approach? Int. J. Qual. Health Care 16 (5) (2004) 407–416.
[13] R.G. Berger, J.P. Kichak, Computerized physician order entry: helpful or harmful? J. Am. Med. Inform. Assoc. 11 (2) (2004) 100–103.
[14] R. Kaushal, K.G. Shojania, D.W. Bates, Effects of computerized physician order entry and clinical decision support systems on medication safety a systematic review, Arch. Intern. Med. 163 (12) (2003) 1409–1416.
[15] D. Bails, K. Clayton, K. Roy, M.N. Cantor, Implementing online medication reconciliation at a large academic medical center, J. Comm. J. Qual. Patient Saf. 34 (9) (2008) 499.
[16] M.F. Thouin, J.J. Hoffman, E.W. Ford, The effect of information technology investment on firm-level performance in the health care industry, Health Care Manage. Rev. 33 (1) (2008) 60.
[17] A.S. Kazley, Y.A. Ozcan, Do hospitals with electronic medical records (EMRs) provide higher quality care? An examination of three clinical conditions, Med. Care Res. Rev. 65 (4) (2008) 496.
[18] W.T. Lester, A.H. Zai, R.W. Grant, H.C. Chueh, Designing healthcare information technology to catalyse change in clinical care, Inform. Prim. Care. 16 (1) (2008) 9.
[19] B. Chaudry, W. Jerome, W. Shinyl, M. Margaret, M. Walter, R. Elizabeth, C.M. Sally, G.S. Paul, Systematic review: impact of health information technology on quality, efficiency, and costs of medical care, Ann. Intern. Med. 144 (2006) 742–752.
[20] D. Avison, T. Young, Time to rethink health care and ICT? Commun ACM 50 (6) (2007) 69–74.
[21] B. Kaplan, K. Harris-Salamone, Health IT Success and failure: recommendations from literature and an AMIA Workshop, J. Am. Med. Inform. Assoc. 16 (3) (2009) 291–299.
[22] D.A. Ludwick, J. Doucette, Adopting electronic medical records in primary care: lessons learned from health information systems implementation experience in seven countries, Int. J. Med. Inform. 78 (1) (2009) 22–31.
[23] L. Lapointe, S. Rivard, Clinical information systems: understanding and preventing their premature demise, Healthc. Q 8 (2) (2005) 92–100.
[24] E.M. Campbell, D.F. Sittig, J.S. Ash, K.P. Guappone, R.H. Dykstra, Types of unintended consequences related to computerized provider order entry, J. Am. Med. Inform. Assoc. 13 (5) (2006) 547–556.
[25] B. Demchak, W.G. Griswold, L.A. Lenert, Data quality for situational awareness during mass-casualty events, AMIA Annu. Symp. Proc. (2007) 176–180.
[26] R. Nolan, F.W. McFarlan, Information technology and the board of directors, Harv. Bus. Rev. 83 (10) (2005) 96.
[27] E. Brynjolfsson, The productivity paradox of information technology: review and assessment, Commun. ACM 36 (12) (1993) 67–77.
[28] R.E. Freeman, Strategic Management: A Stakeholder Approach, Pitman, Boston, 1984.
[29] M. Skouroliakou, G. Soloupis, A. Gounaris, A. Charitou, P. Papasarantopoulos, S.L. Markantonis, C. Golna, K. Souliotis, Data analysis of the benefits of an electronic registry of information in a neonatal intensive care unit in Greece, Perspect. Health. Inf. Manag. (2008) 5.
[30] J. Fairbank, G. Labianca, H. Steensma, R. Metters, Information processing design choices, strategy, and risk management performance, J. Manag. Inform. Syst. 23 (1) (2006) 293–319.
[31] A. Donati, V. Gabbanelli, S. Pantanetti, P. Carletti, T. Principi, B. Marini, S. Nataloni, G. Sambo, P. Pelaia, The impact of a clinical information system in an intensive care unit, J. Clin. Monit. Comput. 22 (1) (2008) 31–36.
[32] M. Reckmann, J. Westbrook, Y. Koh, C. Lo, R. Day, Does computerized provider order entry reduce prescribing errors for hospital inpatients? A systematic review, J. Am. Med. Inform. Assoc. 16 (5) (2009) 613–623.
[33] A. Schedlbauer, V. Prasad, C. Mulvaney, S. Phansalkar, W. Stanton, D.W. Bates, A.J. Avery, What evidence supports the use of computerized alerts and prompts to improve clinicians' prescribing behavior? J. Am. Med. Inform. Assoc. (2009).
[34] E. Ammenwerth, H.P. Spötl, The time needed for clinical documentation versus direct patient care, Methods Inf. Med. 48 (2009) 84–91.
[35] G.J. Kuperman, R.F. Gibson, Computer physician order entry: benefits, costs, and issues, Ann. Intern. Med. 139 (1) (2003) 31–39.
[36] A.S. Young, E. Chaney, R. Shoai, L. Bonner, A.N. Cohen, B. Doebbeling, D. Dorr, M.K. Goldstein, E. Kerr, P. Nichol, Information technology to support improved care for chronic illness, J. Gen. Intern. Med. 22 (2007) 425–430.
[37] A.X. Garg, N.K.J. Adhikari, H. McDonald, M.P. Rosas-Arellano, P.J. Devereaux, J. Beyene, J. Sam, R.B. Haynes, Effects of computerized clinical decision support systems on practitioner performance and patient outcomes a systematic review, JAMA 293 (10) (2005) 1223–1238.
[38] L. Magnusson, E. Hanson, M. Borg, A literature review study of information and communication technology as a support for frail older people living at home and their family carers, Technol. Disability 16 (4) (2004) 223–235.
[39] K. Horton, The use of telecare for people with chronic obstructive pulmonary disease: implications for management, J. Nurs. Manag. 16 (2) (2008) 173.
[40] J.S. Ash, M. Berg, E. Coiera, Some unintended consequences of information technology in health care: the nature of patient care information system-related errors, J. Am. Med. Inform. Assoc. 11 (2) (2004) 104–112.
[41] S.J. Wang, B. Middleton, L.A. Prosser, C.G. Bardon, C.D. Spurr, P.J. Carchidi, A.F. Kittler, R.C. Goldszer, D.G. Fairchild, A.J. Sussman, A cost–benefit analysis of electronic medical records in primary care, Am. J. Med. 114 (5) (2003) 397–403.
[42] N. Menachemi, R.G. Brooks, Reviewing the benefits and costs of electronic health records and associated patient safety technologies, J. Med. Syst. 30 (3) (2006) 159–168.
[43] R. Mador, N. Shaw, The impact of a Critical Care Information System (CCIS) on time spent charting and in direct patient care by staff in the ICU: a review of the literature, Int. J. Med. Inform. 78 (7) (2009) 435–445.
[44] M.J. Ball, C. Weaver, P.A. Abbott, Enabling technologies promise to revitalize the role of nursing in an era of patient safety, Int. J. Med. Inform. 69 (1) (2003) 29–38.
[45] A. Georgiou, J. Westbrook, Clinician reports of the impact of electronic ordering on an emergency department, Stud. Health. Technol. Inform. 150 (2009) 678–682.
[46] M. Ballermann, N. Shaw, K. Arbeau, D. Mayes, R. Noel Gibney (Eds.), Impact of a Critical Care Clinical Information System on Interruption Rates During Intensive Care Nurse and Physician Documentation Tasks, 160, Medinfo, 2010, pp. 274–278.

[47] M. Prgomet, A. Georgiou, J. Westbrook, The impact of mobile handheld technology on hospital physicians' work practices and patient care: a systematic review, J. Am. Med. Inform. Assoc. 16 (6) (2009) 792–801.
[48] M.A. Hebert, Impact of IT on health care professionals: changes in work and the productivity paradox, Health Serv. Manage. Res. 11 (2) (1998) 69.
[49] Z. Nagykaldi, J.W. Mold, The Role of Health Information Technology in the Translation of Research into Practice: an Oklahoma Physicians Resource/Research Network (OKPRN) Study, J. Am. Board Fam. Med. 20 (2) (2007) 188.
[50] J.T. Scott, T.G. Rundall, T.M. Vogt, J. Hsu, Kaiser Permanente's experience of implementing an electronic medical record: a qualitative study, Br. Med. J. 331 (7528) (2005) 1313–1316.
[51] E. Brynjolfsson, L.M. Hitt, Beyond the productivity paradox, Commun. ACM 41 (8) (1998) 49–55.
[52] P. Attwell, Technology and the productivity paradox, in: D.H. Harris (Ed.), Organizational linkages: understanding the productivity paradox., National Academy Press, Washington, 2003.
[53] S. Dewan, K.L. Kraemer, International dimensions of the productivity paradox, Commun. ACM 41 (8) (1998) 56–62.
[54] N. Carr, It doesn't matter, Harv. Bus. Rev. 81 (5) (May 2003).
[55] M.E. Thatcher, D.E. Pingry, Modeling the IT value paradox, Commun. ACM 50 (8) (2007) 41–45.
[56] M.E. Frisse, Comments on Return on Investment (ROI) as it applies to clinical systems, J. Am. Med. Inform. Assoc. 13 (3) (2006) 365–367.
[57] R.A. McNutt, R. Abrams, D.C. Aron, Patient safety efforts should focus on medical errors, Am. Med. Assoc. (2002).
[58] J.M. Rothschild, E. Fang, V. Liu, I. Litvak, C. Yoon, D.W. Bates, Use and perceived benefits of handheld computer-based clinical references, J. Am. Med. Inform. Assoc. 13 (6) (2006) 619–626.
[59] P.K. Lindenauer, D. Ling, P.S. Pekow, A. Crawford, D. Naglieri-Prescod, N. Hoople, J. Fitzgerald, E.M. Benjamin, Physician characteristics, attitudes, and use of computerized order entry, J. Hosp. Med. 1 (4) (2006).
[60] P.P.M. Harteloh, Quality systems in health care: a sociotechnical approach, Health Policy 64 (3) (2003) 391–398.
[61] B. Kaplan, N. Shaw, Future directions in evaluation research: people, organizational, and social issues, Methods Inf. Med. 43 (3) (2004) 215–231.
[62] B. Dehning, K.E. Dow, T. Stratopoulos, Information technology and organizational slack, Int. J. Acc. Inf. Sys. 5 (1) (2004) 51–63.
[63] T. Stratopoulos, B. Dehning, Does successful investment in information technology solve the productivity paradox? Inform. Manage. 38 (2) (2000) 103–117.
[64] Aspects of the stakeholder concept and their implications for information systems development, in: A. Pouloudi (Ed.), Proceedings of the Thirty-second Hawaii International Conference on Systems Sciences (HICSS-32), Maui, HI, 1999.
[65] R. Vidgen, Stakeholders, soft systems and technology: separation and mediation in the analysis of information system requirements, Inform. Syst. J. 7 (1) (1997) 21–46.
[66] D.E. Burke, N. Menachemi, Opening the black box: measuring hospital information technology capability, Health Care. Manage. Rev. 29 (3) (2004) 207–217.
[67] G. Geiger, Y.D. Derman, Methodology for evaluating physician order entry (POE) implementations, J. Eval. Clin. Pract. 9 (4) (2003) 401.
[68] A. Grant, I. Plante, F. Leblanc, The TEAM methodology for the evaluation of information systems in biomedicine, Comput. Biol. Med. 32 (3) (2002) 195–207.
[69] A. Kazanjian, C.J. Green, Beyond effectiveness: the evaluation of information systems using a comprehensive health technology assessment framework, Comput. Biol. Med. 32 (3) (2002) 165–177.
[70] S.S. Lyons, T. Tripp-Reimer, B.A. Sorofman, J.E. DeWitt, B.J. BootsMiller, T.E. Vaughn, B.N. Doebbeling, VA QUERI informatics paper Information technology for clinical guideline implementation: Perceptions of multidisciplinary stakeholders, J. Am. Med. Inform. Assoc. 12 (1) (2005) 64–71.
[71] M.J. Gilmartin, R.E. Freeman, Business ethics and health care: a stakeholder perspective, Health Care Manage. Rev. 27 (2) (2002) 52.
[72] R.R. Panko, Is office productivity stagnant? MIS Quart. (1991) 191–203.
[73] K.M. Eisenhardt, Building theories from case study research, Acad. Manage. Rev. 14 (4) (1989) 532–550.
[74] L. Lapointe, S. Rivard, A triple take on information system implementation, Organ Sci. 18 (1) (2007) 89.
[75] L. Lapointe, S. Rivard, A multilevel model of resistance to information technology implementation, MIS Quart. 29 (3) (2005) 461–491.
[76] L. Lapointe, S. Rivard, When good systems go bad: understanding and preventing their premature demise, Healthc. Q 8 (2) (2005) 92–100.
[77] L. Lapointe, S. Rivard, Learning from physicians' resistance to CIS implementation, CMAJ 174 (11) (2006) 1573–1584.
[78] B.F. Crabtree, W.L. Miller (Eds.), Doing Qualitative Research, Sage, Newbury Park, CA, 1992.
[79] M.Q. Patton, Qualitative Research and Evaluation Methods, 3rd ed., Sage, Thousand Oaks, CA, 2002.
[80] B.G. Glaser, A. Strauss, The Discovery of Grounded Theory: Strategies for Qualitative Research, Aldine Publishing Company, Chicago, 1967.
[81] A. Strauss, J. Corbin, Basics of Qualitative Research: Grounded Theory Procedures and Techniques, Sage, Newbury Park, 1990.
[82] M.B. Miles, M. Huberman, Qualitative Data Analysis: An Expanded Sourcebook, second ed., Sage Publications, Inc., 1994.
[83] J.J. Cimino, V.L. Patel, A.W. Kushniruk, The patient clinical information system (PatCIS): technical solutions for and experience with giving patients access to their electronic medical records, Int. J. Med. Inform. 68 (1–3) (2002) 113–127.
[84] D. Morin, A. Tourigny, D. Pelletier, L. Robichaud, L. Mathieu, A. Vézina, L. Bonin, M. Buteau, Seniors'views on the use of electronic health records, Inform. Prim. Care. 13 (2) (2005) 125.
[85] S. Ornstein, A. Bearden, Patient perspectives on computer-based medical records, J. Fam. Pract. 38 (6) (1994) 606–610.
[86] C.M. DesRoches, E.G. Campbell, S.R. Rao, K. Donelan, T.G. Ferris, A. Jha, R. Kaushal, D.E. Levy, S. Rosenbaum, A.E. Shields, Electronic health records in ambulatory care—a national survey of physicians, N. Engl. J. Med. 359 (1) (2008) 50.
[87] A qualitative analysis of academic and private physicians and administrators' perceptions of health information technology, in: L. Grabenbauer, R.S. Fraser-Maginn, J.C. McClay, J.R. Windle (Eds.), Proceedings of the AMIA Annual Symposium, 2007, p. 965.
[88] D. Stengel, K. Bauwens, M. Walter, T. Kopfer, A. Ekkernkamp, Comparison of handheld computer-assisted and conventional paper chart documentation of medical records a randomized, controlled trial, J. Bone Joint Surg. 86 (3) (2004) 553–560.
[89] J.S. Simon, T.G. Rundall, S.M. Shortell, Adoption of order entry with decision support for chronic care by physician organizations, J. Am. Med. Inform. Assoc. 14 (4) (2007) 432–439.
[90] J. Glaser, J. Stone, Effective use of business intelligence, Healthc. Financ. Manage. 62 (2) (2008) 68.