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Voice over Internet Protocol (VoIP) in the Emergency Department (ED): A Process Innovation

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Abstract

The purpose of this research in progress is to empirically test whether VoIP communications in the ED decrease the overall time it takes to see and treat a patient. We are reengineering the business process of Disposition Communication. Business Process Reengineering or Redesign (BPR) literature suggests that redesign projects involving IT do not usually deliver successful results (Mitchell and Zmud, 1999). Caccia-Bava et al. (2005) suggest that there adding value and technology fit are two often neglected, yet very important factors that healthcare leaders must address when streamlining a process. These two factors relate directly to the process redesign and information technology elements in Mitchell and Zmud's model. We use a single group experimental design (pre-treatment, treatment, post-treatment) and t-tests to evaluate differences in time data relating to the Disposition Communication Event. We manipulate the method in which doctors communicate and test for decreases in time and increases in throughput.

Keywords: Healthcare, Business Process Redesign, Voice over Internet Protocol, Emergency Department, patient flow, wait times.
1. Introduction

1.1 Context

Healthcare providers understand that it is critical for patients with injuries or illnesses involving loss of life, limb or eyesight to be seen and treated very quickly. The first moments for these patients are considered “golden” in medicine. It has been shown that patients who are seen and treated during this initial period are far more likely to have favorable outcomes than those who are not. Nowhere is the need for timely patient care better understood than in Emergency Medicine.

Despite the need to see and treat patients quickly, visits to the ED are not usually speedy for a variety of reasons. Not all patients who show up to the ED need emergency care (Field and Lantz, 2006). Emergency Departments suffer from overcrowding and scarce resources and most patients in the ED experience long, uncomfortable wait times (Rondeau et al., 2005). Physicians, nurses and staff in the ED work in an environment of managed chaos riddled with constant interruptions (France et al., 2005). One of the biggest problems in this loud, chaotic, time sensitive environment is person-to-person communication. Delayed communication among staff members that would expedite the treatment and disposition of a patient introduces additional waiting time for both doctors and patients.

1.2 Purpose of Research

The use of Information Technology (IT) in healthcare has been well documented and researched (Currie and Guah, 2006). Computer-based medical equipment, dynamic hospital websites, e-mail, automated systems that manage the patient encounter, and the electronic patient record are all initiatives seen in many of today’s hospitals. Healthcare leaders have pursued these IT initiatives since the late 1980s, to improve the quality of care for patients. These systems attempt to manage, store and transfer healthcare-oriented text and image data, to battle data quality and retrieval issues and make processes more efficient (Mahaffey, 2004 and Lin and Umoh, 2002). In many cases, these IT solutions have greatly improved healthcare delivery and created a higher quality experience for both patients and providers.

Interestingly, many of the business processes involving voice data still use standard telephones and pagers. These technologies are not as dynamic as emerging voice technologies. They often involve bigger and bulkier devices. They are slower to respond and involve multiple, redundant steps (such as paging someone and waiting for a call-back response). And they do not integrate well into new, emerging infrastructure.

Forward thinking facilities are attempting to apply emerging voice technology initiatives to the healthcare arena in hopes of reducing interruptions, decreasing noise levels (Baevsky and Smithline, 2004), and facilitating speedy treatment and disposition of patients (Mahaffey, 2004). One such hospital, Riverside Methodist in Columbus, Ohio, operates a, “wearable, push-button communication system,” (Walsh and Yamarick, 2005) in their ED. A VoIP device is built into the identification badge worn by each staff member. The badges operate over the hospital’s existing wireless network and give each staff member real-time access to anyone on the network. While leaders at Riverside report that the system creates the efficiencies previously mentioned, the use of the VoIP devices to reengineer communication business processes has not been empirically tested in the healthcare environment.

While there are certainly other technologies available, we consider only the use of VoIP for our particular needs based on reports from other facilities using it and the intuitive fit of the technology which we discuss at length in this paper.

While the use of VoIP solutions has been researched in many arenas, including providing Emergency Services (Lookabaugh et al., 2006), the specific use of VoIP in an ED has not been academically researched. The purpose of this research is to explore this gap and empirically test if we can improve patient care in the ED by redesigning communication processes using this emerging technology. Specifically, we pose the question; can we reduce the time for routine communication events in the ED? Further, if we achieve a significant time reduction, will this decrease patient wait time and/or increase throughput? Results of these tests could have obvious academic and practical implications.
2. Formulation of the Research

2.1 Description of the Research Problem

This research takes place at one of the Army’s largest and busiest Emergency Departments. The ED is part of an Army Medical Center that serves as a Level 1 Trauma facility for a major metropolitan area. This paper represents the initial efforts of an ongoing, larger research project. The ED is a dynamic environment full of many processes; in the spirit of parsimony, we will focus on just one. We generalize that if VoIP communication can reduce the time for this process, it may reduce the time for other processes as well. The specific communication event of interest involves the disposition of a patient. When a patient in the ED is ready to either be admitted, or when an outside department needs to be consulted, it generates a communication event. The attending physician must consult with a physician from another department. The consulting physician will admit the patient to the hospital or provide information necessary before the disposition can take place. We refer to this event as the “Disposition Communication Event”.

Currently, the AS IS Disposition Communication Event involves the following process (Figure 1). First, the attending physician tells the clerk to page the consulting physician. The clerk places the page. The consulting physician returns the page and calls the clerk. The clerk then alerts the attending to come back to the phone. The attending physician and the consulting physician then talk on the phone.

We will sample the AS IS Disposition Communication Events across different shifts, different times of day and week, and different doctors and gather times as a baseline. We believe this will give us a representative sample to the type of events generated during average work time. We believe we will need around 80 events to achieve statistical significance during data analysis.

2.2 Explanation of the Treatment

We then plan to introduce VoIP devices, provided by Cisco, and train the staff on a new TO BE protocol. The attending physicians, consultants, and other players will be outfitted with VoIP devices. Because the devices and processes currently in use are far more complicated than the single push-button VoIP devices we will introduce, we do not anticipate major learning curve issues with training.

The TO BE protocol (Figure 2) is much less involved than the AS IS. The Attending Physician calls the Consultant with the VoIP device and the two doctors talk directly.
The players and steps eliminated by the TO BE Disposition Communication Event do not have to be replaced. This new protocol eliminates any non value adding steps and people. While the critic might argue that there will still be conflicts, interruptions, or times when the consulting physician gets a call and is busy. We point out that this is a self correcting problem. All of the conflicts present in the TO BE protocol were also present in the AS IS. We are simply eliminating the non value adding parts of the protocol over which we have control.

We will sample these events in the same manner as we did for the AS IS protocol and gather times. We will then compare times for the TO BE process with the AS IS process times to see if there is a treatment effect.

2.3 Research Questions

We are interested in four main dynamics of time savings. Primarily we are interested to see if we can affect the time it takes to complete the Disposition Communication Event with the new protocol. Next, we are interested in the overall treatment effect of the TO BE protocol on service time in the ED. We define service time as the overall time, from sign-in to disposition, a patient is in the ED. This would show improved efficiency in internal communication within the ED and between the ED and other hospital departments. Because patients are the focus of healthcare, we are also interested in the effects this new protocol may have on waiting time. We define waiting time as the amount of time, after signing in, that a patient waits to be seen by a doctor in the ED. Finally, we are interested in number of patients affected. Hospitals are compensated in many ways based on the amount of patients they can safely see and treat. In basic terms, more patients are better. We will test to see if this protocol allows the ED to see more patients. We define throughput as the number of patients who receive a disposition in a given amount of time.

RQ1: Does the TO BE communication protocol decrease the time for a Disposition Communication Event?
RQ2: Does the TO BE communication protocol decrease service time during an ED visit?
RQ3: Does the TO BE communication protocol decrease the wait time for patients in the ED?
RQ4: Does the TO BE communication protocol increase patient throughput for the ED?

2.4 Hypotheses

Based on VoIP literature and reports from facilities currently using these systems (Walsh and Yamarick, 2005), we hypothesize that the TO BE protocol will have the desired effect of improving both the time it takes to complete a Disposition Communication Event and the overall service time in the ED. We contend this effect will show that we can service patients faster with the TO BE protocol. Further, we contend that the faster we can service a patient while in the ED, the faster a patient in the waiting room will be seen. This will decrease patient waiting time. If we are servicing patients quicker and patients are being seen sooner, then we believe that we will be able to process more patients in the same amount of time. This should increase throughput. While there are undoubtedly constraints in the admission and disposition process that lie outside the ED, we anticipate that greater efficiency in the ED will lead to greater efficiency in the entire process of seeing patients.
H1: The TO BE communication protocol will significantly decrease the time for a Disposition Communication Event in the ED.

H2: The TO BE communication protocol will significantly decrease the overall service time for an ED visit.

H3: The TO BE communication protocol will significantly decrease ED patients’ wait times.

H4: The TO BE communication protocol will significantly increase patient throughput.

3. Background and Literature Review

3.1 Theoretical Framework

Reengineering a business process like the Disposition Communication Event seems easy enough to understand. Our underlying theory, Business Process Reengineering or Redesign (BPR), at its most basic, is coming up with a new way to conduct a business process. However, the literature suggests that redesign projects, especially ones involving IT, do not usually deliver successful results (Mitchell and Zmud, 1999). The literature explains that poor planning, fit and execution are among the key reasons for redesign project failure (Mitchell and Zmud, 1999). This section addresses the theoretical framework we believe is at the core of this redesign research.

BPR literature identifies many different methods and strategies for process redesign. The one that best fits our project is referred to as a Process Innovation. This framework views, “the organization as an open system whose interdependent parts or subsystems evolve in response to environmental conditions;” (Mitchell and Zmud, 1999). It describes redesign as, “organizational adaptations that meld two distinct yet related subsystems: a new business process and an evolving IT infrastructure,” (Mitchell and Zmud, 1999).

Mitchell and Zmud (1999) present a model to explain how these two key factors (business process and technology) create a Process Innovation and subsequently affect project performance outcomes. While our research does not focus on strategy types or styles, as does Mitchell and Zmud’s, we submit that a modified version of their model is helpful in understanding the theoretical framework involved in redesigning the Disposition Communication Event. Figure 3 shows that an organization’s process redesign, coupled with a specific IT, creates a Process Innovation and the coupling drives project performance. In basic terms, the way we plan to redesign a process, coupled with the technology we use, will directly affect a Process Innovation and lead to successes or failures.

Figure 3. Theoretical Elements of Process Innovation
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Our research project attempts to manipulate both the design and the technology involved with the Disposition Communication Event (our TO BE protocol). We contend that this Process Innovation will lead to the already mentioned performance outcomes of reduced times and increased throughput.

3.2 Analysis of Related Work

While we have found no academic research involving VoIP to reduce service time in an ED, using IT to streamline or reengineer a healthcare business process is not a new idea. Efforts to identify emerging technology and exploit IT in healthcare have been ongoing since the 1980s. This section applies Mitchell and Zmud’s theoretical model for process innovation to the healthcare arena specifically. We also review the literature to show how this redesign adds value to the patient care process and how VoIP is the right fit for communication in the ED.

Recent research suggests that successfully reengineering a healthcare business process and exploiting technology relies on some often neglected factors. Caccia-Bava et al. (2005) suggest, “the value-added element of every business activity, and applying the right innovative technology,” are often neglected, yet very important factors that healthcare leaders must address when streamlining a process. Interestingly, these two factors relate directly to the two key elements in Mitchell and Zmud’s model. The value added element of the business activity drives the process redesign and applying the right technology drives the selection of a specific IT. Figure 4 integrates these two questions at the coupling of process design and IT; answering them correctly leads to a more successful Process Innovation. We submit that this research attempts to manipulate the value-added elements of the business activity and that VoIP is the right innovative technology for the ED.

![Figure 4. Theoretical Elements of Process Innovation with Questions](image)

The introduction of these two new questions should not confuse the issue. These are not new research questions. We believe adding these questions to the model may lead to a better outcome for our particular Process Innovation. Also, since no research has been done on our specific area, we use these two questions to frame up our review of the literature. We present a relevant review of the existing literature by attempting to answer these two questions.

3.3 Does this Redesign Add Value to the Business Activity?

Communicating in the ED is necessary, but it creates many non-value-added byproducts. A recent study listed phone calls among the most important communication tasks in the ED, but also listed face-to-face communication, pages, phone calls, and equipment malfunctions (like telephones) as significant sources of interruptions for physicians in the ED (France et al., 2005). The value in the Disposition Communication Event is achieved when the attending physician and the consulting physician talk directly. All other steps and the time they take up are non-value added parts of the process.
While the direct value in making this process more efficient is apparent, there is some less obvious second and third order value as well. Although they see healthcare delivery from two different perspectives, both patients and healthcare providers perceive timeliness and streamlined communication processes as indicators of a quality healthcare experience. By this rationale, making a communication process more efficient and reducing wait times would add perceived value to the business activity.

Patients list long wait times in the ED as a leading cause for them leaving the hospital without being seen by a physician (Monzon et al., 2004 and McMullin and Veser, 2004). Leaving without being seen is a source of great personal and professional liability for patients and providers respectively (Monzon et al., 2004). Further, 76% of patients in a recent Canadian study expected ED staff to update them every 30 minutes and they expected that critical patients should be seen within 1 hour (Cooke et al., 2006). The current average ED wait time at around 8 hours. This clearly indicates that patients view efficient communication systems and reduced wait times as indicators of quality healthcare delivery.

When patients think of overcrowding in the ED, they are likely to picture a crowded waiting room. Providers define overcrowding as a, “situation where patients in the ED requiring inpatient care are unable to gain access to appropriate hospital beds within a reasonable time frame,” (Rondeau et al., 2005). Overcrowding and scarce resources are among the biggest issues facing ED providers and staff (Rondeau et. al., 2005). Providers and staff keep patients flowing through the ED by achieving appropriate admissions and dispositions in a timely manner and freeing up bed space for new patients.

Clearly, ED providers value efficient systems. In fact, ED staffs describe, “excellence in patient care processes and systems” as essential elements of a healthy workplace (Parsons et al., 2005).

For these reasons, we believe that a process redesign involving fewer steps and less overall time will add both real and perceived value to the business activity and the overall business process.

**3.4 Is VoIP the Right Innovative Technology?**

There are numerous references in healthcare literature to wireless networks, VoIP, and devices like SmartPhones. These technologies are referred to as either, “state of the art” or, “the future” in healthcare trends (Baevsky and Smithline, 2004; Currie and Guah, 2006; France et al., 2005; Lin and Umoh, 2002; Mahaffey, 2004; Shohet and Lavy, 2004; Simpson, 1995; Simpson, 2003; and Walsh and Yamarick, 2005). Notification and messaging are listed among the top uses and benefits of emerging health care technologies (Simpson, 2004). “Wireless communications”, “universal mobile telecommunications service”, and “third-generation broadband systems that transmit text, voice, video, and other multimedia” are also identified as trends in new technology in mobile healthcare (Simpson, 2004). The trend of “pervasive computing” has even been characterized by, “Tiny (even invisible) apparatuses, which can be either mobile or embedded in almost any type of object imaginable—including medical devices—that communicate through increasingly interconnected networks,” (Simpson, 2004). These future trends, systems and devices describe the VoIP devices and system we will employ in our research.

Technically, VoIP is not just an “IP version of telecom-as-usual” (Ahuja and Ensor, 2004). VoIP does not treat voice data with the standard Public Switched Telephone Network (PSTN) telephony paradigm. Instead, VoIP handles voice data with a burst communication or packed switching methodology. This can be achieved at low to no cost over existing packet switched networks (like the Internet), using existing servers, without the need for switchboard operators. Controls for managing the communication are with the end user rather that at some centralized telephone switch. This results in an inexpensive, efficient, and locally configurable method to rapidly deliver and manage voice communication (Ahuja and Ensor, 2004).

The two major problems with VoIP services are Emergency Service integration and Security (Lookabaugh et al., 2006). These negative issues associated with VoIP communication do not seem to apply to the ED scenario. Companies (like Vonage, Time Warner, and AT&T) wishing to provide VoIP services to the masses face these particular issues (Graham and Ure, 2005). Because VoIP uses IP rather than PSTN, providers are not yet required by law to include 911 or emergency numbers as part of their phone service. VoIP service providers have to tackle this integration issue to make their service competitive with local phone services.

There is also a great potential for a specific type of Spam called SPIT, Spam over Internet Telephony. SPIT consists of digitally recorded messages (usually advertisements) delivered to members of a network who did not solicit the messages. Because VoIP runs over a packet switched network, hackers can access VoIP devices or voice mailboxes and deliver these unwanted advertisements or messages (Graham and Ure, 2005).
Again, these known issues with VoIP do not apply to using the technology in the ED. There is no requirement for Emergency Service integration. SPIT or other security issues are already addressed as the VoIP system will run over the hospital’s existing intranet, which is already secured by the hospital’s IT department. Reducing the impact of the known problems with VoIP allows the ED to capitalize on the obvious benefits of using this technology.

4. Research Approach and Methodology

We use a single group experimental design (pre-treatment, treatment, post-treatment) and t-tests to evaluate differences in data relating to the Disposition Communication Event. Pre-treatment, we gather time data for 80 Disposition Communication Events using the AS IS protocol. We then manipulate the independent variable (protocol) by introducing the TO BE protocol for communication. Post-treatment, we gather time data for 80 Disposition Communication Events using the TO BE protocol. For each of our hypotheses, we conduct one-tailed t-tests with alpha = .05 to see if there is a treatment effect on our dependant variables, (time for H1-H3, and number of patients seen for H4).

For H1 we test to see if the overall times for the Disposition Communication Events are shorter post-treatment. For H2, we use data archived in the hospital’s database, to test if the average service time (total time a patient is in the ED) is shorter post-treatment. For H3, we again use archived data to test if wait times (a subset of overall service time) are shorter post-treatment. For H4, we use archived data to see if the average number of patients seen (throughput) goes up post-treatment.

5. Expected Results, Limitations, and Conclusion

5.1 Initial Data Collection

We have received our approved protocol from IRB and are ready to begin collecting data. We anticipate data collection to run for the next three months. Data collection should be complete by mid June and we should have actual results to report by August. To illustrate our expected results we calculated potential time saving based on our intuitive projections. This section only addresses RQ1/H1.

We have collected a sample of convenience of Disposition Communication Events, using the AS IS protocol (n=30) to generate a list of possible outcomes. The average time for these events is approximately 8 minutes per event (x=7.94) with a Standard Deviation of 4.75 minutes. We create a second notional sample by subtracting 2 minutes from each of our 30 gathered times (around half of one standard deviation). We then evaluate the notional sample against our collected sample to see if there would be a statistically significant difference. We conduct a one-tailed t test with α = 0.05 and df = 58. With these notional values we see a significant difference in the two sets of times (p<0.05). We can reject the null hypothesis. We know that there are approximately 16 Disposition Communication Events during an average 8 hour shift. There are 3 shifts per day. This gives us 48 Disposition Communication Events per day. With a 2 minute saving per event, we would save 1.6 hours a day or 11.2 hours per week. A Full Time Equivalent (FTE) physician works 40 hours per week. This equates to around a third of an FTE in time savings alone. So, not only would a time savings of 2 minutes per event seem conservatively achievable, it would also be a statistically and practically significant time savings to the ED staff as well.

Results for RQ2, RQ3, RQ4, H2, H3 and H4 should follow the same rational and calculations, but explanations may be different. Figure 5 shows the possible constraints in the patient flow process. RQ1 and H1 only address the specific time for the protocol. RQ2 and H2 address the overall internal processes in the ED. Making these processes have fewer steps and take less time should make them more efficient and should directly affect any constraints in the ED proper. But this only directly affects things in the ED. If other constraints do not exist, making the internal ED processes more efficient should lead to a reduction in wait times for patients in the waiting room (RQ3 and H3). If other constraints do not exist, more efficient ED processes should also improve throughput of patients to other hospital areas (RQ4 and H4). The issue here is that there are likely constraints in other areas outside the ED which may constrain the wait times and throughput regardless of how efficient our internal ED processes are. Our study will capture and recognize this because we are collecting time data at each step in the process. Results that support H1 and H2, but not H3, or H4 would show that there are constraints elsewhere in the system. It would be practically significant to know that even after making internal processes better in the ED, there is
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something else causing long wait times or decreased throughput. This could serve as a starting point for future academic research and also as a practical guide for hospital leaders to make resource allocation decisions.

Figure 5. Constraint Areas by Research Question and Hypothesis

5.2 Contributions

This research may very well show ED providers how to leverage a low cost solution and improve healthcare delivery using the resources over which they have direct control. It may also pin-point other areas in the hospital where constraints exist. Hospital leadership could use this information to make staffing and other operational decisions. Theoretically, this research could add credence to presented Process Innovation framework. It may also identify efficiencies achieved by VoIP systems that cannot be achieved by other less robust technology.

5.3 Limitations

This research is based on a single ED and there are elements of action research at work. The research initiative was developed and is led by Emergency Medicine Physicians. The research takes place at an Army Medical Center; the findings may not generalize to civilian for-profit or not-for-profit hospitals or Emergency Departments.

5.4 Conclusion

We are enthusiastic that our attempts at process redesign will both add value to the business activity and employ the right new technology. We are hopeful that this project will result in a more productive work environment for providers and staff, and that it will lead to greater access to quality healthcare for patients.
References


