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Research-in-Progress

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Abstract

Communication problems among healthcare professionals are known to adversely affect patient care. Web-based healthcare messaging systems (WMS) are seen as a means to improve communication. However, power imbalances among healthcare professionals may affect their communication and WMS use. In this study, we aim to understand how power relations affect WMS usage patterns. The hypotheses are tested through content analysis of over 70,000 WMS messages exchanged through a hospital WMS. We find that powerful parties (physicians) send a greater proportion of conflict resolution messages to weaker parties (administrative staff members and nurses) by WMS than vice versa. Weaker parties send higher proportion of coordination messages to physicians than vice versa. Hospital staff members send higher proportion of relationship development messages to colleagues as compared to other parties. Juniority of physicians is positively related to the number of information gathering messages from nurses. The expected contributions and remaining research plan are outlined.

Keywords: Computer-mediated communication (CMC), health informatics/health information systems/medical IS, human factors, content analysis, IS use

Introduction

Communication and coordination problems among healthcare professionals are known to adversely affect patient care in a hospital. Previous studies indicate that over 70% of medical events resulting in death or injury can be attributed to such issues (Leonard et al. 2004). However, despite reports suggesting that information systems could help improve the situation (Runyon et al. 2009), hospitals have been slow in adopting newer technologies such as messaging systems to mitigate these problems. For example, 65% of physicians reported still using numerical pagers (and not other more advanced communication devices) as their primary mode of communication (Soto et al. 2006).

Nevertheless, awareness is increasing on the use of more advanced messaging systems to support timely communication among healthcare workers. For example, Poon et al. (2002) described a system that allows laboratory staff to expedite the notification of critical results (e.g., blood tests) to physicians via alphanumeric pagers. Although alphanumeric pagers indicate an improvement over numerical pagers, today's technology allows more efficient communication using SMS (Scornavacca et al. 2009).

As a further advancement, Web-based Healthcare Messaging Systems (WMS) have been emerging in the last few years. Such systems allow users to send messages through a web portal which are received through the same web portal or through other means such as SMS (e.g., Cheng et al. 2009). WMS offers users several advantages including the ability to engage in unidirectional communication and to contact others in a non-intrusive way (Runyon et al. 2009). However, it is a relatively new technology that has yet to see widespread adoption in hospitals. Thus, research is needed in this area to investigate and understand the usage of WMS in hospitals.

Further, most previous studies on healthcare messaging systems were in the medical informatics domain and tend to be descriptive in nature without a theoretical foundation to predict and explain observed patterns of use (Guerrero et al. 2009; Nguyen et al. 2006). This has led researchers to comment that in the context of healthcare systems, *"better person-to-person models are needed to understand how the collegiate and interpersonal elements of care delivery could be embodied better in [healthcare]"* (Avison and Young 2007, p. 73). Other researchers have called for studies to understand the impact of messaging systems for physicians and nurses (Karpati et al. 2009). While such systems are intended to improve communication and coordination among physicians and other healthcare workers such as nurses (Coiera 2006), it is not clear if systems are used appropriately by the different parties (physicians, nurses, and others) and whether they are used for other purposes besides communication and coordination related to patient care. Hence, while new technologies such as WMS have the potential to improve communication, it is important to investigate the purposes that various parties are using WMS for.

We also note that there are power imbalances between nurses and physicians, and among physicians, which may affect their communication and have negative effects on patient care (Mantzoukas and Jasper 2004). For example, residents (junior physicians) are sometimes hesitant to raise concerns to their attending (senior) physician in fear of appearing incompetent (Sutcliffe et al. 2004). In one case, although the resident was against the attending physician's plan, he failed to raise it with his superior. As a result, the patient *"survived with serious complications"* (Sutcliffe et al. 2004, p. 189). Additionally, what is perceived as important by nurses may not be so in the view of the physicians. For example, physicians sometimes do not share nurse's views on the urgency of certain reports which are mandated by nursing regulations (e.g., weight loss reports) (Reynolds 2004). Not surprisingly, it has been observed that physicians and nurses sometimes clash over issues related to patient management and treatment plans (Henneman 2007; LeTourneau 2004). Power imbalances among healthcare professionals may affect the usage of WMS adversely. For example, powerful parties may make use of WMS to exert their power through certain kinds of messages (e.g., reprimand the subordinate) while not using the system for other kinds of messages that are more appropriate (e.g., rectify the problem).

In light of the power imbalances in the healthcare context, we will investigate the effects of power relationships on communication through WMS. Specifically, we aim to understand to what extent powerful and weaker parties use WMS to communicate different kinds of messages. We consider physicians as powerful individuals, while administrative staff members and nurses are considered as the weaker parties. Our study attempts to address the following research questions "RQ1: What are the usage patterns of WMS for the various parties for different kinds of messages? RQ2: How do power relationships affect these usage patterns of WMS?" Our study will make use of actual usage of WMS data instead of self reported usage. Data for this study was obtained from a hospital that implemented a WMS. The data was analyzed based on the message content. Findings from this study can help us

understand the actual usage of WMS by various parties for different purposes and also how power relationships in a hospital may affect the usage of WMS.

Conceptual Background

Power Relationships

The increased education of healthcare workers has changed what nurses used to do in a hospital. However, despite regulations governing the enhanced role of a nurse, researchers still report a perceived power imbalance between physicians and nurses (e.g., Mantzoukas and Jasper 2004). Specifically, nurses are known to view their judgment of patient care as inferior to that of the physician and as a result, *"the nurse's area of practice was totally dependent on physician orders"* (Jones 1994, p. 40). As discussed above, power imbalance is also evident among junior and senior physicians (Sutcliffe et al. 2004), where power is defined structurally as focusing on "*authority, information, and expertise as bases of power"* (Bradshaw-Camball and Murray 1991, p. 383).

In IS research, the concept of power has been applied to understand various topics such as trust in virtual teams (Panteli and Tucker 2009), negotiation (Thompson et al. 2010), organizational learning (Lawrence et al. 2005) and information technology governance (Yajiong et al. 2008). Power relationships also affect the usage of communication systems. For example, Jasperson et al. (2002) found that weaker individuals tend to get themselves noticed by being more proactive in the process of decision making through the use of IT communication systems. This has been attributed to the nature of computer-mediated communication (CMC) where communication cues are reduced and individuals hence feel more comfortable in expressing themselves (Jasperson et al. 2002). However, other studies suggest that CMC can reinforce power inequalities and magnify power differentials (Spears et al. 2002). These mixed findings call for further investigation in this area, particularly for new media such as WMS.

Media Usage

CMC researchers have conducted studies on how different communication media support various tasks in the workplace. For example, studies have found that individuals tend to use Instant Messaging (IM) systems to clarify simple matters and arrange for meetings on a separate channel (e.g., using IM to ask if one is free to make a phone call) (Nardi et al. 2000). Despite the considerable CMC research, there is a gap in our understanding of how CMC can support work in hospitals (Coiera 2006).

For the purpose of analyzing the use of different media for communication within organizations, Watson-Manheim and Belanger (2007) established a classification of communication purposes. These communication purposes are coordination, information gathering, relationship development, conflict resolution, and knowledge sharing. In our study, we are concerned with how the target medium (WMS) is used by different parties (e.g., physician, nurse) for various communication purposes. Therefore, we will use the above classification of communication purposes to categorize the WMS messages in our study with the exception of knowledge sharing. Knowledge sharing is not included as we do not expect users to frequently use WMS for knowledge sharing due to the limit on message length imposed by SMS. Our data supports this assumption since only 0.16% of messages were for this purpose.

Coordination is the process through which *"interdependence of tasks among individuals is managed"* (Watson-Manheim and Belanger 2007, p. 275). It includes both simple coordination (e.g., task assignment and scheduling of appointments) and complex coordination (e.g., developing a shared understanding of issues). *Information gathering* involves obtaining specific information to complete work activities (Watson-Manheim and Belanger 2007). This requires one to contact the person who has the needed information. *Relationship development* refers to the introduction of organizational members to each other and the development of interpersonal relationships (Watson-Manheim and Belanger 2007). This is important for establishing networks within the organization. *Conflict resolution* involves reuniting individuals who are engaged in some form of disagreement where each took a different stand on an issue (Watson-Manheim and Belanger 2007). Such conflicts tend to be attributed to personality differences or conflicting objectives and directions on tasks.

Hypotheses Development

Our hypotheses focus on the three key parties in healthcare organizations, i.e., physicians, nurses and administrative staff members. We develop hypotheses regarding each type of message, i.e., coordination, information gathering, relationship development and conflict resolution.

Physicians exercise influence over nurses and administrative staff members in the management of wards and patient care (Hunter 1996; Mantzoukas and Jasper 2004). Research has also suggested that such differences in power will affect how different parties communicate (Jasperson et al. 2002). Specifically, in terms of achieving a sense of justice, researchers have proposed that powerful individuals will tend to express their frustration more and justify issues to their advantage despite being viewed as unjust by weaker individuals (Kabanoff 1991). Thus, we hypothesize that powerful parties (physicians) will use WMS to send more conflict surfacing and resolution messages to weaker parties (administrative staff members and nurses) as compared to conflict messages sent from weaker parties to physicians. Hence, we hypothesize:

H1: Physicians will use WMS to send a greater proportion of *conflict resolution* messages to weaker parties (administrative staff members and nurses) as compared to the proportion of conflict resolution messages sent by weaker parties to physicians.

In contrast, individuals who are similar in terms of power tend to engage in higher levels of interaction and in enhancing social relationships (Kabanoff 1991). With the similarities in power, we propose that hospital staff members will use WMS to engage in more relationship development with fellow colleagues in the same user group (e.g., physicians to physicians) as compared to such messages sent to other user groups (e.g., physicians to nurses).

H2: Hospital staff members (all user groups) will use WMS to send a greater proportion of *relationship development* messages to fellow colleagues (in the same user group) as compared to the proportion of relationship development messages sent to other parties.

Weaker parties (i.e., administrative staff members and nurses) will have to coordinate tasks with physicians as part of their job. As physicians are often busy people on the move, weaker parties may not be comfortable contacting them personally or coordinating tasks through face-to-face meetings. WMS provides a non-intrusive way of contacting others as receiving an SMS does not cause as much interruption or disturbance as receiving a phone call. Thus, it can be used as a medium by weaker parties to coordinate tasks with powerful parties. Hence, we hypothesize that weaker parties are more likely to use WMS to engage in coordination work with powerful individuals (physicians) as compared to coordination messages sent from physicians to weaker parties.

H3: Weaker parties (administrative staff members and nurses) will use WMS to send a greater proportion of *coordination* messages to physicians as compared to the proportion of coordination messages sent by physicians to weaker parties.

Power imbalance can also be seen among physicians. For example, medical interns experience a high level of workload and stress as compared to residents and attending physicians in a hospital (Stucky et al. 2009). This high level of workload has been effected through the communication device held by interns. Specifically, ward nurses page interns frequently to ask about medication and patient assessment issues especially during on call hours (Harvey et al. 1994). We hence propose that the more junior the physician is, the more likely he/she will receive messages from nurses to gather information pertaining to work.

H4: Juniority of physicians is positively related to the number of *information gathering* messages received from nurses through WMS.

The hypotheses are summarized in Figure 1.

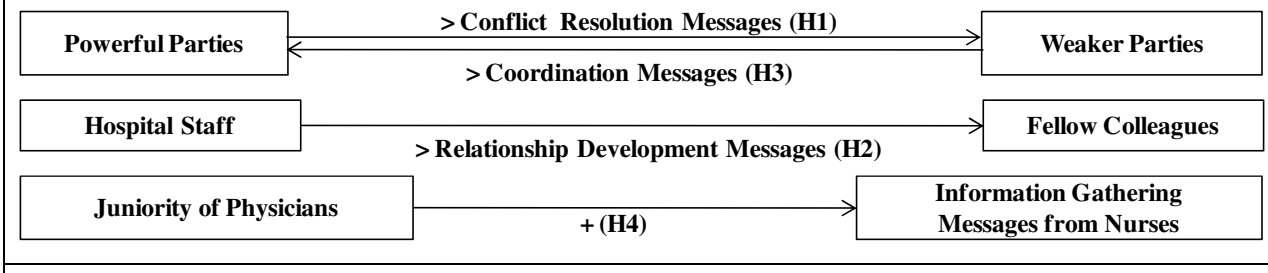

Figure 1. Research Model

Research Methodology

Content analysis was conducted to investigate usage of WMS in a hospital setting. Specifically, *"content analysis is a research technique for making replicable and valid inferences from data to their context"* (Krippendorff 1980, p. 21). As a positivist research method, it has been widely used as a technique to obtain objective description of content in social science research (Krippendorff 1980). For example, researchers have used it to analyze text relating to advertisements, chat messages, and online customer feedback (Pavlou and Dimoka 2006; Riffe 2005; Zou 2007). One of the advantages of content analysis is that it allows data to be collected non-intrusively. Specifically, studies have shown that measurement acts can interfere with the phenomena being assessed and cause inaccuracy to results (Krippendorff 2004).

Hospital and System Background

Established in 1985, Hospital A (name changed to protect confidentiality) is a comprehensive healthcare provider that also serves to educate medical, dentistry and nursing students. It has more than 900 beds and serves as a general medical center in providing subsidized tertiary healthcare for its patients.

Deployed in 2006, the WMS at Hospital A is used to support communication among hospital staff members with the aim to improve patient care. All employees including nurses and administrative staff members in the hospital are given individual accounts for the web portal which they can use to contact others, through the support of asynchronous telecommunication services, i.e., SMS. This is especially useful for contacting physicians who are frequently on the move in the hospital. In support of their mobility, physicians are each issued with a mobile phone so as to ensure that they remain contactable at all times. The system however imposes a maximum limit of 160 characters per message so as to encourage users to keep their messages short.

The messaging system primarily serves to support clinical messaging within the hospital and to replace the use of pagers. The system allows users to search for other staff members in the web directory and to send messages out to a selected group of people. The system also allows users to send messages to the doctor on duty for the day, without the need for the user to find out who the doctor is.

Data Collection

The WMS implemented in Hospital A logs all messages sent and stores them in a database. Additionally, all staff members working in the hospital are informed by the management that these messages are recorded and may be retrieved and viewed at the discretion of the management. The data for this study was obtained from the message logs recorded in the database.

Studies have shown that IT systems affect power relationships in an organization initially and it takes time for them to stabilize (Jasperson et al. 2002). As the WMS has been used in the hospital since 2006, the usage patterns should have reached an equilibrium state as users have already been using the system for several years. The authors were approached by the hospital management to study the usage patterns of WMS by different parties. After consultation with the hospital's management, we decided to analyze messages exchanged through the WMS in the month of May 2009. The month of May was determined to be a suitable working month as it does not coincide with major holidays in which a substantial number of staff members may go on leave, hence affecting the validity of the study. Our

initial data consists of a total of 70,218 usable messages from more than 2000 staff members, which came with information on message threading and time stamps.

Content Analysis Procedures and Measures

We followed closely the five-stage approach suggested for analyzing text messages (Zou 2007). Specifically it involves (1) Codebook development and data preparation (2) Coding constructs (3) Calculating continuous construct's value (not applicable in our study as we are using categorical units instead of continuous values) (4) Preparing data for analysis (5) Hypotheses testing. In addition, we required coders to re-code 10% of their data to ensure intra-coder reliability (Pavlou and Dimoka 2006). As the number of messages in our data set is large, we adopted a split half technique where coders independently code a subset of messages after reliability is established (Neuendorf 2002).

As recommended in previous research (Krippendorff 2004; MacQueen et al. 1998), a codebook was developed so as to ensure that all coders consistently follow a similar set of instructions in their coding. Specifically, a codebook is a set of instructions analysts (or coders) follow so as to objectively assign each unit of data to a particular category (Krippendorff 2004) in a content analysis study. Additionally, it provides description and instructions on the semantics of the coding and allows the study to be replicated (Krippendorff 2004).

Researchers also cautioned about the reuse of individuals who are involved in deriving the codebook as they may have established a mental model of the coding categories or implicit consensus without explicitly stating them (Krippendorff 2004). Thus, it is best to employ a different group of coders to test the finalized codebook. Hence, this study employed three coders. Coder 1 was one of the authors of this paper, while Coders 2 and 3 were two doctoral students who were blind to the objectives of the study and recruited for this research.

The various coding categories in the codebook are summarized in Table 1 below. The data set was split into two parts. The first part was coded by both Coders 1 and 2, while the second part was coded by both Coders 1 and 3.

Table 1. Coding Categories in the Codebook

Category	Definition	Example
Coordination	Process through which interdependence of tasks among individuals is managed and governed by procedures/protocols.	wd43b42 patient is vomiting. pls help me order anti vomiting medication and painkillers as well. Thanks.
Information Gathering	Involves requesting specific information needed for the performance of work activities. This category also includes messages that provide information.	dr, 62/6 can feed now? NBM for about 2 days already. how much milk to give? to serve meds also? Thanks.
Conflict Resolution	Process by which disagreements between individuals are surfaced, handled, and ultimately resolved.	I don't think I was consulted about any CABG patient with vomiting but my name appeared on your notes. Pls don't do that again
Relationship Development	Process by which the members of the organization develop interpersonal relationships with others.	hi, how' s your side so far? less busy now? or still busy? any chance for coffee break?

Apart from coding and computing the proportions of different communication categories in the WMS for H1 to H4, we had to obtain data pertaining to the juniority of physicians for testing H4. This was measured by asking the hospital management (including a senior physician) to rank the juniority of all physician designations on a scale of 1-5 (5 is the most junior).

Reliability

Reliability means that the observations must be stable and consistent when coded by different people over time (Krippendorff 2004). Reliability helps ensure that the categories are exclusive and independent by virtue of their

definitions. Researchers should consider three types of reliability in a content analysis study, i.e., stability, reproducibility, and accuracy (Krippendorff 2004).

Stability concerns itself with reproducing the same results by the same person over different time. Otherwise known as intra-coder reliability, stability measures the number of mistakes by a coder due to his carelessness in his work. In measuring such reliability, coders normally are required to randomly re-code a pre-defined amount of data. *Reproducibility* measures the degree to which two or more coders independently agree on a coding decision given similar instructions under varying conditions. Otherwise known as inter-coder reliability, the measure ensures that coding instructions are clear and the decision is indeed sound and hence helps ensure validity in a study. Researchers may ensure *accuracy* in their study by comparing their results against known standards. In addition to ensuring intra and inter-coder reliability, this measure calculates the precision of the coding against the chosen standard. It has been noted that it is difficult to measure accuracy for all phrases of coding as the selection of the standard *"puts … claims regarding accuracy on epistemologically shaky grounds"* (Krippendorff 2004, p. 216).

In light of the above, we decided to use stability and reproducibility measures to ensure reliability. We adopted the Holsti Agreement index for stability and Krippendroff's Alpha value for reproducibility (Holsti 1969; Pavlou and Dimoka 2006; Riffe 2005). Consistent with previous IS research, we chose to adopt a minimum threshold of 0.70 for Krippendorff's Alpha and 0.90 for Holsti's intra-coder reliability (Pavlou and Dimoka 2006). All our intra-coder and inter-coder reliability indices exceeded the thresholds, as shown in Table 2.

Table 2. Reliability Measures

Category	Holsti Agreement Index (Coder 1)	Holsti Agreement Index (Coder 2)	Holsti Agreement Index (Coder 3)	Krippendorff's Alpha (between Coder 1 and 2)	Krippendorff's Alpha (between Coder 1 and 3)
Coordination	0.92	0.99	0.94	0.72	0.93
Information Gathering	0.91	0.98	0.91	0.78	0.80
Conflict Resolution	1.00	1.00	1.00	0.76	0.86
Relationship Development	0.92	1.00	0.91	0.73	0.83

Data Analysis and Results

The WMS implemented in Hospital A is highly utilized with more than 70,000 messages exchanged in the month of May 2009. We collated the number of messages for each dyad group. As shown in Table 3, WMS is used mainly by physicians to send messages to fellow colleagues (physicians). In addition, administrative staff members are found to be the second highest group of users, sending 16390 messages to physicians.

We also collated the messages by content category based on the coding results. The message category statistics (Table 4) shows that people used the system mainly to send coordination (44.05%) and information gathering (43.03%) messages. However, a small but significant number of messages can be attributed to relationship development (6.16%) and conflict resolution (1.93%) issues. Others are messages that do not fit in a specific category.

Table 3. Common User Groups (in descending order of usage)			
Sender	**Recipient**	**Total Count**	**Percentage**
Physician	Physician	18466	29.32
Admin	Physician	16390	26.03
Nurse	Physician	14067	22.34
Physician	Nurse	4887	7.76
Admin	Admin	4347	6.90
Physician	Admin	2014	3.20
Nurse	Nurse	1423	2.26
Admin	Nurse	1383	2.20
TOTAL		62977	100.00
Note: 7241 messages are excluded in this table as these messages are sent to or received by other user groups (e.g., pharmacists) who are not included in this study.			

Table 4. Message Category Statistics		
Category Name	**Total Count**	**Percentage**
Coordination	30928	44.05
Information Gathering	30218	43.03
Conflict Resolution	1356	1.93
Relationship Development	4325	6.16
Others	3391	4.83
All Categories	70218	100.00

Results of Hypothesis Testing

An independent samples t-test was administered to test H1, H2 and H3. Linear regression was used to test H4. The average juniority of physicians is 2.75. Results of the analysis are presented in Table 5. All hypotheses are seen to be supported.

Table 5. Results for Hypotheses Testing				
Hypotheses	**Description**	**T-value**	**P-Value**	**Results**
H1	Conflict Resolution Messages: Powerful to Weak > Weak to Powerful	12.72***	0.000	Supported
H2	Relationship Development Messages: Fellow Colleagues > Others	13.30***	0.000	Supported
H3	Coordination Messages: Weak to Powerful > Powerful to Weak	19.06***	0.000	Supported
Hypotheses	**Description**	**Coefficient**	**P-Value**	**Results**
H4	Juniority of physicians → Information Gathering messages from nurses	0.33***	0.000	Supported
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$				

Discussion and Implications

We found support for all our hypotheses. Specifically physicians (powerful parties) tend to use WMS to express and resolve their conflicts more to nurses and administrative staff members (weaker parties) than vice versa. Hospital staff members also use WMS to send more relationship development messages to fellow colleagues as compared to sending such messages to other parties. Additionally, weaker parties tend to use WMS to coordinate tasks more than powerful parties. Findings from the first three hypotheses affirm past research on the power imbalances between physicians and other hospital staff members in a hospital. In addition, H4 is also supported, which affirms the greater amount of messages received by the more junior physicians and the power imbalance among physicians. Our study has also revealed that administrative staff members are the second highest group of users, sending a large proportion of messages to physicians.

Expected Theoretical Implications

Although past research in healthcare messaging systems has focused mainly on the communication system used and the interaction between physicians and nurses (Locke et al. 2008; Nguyen et al. 2006), we found that such systems are also used extensively by other parties (e.g., administrative staff members). By studying the communication and usage patterns of CMC systems, we can achieve a better understanding of user's behavior and their interactions with one another. In particular, power imbalances affect how different parties use WMS, which affirms past research on the relationship between power and CMC (Spears et al. 2002). This study thus extends the power perspective in IS research to understand the kinds of purposes that various parties use CMC such as WMS for. This can serve as a basis for developing theory on how power imbalance affects communication outcomes for systems such as WMS.

Expected Practical Implications

Our findings can encourage better communication in hospitals. For example, while weaker parties may see WMS as a useful tool for coordination, physicians should also be encouraged to use the system for coordination if it can improve their efficiency and effectiveness. Users can also be more aware about their tendency to send relationship development messages mostly to their fellow colleagues and could be encouraged to build relationships with other parties as well, especially if it improves their job satisfaction and loyalty. Physicians should also be more conscious of their tendency to send conflict messages to weaker parties and reconsider if the WMS medium is suitable for this purpose. Hospital management should be aware of the high number of messages that junior physicians receive from nurses and inform nurses on which physician they should contact using WMS if there is overload. Also, nurses should not abuse the system by sending unnecessary messages to junior physicians. The high usage by administrative staff members also show that WMS can be an effective means for them to contact physicians who are frequently on the go.

Conclusion and Future Plan

There are three main limitations in the current study. First, our data set is from a single hospital and hence our results might not be generalizable. Second, our study is based on a single month of data, even though it is deemed to be a typical month. Third, our study does not tell us if WMS reflects or changes power relationships. In future, we intend to analyze data from other hospitals that implement WMS and over longer periods of time (possibly a year) to increase generalizability of findings. Content analysis can be complemented by other methodologies such as surveys to study communication outcomes. Thus, in our future work we plan to include a survey to analyze communication performance and impact of WMS on patient care. We can also study power relationships based on other data sources to understand if WMS changes power relationships.

Additionally, researchers may want to investigate other factors (e.g., efficacy) that may affect the choice of such communication medium. It may also be worthwhile to study the interruption effects of the WMS system. Further, researchers may want to explore how different media complement each other in a hospital and what each medium is appropriate for. These efforts can help to improve communication and coordination in hospitals, and also shed light on how human factors affect the usage and outcomes of systems such as WMS.

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