The intended and unintended consequences of communication systems on general internal medicine inpatient care delivery: a prospective observational case study of five teaching hospitals

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ABSTRACT

Background Effective clinical communication is critical to providing high-quality patient care. Hospitals have used different types of interventions to improve communication between care teams, but there have been few studies of their effectiveness.

Objectives To describe the effects of different communication interventions and their problems.

Design Prospective observational case study using a mixed methods approach of quantitative and qualitative methods.

Setting General internal medicine (GIM) inpatient wards at five tertiary care academic teaching hospitals.

Participants Clinicians consisting of residents, attending physicians, nurses, and allied health (AH) staff working on the GIM wards.

Methods Ethnographic methods and interviews with clinical staff (doctors, nurses, medical students, and AH professionals) were conducted over a 16-month period from 2009 to 2010.

Results We identified four categories that described the intended and unintended consequences of communication interventions: impacts on senders, receivers, interprofessional collaboration, and the use of informal communication processes. The use of alphanumeric pagers, smartphones, and web-based communication systems had positive effects for senders and receivers, but unintended consequences were seen with all interventions in all four categories.

Conclusions Interventions that aimed to improve clinical communications solved some but not all problems, and unintended effects were seen with all systems.

BACKGROUND

In hospitals, effective communication between clinicians is a critical component in the provision of high-quality patient care.[1–6] Yet, major problems exist on the wards that include frequent use of interruptive communication mechanisms, difficulty in knowing whom to contact, and breakdowns in communication.[1]

To deal with these challenges, a number of hospitals have implemented different communication solutions. These interventions include alphanumeric pagers,[7] smartphones,[8–11] and a web-based interdisciplinary communication tool.[12] Many of these measures, however, have been untested, and their perceived effectiveness is often hampered by challenges and barriers that exist in hospitals.[13 14] Although some quality improvement studies have been conducted to assess the effects of these communication systems, gaps still remain in understanding the impact and role of communication systems in healthcare delivery. To describe the benefits and drawbacks of different communication technologies in inpatient settings, we conducted an ethnographic study to assess different systems used in five hospitals.

SETTING

Between June 2009 to September 2010, a multi-site evaluation study was conducted in general internal medicine (GIM) wards at five different academic teaching hospitals that are affiliated with the University of Toronto—St Michael's Hospital (site 1); Sunnybrook Health Sciences Centre (site 2); University Health Network hospitals consisting of Toronto General Hospital and Toronto Western Hospital (site 3); and Mount Sinai Hospital (site 4). Each site had clinical teaching units with typically four medical teams, each consisting of an attending physician, a senior resident, junior residents, and medical students.

Communication practices

Communication practices that were common to all the hospitals included the use of hospital operators, online and overhead paging systems, and daily interprofessional care rounds. Each site, however, had adopted different communication systems and processes that allowed clinicians to communicate about patients by sending or receiving different types of information in the form of numeric digits, text messages, or phone calls.

At site 1, clinicians relied on traditional numeric pagers.

Site 2 had used a mix of alphanumeric pagers and smartphones since 2006. Previously, numeric pagers were used. On their GIM floors, text messages were primarily sent via an intranet-based messaging system to clinicians' alphanumeric pagers while other non-GIM clinicians would send numeric pages. Clinicians would respond to these pages by either making call backs to the extensions using hospital phones or look for the caller on the wards. Smartphones were carried by the senior residents who used them at their own discretion.

At site 3, all residents used smartphones provided by the institution, and nurses and allied health (AH) professionals sent structured emails using an intranet-based messaging system and/or through direct phone calls to residents' smartphones. Residents would respond by emailing back or picking up the phone calls on these institutional smartphones.[10] Smartphones had replaced numeric pagers in 2008 at site 3. Since 2006, clinicians at site 4 had used an intranet-based task-management messaging system that queued non-urgent messages.[12] When messages became overdue, reminders were sent to the teams' alphanumeric pagers requesting a response. For urgent issues, nurses and AH sent numeric or stat pages directly to the residents' pagers. Residents responded to messages by logging into the messaging system using computers on the wards to review the messages or calling the numbers reflected on their numeric pager using the ward phones. Table 1 highlights the different communication devices and methods adopted at these hospitals.

METHODS

Using a mixed-methods ethnographic approach, we collected different data sources to describe the effect of different communication systems on inpatient care delivery. Ethical approval was obtained from the respective institutions' research ethics board committees. A breakdown of the total data collection by site is listed in table 2. A subset of these data has been previously described in a study that focused on the effects of smartphone technology.[10]

Observations

The communication processes in the hospitals were observed by conducting (1) ward observations that recorded clinicians' interactions at the GIM nursing stations, which are the hubs of all communications and (2) a 'work-shadowing' approach that followed up individual residents who are end users of the communication systems in their everyday work.

A non-participatory observation technique was adopted where all communication interactions and patterns were observed from a distance. Data collection included timing of events and writing field notes using a structured data collection sheet that was pretested. Only communication activities and workflow interruptions were recorded, and no patient-related information was collected or documented. All work-shadowing was conducted by VL, and ward observations were performed by VL and KT.

Interviews

We conducted semistructured interviews with 108 hospital staff across all the sites to examine how clinicians perceived the impact of communication systems on their patient care and workflow. The interviews were audio-taped and consisted of open-ended questions with additional probes to elicit more detailed information from these frontline clinicians who initiate and receive communication. Participants were recruited using a purposive sampling approach where we sampled until we reached saturation from different clinical roles that included physicians, residents, nurses, medical students, and AH personnel. Interview recordings were then transcribed.

Analysis

Using an inductive thematic content analysis, transcribed field notes from the observations and interviews were coded and reviewed for key emergent themes and critical incidents that highlighted the key emergent themes. An initial sample of the transcripts was independently read and coded to derive and identify broad themes across all the sites. The provisional thematic categories were discussed among three researchers (RCW, VL, and KT) and then organized into a preliminary structure for coding the rest of the data with additional themes reported for each site as they emerged. This coding process involved identifying patterns, relationships, and differences to develop a detailed and systematic record of the major themes and subthemes into a framework. The themes and verbatim comments extracted were then entered into a qualitative software program (NVivo 8, QSR International) to facilitate coding and sorting of the data. Upon completion of the coding, the categories were again reviewed, refined, and structured.

Quantitative analyses were undertaken from ward observations and work-shadowing data. Field notes collected during the observation sessions were transcribed into raw documents detailing formal descriptions of the sequence of time-stamped observed events. Each transcribed document was coded (by VL, KT, and RCW) where communication activities and issues were identified and categorized into different communication events. Specifically, each event was reviewed to determine whether it was an interruption, what activity had been performed, who performed the activity, if any other person(s) was involved and their role(s), and any other characteristics that would make the category mutually exclusive of other categories. We defined workflow interruptions as an intrusion of an unplanned and unscheduled task, causing a discontinuation of tasks, a noticeable break, or task-switch behavior.[15] Participants were further divided and analyzed according to their clinical roles. Upon completion of the coding, descriptive statistics were generated.

Findings from the observational data were then cross-referenced and further augmented by the thematic framework that emerged from the clinicians' interviews to help validate our analyses and provide insights into clinicians' direct experiences, attitudes, and views of how existing communication systems affected them and healthcare delivery outcomes. To generate more comprehensive insights from both the clinician's perceptions and the actual observations, efforts were made to converge findings by triangulating the multiple sources of evidence from different hospitals. This process was reviewed collaboratively by three of the researchers (RCW, VL, and KT).

RESULTS

The key primary impacts of different communication technology were grouped into four categories: *senders*, *receivers*, *interprofessional collaboration*, and *informal communication methods,* and are summarized in table 3. Quantitative analyses are found in tables 4–6.

Impacts on sender
Waiting for a response
Numeric paging worked more often than not for senders. From ward observations at site 1, 67% of numeric pages (98 of 147) received responses, and responses took an average of 2 min. A key theme that emerged across all sites from the interview data focused on clinicians' frustrations over their wasted time while waiting for a response to a page or a message. Senders of numeric pages often had to either wait by the phone or implore help from other clinicians to help them track call-backs to their sent pages (box 1: point 1). Communication issues from the ward observations showed that clinicians at site 1—which relied primarily on the numeric paging method—generated 7.5 occurrences of informing others about a page compared with ≤4.4 occurrences at the other sites that could send written messages (table 6). Written messages in the form

Table 1 Communication devices and methods across the five hospitals

| Information | Study sites | | Site 3 University Health Network's Hospitals | | |
	Site 1 (St Michael's Hospital)	Site 2 (Sunnybrook Health Sciences Centre)	Toronto General Hospital	Toronto Western Hospital	Site 4 (Mount Sinai Hospital)
Number of general internal medicine (GIM) beds	60+4 step-up unit beds	100	76	80	84+4 Step-down beds
Number of wards	2	4	2	2	3
Location of wards	Both wards are located on the same floor	3 Wards are located on the same floor, 4th ward is 2 floors below the rest	The wards are located 1 floor apart	Both wards are located on the same floor	2 Wards are located on the same floor, 3rd ward is 5 floors below the others
Method of locating most responsible physician on GIM wards	Contact team numeric pager	Contact or message physician's alphanumeric pager	Message or call team smartphone		Post online messages and task requests to team Contact physician's numeric pager
Types of devices carried by clinicians					
GIM team device	Numeric pager	Alphanumeric pager and smartphone	Smartphone		Alphanumeric pager
GIM physician	Numeric pager	Alphanumeric pager	Smartphone		Numeric pager
GIM nurse	None	None	None		Mobile phone
GIM allied health professionals	Numeric pager	Numeric or alphanumeric pager	Numeric pager		Numeric pager
Standard/institutional communication method (if formal rounds or face to face not available)					
Nurse to GIM physician	▶ Numeric paging via the landline phone (contact number retrieved from patients' charts and table tents) ▶ Numeric Paging via intranet-based numeric paging system ▶ Numeric paging via hospital operator	▶ Text or numeric messages via intranet-based messaging system ▶ Numeric paging via hospital operator	▶ Structured emails via intranet-based messaging system ▶ Direct phone calls to physicians' smartphones ▶ Numeric paging via hospital operator		▶ Tasks requests and messages via Intranet-based task-management/messaging system ▶ Numeric paging via hospital operator
GIM physician to nurse	▶ Call to ward	▶ Call to ward	▶ Call to ward ▶ Reply to nurses' structured emails on their Smartphones		▶ Call to ward ▶ Call nurse's mobile phone ▶ Reply to nurses' messages via the intranet-based task-management/ messaging system
Allied health professional to GIM physician	▶ Numeric paging via the landline phone, intranet-based numeric paging system or hospital operator	▶ Text message and/or numeric paging via intranet-based messaging system ▶ Numeric paging via hospital operator	▶ Structured emails via intranet-based messaging system ▶ Regular emails using institutional accounts ▶ Phone calls to physicians' smartphones		▶ Numeric paging ▶ Hospital operator
GIM physician to allied health (AH) professional	▶ Numeric paging via the phone and/or intranet-based numeric paging system ▶ Call to ward	▶ Text message and/or numeric paging via intranet-based messaging system ▶ Call to ward if required	▶ Numeric paging via hospital operator ▶ Reply to emails via their smartphones if required ▶ Call back to AHs' messages via their smartphones		▶ Numeric paging via hospital operator ▶ Call to ward
GIM physician to GIM physician	▶ Numeric paging via the landline phone, intranet-based numeric paging system or hospital operator	▶ Text messages and/or numeric paging via intranet-based messaging system	▶ Phone calls, Short Message Service (SMS) or emails via their smartphones		▶ Numeric paging via hospital operator
Off-service physician to GIM physician (and vice versa)	▶ Numeric paging via hospital operator	▶ Text message and/or numeric paging via intranet-based messaging system ▶ Numeric paging via hospital operator	▶ Numeric paging via hospital operator		▶ Numeric paging via hospital operator

of short texts and emails enabled senders to provide information that identified themselves with call-back numbers. Having the capability to identify oneself was valuable for mobile clinicians who could resume work quickly with the assurance that the receiver knew whom they needed to locate when they called back (box 1: point 2).

Table 2 Data collection by methods and sites

	Sites					
			Site 3 University Health Network Hospitals			
Methods	Site 1 (St Michael's Hospital)	Site 2 (Sunnybrook Health Sciences Centre)	Toronto General Hospital	Toronto Western Hospital	Site 4 Mount Sinai Hospital	All Hospitals
Observations at nursing stations						
Hours (No of sessions)	48 h (24 sessions)	72 h (37 sessions)	42 h 28 min (21 sessions)	29 h 51 min (15 sessions)	68 h (34 sessions)	260 h 19 min (131 sessions)
Workshadowing residents						
Hours (No of residents)	60 h (12 residents)	35 h (7 residents)	57 h 55 min (12 residents)	27 h 46 min (6 residents)	15 h (3 residents)	195 h 41 min (40 residents)
Interviews with clinicians						
Physicians	10	5	8		5	28
Nurses	9	11		15	14	49
Allied Health	7	10		8	6	31
(Total)	(26)	(26)		(31)	(25)	(108)

Table 3 Positive and negative effects of different communication interventions

Areas of impacts	Methods			
	Numeric paging	Alphanumeric paging with intranet-based messaging	Smartphone with intranet-based messaging	Task-management messaging system that queues non-urgent messages
Impacts on sender				
Waiting for response	+ Usually works (67%), but often no response − Often need to repage − No acknowledgment of page sent or received by recipient	− No acknowledgment of page sent or received by recipient	+ Direct calls resolved quickly if receiver picks up + No longer need to wait by phone for response, can continue to work + Can page to smartphone and continue to work (for smartphone users) − May take longer for sender to receive a response − No acknowledgment of email message received	− Can have significant delays in non-urgent messages
Conveyance of urgency	− Unable to convey urgency	+ Conveys urgency within paging message	+ Conveys urgency by calling directly Conveys urgency within paging message	+ Conveys urgent messages—direct notification, while non-urgent messages are queued
Impacts on receiver				
Receipt of context	− No context	+ Able to receive context	+ Able to receive context	+ Able to receive context
Ability to respond to messages	+ Can defer returning page − May not be able to return page—if error occurs in callback number − May not be able to return page if initial caller is gone	+ Easier to respond as message usually contains the senders name and can ask for directly	+ Able to respond easily with mobile phone + Able to respond easily to emails with smartphone + Don't need to respond to some emails (info only) + Easier to respond—often knows nurses name and can ask for directly	− Need to find a computer to review
Frequency of interruptions	− Highly interruptive, as need to return page	+ Less interruptive as may not need to disrupt activity for some messages	+ Emails can interrupt but email response is less disruptive than calling back − Direct calls very interruptive − High level of interruptions	+ No interruptions for non-urgent items as long as reviewed before timing out
Other areas				
Interprofessional collaboration	− Frustrating when lack of response by doctor of medicine (MD) − Frustrating when paged for unimportant items	− Frustrating when lack of response by MD − Frustrating when paged for unimportant items	− Frustrating when lack of response by MD − Frustrating when paged for unimportant items − May have worse relationships with lack of verbal communication − May be difficult to resolve complex problems with emails	− Frustrating when lack of response by MD − Frustrating when notified for unimportant items
Informal systems	− Very difficult to coordinate teams–Paging codes used—not well known—errors occur − Use of personal devices for clinical communication	+ Easier to coordinate team members—can send alpha text via computer − Use of personal devices for clinical communication	+ Less use of personal devices for clinical communication for those with hospital smartphones − Use of insecure messaging between other care providers	− Use of personal devices for clinical communication

Table 4 Frequency of interruptions and responses by hospital sites (work-shadowing analysis)

Communication modes	Institutions							
	Site 1		Site 2		Site 3		Site 4	
	Juniors n=8 (40 h)	Seniors n=4 (20 h)	Juniors n=3 (15 h)	Seniors n=4 (20 h)	Juniors n=8 (37.43 h)	Seniors n=10 (48.25 h)	Juniors n=2 (10 h)	Seniors n=1 (5 h)
Face to face communication events								
Interruptions frequency								
Average (range) per hour	2.45 (0.8–4.4)	2.65 (0.8–4)	2.33 (1.4–2.8)	4.45 (3.2–6.6)	1.73 (0.7–3.4)	2.57 (0–4.4)	1.7 (1.8–2.2)	1.2 N/A
Response frequency								
Average (range) per hour	2.4 (0.8–4)	1.3 (0.8–3.8)	2.33 (1.4–2.8)	4.4 (3.2–6.4)	1.5 (0.7–3.1)	2.36 (0–4.1)	1.7 (1.8–2.2)	1.2 N/A
Numeric pages communication events								
Interruptions frequency								
Average (range) per hour	1.53 (0.6–3.8)	2.3 (1.6–3.2)	0.27 (0–0.8)	0.75 (0.2–1.4)	0.05 (0–0.2)	0.21 (0–0.6)	0.6 (0.2–1)	1 N/A
Response frequency								
Average (range) per hour	1.4 (0.4–3.8)	2.3 (1.6–3.2)	0.27 (0–0.8)	0.7 (0.2–1.4)	0.03 (0–0.03)	0.19 (0–0.4)	0.6 (0.2–1)	1 N/A
Alphanumeric pages communication events								
Interruptions frequency	N/A	N/A			N/A	N/A	N/A	N/A
Average (range) per hour			0.67 (0.6–1.4)	1.5 (0.4–2.4)				
Response frequency	N/A	N/A			N/A	N/A	N/A	N/A
Average (range) per hour			0.47 (0–1.4)	0.8 (0.2–1.2)				
Smartphone related communication events								
Interruptions frequency	N/A	N/A	N/A				N/A	N/A
Average (range) per hour				0.1 (0–0.4)	2.21 (1.2–4.5)	2.84 (0.4–7.2)		
Response frequency	N/A	N/A	N/A				N/A	N/A
Average (range) per hour				0.1 (0–0.4)	1.3 (0.4–3.1)	1.89 (0.4–5.7)		
Task-management messaging communication events								
Interruptions frequency Average (range) per hour	N/A	N/A	N/A	N/A	N/A	N/A	0 (0)	0 (0)
Response frequency Average (range) per hour	N/A	N/A	N/A	N/A	N/A	N/A	1.2 (0.8–1.6)	0 (0)

As the sophistication of the communication and messaging systems increased, senders' desires and demands for sophisticated acknowledgments also increased. For example, users of the basic numeric paging system wanted verification that their pages were sent and received (box 1: point 3). For sites with text messaging systems that documented the history of the message thread, senders wanted acknowledgment that their messages were read. At sites where smartphones and the task management system were used, senders wanted to obtain responses from the receivers and also to be informed of updates and changes relevant to the communicated issue and patient's care plan (box 1: points 4–5). As observed on the wards in table 6, senders' communication issues were prevalent at site 1 which relied primarily on traditional numeric paging and also at site 3 that used smartphones.

One unintended effect of written messages was a perceived decrease in the frequency and increase in the waiting time for responses in comparison with numeric pages (box 1: point 6). Senders perceived that they obtained much faster responses when they sent numeric pages, which contained minimal information (box 1: point 7). With numeric pages, receivers are forced to respond to find out about the issue. Senders perceived that since receivers now had access to the clinical context, they could be less responsive if the issue was not urgent. Receivers could choose to ignore the message or act directly on the issue without any notification back to the sender (box 1: point 8). This observation was confirmed in the work-shadowing data in table 4: receivers were less likely to respond to text pages than to numeric pages.

At sites with smartphones, residents experienced improved efficiency in using the devices to initiate communication by calling or sending text messages to other clinicians. They made on average 1.4 calls an hour and sent 1.0 emails an hour. The devices allowed rapid communication by text as well as the ability to page to their smartphone, allowing them to be mobile and continue with their work (box 1: point 9).

Conveyance of urgency

Senders wanted the ability to specify urgency so they could obtain a quick response when required. Alphanumeric paging, smartphones, and task-management systems allowed senders to convey urgency in the text of the message. Another key advantage of text messages is the ability for senders to provide details and convey the purpose of their communication, as well as indicate the urgency of the problem. There was consensus among clinicians across all the sites that text messages were useful in providing context and details for the communicated event. Specifically, senders found written messages to be most valuable when communicating simple notifications that did not require responses or were about non-urgent issues (box 1: points 10–12). This was confirmed in the observational data in table 6, for example at site 3 where 47% (45 of 95) of the observed messages sent from the nursing stations were primarily information-only pages that did not need a reply.

Although senders appreciated the ability to send real-time information in text messages, different degrees of dissatisfaction were expressed among senders over the use of texts in the conveyance of urgent issues. For example, some nurses found that elaborating urgent problems through text messaging could be more cumbersome than a simple overhead or numeric paging

Table 5 Distribution on the types of response channels used by residents to device interruptions by sites (work-shadowing analysis)

Types of response channels to device interruptions	Institutions							
	Site 1 Numeric pager		Site 2 Alphanumeric pager		Site 3 Smartphones		Site 4 Numeric and Task-management Pagers	
	Juniors (40 h)	Seniors (20 h)	Juniors (15 h)	Seniors (20 h)	Juniors (37.4 h)	Seniors (48.3 h)	Juniors (10 h)	Seniors (5 h)
Use of face-to-face conversation as response channel								
Total usage observed	1	2	1	3	1	1	0	0
Average use per hour	0.025	0.1	0.06	0.15	0.03	0.02	0	0
Range per hour	0–0.2	0–0.4	0–0.2	0–0.2	0–0.2	0–0.2	0	0
Use of landline telephone as response channel								
Total usage observed	55	44	9	18	2	2	6	5
Average use per hour	1.38	2.2	0.6	0.9	0.05	0.04	0.6	1
Range per hour	0.4–3.8	1.6–3.2	0–1.8	0.2–1.4	0–0.2	0–0.2	0.2–1	N/A
Use of intranet-based messaging system as response channel								
Total usage observed	N/A	N/A	0	1	N/A	N/A	0	0
Average use per hour	N/A	N/A	0	0.05	N/A	N/A	0	0
Range per hour	N/A	N/A	0	0–0.2	N/A	N/A	0	0
Use of institutional smartphone device as response channel								
a. Phone calls via institutional smartphone								
Total usage observed	N/A	N/A	N/A	1	29	64	N/A	N/A
Average use per hour	N/A	N/A	N/A	0.05	0.8	1.33	N/A	N/A
Range per hour	N/A	N/A	N/A	0–0.2	0.4–1.54	0.4–4.6	N/A	N/A
b. Email/text via institutional smartphone								
Total observed	N/A	N/A	N/A	N/A	16	24	N/A	N/A
Average per hour	N/A	N/A	N/A	N/A	0.4	0.5	N/A	N/A
Range per hour	N/A	N/A	N/A	N/A	0–1.4	0–1	N/A	N/A
c. Overall total responses via institutional smartphone								
Total observed	N/A	N/A	N/A	N/A	48	88	N/A	N/A
Average per hour	N/A	N/A	N/A	N/A	1.3	1.82	N/A	N/A
Range per hour	N/A	N/A	N/A	N/A	0.4–3.1	0.4–5.7	N/A	N/A
Use of personal cell phone as response channel								
Total observed	0	0	1	7	0	0	0	0
Average per hour	0	0	0.07	0.35	0	0	0	0
Range per hour	0	0	0–0.2	0–1.4	0	0	0	0
Overall responses to device interruptions								
Total observed	56	46	11	30	51	91	6	5
Average per hour	1.4	2.3	0.73	1.5	1.4	1.89	0.6	1
Range per hour	0.4–3.8	1.6–3.2	0–2.2	0.4–2.2	0.6–3.3	0.4–5.7	0.2–1	N/A

(box 1: points 13–14). Moreover, senders commented that there were varying degrees of urgency that was not always clearly defined. Some events that were not life-threatening still required the receiver to respond quickly (box 1: points 15–16).

Impacts on receiver
Receipt of context
Recipients preferred written messages on their alphanumeric devices or smartphones to numeric pages. Written messages provided valuable information that enabled recipients to distinguish and triage urgent or non-urgent pages, which helped minimize disruptions to their workflow and patient care activities (box 2: points 1–2).

Ability to respond
Recipients of the pages also welcomed having information such as the senders' identification and details in the written texts on their alphanumeric devices or smartphones. Observational and interview data suggest that such information improved receivers'

efficiency when responding to their pages by tracing the caller directly rather than wasting time locating an unknown sender (box 2: points 3–4). Smartphones appeared to make it easier to respond to communications either by a return call or by a text message (table 5).

Frequency of interruptions
Interruption of work was a concern among receivers of communications, and it appeared to be higher at the site with smartphones. From work-shadowing data (table 4), it was observed that residents using smartphones at site 3 experienced the highest occurrences of interruptions from their devices whereby the junior and senior residents experienced on average 2.2–2.8 interruptions per hour. Qualitative data from the interviews and observational data suggested that this high number of interruptions appeared to be made worse by the multiple communication channels that included direct calls, emails and text messages from the smartphones (box 2: points 5–6). Direct calls were perceived by clinicians to be the most disruptive as they could not

Table 6 Paging activity and communication issues seen across the hospital sites (wards observations analysis)

Observed communication events	Site 1 (Numeric paging)				Site 2 (Alphanumeric paging)				Site 3 (Mixture of text messages and numeric paging)[1]						Site 4 (Task management system messages and numeric paging)			
						Numeric pages			Emails			Numeric pages				Numeric pages		
	Direct paging	Hospital operator	Online paging	Total	Alpha/ text pages	Direct paging	Hospital operator	Total	Information only	Email response	Call-back requests	Direct paging	Hospital operator	Total	Task management messages	Direct paging	Hospital operator	Total
Observed paging activity																		
Total number of sent pages observed	88	7	3	98	19	30	8	57	45	21	29	50	12	157	19	12	19	50
Total number of sent pages observed (Per hour)		1.98	0.06	2.04	0.26		0.53	0.79		1.31			0.86	2.17	0.28		0.46	0.74
Observed communication issues (standardized to 40 h)																		
Need to inform others about communication		7.5			0.6		3.9	4.4		0.6			3.9	4.4	0		1.3	1.3
Unreturned communication		5.8			0		0.6	0.6		3.3			3.9	7.2	0		1.3	1.3
Repeat communication for same issue		8.3			0		0	0		1.7			0.6	2.2	0		0.7	0.7
Communication returned by receiver but not answered by sender		2.5			0		5.0	5.0		0			4.4	4.4	0		5.3	5.3
Obvious frustration due to poor communication		0			0		0	0		2.2			0.6	2.8	0		0	0
Incorrect person paged		1.7			0		0	0		0			0.6	0.6	0		0.7	0.7
Total		25.8			0.6		9.4	10		7.8			13.9	21.6	0		9.3	9.3

1While UHN's GIM residents use smartphones, other off-service clinicians still continued to use their numeric pagers on the GIM wards.

Box 1   Impacts on sender

1. A nurse talks to the ward clerk that she had paged for a resident and to let know her if the phone rings. The nurse leaves. *(Site 1 Workshadowing MD7-March 19, 2010)*
2. '..It (text paging) is very much time saving, easy and effective. I can just send a page and continue my work and then when they call back, they call back…' *(Site 2 Interview Nurse 11)*
3. 'I mean an ideal system is one whereby you have verification that the recipient of your message has received it.' *(Site 1 Interview MD7)*
4. 'People who respond to the messages, if they could just find the nurse and say about it. I think that's important for a nurse to know what is happening with her patient. I had a couple of times a doctor came in, spoke to (the patient) and then I come back and the patient tells me about it. I don't know anything. I am getting information from the patient.' *(Site 3 Interview Nurse 5)*
5. '..some of the most annoying thing is if you WIPS (use the task management system) and they write the comment…you have to check your previous WIPS (entries of the task management system) to see and we don't typically work in that manner, unless they call you or they write an order…For example, you say the INR is high and we need blood work and then they (receivers) write back in the comment like, "orders will follow" or, like, "no action required". We don't go back to the WIPS, because we expect them to either write an order or if they can notify us verbally over the phone, instead of us having to keep going back through the WIPS.' *(Site 4 Interview Nurse 8)*
6. 'But if you need a Tylenol order or something for pain, it could take maybe 20 min, 15 min or half an hour. Something you don't even get a response, depending how busy they are.' *(Site 2 Interview Nurse 2)*
7. 'They already have the information they don't need to call us to find out "So what is going on?" Cause all they would get is a little number that's it. No information. So they had to respond to find out.' *(Site 3 Interview Nurse 10)*
8. 'When I give them the issue in the page then I never get a call back. It's not to say they are not dealing with issue but I don't if they are dealing with the issue because they don't respond. So in that sense, it is frustrating and I feel like I should just go back to the old way of paging, it's actually get them to call me back.' *(Site 2 Interview Allied Health 8)*
9. 'Especially when you are trying to get in touch with specialists. You don't have to stick around the telephone to wait for a phone call back. You can do your things and the specialist can call you at his convenient time.' *(Site 3 Interview Resident 2)*
10. 'Alphanumeric pager is great for sending information when you don't expect a reply.'*(Site 2 Interview MD1)*
11. 'If it's not urgent, I wouldn't mind using the WIPS. I think it is fast just to type it in and page them and it's something that they can see on the screen what needs to be done.' *(Site 4 Interview Nurse 7)*
12. 'We just want to make sure that they know so we just send them an information-only page…You would feel kind of silly calling them and having them call you back just to say 'The hemoglobin is this'. 'Oh yeah, I know'. But this way we can just send it and not have to worry as much because they'll just have to glance at it and that's it.' *(Site 3 Interview Nurse 6)*
13. '…for urgent things, I find that it's kind of a hassle because then if it's something urgent or stat, sorry, then you're trying to type on the WIPS, when it's easier for us to call them overhead. So-and then you're waiting 5, 10 min for them to respond. While if it's a stat order, sometimes if we just pick up the phone and get them paged, it's kind of faster.' *(Site 4 Interview Nurse 8)*
14. 'It's sometimes hard to convey that urgency through a written message (and) I don't like to keep sending another page over and over again. It feels like I'm annoying the physician probably (laughs).' *(Site 3 Interview Nurse 3)*
15. 'Also is this (issue) supposed to be like an hour thing? Or is this supposed to be a stat? There are some things what they don't fall in those categories. Like it's really not urgent, you don't want to page them urgent for something that could be maybe responded to in 30 min and then 1 hour so it looks like it's too long.' *(Site 4 Interview N5)*
16. '…but sometimes non-urgent I still need to get a response right away. It's not urgent; nothing-no one is dying, no one is crashing, but it's pretty urgent to me. But I can't WIPS that urgent-urgent, but I want to still get a hold of this person in a few minutes or so.' *(Site 4 Interview Nurse 6)*

INR, international normalized ratio; WIPS, web-based interdisciplinary paging system.

be deferred (box 2: point 7). Site 1 had the next most frequent interruptions where a resident experienced 0.4–3.6 interruptions in the form of pages per hour. In comparison with phone calls, numeric pages could be deferred temporarily, but there were perceptions of inefficiencies, including wasted time spent on calling back and trying to locate the sender to discuss the purpose of the issue (box 2: point 8).

Impacts on interprofessional collaboration

The communication systems also appeared to affect interprofessional collaboration. Clinicians who relied on mechanisms such as texts, emails, and task-management systems agreed that these channels helped expand communication and increased information exchange between clinicians. Although the quantity of communication had increased, clinicians felt that the quality of communication might have deteriorated (box 3: points 1–2).

Clinicians perceived oral discussions to be of high value that offered richness in the interactions. The increase in text communication reduced oral discussion and appeared to deprive clinicians of the opportunities to interact and know their team members better (box 3: point 3).

Dissatisfaction experienced by senders and receivers arising from poor patterns of communication also impeded the quality of collaborative relationships. Senders expressed frustration with delays and the lack of responses to their pages (box 3: points 4–5), and with receiving text replies with inadequate information (box 3: point 6). Consequently, added frustrations were felt amongst senders when repeated attempts and pages were sent in hope of obtaining a response. The level of frustration also increased when there were multiple channels and options to receive responses. For example, increased frustrations were observed on the wards and in the interviews among clinicians at

Box 2	Impacts on sender

1. 'Whereas the nice thing about the text page is yesterday I got a text page 'please come, this patient is not rousable', I stopped what I was doing and got up and left. So that was a good page to get. Whereas if I had gotten called with five numbers, they would have just been another number. Whereas I got that text page in the middle of other text pages about reordering certain medication, I'll just go do that right away because it seems serious.' *(Site 2 Interview MD5)*

2. At 18:11, the team 9's Blackberry goes off. Junior takes a look. It is a for your information only message from a nurse. He puts the Blackberry away. *(Site 3 Workshadowing MD 13, February 9, 2010)*

3. 'So if it's just a number, you call back and say blue team, you have to find the nurse waiting for you or who needs it…and sometimes they say no-one paged you and obviously someone did. But with the text pages, it's better because they usually leave their name so you can just say blue team calling back for Wendy. And then, they would say, Wendy come, instead of saying nurse taking care of patient X, room this, it's a lot faster.' *(Site 2 Interview MD4)*

4. At 16:20, senior's text pager goes off. He takes a look. It is a message from a nurse. Ext: 4312. Message: x-ray tech unable to do the chest x-ray. Patient Mrs G is uncooperative fighting and scratching (nurse's name-JA) RN D4. At 16:22, senior makes a call to return the page. At 16:23, senior talks to the nurse JA regarding x-ray refusal and informs the nurse that they will look into it. At 16:24pm, he hangs up. *(Site 2 Workshadowing MD 4, April 19, 2010)*

5. At 19:25, MD11 returns to the patient's room and continues examining her. While in the patient's room, I could her talking on the Blackberry (I asked her later what calls she had while in the room). It turns out she had three phone calls and two texts. Two of the calls were from the radiation oncologists and one call from the pathologist. She also received one text on the team Blackberry and one text on the senior's Blackberry from the pharmacist. *(Site 3 Workshadowing MD11 January 27, 2010)*

6. 'The only negative I can think of is just the incredible number of communications that you get, you know, text messages and emails and everything else. So the number can sometimes be overwhelming.' *(Site 3 Interview MD1)*

7. At 20:01, senior goes and sees a patient. At 20:04, the team BlackBerry rings and she picks up. She informs caller to call her right back as she is with a patient (the call was from 13th nursing station). *(Site 3 Workshadowing MD11 February 1, 2010)*

8. Junior's pager goes off. She returns the page. Her staff has paged her. The staff asks junior to page another resident JE on the team to meet her in a few minutes. | Junior hangs up and pages resident JE on her team using phone #;1. She then continues to chart her notes | Junior's pager goes off. She goes and returns the page on phone #;2. It is the case manager CA calling regarding the patient in the step-up unit. Phone #;1 rings. But Junior is talking on phone #;2 with case manager CA | Junior stretches over to pick up phone #;1 while continuing to talk with case manager CA on phone #;2 | Conversation ends on phone #;2. Junior returns to phone #;1 but resident JE has hanged up already. She then repage for resident JE on phone #;1. Soon after, team B's pager goes off. Junior returns the page on phone #;2. At the same time, phone #;1 rings. Junior puts the caller on phone #;2 on hold | At 3:20, she picks up phone #;1 and talks to resident JE quickly. Junior rely the staff meeting information to resident JE and hangs up. Junior then returns to phone #;2. It is a page from the nurse regarding co-signing. Issue: Patient refusing to go for x-rays without the resident. *(Site 1 Workshadowing MD9 April 9, 2010)*

site 3, which relied on smartphones, perhaps owing to the lack of certainty about the method (eg, email or call back) the receiver would use to respond to a sender's page (box 3: points 7–8).

For receivers, annoyance and resentment were noted when they were interrupted by what they perceived as unimportant information sent during patient care activities or protected times such as teaching rounds or sleeping hours (box 3: point 9). The tensions worsened when there were discrepancies between the sender's and the receiver's perceptions of which issues were required communication, as well as expectations about responses to pages. (box 3: point 10).

Impacts on the use of informal communication systems

Communication systems appeared to influence the adoption of informal or unofficial communication processes amongst clinicians. With the numeric paging method, messages were limited to numbers. Some clinicians attempted to circumvent this situation by resorting to codes such as '911' and '000' in their pages either as warning alerts to indicate urgency or as means of identification (box 4: points 1–3). Unfortunately, these unofficial and informal processes sometimes created confusion amongst new team members (box 4: point 4). Informal processes of communication exchanges were also seen, such as post-it notes on patient charts or annotations of notes written on clipboards with requests or updates on specific patients' care plans (box 4: points 5–6).

Another behavior observed was the use of personal mobile phones or smartphones for clinical communication. Residents would share their personal cell phones numbers among themselves so that they could call, send texts or even instant message one another about patients, often including personal health information in the communication (box 4: points 7–9). Even at sites where official smartphones were provided, users would still communicate using insecure channels such as Short Message Service text messages (box 4: point 10). Users were aware of the privacy infringements, but appeared to favor efficiency over confidentiality, although attempts were made to reduce the risks by minimizing information that identified patients (box 4: point 11).

DISCUSSION

Previous evaluations of communication interventions describe the impacts and issues from single pilot site studies. These include difficulty in knowing whom to contact,[16 17] high level of interruptions with numeric paging,[18–21] and paging shortcuts that can cause adverse events.[22] By applying multiple methods across five sites, our study is one of the largest and most comprehensive conducted in the field and provides a view of different methods used to manage hospital communication on GIM wards. We were able to describe current problems with communication methods and effects of communication system interventions. We found that there were intended and unintended consequences on senders, receivers, interprofessional

Box 3 Interprofessional collaboration

1. 'I think we rely too much on computers and forget to talk to people. For example, on the weekend, one of the residents entered medications into the system at 3:00. Nobody checks for med updates at that time. So if you are going to make changes at 3am, you need to tell somebody.' *(Site 3 Interview Nurse 8)*
2. 'Being on the computer is kind of cold because you don't who you are talking to, for one thing. And you don't hear their voice. And a lot of meaningful interaction is lost because it is just the cold, hard thing you are sending.' *(Site 2 Interview Nurse 2)*
3. 'Before, we actually get to know who the patients' doctors were and you actually get to talk to them and build a rapport with them. It's really more so if we are working directly with a patient (and) at the patient's bedside that we will get to know the doctors and really understand their perspectives and bring up issue sot their attention. So I think that is lacking a bit since the Blackberry has been implemented.' *(Site 3 Interview Nurse 9)*
4. 'Sometimes when you page them three times and then you end up calling them and say 'Did you get my page?' 'Oh yes, I got them'. Well then, why didn't you respond to them?' *(Site 3 Interview Nurse 13)*
5. 'Especially when you're on call and you're trying to reach someone and they're not calling you back. You don't know why they're not calling back. (Whether) they haven't received the pages (or) it went to the wrong person, (or) they're no longer carrying their pager for some reason, or they're just busy. It can foster some sort of negative feelings of just being annoyed at this person for not returning your page and you're waiting around for them to call you back. Sometimes they'll call you and phone is engaged, busy, because someone else sat at the phone and spoke to them so now they get annoyed at you. I think foster a bit of negativity around that.' *(Site 1 Interview MD1)*
6. 'Yeah, some of the responses are quite vague. Like they would page and say this task was completed by this and this person. But from the nursing perspective, what do you mean it was completed? Did someone look at it and will be coming to see the patient? Or did someone pass it on to someone else to complete?' *(Site 4 Interview Nurse 5)*
7. At 18:58, Nurse D sent a webpage to team 4 for a call back request. Message: 'pt's BP is 200/120, HR 93, T 37.5, R 22, O2 sat 94 on 1 L. c/o not feeling well'. At 19:00 nurse D looks anxious and frustrated after sending her WP. She keeps looking at her watch and tells other nurses about she is waiting for a call back and that she needs it soon: *I need a call back right now…they haven't called back yet…the BP is too high*' She checks her email to see if they sent an email response instead. There was no email response. At 19:05pm, Nurse D repeats her webpage to team 4 for a call back request. Message: BP high, 200/120. Pt c/o not feeling well and is very confused, pulling at line. Please call back. At 19:06pm, nurse D is very anxious and is complaining to other nurses about not getting a call back. *(Site 3 Ward Observations, March 18, 2010)*
8. 'There was no choice. Now there's a choice to page, there's a choice to text page. You can ask for no response, email response, call back response or call so there's six choices right?..Because there is so many choices it's likely what the resident would have liked and what the nurse did is probably not going to align'.' *(Site 3 Interview MD3)*
9. 'If I'm in morning teaching or noon rounds then it's-especially if you get a couple pages like it's a little bit frustrating because you're trying to do something else at the same time and sometimes it's totally non-urgent. I understand emergency pages…but when it's non-urgent, it's a bit frustrating… ' *(Site 1 Interview MD6)*
10. 'If a doctor comes up to you and says 'why did you webpage (text message) me this?' To him, this is stupid you know. 'You didn't have to webpage me this' That's frustrating.' *(Site 3 Interview Nurse 7)*

BP, blood pressure; WP, webpage.

collaboration, and the use of informal communication processes. Use of alphanumeric paging, task-based management systems, and smartphones appeared to lead to more communication occurring by text instead of by talking. Use of smartphones appeared to be related to a higher rate of interruptions and increased confusion around which of the multiple communication channels to use.

Our findings also highlight the complex nature of clinical communication. Communication systems affect the sender and the receiver of clinical exchanges and also affect the quality of interprofessional collaboration and the adoption of unreliable, informal processes among clinicians. Future work should take this complexity into account and consider how communication methods impact both the senders and receivers of communication, interprofessional collaboration, and the use of informal, often insecure modes of communication.

The study had limitations that need to be noted. Our evaluation was conducted in academic teaching hospitals and had a specific focus on medical residents. This focus may make the findings less applicable to the broader topic of interprofessional communication, especially at community institutions. Data collection and analysis could have been improved as there was also underweighting for work shadowing at site 4. Ideally, inter-recorder and inter-rater reliability would have been performed, and we would have captured and analyzed the content and intent of messages. Similarly, base rates of communication and interruptions before implementation of communication interventions would be helpful to understand the effects. Finally, it is important to note that smartphone communication is rapidly evolving. While four sites continue to use the same communication method, site 1 has adopted smartphones for clinical communication since we collected our data. Nonetheless, we collected a large and substantial set of data which included hundreds of hours of observations at nursing stations and work shadowing, along with interviews obtained from five hospitals. Our study provides a rich description of communications issues and problems in GIM wards in five hospitals that are likely to be generalizable to many other sites.

In conclusion, interventions to improve clinical communications appeared to improve specific problems. None appeared to deal with all the issues, and unintended negative effects were seen in all systems. More advanced communication systems with smartphones appeared to increase interruptions but made it

Box 4   Use of informal processes

1. 'Sometimes if it's something really important we have a little codes for each other… if it's something that really needs to be addressed, we'll put in 99 or something we made up between ourselves, we made up little things that this mean by putting 99 it's very serious. So kind of like prompt them to call back right away'. *(Site 1 Interview Allied Health 7)*

2. 'Usually when it's one resident paging another, someone on your team, we usually enter in '000' before your extension. And the reason why we do that is we can identify whether we're being paged from within our own team. And that often is-it's important because we will respond to pages faster if you know if it's someone-one of your colleagues. Whereas if it's the emergency room or something like that you may not be as quick to return a page.' *(Site 4 Interview MD3)*

3. At 14:38, senior's pager goes off. Senior commented to the team that junior-CE just paged as she usually double paged to identify (ie, 1234 1234). *(Site 4 Workshadowing MD2, August 4, 2010)*

4. 'There was actually a big event when I was on the team I was in, just couple of months ago. I got paged 99 and then four digits, and nobody had told us that 99 just means urgent and then the next four digits is what you call back. So I was calling back it was like 993547 so I was calling 9935, 994-like I was trying different combinations but I wasn't able to get in touch with them and it wasn't until maybe 5 or 10 min later when my staff called me and said do you know this one patient, like he was crashing and ICU was up there and everything and this person ended up being incubated later that day, so he was very, very sick. And I didn't know, nobody had told me that's what 99 means.' *(Site 1 Interview MD6)*

5. 'Senior shows me a yellow sticky note. The pharmacist has left a sticky note on the patient's chart for senior to see it or else the pharmacist will call senior to let him know there is a note'. Message: *If assess, patient needs 25mgs of hydrochlorothiazide PO-Patient was on it at home*' Senior continues charting his notes. *(Site 2 Workshadowing MD1, April 7, 2010)*

6. 'If there is a change and it is not urgent they need to know then I let them know by page. We used to have a clipboard that we used to write stuff that we will check in the morning and I really do not know where that went.' *(Site 1 Interview Nurse 4)*

7. 'I often have my cell phone with me so I give them my direct cell phone number and then they'll call me, and that's pretty much it.' *(Site 4 Interview MD3)*

8. Senior is carrying the code pager and own pager. He is also carrying the hospital Blackberry, although he does not know the password to the BlackBerry and does not know how to use it. Senior says he hardly use the BlackBerry though he carries it around. Senior prefers others to call him on his cellphone to talk. *(Site 2 Workshadowing MD4, April 19, 2010)*

9. Junior commented that while she was on general surgery rotation, she would use her personal Blackberry to return pages on her pager. Her team will either text or BBM each other on their personal devices. She thinks it is more efficient as there is less need to wait around for call backs. Resident JA takes a look at her personal Blackberry and commented that their team senior has sent her an email about electrolytes. *(Site 1 Workshadowing MD8)*

10. At 21:53, senior's BlackBerry beeps. Junior AE had just Short Message Service him. Senior replied to junior AE's message about reviewing a patient case. Junior AE replies back at 21:54. *(Site 3 Workshadowing MD18, March 27, 2010)*

11. 'Through texting…although the issue with texting is the confidentiality, there's no guarantee that it is confidential so you have to encrypt people's names. So you say Mr G or my patient with this, whatever, like you identify that you know what they have, so there is an issue with that.' *(Site 1 Interview Medical Student 2)*

BBM, BlackBerry Messenger; ICU, intensive care unit.

easier to respond, thus possibly reducing disruptions. Given the complexity of clinical communication, interventions to improve communication should be designed and evaluated from multiple aspects, ranging from the individual sender and receiver level, the interprofessional team level, and, finally, at the system level.

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