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Healthcare Quarterly

PHYSICIANS AND DIGITAL TRANSFORMATION

+

Leveraging Patient Data

Introducing Electronic Order Sets

Effectiveness of Real-Time Locating

Smartphones in the Clinical Setting

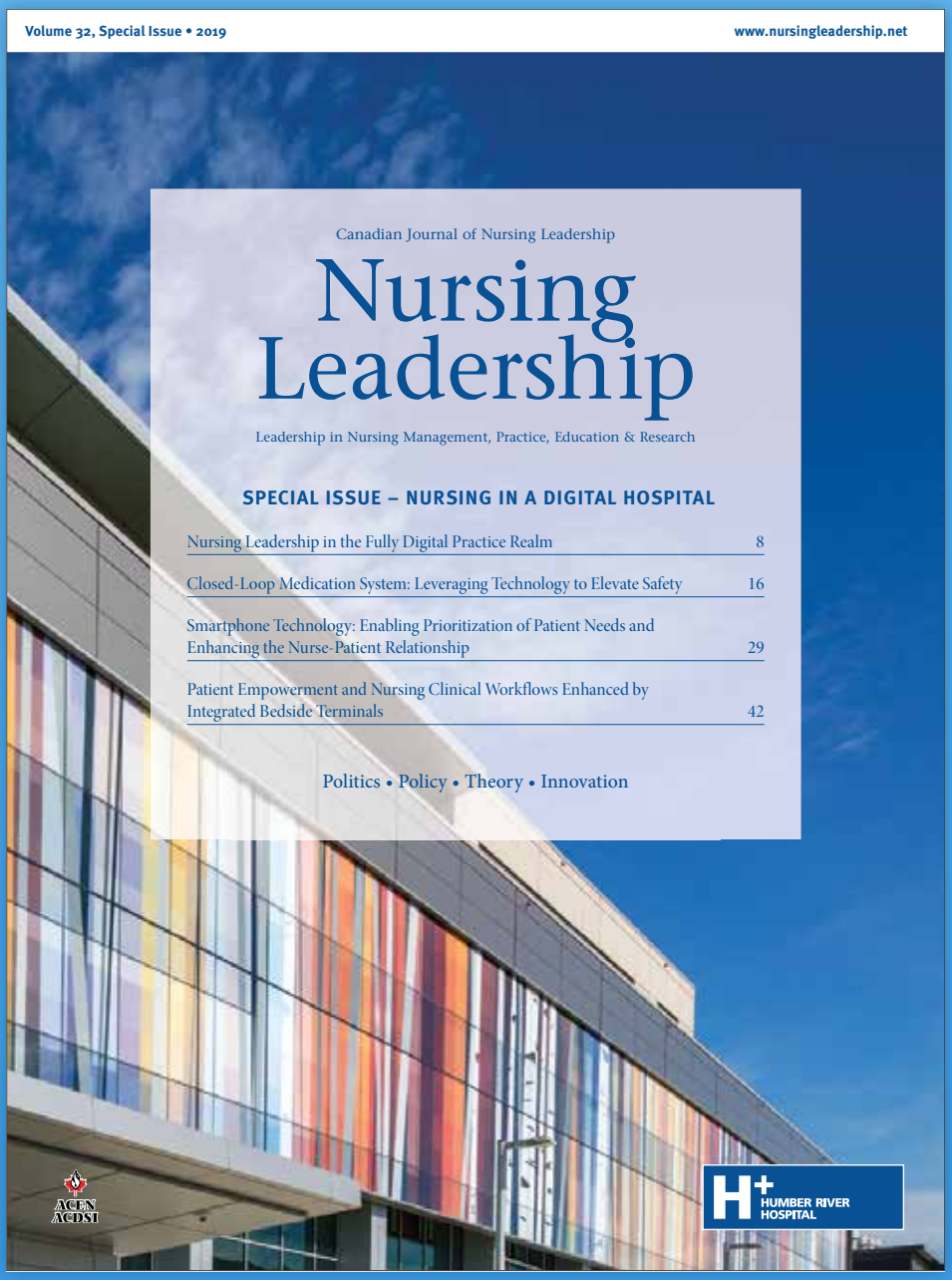
Perceptions of Patients and Medical Learners

Technology Across Generations

In this issue *Vol.23 Special Issue 2020*

Nursing in a Digital Hospital

In 2019 Humber River Hospital sponsored an issue of *Nursing Leadership*.



"As you read each article, your questions may be answered or you may find that certain papers raise more questions than they answer. You may find aspects of the digitalization of healthcare, as explored in this issue, exciting and may hunger for more information, or you may disagree with certain aspects."

Guest Editor Sandra DeLuca

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Physician Experience at the Leading Edge of the Digital Healthcare Transformation

Michael Gardam

Physicians as a group have a highly variable love/hate relationship with digital technology: there is no doubt that digital technology has the potential to dramatically improve the care that we provide to our patients; however, it also has the potential to negatively disrupt how we work and interact with one another and may even cause harm, albeit rarely (Wachter 2015). One suspects that this trade-off is similar to what has been experienced by society as a whole as we have undergone the digital revolution over the past two decades. For example, although digital platforms have allowed us to stream more music than could ever be purchased by one individual, it comes at the cost of sound quality. Social media has allowed billions of people to connect across cultures but has opened up a whole new world of cyberbullying and "fake news."

Thus, technological advances are rarely, if ever, all positive or all negative but rather somewhere in between. This special issue of *Healthcare Quarterly* is an initial glimpse into the impact of digital technology on physicians at a highly technologically advanced community hospital in Toronto, Canada. In addition to using an electronic health record (EHR) for all in-patient and much of ambulatory care, Humber River Hospital (HRH) has taken digital technology to a higher level in the form of a command centre that tracks patient flow and possible harm events, network-connected clinical devices, dedicated communications technology and patient and staff tracking using real-time location systems (RTLSs). The pace of digital adoption at HRH has been fast and steady over the past 5 years, and the six papers in this issue give us insight into how technology has impacted our physicians as educators, clinicians, team members and researchers.

Benefits of Digital Healthcare Technology

The impact of healthcare technology on front-line physicians has been eloquently captured by Dr. Atul Gawande in his *New Yorker* article: "Why Doctors Hate Their Computers," in which he provides a commentary on the implementation of an EHR at a Boston teaching hospital (Gawande 2018). Without a doubt, EHRs are a major advancement in healthcare documentation over paper charts. Digital patient records greatly improve the accuracy and accessibility of patient information and result in improved efficiency, safety and patient-centredness as patients can access their own charts from anywhere in the world. Similarly, in the world of diagnostic imaging, digital Picture Archiving and Communications Systems (PACSs) have essentially eliminated looking for lost films and can allow for the reading of medical images from anywhere in the world with an Internet connection. Such systems also are a boon for research as huge amounts of information can now be searched, measured and analyzed (Jensen et al. 2012). Chart reviews involving actual paper charts are, fortunately, becoming a thing of the past. Indeed, in this issue of *Healthcare Quarterly*, Hagen et al. (2020) show the ease with which quality and

research data can be extracted from an EHR — something that would take months and considerable resources to perform in the paper chart era.

In addition to being a searchable repository for physician documentation, electronic reminders built into EHRs can also make it easier for the clinician to track important but less frequent interventions, such as vaccinations and cancer screening. If vital signs equipment is connected to the EHR, as has been done at HRH, simple but critical data, such as temperatures, blood pressures, pulse rates and oxygen saturation, can be uploaded into the patient chart instantaneously. HRH has taken this one step further by combining the components of the National Early Warning Score (NEWS) 2 for sepsis (Royal College of Physicians n.d.), taken from the EHR into a sepsis early warning system that sends messages to the clinical team when a patient begins to show signs of early sepsis. In a similar fashion, closed-loop medication systems such as the one at HRH can automatically document that a medication was given while at the same time verifying that it was given at the correct dose. All of these advances clearly have the potential to save valuable time and improve efficiency and have been widely supported by the medical staff.

If vital signs equipment is connected to the EHR, as has been done at HRH, simple but critical data, such as temperatures, blood pressures, pulse rates and oxygen saturation, can be uploaded into the patient chart instantaneously.

The Downsides of Digital Healthcare

In his article, Gawande (2018) acknowledged the benefits of digital information technology while also detailing the perhaps unanticipated, or at least underestimated, negative impact of such systems. Although physicians' notes and orders input into an EHR are readable and accessible, the time required to document in EHRs has significantly impacted physicians. This is especially true in the US, where documentation has both billing and medical legal implications that are more significant than in Canada. This impact has been so significant that EHRs are now considered the leading cause of the current epidemic of burnout affecting physicians (West et al. 2018). It has been shown that after a busy working day, clinicians frequently head home to complete their documentation in the evenings and on weekends (Gardner et al. 2019). Hospitals, including those in Canada, are now considering employing scribes who follow physicians and document on their behalf, especially in high-volume areas such as emergency departments (Graves et al. 2018). While having the potential to save hours of physician time each week, this approach also requires new resources to pay for the scribes and must awkwardly involve another person in the physician–patient relationship. For clinicians who are predominantly paid through a fee-for-service model, the introduction of electronic charting can negatively impact their income if they try to control the number of hours they work each week while also taking considerably longer to document their patient encounters. An added complication for Canadian physicians is that essentially all the EHRs used in Canada were designed for the American healthcare system and thus are not as tailored to our practice in a single-payer, less litigious system.

As one might hypothesize, these challenges have a generational component. In this issue, Nimjee et al. (2020) describe the generational differences at play when electronic charting is introduced into a busy urban emergency department. Perhaps not surprisingly, younger generations seem to be more accepting of EHRs; however, they also demand more customization than their predecessors. Given that the average age of Canadian physicians is in the mid-50s (CIHI 2018), Nimjee et al.'s study suggests that a large proportion of our doctors are going to struggle with the digital world over the coming decade. Miller et al. (2020) also show that learners (i.e., the youngest of doctors) generally adapt fairly well to EHRs. These two papers suggest that, fortunately, the negative impact of EHRs on physician wellness may lessen in time. The impact may be further helped by system upgrades that lead to more intuitive and user-friendly interfaces.

Electronic documentation has also disrupted physician–patient relationships: physicians can be seen as spending more time interacting with their computer screen than the patient in front of them, leaving patients feeling ignored (Gardam and John 2018; Toll 2012). Typing while interviewing a patient can be highly disruptive and off-putting to the patient, even if the physician has excellent typing skills. Voice recognition software has considerably improved over the past decade for those who eschew typing; however, the time required to review one's dictations when all notes are electronic can be considerable. Simply put, computer screens get in the way of connecting with patients and have the potential to make emotional and difficult encounters even more trying. Miller et al. (2020) report similar findings when studying the negative impact of EHRs on learners and the doctor–patient relationship. They concluded that provider practice has an important role in how intrusive the computer is in the doctor–patient interaction: the computer has the potential to interfere, but it does not have to. It is hoped that future generations of hardware, such as tablets and handheld devices, may lessen the intrusion of the computer screen. The lesson here is not to do away with the computer but rather to be mindful of its potential negative impact on the doctor–patient relationship and adapt one's practice.

EHRs have also disrupted hospital social networks: where in the past physicians would normally chart alongside nurses in the nursing station, they now often do so from another part of the hospital. Wachter described nursing stations devoid of human interactions with clinicians glued to their screens (Wehrwein 2015). In a similar fashion, PACSs have largely stopped what was once regular interactions between front-line clinicians caring for a patient and the radiologists who read the images. All of us who worked in the pre-PACS era can think of clinical puzzles that were solved during these sessions. The impact of this disruption is largely unknown; however, it cannot be negligible. The literature is clear on the importance of frequent and resilient interactions between individuals in creating high-functioning teams (Keller and Meaney 2017). What happens to such a team when its members become removed from face-to-face interaction because of digital technology and communicate through other means? Interestingly, Manocha et al. (2020) show in this issue that replacing pagers with smartphones, which are meant to improve team communication, are not that well liked by physicians but are appreciated by nursing staff. Physicians reported that, unlike a pager, which allowed them to respond when it fit their schedule, telephone calls were far more intrusive. In their feedback, they felt that secure texting would allow for more communication than traditional pagers but still allow for physicians to prioritize which issue to respond to first. In response to this, HRH is now trialling a novel communication application that will, hopefully, be better accepted and perhaps even preferred by the medical staff.

Computerized physician order entry (CPOE) and order sets also have the potential to be double-edged swords: theoretically, completing one's orders digitally should result in efficiencies as clicking on orders should be faster than remembering what to order and then writing it down. For simple clinical problems, however, requiring digital orders takes longer than writing them, and order sets may contribute to over testing and increased costs as they can make it easy to click on additional tests (Choi and Atlin 2018). Computerized order sets are also often used to drive physician prescribing and ordering practice, with the aim of standardizing practice to meet current guidelines. For example, post-myocardial infarction order sets will invariably include all of the current recommended treatments, whereas those for a hospital-acquired pneumonia will include the recommended antibiotic and duration of therapy. This is an important and laudable use of digital technology; however, physicians often state that it also hinders their ability to see patients as unique individuals and causes them to move toward a "one size fits all approach," which does not adequately acknowledge the complexities of clinical care and may paradoxically cause harm (Shah and Cifu 2018).

In their study of mostly new physicians, Fishbein et al. (2020) report in this issue that the majority found order sets to be helpful at improving efficiency, yet respondents also confirmed that physician judgment was still required. It is important to consider order sets as living documents that change as the recommendations change and that can be adapted in ways that best fit the users' practice.

RTLSs have emerged as an important technology in healthcare environments. Such devices can be used to find equipment such as beds, wheelchairs and dialysis machines, in addition to tracking patient and staff locations. In the case of patients, such systems can regularly update family members as a patient moves throughout the hospital (e.g., when moving from the preoperative area, to the operating room and to the post-anesthesia care unit), thus minimizing a major source of anxiety. For staff, such systems can provide an additional level of safety by enabling them to call for help at the push of a button and have responders automatically know their location. Of course, such systems can also engender concerns that hospital staff are being watched, which can undermine the organizational culture unless carefully managed. In this issue, Heller et al. (2020) describe a less than ideal surgeon experience with one such system that geolocates patients travelling through the surgical program. Although surgeons were generally very supportive of such a system in theory, in reality, system shortcomings made it sometimes hard for them to rely on the information reported. Families, on the other hand, generally liked the system but had no idea of the manual work going on behind the scenes to provide them with accurate information. Presumably, as the reliability of the system is improved, this technology would be welcomed in the operating room by the surgeons.

The intent is thus not to return to pen, paper and illegible handwriting but to move into the digital age with our eyes wide open.

Adaptability Is the Keyword

As the healthcare system adopts more digital systems, a dependency on such systems will inevitably develop. Nowhere is this more obvious than during system downtimes, both planned and unplanned. These events require considerable resources to enable clinical care to continue and are a shocking reminder of both how much digital systems have changed our work environment and how difficult it would be to turn the clock back to the analog past. Without our digital environment, all activities must be documented on paper, lab results must be faxed or conveyed by phone and extra staff are often required. Physicians dread downtimes, not only because of the immediate disruption but also because they precede system upgrades where they may be required to relearn and adapt to a new system.

Despite the aforementioned caveats associated with digital technology in healthcare, these systems are clearly a major

advancement over paper documentation, and their use is only going to increase. This is not a "flavour of the month": digital technology will continue to spread, supported by the overwhelming evidence that they offer tangible improvements, albeit with some real consequences to physicians. The intent is thus not to return to pen, paper and illegible handwriting but to move into the digital age with our eyes wide open. HRH has invested heavily into using this technology as it has the potential to positively transform how we deliver care, but we must anticipate the many bumps along the road. The experience of any early adopter of technology is that there will be some false steps, and there must be a willingness to learn from failure and try again. Furthermore, as with any change initiative, physicians need to be engaged at every step along the way and have a hand in creating the future. As administrators, we need to be sensitive to physician concerns and not simply ascribe them to physicians being change averse. The six articles in this issue of *Healthcare Quarterly* show a willingness by physicians to try new technology and indicate a requirement for those of us leading the change to understand how adoption can sometimes be challenging.

References

Canadian Institute for Health Information (CIHI). Physicians in Canada, 2018. Retrieved January 6, 2020. <https://www.cihi.ca/sites/default/files/document/physicians-in-canada-2018.pdf >.

Choi, J. and C.R. Atlin. 2018. Path of Least Resistance: How Computerised Provider Order Entry Can Lead to (and Reduce) Wasteful Practices. *BMJ Open Quality* 7:e000345. doi:10.1136/bmjoq-2018-000345.

Fishbein, D., M. Samant, N. Safavi, S. Tory, E. Miller and S. Solomon. 2020. Physician Experience with Electronic Order Sets. *Healthcare Quarterly* 23(Special Issue): 14-22. doi:10.12927/hcq.2020.26176.

Gardam, M.A. and J. John. 2018. The Continuing Challenge of Patient-Centred Care. *Canadian Journal of Physician Leadership* 4(3): 87–91.

Gardner, R.L., E. Cooper, J. Haskell, D.A. Harris, S. Poplau, P.J. Kroth et al. 2019. Physician Stress and Burnout: The Impact of Health Information Technology. *Journal of the American Medical Informatics Association* 26(2): 106–14. doi:10.1093/jamia/ocy145.

Gawande, A. 2018, November 12. Why Doctors Hate Their Computers. *The New Yorker*. Retrieved March 18, 2020. <https://www.newyorker.com/magazine/2018/11/12/why-doctors-hate-their-computers>.

Graves, P.S., S.R. Graves, T. Minhas, R.E. Lewinson, I.A. Vallerand and R.T. Lewinson. 2018. Effects of Medical Scribes on Physician Productivity in a Canadian Emergency Department: A Pilot Study. *CMAJ Open* 6(3): E360–64.

Hagen, J., L. Klein, E. Miller and S. Solomon. 2020. Leveraging Digital Infrastructure for Data Analysis: An Example in Bariatric Surgery. *Healthcare Quarterly* 23(Special Issue): 8-13. doi:10.12927/hcq.2020.26177.

Heller, M., J. Koval, E. Miller and S. Solomon. 2020. The Impact of a Real-Time Locating System within the Perioperative Environment on Physicians and Patients' Families. *Healthcare Quarterly* 23(Special Issue): 24-32. doi:10.12927/hcq.2020.26175.

Jensen, P.B., L.J. Jensen and S. Brunak. 2012. Mining Electronic Health Records: Towards Better Research Applications and Clinical Care. *Nature Reviews Genetics* 13(6): 395–405. doi:10.1038/nrg3208.

Keller, S. and M. Meaney. 2017, June. High-Performing Teams: A Timeless Leadership Topic. *McKinsey Quarterly*. Retrieved December 30, 2019. <https://www.mckinsey.com/business-functions/organization/our-insights/high-performing-teams-a-timeless-leadership-topic>.

Manocha, S., J. Speigelman, E. Miller and S. Solomon. 2020. Smartphone Technology: Impact on Interprofessional Working Relations between Doctors and Nurses. *Healthcare Quarterly* 23(Special Issue): 34-42. doi:10.12927/hcq.2020.26174.

Miller, E., V. Burkoski, J. Yoon and S. Solomon. 2020. A Narrative Study on the Impact of Information and Communication Technology on the Relationship between Patients and Medical Learners. *Healthcare Quarterly* 23(Special Issue): 44-50. doi:10.12927/hcq.2020.26173.

Nimjee, T., E. Miller and S. Solomon. 2020. Exploring Generational Differences in Physicians' Perspectives on the Proliferation of Technology within the Medical Field: A Narrative Study. *Healthcare Quarterly* 23(Special Issue): 52-59. doi:10.12927/hcq.2020.26172.

Royal College of Physicians. n.d. National Early Warning Score (NEWS) 2. Retrieved February 26, 2020. <https://www.rcplondon.ac.uk/projects/outputs/national-early-warning-score-news-2>.

Shah, S.D. and A.S. Cifu. 2018. From Guideline to Order Set to Patient Harm. *JAMA* 319(12): 1207–208. doi:10.1001/jama.2018.1666.

Toll, E. 2012, June 20. The Cost of Technology. *JAMA* 307(23): 2497–98. doi: 10.1001/jama.2012.4946.

Wachter, B. 2015, March. How Technology Led a Hospital to Give a Patient 38 Times His Dosage. *Wired*. Retrieved January 5, 2020. <https://www.wired.com/2015/03/how-technology-led-a-hospital-to-give-a-patient-38-times-his-dosage/>.

Wehrwein, P. 2015, May 8. A Conversation with Robert Wachter, MD: Medicine's Bumpy Ride into the Digital Age. *Managed Care*. Retrieved December 30, 2019. <https://www.managedcaremag.com/archives/2015/5/conversation-robert-wachter-md-medicines-bumpy-ride-digital-age>.

West, C.P., L.N. Dyrbye and T.D. Shanafelt. 2018. Physician Burnout: Contributors, Consequences and Solutions. *Journal of Internal Medicine* 83(6): 516–29. doi:10.1111/joim.12752.

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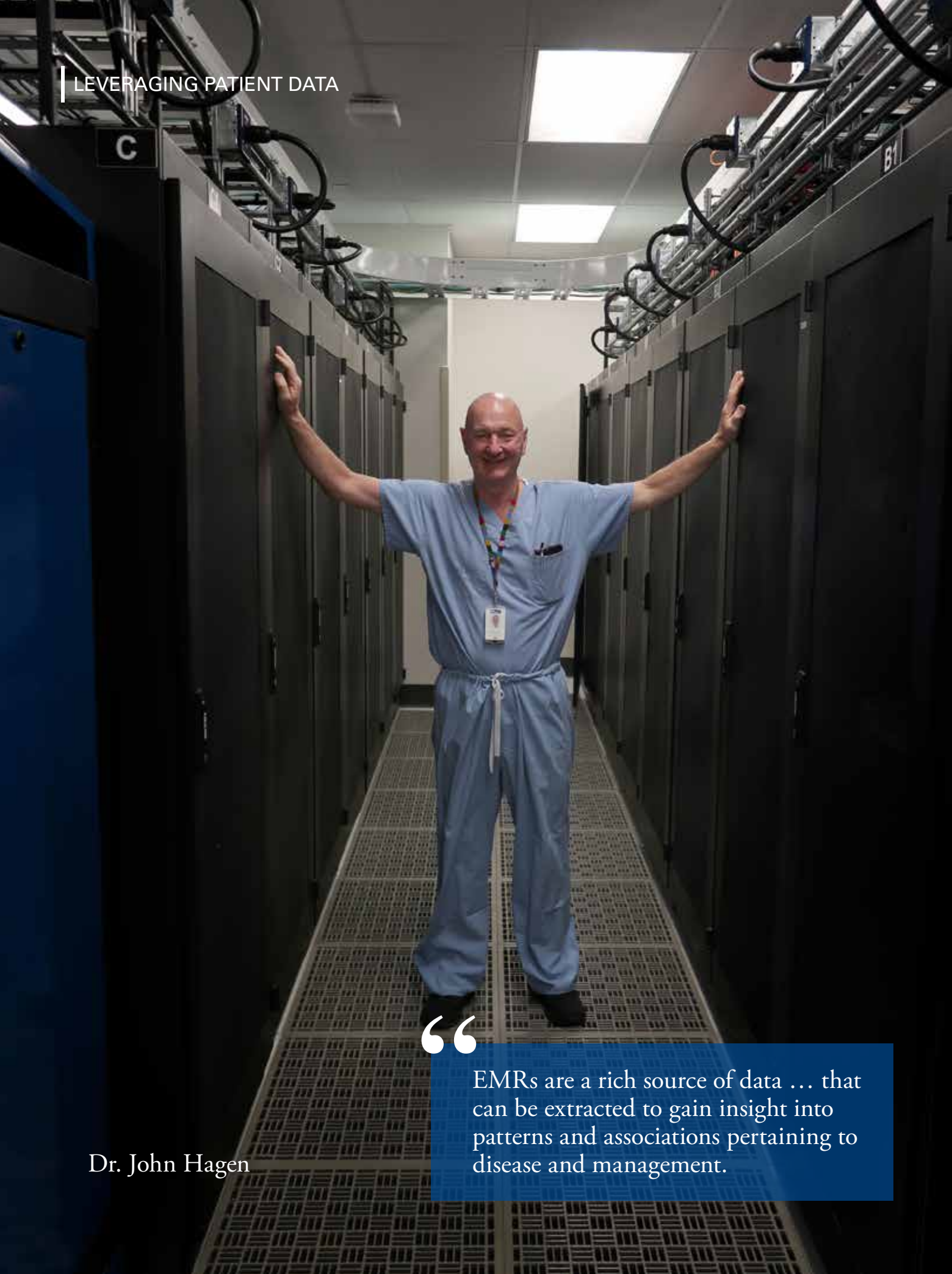

> “EMRs are a rich source of data … that can be extracted to gain insight into patterns and associations pertaining to disease and management.

Dr. John Hagen

Leveraging Digital Infrastructure for Data Analysis: An Example in Bariatric Surgery

John Hagen, Lazar Klein, Ethan Miller and Shirley Solomon

Abstract

Background: **The digitalization of healthcare information provides hospitals with the ability to gain insight into patterns and associations pertaining to disease and management. Using bariatric patient data as an example provided an opportunity to explore the potential of electronic medical record (EMR) data to generate insights.**

Objective: **The aim of this study was to extract EMR data pertaining to bariatric patient information as a means to explore predictive factors of weight loss post-bariatric surgery.**

Methods: **We conducted a retrospective cohort study of patients undergoing bariatric surgery between January 1, 2018, and April 30, 2019, at Humber River Hospital. Multiple linear regression was used to examine whether age, pre-surgery body mass index (BMI), comorbidities and mental health disorders predicted higher weight loss 6 months following bariatric surgery.**

Results: **A total of 502 patients were included in the final analysis. Age (ß = 0.04 [95% CI 0.01, 0.06], $p = 0.005$), baseline BMI (ß = –0.16 [95% CI –0.19, –0.13], $p = <0.0001$) and diabetes (ß = 0.82 [95% CI 0.23, 1.42], $p = 0.007$) were associated with weight loss six months post-bariatric surgery.**

Conclusion: **EMRs are a rich source of data with the potential to generate insights that can lead to improved care.**

Introduction

The advent of electronic medical records (EMRs) has allowed for extensive documentation and storage of critical patient data. EMRs provide access to information such as in-patient and outpatient records, laboratory results and imaging. In addition to recording and documenting patient information into EMRs, analysis of the data may be employed for clinical research and be used to guide clinical decisions. Healthcare institutions may extract patient data to gain insight into patterns and associations pertaining to disease and management. The aim of this study was to use EMR data to explore preoperative predictors of weight loss following bariatric surgery.

Obesity increases the risk of developing comorbidities such as diabetes, hypertension, hyperlipidemia and obstructive sleep apnea (CIHI 2014). Achieving significant weight loss post-bariatric surgery is key as it is correlated with success in improving existing comorbidities by reducing blood glucose or resolving hyperglycemia more effectively than medical therapy alone (Schauer et al. 2017). Several studies have found that comorbidities were important factors causing less excess weight loss following bariatric surgery (Carbonell et al. 2008; Júnior et al. 2011). This may pose a problem for patients with existing comorbidities, who may not lose as much excess weight after bariatric surgery as those without comorbidities.

In addition to physical comorbidities associated with obesity, psychological issues arise as well. In a study conducted by Goldsmith et al., (2006), it was found that 55.6% of obese patients (n = 54) met the criteria for major depression. In addition to the association between mental illness and obesity, mental illness might also play a role in preventing significant weight loss. A prospective analysis examining 104 bariatric surgery candidates found that patients with a current or lifetime history of mood disorders lost significantly less weight than patients without a psychiatric diagnosis following bariatric surgery (Semanscin-Doerr et al. 2010). Furthermore, a study conducted by Kinzl et al. (2006) exploring psychiatric disorders among bariatric surgery patients in relation to weight loss success found that there were poorer weight loss outcomes among patients with multiple psychiatric disorders.

EMRs contain a great deal of data that can be extracted and analyzed and allow for rapid and convenient data collection, which might later be used to examine data patterns and associations. With extensive data analysis, interventions might be discovered that improve patient care and management outcome. This study explored body mass index (BMI) reduction in bariatric patients using EMR-related variables from a single-site institution.

HUMBER RIVER HOSPITAL is one of Canada's largest community acute care hospitals, serving a population of more than 850,000 people in the north-west Greater Toronto Area. The multi-site hospital currently operates out of its Wilson Avenue acute care site and Finch and Church Street reactivation care centres with a total of 722 beds, just over 3,800 employees, approximately 700 physicians and over 1,000 volunteers.

Affiliated with the University of Toronto and Queen's University, Humber River Hospital is North America's first fully digital hospital. Part of Humber River Hospital's digital infrastructure includes completely automated laboratory services, robots sorting and mixing medications, electronic health records, tracking systems, for patients undergoing surgery, that update families through their cellphones and patient bedside computer terminals – all varieties of technologies that automate information, eliminate paper and provide a connected experience for patients, staff and families.

Humber River Hospital was awarded Accreditation with Exemplary Standing in 2018 and, since its opening in 2015, has received numerous awards and accolades for technological advancements and innovation (www.hrh.ca).

Methods

Data source and data collection

Data for this study were extracted from the Ontario Bariatric Registry (Anvari et al. 2019). The registry collects standardized information on consenting patients undergoing bariatric treatment at participating Bariatric Centres of Excellence in Ontario. A secondary analysis of de-identified data was conducted on patients undergoing bariatric surgery between January 1, 2018, and April 30, 2019 (N = 718), at Humber River Hospital (HRH). Data collected included baseline patient characteristics obtained at the initial assessment (age, height and weight), medical history (obesity-related comorbidities), history of mental health conditions (mood disorder, anxiety disorder), weight measurement on the day of surgery and 6-month follow-up assessment (weight at 6 months). The final dataset included

only bariatric surgery patients who completed a baseline assessment as well as a 6-month follow-up assessment (n = 503; 70% of patients from the original dataset). Ethics clearance was granted by Veritas IRB, an external Research Ethics Board.

Data analysis

Variables at baseline were presented as frequency with percentage or mean with standard deviation. BMI was calculated as kg/m^2. The outcome variable was weight loss following bariatric surgery, which was calculated by subtracting the BMI on the day of surgery from the BMI measurement at 6 months following surgery for each patient. Predictor variables included age, baseline BMI (BMI on the day of surgery), obesity-related comorbidities in the past 12 months (diabetes type 1 and 2, hypertension, hyperlipidemia, chronic lung disease and sleep apnea) and a history of psychiatric illness (mood disorder and anxiety disorder).

The associations between independent variables and change in BMI 6 months following bariatric surgery were first evaluated using simple linear regression analyses. Next, multiple linear regression with backward elimination (probability for removal, $p > 0.1$) was performed, with all independent variables entered simultaneously to examine the most significant factors associated with change in BMI at the 6-month follow-up.

All regression assumptions of linearity, normality of residuals and homoscedasticity of residuals were assessed and met. Collinearity diagnostics revealed that no multicollinearity was present in the final model. All analyses were conducted using SPSS Version 25 statistical software. A p-value < 0.05 was considered statistically significant.

Results

Baseline variables are summarized in Table 1. The average age of the sample was 44.4 (SD = 10.28) years, and the mean baseline BMI of the sample was 45.9 (SD = 7.6). Of the total sample, 83.7% reported having at least one obesity-related comorbidity in the past 12 months, including diabetes (21.7%), hypertension (40.2%), hyperlipidemia (25.8%) and chronic lung disease (15.1%). Additionally, 30.2% reported having a history of mood disorder and 25.6% reported having a history of anxiety disorder.

Overall, study participants lost an average of 27.7 kg (SD = 8.7 kg) from the day of surgery to the 6-month follow-up. The mean 6-month postoperative change in BMI was –10.1 (SD = 3.0). The results from the simple linear regression analyses between the independent variables and postoperative weight loss are presented in Table 2. Younger age, higher baseline BMI, non-diabetic status, non-hypertension status and non-hyperlipidemia status were significantly associated with a greater reduction in BMI 6 months following bariatric surgery. In the final multiple regression analysis, only younger age, higher baseline BMI and non-diabetic status were associated with greater BMI reduction (R^2 = 0.21, F(3,45.20), p< 0.001). After controlling for age, baseline weight and diabetes, non-hypertension status and non-hyperlipidemia status were not significantly associated with loss of body mass in the final model.

TABLE 1.
Characteristics of study participants

Mean (SD), frequency (%) (N = 503)	
Age (yr)	44.4 (10.3)
Baseline weight (kg)	131.9 (26.5)
Baseline BMI (kg/m^2)	45.9 (7.6)
Obesity-related comorbidities (past 12 months)	
Diabetes	109 (21.7%)
Hypertension	202 (40.2%)
Hyperlipidemia	130 (25.8%)
Chronic lung disease	76 (15.1%)
Sleep apnea	328 (65.2%)
History of psychiatric illness	
Mood disorder	152 (30.2%)
Anxiety disorder	129 (25.6%)

BMI=body mass index.

Discussion

In digital healthcare organizations such as HRH, rich data are generated from multiple sources, including EMRs and administrative systems. Employing data analysis and data mining in healthcare can be a valuable technique for predicting various diseases and assisting physicians with clinical decision-making (Jothi and Husain 2015). This study analyzed EMR data pertaining to bariatric patient information as a means to explore potential associations between the data variables.

Obesity persists across the world as an epidemic disease contributing to the development of significant comorbidities, such as diabetes mellitus type 2, hypertension, coronary artery disease and cancer (Nickel et al. 2019). The onset of obesity varies greatly by age and ranges from childhood to adolescence and adulthood (Nickel et al. 2019). The findings from this study revealed that possible predictors of greater weight loss in BMI 6 months following bariatric surgery were younger age, higher baseline BMI and non-diabetic status. This model explained 21% of the variance in BMI loss. Our results are similar to those of some previous studies that identified non-diabetes status and younger age as possible predictors of better weight loss after surgery (Fox et al. 2015; Livhits et al. 2012; Ma et al. 2006; Mitchell et al. 2016; Nickel et al. 2019). Our study also identified a higher baseline BMI as a predictor of change in BMI; however, the findings in the literature on the association between preoperative BMI and weight loss following bariatric surgery were mixed

TABLE 2.
Linear regression of BMI reduction six months following bariatric surgery and potential predictors

Characteristic	Simple regression		Final multiple regression (*N* = 502)	
	ß (95% CI)	*p*-value	ß (95% CI)	*p*-value
Age	0.07 (0.04 to 0.09)	< 0.0001	0.04 (0.01 to 0.06)	0.005
Baseline BMI	–0.17 (–0.20 to –0.14)	< 0.0001	–0.16 (–0.19 to –0.13)	< 0.0001
Obesity-related comorbidities				
Diabetes	1.09 (0.45 to 1.73)	0.001	0.82 (0.23 to 1.42)	0.007
Hypertension	0.65 (0.11 to 1.19)	0.019		
Hyperlipidemia/high cholesterol/high triglycerides	1.16 (0.56 to 1.76)	< 0.0001		
Chronic lung disease	0.25 (–0.49 to 0.99)	0.508		
Sleep apnea	–0.22 (–0.78 to 0.34)	0.435		
History of psychiatric illness				
Mood disorder	–0.07 (–0.65 to 0.51)	0.819		
Anxiety disorder	–0.39 (–1.00 to 0.22)	0.206		

Note: Unstandardized regression coefficients are reported.
BMI=body mass index; CI=confidence interval.

(Livhits et al. 2012). These contradictory results could be due to the lack of a consistent metric for reporting weight loss outcome (i.e., change in BMI, total absolute weight loss, etc.).

Our study also found that a history of psychiatric illness, including mood and anxiety disorders, was not associated with greater weight loss in BMI 6 months following bariatric surgery. Our results are similar to those of previous studies that found no significant difference in the percentage of total weight loss following bariatric surgery across several psychiatric illnesses, including substance abuse and mood and anxiety disorders (Thomson et al. 2016). Our study supports other research suggesting that patients with psychiatric illness should not be excluded from bariatric surgery on the assumption that post-surgical weight loss will be poor and psychiatric symptoms following surgery will be worse (Thomson et al. 2016). This finding highlights the important issue of health inequity in accessing bariatric surgery. Jackson et al. (2014) suggested that the population that receives bariatric surgery does not reflect the individuals who need it the most. To move toward greater health equity in the treatment of obesity, further research that clarifies the predictors of successful bariatric surgery and closes the gaps in our understanding of the risks is necessary.

Implications

This study provided the opportunity to explore the potential of EMR data to generate actionable insights that foster improved care. Data analytics and data mining can support the ability of researchers and clinicians to improve the use of available research and evidence and capture care experience to create a continuous learning healthcare system (Lee and Yoon 2017). At HRH, we are just beginning to access the massive repository of data that exists within our electronic world of healthcare. In building a data strategy, there is no standardized protocol to model or compare (Lee and Yoon 2017). Recognizing that the accumulation of big data is insufficient to solve problems or answer questions, HRH is developing a robust data analytics system with the goal of improving healthcare through predictive modelling for risk and resource use, disease and treatment heterogeneity, clinical decision support, quality of care and performance measurement.

Limitations

This study has some limitations, such as the low rate of follow-up data and the short follow-up time frame of 6 months; as such, the findings may be biased. Additional predictors affecting weight loss outcome, such as motivation to lose weight, dietary habits and levels of physical activity were not studied. Furthermore, the lack of an established metric for weight loss further limits comparability across studies (Adams et al. 2013). Although the most frequently reported outcome measure in bariatric literature is the percentage of excess weight loss (%EWL), this measure may also not reflect "successful" weight loss as patients with a BMI in the higher ranges will often have a lower %EWL than patients with a lower BMI despite achieving greater absolute weight loss (Adams et al. 2013).

Conclusions

EMRs are a rich source of data in healthcare organizations

that can be extracted to gain insight into patterns and associations pertaining to disease and management. Obesity is a national epidemic that affects many Canadians. Interventions to combat obesity include lifestyle modification and bariatric surgery (CIHI 2014). By employing data analysis on bariatric patient data, we were able to explore the associations between data variables and provide insight into clinical practices that may support improved quality of care.

What We Learned:

1. Our example of data analytics generated actionable insights that may foster improved care in the bariatric patient population; for example, the focus on reducing childhood and adolescent obesity requires more than just therapies aimed at increasing healthy food consumption and exercise but may necessitate consideration of bariatric surgical intervention.

2. Similar to previous studies, our findings suggested that patients with psychiatric illness should not be excluded from bariatric surgery on the assumption that post-surgical weight loss will be poor and psychiatric symptoms following surgery will be worse.

3. The findings from our study highlight the important issue of health inequity in accessing bariatric surgery.

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References

Adams, S.T., M. Salhab, Z.I. Hussain, G.V. Miller and S.H. Leveson. 2013. Roux-en-Y Gastric Bypass for Morbid Obesity: What Are the Preoperative Predictors of Weight Loss? *Postgraduate Medical Journal* 89(1053): 411–16. doi:10.1136/postgradmedj-2012-131310.

Anvari, M., A. Sharma, S. Yusuf, D. Hong, J.-E. Tarride, M. Tiboni et al. 2019. Bariatric Registry. Population Health Research Institute and the Centre for Surgical Invention and Innovation – Supported by the Ministry of Health and Long Term Care. Hamilton, ON: Authors.

Canadian Institute for Health Information (CIHI). 2014, May. Bariatric Surgery in Canada. Retrieved March 18, 2020. <https://secure.cihi.ca/free_products/Bariatric_Surgery_in_Canada_EN.pdf>.

Carbonell, A.M., L.G. Wolfe, J.G., Meador, H.J. Sugerman, J.M. Kellum and J.W. Maher. 2008. Does Diabetes Affect Weight Loss after Gastric Bypass? *Surgery for Obesity and Related Diseases* 4(3): 441–44.

Fox, B., E. Chen, A. Suzo, S. Jolles, J.A., Greenberg, G.M. Campos et al. 2015. Dietary and Psych Predictors of Weight Loss after Gastric Bypass. *Journal of Surgical Research* 197(2): 283–90. doi:10.1016/j.jss.2015.04.019.

Goldsmith, S.J., K. Anger-Friedfeld, D. Rudolph, M. Boeck and L. Aronne. 2006. Psychiatric Illness in Patients Presenting for Obesity Treatment. *International Journal of Eating Disorders* 12(1): 63–71. doi:10.1159/000492000.

Jackson, T.D., R. Zhang, D. Glockler, J. Pennington, J.I. Reddigan, O.D. Rotstein et al. 2014. Health Inequity in Access to Bariatric Surgery: A Protocol for a Systematic Review. *Systematic Reviews* 3(1): 15.

Jothi, N. and W. Husain. 2015. Data Mining in Healthcare — A Review. *Procedia Computer Science* 72: 306–13.

Júnior, W.S., J.L. do Amaral and C.B. Nonino-Borges. 2011. Factors Related to Weight Loss Up to 4 Years after Bariatric Surgery. *Obesity Surgery* 21(11): 1724–30.

Kinzl, J.F., M. Schrattenecker, C. Traweger, M. Mattesich, M. Fiala and W. Biebl. 2006. Psychosocial Predictors of Weight Loss after Bariatric Surgery. *Obesity Surgery* 16(12): 1609–14. doi:10.1381/096089206779319301.

Lee, C.H. and H.-J. Yoon. 2017. Medical Big Data: Promise and Challenges. *Kidney Research and Clinical Practice* 36(1): 3–11.

Livhits, M., C. Mercado, I. Yermilov, J.A. Parikh, E. Dutson, A. Mehran et al. 2012. Preoperative Predictors of Weight Loss following Bariatric Surgery: Systematic Review. *Obesity Surgery* 22(1): 70–89. doi:10.1007/s11695-011-0472-4.

Ma, Y., S.L. Pagoto, B.C. Olendzki, A.R. Hafner, R.A. Perugini, R. Mason et al. 2006. Predictors of Weight Status following Laparoscopic Gastric Bypass. *Obesity Surgery* 16(9): 1227–31.

Mitchell, J.E., N.J. Christian, D.R. Flum, A. Pomp, W.J. Pories, B.M. Wolfe et al. 2016. Postoperative Behavioral Variables and Weight Change 3 Years after Bariatric Surgery. *JAMA Surgery* 151(8): 752–57. doi:10.1001/jamasurg.2016.0395.

Nickel, F., J.R. de la Garza, F.S. Werthmann, L. Benner, C. Tapking, E. Karadza et al. 2019. Predictors of Risk and Success of Obesity Surgery. *Obesity Facts* 12(4): 427–39. doi:10.1159/000496939.

Schauer, P.R., D.L. Bhatt, J.P. Kirwan, K. Wolski, A. Aminian, S.A. Brethauer et al. 2017. Bariatric Surgery versus Intensive Medical Therapy for Diabetes – 5-Year Outcomes. *New England Journal of Medicine* 376(7): 641–51. doi:10.1056/NEJMoa1600869.

Semanscin-Doerr, D.A., A. Windover, K. Ashton and L.J. Heinberg. 2010. Mood Disorders in Laparoscopic Sleeve Gastrectomy Patients: Does It Affect Early Weight Loss? *Surgery for Obesity and Related Diseases* 6(2): 191–96. doi:10.1016/j.soard.2009.11.017.

Thomson, L., K.A. Sheehan, C. Meaney, S. Wnuk, R. Hawa and S. Sockalingam. 2016. Prospective Study of Psychiatric Illness as a Predictor of Weight Loss and Health Related Quality of Life One Year after Bariatric Surgery. *Journal of Psychosomatic Research* 86: 7–12. doi:10.1016/j.jpsychores.2016.04.008.

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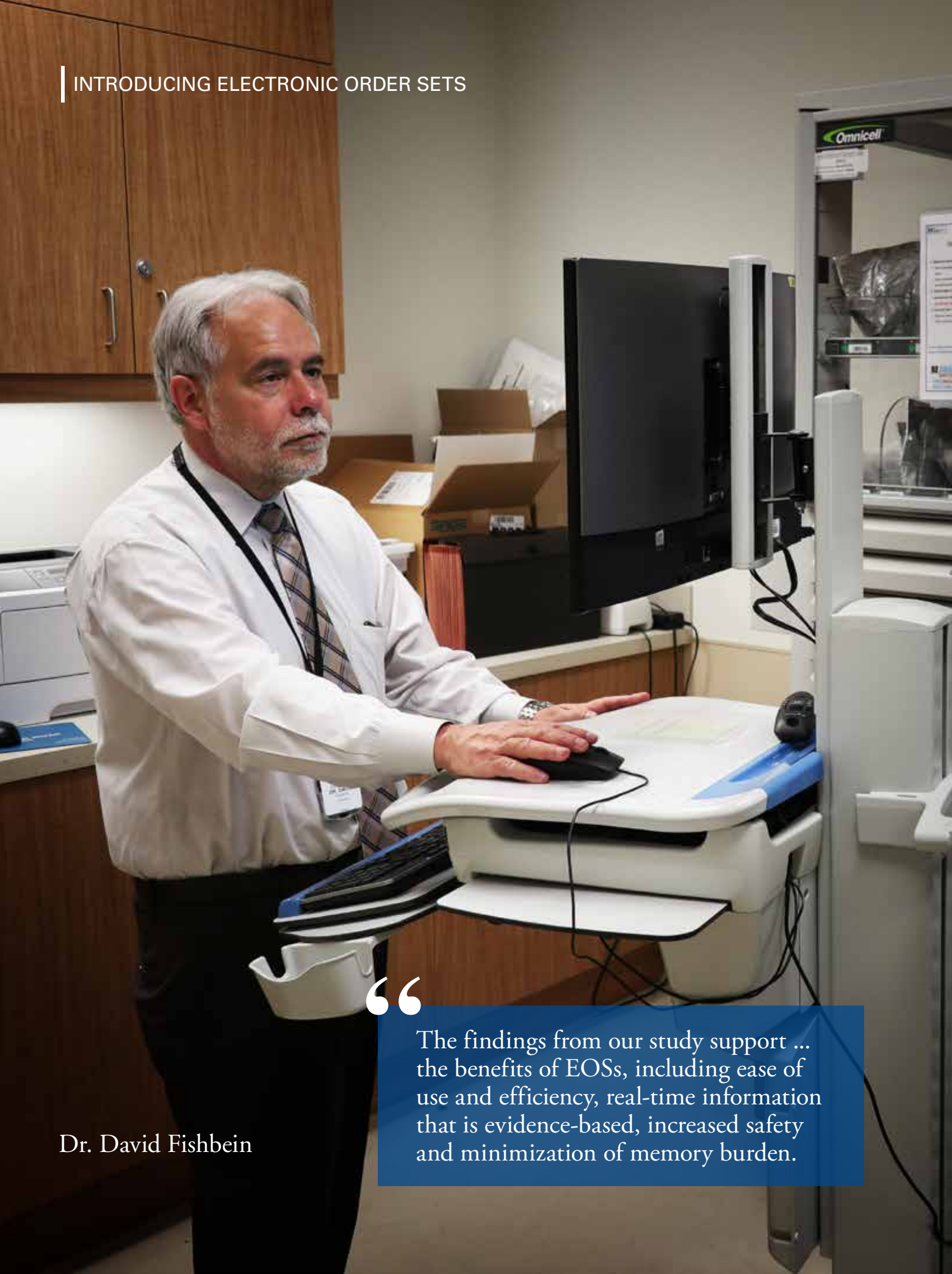

> “The findings from our study support ... the benefits of EOSs, including ease of use and efficiency, real-time information that is evidence-based, increased safety and minimization of memory burden.

Dr. David Fishbein

Physician Experience with Electronic Order Sets

David Fishbein, Meghana Samant, Nasrin Safavi, Susan Tory, Ethan Miller and Shirley Solomon

Abstract

Background: ***Electronic medical record*** **(EMR) and** ***electronic health record*** **(EHR) are used interchangeably to describe a computerized medical information system that collects, stores and displays patient information (Boonstra and Broekhuis 2010). Blumenthal and Tavenner (2010) suggested that computerized medical implementation improves decision-making and patient management. As part of its EMR, Humber River Hospital has implemented electronic order sets (EOSs) by building them into the computerized physician order entry (CPOE) system. Electronic prescribing renders paper prescriptions obsolete as it reduces errors; increases accuracy; and enhances efficiency, compliance and record-keeping (Canada Health Infoway 2017).**

Objective: **The aim of this research was to explore physicians' perspectives and experiences using EOSs.**

Methods: **This qualitative study examined the perceptions of various physicians on the impact of EOSs. Data were collected through semi-structured, in-depth interviews with eligible physicians. Domains explored included usability, efficiency, safety and implications for the physician profession.**

Results: **Major themes that emerged included usability, efficiency and safety. Several implications for physician practice were also revealed.**

Conclusion: **The findings from our study support previous studies that describe the benefits of EOSs, including ease of use and efficiency, real-time information that is evidence-based, increased safety and minimization of memory burden. EOSs were not perceived to be a replacement for clinical reasoning.**

Introduction

Since 1997, the Canadian government has endorsed the benefits of information and communication technology in the healthcare system, citing the potential and significant benefits of electronic systems as increasing accessibility and quality of health practices, as well as enhancing efficiency and reducing errors (Government of Canada 2004). Canada established an organization called Canada Health Infoway in 2001 with the mission of accelerating and spreading the use of digital health throughout the nation (Canada Health Infoway 2017). *Electronic medical record* (EMR) and *electronic health record* (EHR) are used interchangeably to describe a computerized medical information system that collects, stores and displays patient information (Boonstra and Broekhuis 2010). Blumenthal and Tavenner (2010) suggested that computerized medical implementation improves decision-making and patient management. Based on the Canada Health Infoway annual report for 2017, 162,000 active EHR users were identified across Canadian healthcare organizations (Canada Health Infoway 2017).

Humber River Hospital (HRH) is a digital hospital with an integrated EMR. As part of its EMR, the hospital has implemented electronic order sets (EOSs) by building them into the computerized physician order entry (CPOE) system. Order sets are a collection of specific items that are grouped together in a convenient template and can be standardized to contain treatment options for specific medical conditions (Li et al. 2019). For example, if a patient presents to a physician with symptoms concerning congestive heart failure, an order set might include such tests and medication as complete blood count, basic metabolic panel and furosemide (Li et al. 2019). If the patient is subsequently diagnosed with diabetes, then another order set might include hypoglycemic agents and point-of-care glucose checks. Electronic prescribing renders paper prescriptions obsolete as it reduces errors, increases accuracy and enhances efficiency, compliance and record-keeping (Canada Health Infoway 2017).

Various studies have examined the outcomes of CPOE systems. A systematic review of 67 studies examining the impacts of CPOE systems from 1966 to 2006 found overall positive results regarding "adherence to guidelines," "appropriateness of alerts," "costs and organizational efficiency" and "satisfaction and usability" (Eslami et al. 2008). However, there is a paucity of literature pertaining to user experience with EOSs. Li et al. (2019) suggested that order sets are intended to help clinicians, but the extent to which order sets support physician practice and workflow is not well understood. The aim of this research was to explore physicians' perspectives and experiences using EOSs.

HUMBER RIVER HOSPITAL

HUMBER RIVER HOSPITAL is one of Canada's largest community acute care hospitals, serving a population of more than 850,000 people in the north-west Greater Toronto Area. The multi-site hospital currently operates out of its Wilson Avenue acute care site and Finch and Church Street reactivation care centres with a total of 722 beds, just over 3,800 employees, approximately 700 physicians and over 1,000 volunteers.

Affiliated with the University of Toronto and Queen's University, Humber River Hospital is North America's first fully digital hospital. Part of Humber River Hospital's digital infrastructure includes completely automated laboratory services, robots sorting and mixing medications, electronic health records, tracking systems, for patients undergoing surgery, that update families through their cellphones and patient bedside computer terminals – all varieties of technologies that automate information, eliminate paper and provide a connected experience for patients, staff and families.

Humber River Hospital was awarded Accreditation with Exemplary Standing in 2018 and, since its opening in 2015, has received numerous awards and accolades for technological advancements and innovation (www.hrh.ca).

Methods

Study design and participants

This qualitative study examined the perceptions of various physicians on the impact of EOSs. Domains explored included usability, efficiency, safety and implications for the physician profession (Table 1). Detailed descriptive accounts were elicited from participants. Participant eligibility criteria included physicians who had experience using the EOSs at HRH for a minimum of 1 year. In addition, all of those who wished to participate in the study were at least 18 years of age, spoke fluent English and possessed the capacity to consent.

TABLE 1.
Interview Guide

Domain	Sample question
Usability	*Do you find that the system is easy to navigate?*
Efficiency	*Is the EOS beneficial to your workflow? Why or why not?*
Safety	*Can the system reduce medication errors? Why or why not?*
Implications for physician profession	*Do you believe that it can improve your skills as a physician? Can it impair your skills? Why or why not?*

Data collection

Data were collected through semi-structured, in-depth interviews with eligible physician participants at HRH in November 2019. Physician participants had the choice of being interviewed in one-on-one sessions or focus group settings according to their preference. One-on-one interviews lasted approximately 20 minutes, whereas focus group settings ranged from 30 to 45 minutes. Prior to conducting interviews, informed consent and demographic data were obtained. Trained members of the research team continued to conduct interviews until data saturation was met. Veritas IRB, an independent Research Ethics Board, approved the study.

Data analysis

Manifest content analysis was used to analyze the transcribed interviews. This method of analysis identifies core meanings that emerge in the interview transcripts (Downe-Wamboldt 1992). Two analysts independently reviewed the transcribed text and then extracted words and sentences relevant to each domain. Emerging ideas were identified and grouped into themes for each domain. Analysts extensively discussed the analytic categories, and any inconsistencies in themes were discussed until consensus was reached. Quotations were selected to highlight participants' key points. Sociodemographic characteristics from the survey data were summarized using descriptive statistics.

Results

Eighteen physicians participated in the focus groups and one-on-one interviews. Major themes emerging from the in-depth interviews are described below for each domain, along with supporting quotations from the participants. Descriptive statistics of demographic characteristics of the participants are presented in Table 2.

Usability

Two themes could be extracted from the interviews on usability of the EOSs: ease of use and searchability issues. One of the strengths of the EOSs reported by participants was that the system was simple and straightforward. Participants stated:

> I have found that it's been fairly easy to navigate, no question about it. ... I hadn't really had any difficulty with ordering things off of it all. It's very user-friendly from my perspective.

> It's pretty user-friendly; it's pretty intuitive. Point and click. It's not super complicated.

Additionally, participants who reported difficulty mastering the system as a new user were still in favour of it despite the slow adaption initially. Some participants stated:

> It is a bit of a learning curve, but once you're used to it, you're much faster.

> In the beginning, it takes a couple of people to tell you how to do it and know. It's not a huge learning curve – maybe a little bit. Overall, it's fairly easy to do.

An additional theme related to usability was issues with searchability. The most frequently mentioned issue was difficulty identifying the correct search query. For example, some found that certain medications could only be searched for by either their generic or branded names. Another cited issue was search outputs, which were long and slow to navigate:

> When they do the upgrades, we lose a lot of the names between the generics and the actual name of the medication, and now you can't search it the same way.

> [D]epending on the word that you type in, things will not come up. I find that [to be] a huge deal because sometimes if you don't guess the right word, you won't find it. There are things that I have never found because I don't know what it is supposed to be called.

TABLE 2.
Demographic characteristics of physician study participants, *n* = 17*

	n	(%)
Age range		
25–34 years	4	23.5%
35–44 years	7	41.2%
45–54 years	3	17.6%
55–64 years	2	11.8%
65–74 years	1	5.9%
75 years and over	0	0.0%
Gender		
Male	12	70.6%
Female	5	29.4%
Gender diverse	0	0%
Years of experience as a physician		
1 to < 3 years	1	5.9%
3 to < 5 years	4	23.5%
5 to < 10 years	4	23.5%
10+ years	8	47.1%
Length of time at Humber River Hospital		
1 to < 3 years	4	23.5%
3 to < 5 years	3	17.6%
5 to < 10 years	5	29.4%
10+ years	5	29.4%

*One participant did not provide demographic data.

> What I find is that the lists are humongous. ... With imaging, … you just want a CT of the chest or X-ray of the knee, but there's like a zillion trillion choices.

Furthermore, when looking for a particular medication using the system, some had difficulty finding the appropriate category assigned to it:

> Albumin is not in the medication orders; it's in the non-medication orders. But …, technically, it's a medication. [I]t's a blood product; it should be under medications, and it looks like its blood work. So also, for a long time, I couldn't figure out how to order albumin.

> I do think finding the order sets sometimes can be challenging, which is really annoying. If you're not in the right category or the right set. Or the names aren't interchangeable. You have to know exactly what you want. Sometimes it's frustrating when you're on call and you can't find the order set you want.

However, all participants preferred the system to paper order sets, observing that the EOSs were more efficient and far superior to their paper counterparts:

> It's better than writing it; it's still better than writing it.

Efficiency

The main theme extracted from the interviews was positive impact on workflow. Participants emphasized multiple benefits of EOSs on efficiency, most notably that their speed of placing orders had increased because EOSs are readily accessible compared to printed order sets, which were often difficult to find. Another advantage mentioned by participants was that they did not have to return to the patient's bedside to ascertain any additional information as the EOSs could be completed at the bedside:

> The biggest advantage to me is everything is in one place. ... It's a huge piece of efficiency. Otherwise, if things are in different places, I need to get this from here and this from there and this from there, so it's open and closed, and then I'm done.

> I work in two hospitals: one is paper-based, and this is the other one. My efficiency here is 50% better. I will see twice as many consults in the same amount of time because of the order sets.

Additional themes mentioned by participants were facilitated information retrieval and reduction in task completion time. These ultimately resulted in efficiencies in healthcare delivery, especially within the emergency department, as illustrated by the following comments from participants:

> For me, especially for things outside of your particular discipline, like when you're doing acute coronary syndrome – everything is there. All the categories. The platelet, beta-blockade, ACE inhibitors – it's all there for you to click on. [You spend] less time ... typing in medications and remembering what you want to choose. It's nice to be able to just click.

> It makes things faster and easier, especially in [the emergency department]. In [the emergency depart-

ment], when you're admitting 20 patients a night, it's faster because you go through checking things off, and the flow is a little bit easier.

Safety

All participants cited increases to the safety of the care prescribed through EOSs. The most common theme mentioned was increased adherence to guideline-recommended practices, especially for disease-specific order sets such as acute coronary syndrome and deep vein thrombosis (DVT). Evidence-based guidelines were also seen as especially crucial for physicians providing care for patients with uncommon conditions. A decreased reliance on memory was also highlighted in relation to this theme:

> [E]specially if people are not as familiar with a certain area, [such as] a general internist who doesn't do medicine call very much, or a subspecialist, for instance,[such as a] rheumatologist doing [a] general medicine call, they're probably not going to be as up-to-date on the latest cardiac care, for instance. So it helps … remind them what you should be ordering for a patient, and, again, it makes sure that there's some consistency … across the board.

> For instance, we've seen patients who have been admitted with acute coronary syndrome, and the physician doesn't use an order set, so they don't order the correct drugs for them; … they'll order aspirin and Plavix, but they'll forget to order fondaparinux. So I think it does reduce errors if physicians are not as familiar with that condition [and] what the standard of care is. So it provides that for you, which is very helpful. ... [A]lso, when people are busy, that's the other circumstance; ... a lot of the time physicians admitting patients in the [emergency department] are busy, so they're more likely to forget some things. So the order set reminds you so that you don't forget these things. … DVT prophylaxis can be very important, but it might be something that someone could forget if it's not in the order set.

> I like that it standardizes care. And [emergency department] physicians who may come from many different areas of training or levels of training, or some of them may not keep up to the same extent as others do. ... So I find that standardization of care zeros in on specific drugs you can select for specific conditions. So that's been good.

> You don't forget to order something; acute coronary syndrome is a good example because there's a lot of different categories of medication; it's easy to forget. For efficiency and avoiding to omit, it's helpful."

Implications for physician practice

There were multiple discussions surrounding the electronic order set and its implications for physician practice; as a result, several themes emerged from the interviews. One theme mentioned by all participants was that the EOSs had the ability to bridge gaps in care. This was cited as being due to its ability to provide real-time access to best practice standards and was considered particularly beneficial in facilitating care outside of the physician's specialty. The following comments from participants illustrate this theme:

> For instance, if I'm in the [chronic obstructive pulmonary disease (COPD)] order set, I want to rule out [pulmonary embolism] on the off-chance that it's an alternate diagnosis or order a CT scan after I'm done the order set. ... It helps you retain the knowledge for disciplines you don't necessarily do every day.

> The benefit is that if it's not something you do on a regular basis, at least that information is right there – that you are following the right processes.

> Sometimes it might make me think a little bit more about the drug choices because it's listing the drug names right in front of me. So I might think … that medication might be better for this patient because the blood pressure's low and the heart rate is a different rate. So it just reminds me [that] I don't have to order the one medication that I often order, that there might be a better medication for this patient.

A secondary theme that emerged from the interviews was the importance of the physicians' own cognitive process. Participants emphasized that although EOSs have helped to bridge gaps in care, they were not considered by most physicians as a replacement for their clinical reasoning. This theme was demonstrated by the following comments:

> ... you think about what you want to do with the patient. You don't use the order set to think for you.

> It helps implement what you've cognitively processed, but it doesn't help you with the cognitive process.

> For a COPD order set, I can click which puffers to use, but in terms of the frequency, there's a clinical decision. So I could do them as [as needed], or I could do them as a standing order, but that piece of the decision-

> making has to come from me. So the fact that I see both of those options will help me to select one or the other, but I have to make that selection.
>
> Say I do an admission order set for someone with COPD and they have another condition in addition to COPD. Am I more or less likely to miss the other condition because I'm anchored by the order set? I don't think so.

However, some participants felt that the EOSs could obviate physicians' skills, as illustrated by the following remarks:

> When there is reliance on a standardized order set, it perhaps can be a disincentive for some clinicians to reduce reading and keeping up on topics because they expect a standard order set to cover things for them.
>
> Everything is in front of you. Does that impair your skills? I hope not. But it's possible.

The last theme mentioned by participants was the importance of providing individualized patient care:

> I think at the end of the day what's important is having the basics, a discussion with your patient, a physical exam, explaining what you're doing and why ...
> [S]ometimes the menus are very helpful, of course; I'm sure there's a lot of thought put into it. But it's very important to recognize [that] there are other things outside of those boxes, and I try very hard not to fall into that.
>
> I guess to some extent it does make some things automatic, so some people may not be thinking as much about the choices that they're making. ... But … as a physician, you're supposed to be thinking about the kind of care of the patient. So although it may save you some time, you should still be considering, "Is this the right medication for this patient?" In the order set, having more than one category that you could pick should still allow you the time to think about what's the best medication for this patient.

Discussion

Our study explored physicians' attitudes regarding EOSs and confirmed the generally favourable impression that physicians have of them. Most respondents found the order sets easy to navigate and use, even if they had limited time to master their use. This would imply that a user-friendly design and interface of the EOSs had been arranged (i.e., physician respondents knew "how" to order a medication). There were some reported challenges in "finding" a specific medication, but, overall, physicians thought the EOSs was easy to use.

Similarly, the physician participants were almost universal in their feeling that order sets enhanced their efficiency, particularly during busy periods of call, when multiple patients require assessment and admission to hospital. Efficiency in workflow was described by physician participants as having readily accessible and reliable information available "in the moment." For example, standardized lists of medications and doses and corresponding evidence-based literature provide a "one-stop shop" for best practices. As described by Zhang et al. (2018), order sets present appropriately grouped medical orders that increase the efficiency of ordering and workflow. With all of the medication orders and protocols located in one place, efficiencies for individual clinician decision analysis are further supported, including the heuristic principle of "minimizing memory load" (Zhang et al. 2003).

The participants also felt that the use of order sets increased safety by ensuring that physicians followed evidence-based practices and minimized the possibility of omitting important interventions. Zhang et al. (2018) suggested that order sets are designed to embed and encourage compliance with best practices. Similarly, Liu et al. (2011) identified the use of CPOE with clinical decision support methods as contributing to reduced medical errors and adverse drug events. Physicians in this study also recognized the value of real-time learning facilitated by CPOE clinical decision supports. Likewise, Lyman et al. (2010) found that clinical decision support alongside CPOE, such as alerting and reminder systems that "nudge" physicians to pause and consider alternative interventions at the point of care, can increase the quality and safety of care delivery.

Physician respondents felt that EOSs use did not substitute or eliminate the need for physicians to apply their own clinical judgment and skills when assessing patients. Lyman et al. (2010) posited that EMRs, CPOE, and clinical decision support systems are insufficient alone to ensure high-quality care. With such value placed on clinical reasoning, we do reflect on the fact that EOSs may represent different things to different providers. For novice practitioners, the EOSs provides a foundational basis of information and considerations for orders "at a minimum" for a particular disease, whereas for practised clinicians, the EOSs represents an opportunity to pause and consider whether they agree with each order or not based on their clinical experience and judgment. Undoubtedly, there may be a perceived tension for physicians between ensuring that individualized care is provided and adhering to standard order sets.

There are some limitations to our study. The majority of physician participants were beginning their practices, which intuitively would suggest a greater comfort level with newer

technology, but also an appreciation for real-time information made available for clinical decision analysis (Lyman et al. 2010; Yu et al. 2013). However, even more experienced physician respondents perceived that when managing a novel disease entity in their area of specialty (as an emergency physician shared), the EOSs also represented real-time clinical support tools. This experience as well was taken from a very digitally advanced hospital with robust support systems for physicians using order sets. The introduction of order sets and computerized order entry was preceded by an extensive period of training provided to all physicians, and the creation of the specific order sets themselves has always involved significant physician input. Perceptions of CPOE from physicians in other various specialties, as well as more senior physicians or physicians who had only limited training in the use of order sets, need to be explored further. Physicians' attitudes toward order sets might be different in organizations without as great an emphasis on digital innovation and where 24-hour supports for physicians are not available. In addition, their attitudes might also have been impacted if the training period was briefer and there was less physician involvement in the creation of the order sets. However, the insights gleaned from this study may support hospitals endeavouring to scale up their digital landscape through the integration of CPOE and clinical decision support systems.

With the growing use of EOSs, there is a need for further studies pertaining to both the physician experience and their outcomes on patient care. Although EOSs are used by all physician groups, no studies have addressed whether attitudes are affected by physician specialty or physician characteristics, such as age or perceived comfort with technology. There is little knowledge regarding whether physician attitudes vary between academic and community hospitals and whether the degree of previous training affects the attitudes toward order sets. Similarly, no studies have addressed whether there is an association between physicians' impressions and the effectiveness with which order sets are used. The actual impact that the use of order sets has on patient outcomes is also an area worthy of further study. Although almost all of the respondents in this study felt that the use of order sets enhances patient safety, no studies have explored the potential relationship between the use of order sets on hospital length of stay, patient satisfaction or other outcomes.

Conclusion

As part of its EMR, HRH has implemented EOSs by building them into the CPOE. Although various studies have been conducted examining outcomes from CPOE systems, this study was intended to explore physicians' perspectives using EOSs. Our results support previous studies that describe the benefits of EOSs, including ease of use and efficiency, real-time information that is evidence-based, increased safety and minimization of memory burden. EOSs were not perceived to be a replacement for clinical reasoning but to provide a "pause" for clinicians as they decide the appropriate orders for their individual patients. Future studies to address whether physician attitudes toward EOSs are affected by physician specialty or characteristics, such as age or perceived comfort with technology, are needed. Additionally, the impact of using order sets on patient outcomes is an area worthy of further study. Other studies examining the use of order sets in relation to patient safety, hospital length of stay and patient satisfaction are required.

What We Learned:

1. Physician participants in our study overwhelmingly agreed that order sets enhanced their efficiency.

2. All physician participants cited increases to the safety of the care prescribed through EOSs.

3. All participants perceived that the EOSs had the ability to bridge gaps in care. In particular, real-time access to best practice standards was considered beneficial in facilitating care outside of the physician's speciality.

References

Blumenthal, D. and M. Tavenner. 2010. The "Meaningful Use" Regulation for Electronic Health Records. *New England Journal of Medicine* 363: 501–04. doi:10.1056/NEJMp1006114.

Boonstra, A. and M. Broekhuis. 2010. Barriers to the Acceptance of Electronic Medical Records by Physicians from Systematic Review to Taxonomy and Interventions. *BMC Health Services Research* 10(1): 231. doi:10.1186/1472-6963-10-231.

Canada Health Infoway. 2017. Year in Review: 2016–2017. Retrieved March 2, 2020. <https://www.infoway-inforoute.ca/en/component/edocman/3350-annual-report-2016-2017/view-document?Itemid=0>.

Downe-Wamboldt, B. 1992. Content Analysis: Method, Applications, and Issues. *Health Care for Women International* 13(3): 313–21.

Eslami, S., N.F. de Keizer and A. Abu-Hanna. 2008. The Impact of Computerized Physician Medication Order Entry in Hospitalized Patients — A Systematic Review. *International Journal of Medical Informatics* 77(6): 365–76.

Government of Canada. 2004, October 1. Canada's Health Infostructure. Retrieved April 6, 2020. <https://www.canada.ca/en/health-canada/services/health-care-system/ehealth/canada-health-infostructure.html>.

Li, R.C., J.K. Wang, C. Sharp and J.H. Chen. 2019. When Order Sets Do Not Align with Clinician Workflow: Assessing Practice Patterns in the Electronic Health Record. *BMJ Quality & Safety* 28(12): 987–96. doi:10.1136/bmjqs-2018-008968.

Liu, S., F. Salvatoriello, J. Dick III, S. Faucett and J. Robb. 2011. Facilitating the Development of Evidence-Based Order Sets and Care Pathways: Lessons Learned from an Academic Medical Centre's Implementation of a New Electronic Health Record. *International Journal of Care Pathways* 15(2): 34–38.doi:10.1258/jicp.2011.011M01.

Lyman, J.A., W.F. Cohn, M. Bloomrosen and D.E. Detmer. 2010. Clinical Decision Support: Progress and Opportunities. *Journal of the American Medical Informatics Association* 17(5): 487–92. doi:10.1136/jamia.2010.005561.

Yu, C.H., A.L. Stephenson and S. Gupta. 2013. The Effect of Patient Care Order Sets on Medical Resident Education: A Prospective before – after Study. *BMC Medical Education* 13(1): 146. doi:10.1186/1472-6920-13-146.

Zhang, J., T.R. Johnson, V.L. Patel, D.L. Paige and T. Kubose. 2003. Using Usability Heuristics to Evaluate Patient Safety of Medical Devices. *Journal of Biomedical Informatics* 36(1–2): 23–30.

Zhang, Y., R. Trepp, W. Wang, J. Luna, D.K. Vawdrey and V. Tiase. 2018. Developing and Maintaining Clinical Decision Support Using Clinical Knowledge and Machine Learning: The Case of Order Sets. *Journal of the American Medical Informatics Association* 25(11): 1547–51. doi:10.1093/jamia/ocy099.

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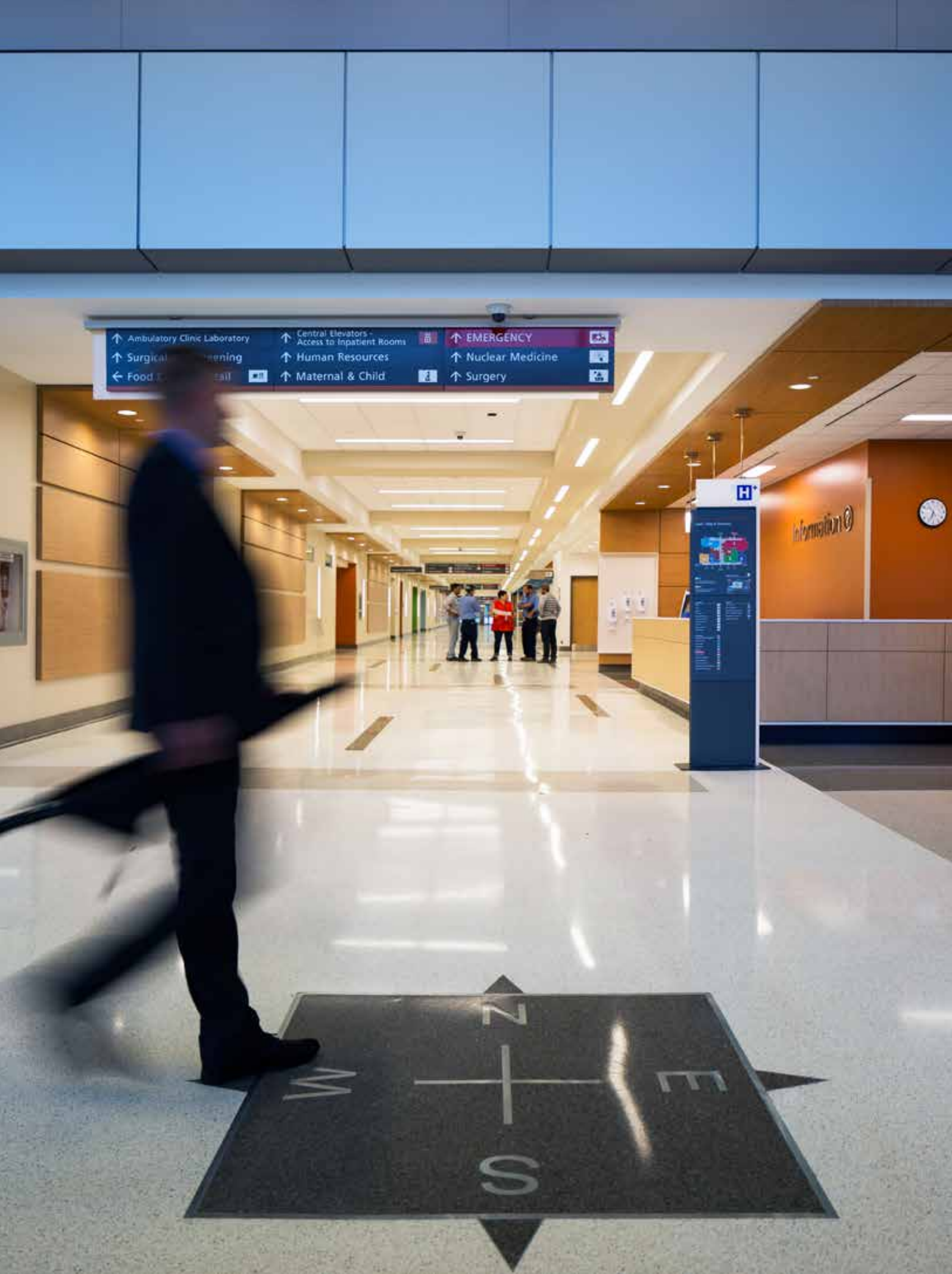
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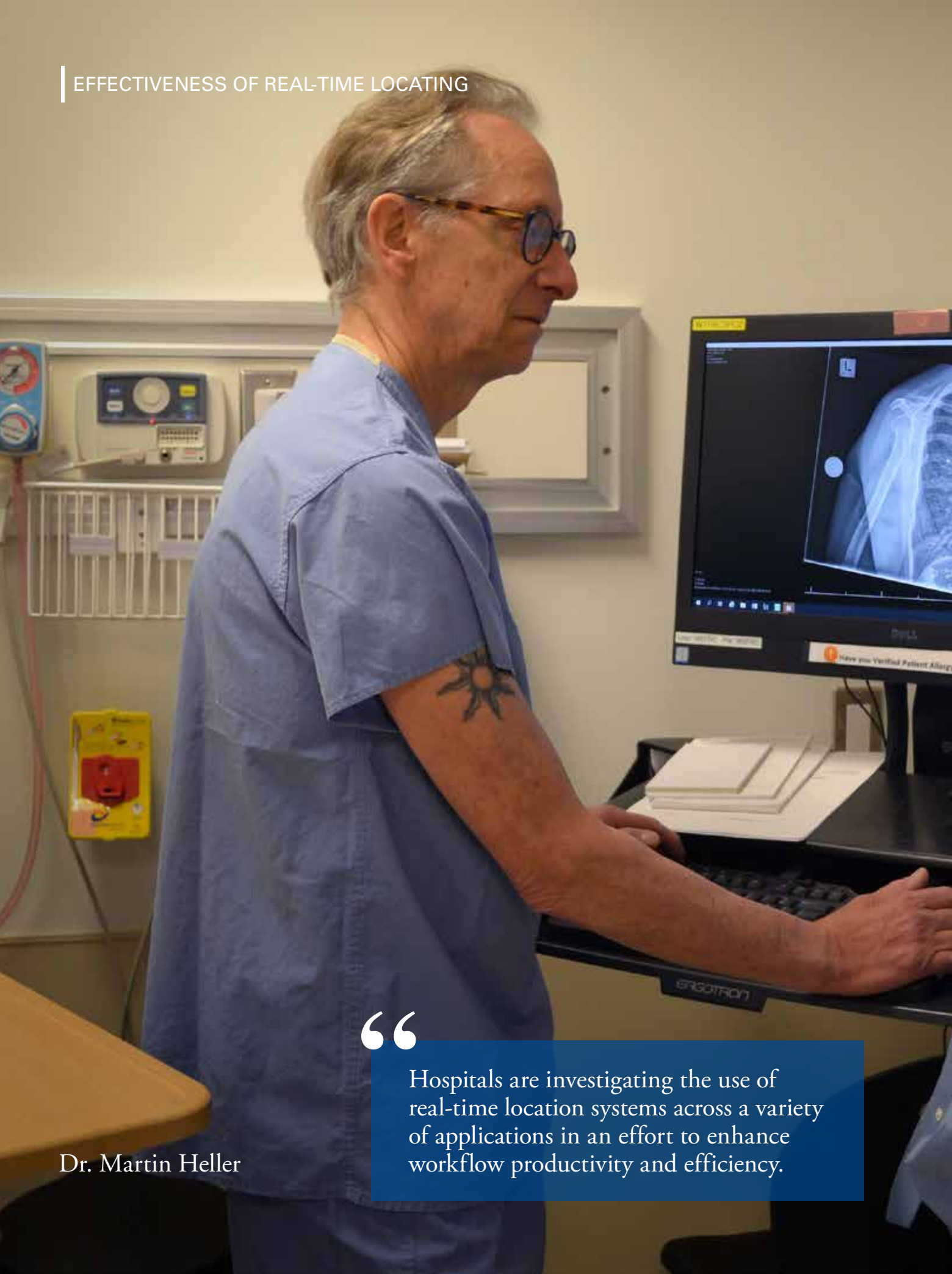

> Hospitals are investigating the use of real-time location systems across a variety of applications in an effort to enhance workflow productivity and efficiency.

Dr. Martin Heller

The Impact of a Real-Time Locating System within the Perioperative Environment on Physicians and Patients' Families

Martin Heller, Joseph Koval, Ethan Miller and Shirley Solomon

Abstract

Background: **Humber River Hospital has implemented a real-time location system (RTLS) within the operating room in order to provide real-time information about patients' status and manage the many components involved during the perioperative journey.**

Objective: **The aim of this study was to explore both physicians' and family members' perceptions of the functionality and efficiency of the RTLS within the perioperative environment.**

Methods: **Semi-structured interviews were conducted with physicians and patients' family members to elicit various perspectives regarding the use of RTLSs throughout the perioperative process. Interviews were recorded and transcribed to extract key themes.**

Results: **Three themes gleaned from physician interviews were system weaknesses, perceptions of potential benefit, and benefits to family members. Three themes uncovered from family member interviews included convenience, ameliorating anxiety, and reducing interruptions.**

Conclusion: **Overall, physicians reported that the RTLS had potential to enhance workflow but that significant improvement regarding its implementation and use was needed to reach its full benefit. Family members were unanimous that it provides them with all the tracking information they desire.**

Introduction

Multifaceted interactions with patients, visitors and staff are constantly occurring in hospitals. Alongside these ongoing human exchanges, various medical supplies and equipment are used in the process of care delivery. Keeping track of patients, visitors, staff and medical equipment and materials poses a significant challenge for hospitals. In the operating room (OR), managing communications and workflow is essential. The ability to track patients, specimens, devices, equipment and staff in a reliable manner facilitates efficient workflows (Fisher and Monahan 2012). Hospitals are investigating the use of real-time location systems (RTLSs) across a variety of applications in an effort to enhance workflow productivity and efficiency (Kamel Boulos and Berry 2012).

Humber River Hospital (HRH) is the first digital hospital in North America and the first hospital in Canada to implement an RTLS in its surgical department (HRH 2018). To enhance the efficiency and productivity of the surgical perioperative process, physicians, nurses, technicians and other staff members who are part of the surgery team require up-to-date and real-time information about the patient's status and operational workflow (Meyer et al. 2007). The advanced software program implemented at HRH provides tracking information to family and friends regarding each phase of the operative journey that the patient undergoes (HRH 2018; Humber River Hospital Foundation n.d.). Family and friends can receive updates sent directly to their smartphones, which include surgical updates and the patient's location, progression through the operative process and visitation readiness (HRH 2018). The RTLS functionality for physicians and other staff is to provide real-time patient status information that supports effective workflow through the stages of the operative process, from preoperative preparation to post-anesthesia care. The purpose of this study was to uncover both physicians' and family members' perceptions of the impact the RTLS has had on workflows, communication, decision-making and efficiency.

HUMBER RIVER HOSPITAL is one of Canada's largest community acute care hospitals, serving a population of more than 850,000 people in the north-west Greater Toronto Area. The multi-site hospital currently operates out of its Wilson Avenue acute care site and Finch and Church Street reactivation care centres with a total of 722 beds, just over 3,800 employees, approximately 700 physicians and over 1,000 volunteers.

Affiliated with the University of Toronto and Queen's University, Humber River Hospital is North America's first fully digital hospital. Part of Humber River Hospital's digital infrastructure includes completely automated laboratory services, robots sorting and mixing medications, electronic health records, tracking systems, for patients undergoing surgery, that update families through their cellphones and patient bedside computer terminals – all varieties of technologies that automate information, eliminate paper and provide a connected experience for patients, staff and families.

Humber River Hospital was awarded Accreditation with Exemplary Standing in 2018 and, since its opening in 2015, has received numerous awards and accolades for technological advancements and innovation (www.hrh.ca).

Methods

Study design and participants

This study was a qualitative analysis examining the efficacy and functionality of the RTLS throughout the perioperative period. The perspectives of physicians and patients' families were elicited. Physicians who met eligibility criteria included those who had a minimum of 1-year experience using RTLS at HRH. Eligibility criteria of patients' family members included participants who had a family member who underwent a surgical procedure at HRH, familiarity and personal use of the RTLS and willingness to participate. All individuals who participated were native English speakers and 18 years of age or older and possessed the capacity to consent to participate in the study. Veritas IRB, an independent Research Ethics Board, approved this study.

Data collection

Data were obtained through semi-structured, in-depth interviews with physicians and patients' family members over the course of 1 month. Twenty participants were interviewed in the study, including 10 physicians and 10 family members. Informed consent and demographic data were collected in person prior to interviews. Members of the research team conducted the interviews in one-on-one or focus group settings according to participant preference. All physicians participated in one-on-one interviews, whereas family members participated in focus group interviews. Physician interviews ranged from 15 to 20 minutes, whereas interviews with family members were typically approximately 10 minutes.

TABLE 1.
Content analysis of transcribed data: examples of meaning units, condensed meaning unit and theme

Meaning unit	Condensed meaning unit	Theme
"[The system] was supposed to time the patient in the room and out of the room so we could track turnovers and operating efficiency. ... A patient comes in with a tag and [the sensor] is supposed to pick up that tag. And to my understanding, it never worked. So if you do want operating room efficiency time, then it's up to the nurses to put in that data manually of when they 'think' the patient came in, when they 'think' the patient got into the operating room, when they 'think' the patient left the operating room."	RTLS system doesn't pick up tag; nurse must input data	System weakness
"[The monitor board] is very, very poor in telling me where the patient is. I would say fifty percent of the time or more I would look at the board and I'll go to that place and the patient won't be there. So the board almost becomes completely useless. Then I have to find one of the nurses and just ask them. So I find that it's not foolproof and not updating within real time most of the time."	The monitor does not provide accurate information; physician has to ask nurse	

Data analysis

Interviews were analyzed by manifest content analysis. This method is suitable for identifying predominant themes from the participant's words (Downe-Wamboldt 1992). First, two analysts read the transcribed text separately. Next, the analysts extracted and summarized the units of meaning and further categorized them based on similarities (see Table 1 for an example of the process). Each analyst created preliminary categories, and any discrepancies were resolved through discussion. To illustrate emerging themes, select quotations were chosen from the data. Descriptive analysis of the survey data was conducted using SPSS version 25.

Results

Three main themes emerged based on analysis of the transcripts from the interviews with physicians: system weaknesses, perceptions of potential benefit and benefits to family members. Additionally, three main themes emerged based on analysis of the transcripts from the interviews with family members: convenience, ameliorating anxiety and reducing interruptions. Each theme is described with quotations from the participants. Descriptive statistics of the demographic characteristics of family members and physicians are presented in Tables 2 and 3.

Themes from interviews with physicians

System weaknesses

The prevailing theme among all physician participants was that the RTLS was prone to error. There was consensus that the inefficiency was primarily due to the system's weak tracking capabilities. Due to this issue, nurses were required to enter patient status information manually when it was not tracked by the system, which meant that physicians were not provided with real-time patient status information. The physician participants explained:

> [The system] was supposed to time the patient in the room and out of the room so we could track turnovers and operating efficiency. ... A patient comes in with a tag and [the sensor] is supposed to pick up that tag. And to my understanding, it never worked. So if you do want operating room efficiency time, then it's up to the nurses to put in that data manually of when they "think" the patient came in, when they "think" the patient got into the operating room, when they "think" the patient left the operating room.

> [The monitor board] is very, very poor in telling me where the patient is. I would say fifty percent of the time or more I would look at the board and I'll go to that place and the patient won't be there. So the board almost becomes completely useless. Then I have to find one of the nurses and just ask them. So I find that it's not foolproof and not updating within real time most of the time.

Another weakness that was pointed out by some of the physician participants was that the tags often went missing.

TABLE 2.
Demographic characteristics of physician study participants

Age range of physicians	*n*	(%)
25–34 years	0	0
35–44 years	3	30%
45–54 years	3	30%
55–64 years	2	20%
65–74 years	2	20%
75 years and over	0	0%
Gender		
Male	9	90%
Female	1	10%
Gender diverse	0	0%
Years of experience as a physician		
1 to < 3 years	0	0%
3 to < 5 years	0	0%
5 to < 10 years	2	20%
10+ years	8	80%
Length of time at Humber River Hospital		
1 to < 3 years	1	10%
3 to < 5 years	2	20%
5 to < 10 years	2	20%
10+ years	5	50%

One physician participant noted:

> A lot of the times the patient's [tag] is broken or missing. The [tags] get attached to the patient, and the [tag] then goes home with them or it goes in the laundry and … just disappears. And that's one of the issues with them because I'm sure they're not cheap. So very few patients have [tags] now.

One physician participant also explained that when they attempt to press the button on the patient's tag to indicate that the patient is ready for surgery, it often does not function:

> Sometimes the beeper thing – you have to walk outside the room. [There are] some areas that don't connect. It doesn't always click right by the patient's bed. You have to walk around the room sometimes to get it to work.

Many physician participants reported that they had ceased using and relying on the RTLS because of the technical and user issues in tracking patients. As one physician participant explained:

> More often than not, I just find myself going into the preop area, and I just ask the nurse, "Where is my patient?" because it's so often wrong that there's no point in me going to the board [to find] where my patient is. [T]hey're not there. [I] come back. I just ask the nurse, which I know defeats the entire purpose of [the system], but the inaccuracies are responsible for me just going to ask [the nurse].

Of note is that issues with the system were not less prevalent among interviewees who considered themselves to be "computer savvy," as noted by the following comment from a physician participant:

> Well, I don't use it, I work with computers a lot, I'm more computer savvy, but I gave up on the system because I found it useless. I couldn't get it running on my phone a couple of times, so I just gave up.

Perceptions of potential benefit

A second theme involved physician participants' perceptions of the RTLS's potential benefit. Although all physician participants agreed that improvements to efficiencies in the OR could be beneficial, participants were divided on whether the RTLS would be capable of providing that benefit. Several physician participants questioned the system's capability of improving processes in the OR. One physician participant commented:

> It cannot affect processes; it just monitors them. It's like recording OR wait times. It has no effect on wait times. It's more a monitoring tool than an impact tool. ... I don't think it's achieved what it's set out to do.

Other physician participants believed that even if the system had functioned as intended, it would not have played a part in supporting their work:

> I'm not hurt by not getting the text message. It doesn't change anything. It's like extra peas for dinner; if it's

TABLE 3.
Demographic characteristics of family member study participants

Age range of family members	*n*	(%)
18–24 years	1	10%
25–34 years	1	10%
35–44 years	3	30%
45–54 years	4	40%
55–64 years	1	10%
65–74 years	0	0%
75 years and over	0	0%
Gender		
Male	1	10%
Female	9	90%
Gender diverse	0	0%
Highest degree/level of education completed		
Less than high school graduation	1	10%
Secondary high school diploma or equivalent	2	20%
Some postsecondary education	3	30%
Postsecondary certificate, diploma or degree	4	40%

there, it's there; if not, it's fine. It's not a significant enhancement.

I have never used it. For me, as long as the patient shows up in the operating room and ends up in the recovery room, that's all I need.

Conversely, other physician participants emphasized the potential benefits of the RTLS, such as potential improvements to time management, patient care and OR efficiency:

If we had data to say what are the delays and why are the turnovers so long because those are the two biggest things that kind of decrease our efficiency; you know, if we have 3 to 4 cases in a day and we are operating for … 4 hours and our turnover time and delays are taking up the rest of the 3 hours in the day, then, certainly, there's an opportunity to increase efficiency.

[I]f I could get an alert on my phone that says that the patient has just left the block room, then I could start making my way to the operating room. You don't want to go to the operating room and the staff are telling you they were waiting for you.The hospital has a big footprint. These are the things that are supposed to help you navigate that.

If we know where our patient is, we can go right there instead of asking a nurse,"Where's my patient?" It would improve the amount of time we are able to spend with patients because we only have a limited amount of time between cases, and if half that time is taken looking for a patient … we have less time to spend with our patient. So I think it would have been able to improve patient care indirectly that way if it were to work.

You could have true benchmarks for operating room turnover, you could know when one patient left and the next came in, housecleaners could know, porters could know, nurses could know, the surgeons could know – everybody would have real data. But instead what we have is what the nurses put in to the [EMR] and compiling it later on and trust that the right time was put in.

Benefits to family members

Counterbalancing the physicians' frustrations with the RTLS was the awareness that it was beneficial to patients' family members. All physician interviewees uniformly agreed that the system provided the greatest benefit to family members, citing most frequently that it greatly reduced their anxiety as they waited for their loved ones to come out of surgery:

[Family members] do have some comfort in knowing where [the patients] are. It does provide them with a little bit of reassurance, and I know I have gotten some positive feedback from family members.

It's certainly nice for patients and families to be able to know where they are in the operation. If an operation is expected to go for two hours and it goes for five hours, then the family is still aware that they are in the operating room or something is still taking place, so they're not wondering what's going on.

Notably, physician participants exclusively referred to the system as a patient tracking system "for family members."

Themes from interviews with family members

Convenient and user-friendly

All participants were enthusiastic about the RTLS. The system was simple to understand, follow, and implement. This allowed for users with varying levels of technological expertise to navigate it with relative ease. One family member participant reported, "I'm bad with technology, … but it was so easy even I could do it." Many other family member participants further supported its use and claimed that it was "really easy" to use and "clear." Furthermore, many family member participants reported that receiving updates directly to their phones made it very convenient to use. Although status updates were displayed on a waiting room monitor, personal phone updates allowed for notifications virtually anywhere. As a result, family member participants were able to leave the waiting area to purchase food or use the restroom, without the fear of missing important status updates. One family member participant stated, "[I]f you're gone, something is going to happen; you're going to miss it. This way it is on your phone and you can take it with you …" In addition, receiving updates directly to one's phone eliminates the need to search for a specific patient's identifying "numbers" among the many other patients on the monitor.

Ameliorates anxiety and reduces interruptions

During the perioperative period, patients' loved ones are often waiting many hours until they finally communicate with the surgeon or reunite with the patient. The RTLS provides status updates directly to the patients' loved ones throughout the perioperative journey. Family member participants reported that the updates and notifications provide "peace of mind" and "relieve a lot of stress on people." A family member participant stated, "[It] makes you feel like you're in the loop throughout the process." The notifications allowed the family member participants to feel involved and not "forgotten." Furthermore, it was perceived that when family member participants received notifications and status updates, it reduced interruptions for healthcare staff. A family member participant explained that a direct notification from the RTLS eliminates "people bothering [the nurses] every two minutes." Moreover, family member participants are aware of what they need to do or where they need to go regarding the patient without having to request information from healthcare staff.

Discussion

The purpose of this study was to evaluate the impact of the RTLS on surgeon and patient family experience at HRH. Focus groups and one-on-one interviews with 10 surgeons and 10 family members were analyzed to examine themes. Of note was the significant divergence between the two groups' experiences. Surgeons felt that the system failed to meet their expectations, with particular reference to real-time patient location. Conversely, family members uniformly found the RTLS to be a valuable asset, significantly improving their perioperative experience. This satisfaction carried a secondary benefit for OR staff and surgeons, who could trust in the efficacy of the family notification process and its resultant reduction in overall family anxiety. Reflecting on the divergence of perspectives highlights how the RTLS represents a focal point of information, demonstrating that these two stakeholder groups (physicians and families) have such differing informational needs. For anxious family members awaiting news of their relative's surgery, the automated RTLS functioned extremely well in alleviating their anxiety and meeting the family's expectations regarding open communication. In contrast, surgeon expectations of the system were not met, primarily due to unfulfilled process information needs. Surgeons viewed the RTLS as having the potential to improve workflow processes, but the failure of the system to provide precise time-tracking functionality for each stage of the perioperative workflow process eliminated the potential for surgeons to monitor or enhance these processes. A properly functioning RTLS has the potential for genuine improvement in OR team satisfaction and ultimately in improved patient care as tracking data are analyzed and incorporated into policy change (Kamel Boulos and Berry 2012). Without this potential, the OR team is limited in its ability to improve the workflow. Prolonged discontentment with workflow may hinder the team's ability to achieve high-reliability processes and outcomes.

Ideally, the RTLS should have provided a precise real-time indication of the patient at all times through automation alone. Simply put, knowing, for example, when the patient is entering the OR allows the surgeon to be present in a timely fashion as there are often multiple diversions requiring attention between cases. Some institutions have employed radiofrequency identification (RFID) tags, which attach to the patient's armband (thus decreasing the likelihood of tags becoming lost with linens, although this does not completely address tags that inadvertently go home with patients); these RFID tags do not require buttons to be pressed but are simply "tracked" for their locations (Kamel Boulos and Berry 2012). However, use of such devices would mean the loss of capturing time for surgeon and anesthesia activity and the assumption that intraoperative activities proceed as soon as the patient has entered the OR. The core issue is that the current RTLS at HRH is configured to provide precise *locating* versus precise *timing*. According to Kamel Boulos and Berry (2012), "In the end, all RTLS technologies share the common objective of determining the location of assets and individuals as precisely as is needed by the target population" (p. 3). The findings from this study have elucidated the need to match the technology application to the needs of the key stakeholders for it to succeed.

Second, using information obtained from the RTLS should allow verifiable parameters to be monitored, such as patient registration, patient preparation, OR turnover time and recovery room delays. Previous studies examining RTLS technology in healthcare have reported enhanced workflow efficiencies in complex practice settings, such as the emergency department (Laskowski-Jones 2012). At best, data that are generated through the RTLS should provide physicians with some ability to make day-to-day decisions through monitoring all of the patient flows (such as anticipating the next surgical case), which is highly variable based on the individual surgeon's practice. Kamel Boulos and Berry (2012) suggested that the RTLS has the capacity to track patient flows for managing throughput and alleviating bottlenecks. Some physician participants reported that colleagues have the RTLS data uploaded to their smartphone, which allows them to make some decisions in their daily scheduling, whereas others forgo seeking any information from the RTLS altogether. This variation of user acceptance can influence the perception of value for surgeons and hospital administrators. Kamel Boulos and Berry (2012) suggested that one of the most common reasons information technology projects fail is because they do not achieve the necessary functionality. Optimizing the existing RTLS at HRH using feedback from physicians and the OR team could salvage the system and standardize its use.

RTLS data should serve as a tool to impact service planning along with the communication and information needs of patients' families. With the feedback received from families, surgeons confirmed that families were in such favour of having the RTLS information that, despite its current state, for the purpose of patient-centred care and in aligning with the hospital's value of compassion, the system is worth the effort to use it. Although the system is not currently reliable and requires fallback to manual data entry by nursing staff in the ORs tracking the patient's progress, surgeons understand the importance of the system to patient experience. Change management strategies based on inefficiencies identified with the patient flow functionality are necessary to improve physician and OR team confidence in the system.

Kamel Boulos and Berry (2012) suggested that RTLSs are high-involvement products that require input and consultation from a large variety of stakeholders. Understanding the clear divergence of experience between patients' family members and surgeons perhaps allows for better future planning when it involves a technologically advanced system such as the RTLS. When multiple stakeholders are impacted, heuristics must be considered. Nielsen-Shneiderman Heuristics identified 14 different principles for human factors analysis that can be applied to RTLSs (Zhang et al. 2003) (see Table 4).

For example, we anticipate that families will use the RTLS solely as a monitoring tool; thus, the principles of "visibility of the system state" and "minimalist" would be most important for this group (e.g., the data tells families where the patient is in the system, and no additional extraneous information is communicated). Surgeons, however, would require a heuristics view of "match between the system and the world" as they would be expected to make decisions regarding the timing of their next surgical case in the context of the current state of the OR environment. Surgeons and hospital administrators would additionally benefit from "informative feedback," such as that derived from this study, and "documentation" that enables continuous quality improvement.

TABLE 4.
Nielsen-Shneiderman heuristic principles

Principles	Analysis
Consistency and standards	Good error messages
Visibility of system state	Prevent errors
Match between system and world	Clear closure
Minimalist	Reversible actions
Minimize memory load	Use users' language
Informative feedback	Users are in control
Flexibility and efficiency	Help and documentation

Source: Zhang et al. 2003.

Functionality for each user group would also entail careful application of implementation science where consistency and process adherence are tested through a small area of the perioperative program (e.g., an orthopedic service only) to identify challenges and incremental changes through Plan–Do–Study–Act cycles. Once user groups accept system functionality and refinements based on the specific inputs provided by key stakeholders, then the appropriate change management requirements can be implemented on a broad scale. Ultimately, initiating a complex system such as the RTLS within the OR should involve rigorous clinical testing in the receiving environment, including soliciting end-user feedback. Once a comprehensive trial has taken place and all concerns have been addressed, the full potential of this technology can be realized.

Study limitations

There are limitations that must be taken into account when interpreting the findings presented in this study. First, memory bias may have influenced the narrative of the participants. As well, the data from this study were obtained via face-to-face interviews, which may have resulted in respondents exhibiting social desirability bias. However, all interviews were conducted

by a research coordinator to limit influence on participants' responses, and both positive and negative perceptions were exhibited by the participants. Lastly, the data were derived from a single hospital site and therefore reduce the degree to which the study's findings are generalizable to other hospital settings.

Conclusions

A significant challenge for hospitals is keeping track of patients, visitors, staff and medical equipment and materials. In the OR, the challenge of managing communications and workflow is essential to enhancing efficiency and productivity across the perioperative process. The ability to track patients is a major factor in facilitating effective communication with family members and raising the level of satisfaction with their experience. At HRH, the advanced software program aimed at tracking patients and ensuring timely and consistent information to family and friends regarding each phase of the operative journey that the patient undergoes has been overwhelmingly successful. The RTLS functionality for physicians and other staff to provide real-time patient status information that supports effective workflow through the stages of the operative process, from preoperative preparation to post-anesthesia care, requires substantive improvement. With continued feedback from surgeons and the OR team, RTLSs can be refined to enable real-time management of perioperative workflow and support continuous quality improvement.

What We Learned:

1. Surgeons were dissatisfied with the RTLS as a tool for managing workflow. Patients' family members were uniformly satisfied with the RTLS as a communication tool.This satisfaction carried a secondary benefit for operating room staff and surgeons, who could trust in the efficacy of the family notification process and its resultant reduction in overall family anxiety.

2. RTLSs must provide precise time-tracking functionality for each stage of the perioperative workflow process to enable monitoring and enhancement of these processes. Regardless of the imprecision of the RTLS time-tracking functionality, family members found that the system reduced their anxiety and was convenient and user-friendly.

3. Future enhancements to RTLSs should consider heuristic design principles.

References

Downe-Wamboldt, B. 1992. Content Analysis: Method, Applications, and Issues. *Health Care for Women International* 13(3): 313–21.

Fisher, J.A. and T. Monahan. 2012. Evaluation of Real-Time Location Systems in Their Hospital Contexts. *International Journal of Medical Informatics* 81(10): 705–12. doi:10.1016/j.ijmedinf.2012.07.001.

Humber River Hospital (HRH). 2018, Autumn. Improving Health Care in Ontario. Retrieved September 23, 2019. <https://www.hrh.ca/wp-content/uploads/2018/10/HRH_community_report-2018.pdf>.

Humber River Hospital Foundation. n.d. Surgery. Retrieved September 23, 2019. <https://www.hrhfoundation.ca/programs-of-care/surgery/>.

Kamel Boulos, M.N. and G. Berry. 2012. Real-Time Locating Systems (RTLS) in Healthcare: A Condensed Primer. *International Journal of Health Geographics* 11(1): 25.

Laskowski-Jones, L. 2012. RTLS Solves Patient-Tracking Emergency. *Health management technology* 33(3): 24–5.

Meyer, M.A., W.C. Levine, M.T. Egan, B.J. Cohen, G. Spitz, P. Garcia et al. 2007. A Computerized Perioperative Data Integration and Display System. *International Journal of Computer Assisted Radiology and Surgery* 2(3–4): 191–202.

Zhang, J., T.R. Johnson, V.L. Patel, D.L. Paige and T. Kubose. 2003. Using Usability Heuristics to Evaluate Patient Safety of Medical Devices. *Journal of Biomedical Informatics* 36(1–2): 23–30.

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Impact of smartphones in healthcare

> “... our findings suggest that smartphone interruption in the process of physician care delivery was a major source of frustration.

Smartphone Technology: Impact on Interprofessional Working Relations between Doctors and Nurses

Sanjay Manocha, Jamie Spiegelman, Ethan Miller and Shirley Solomon

Abstract

Background: **For decades, the main communication technology in hospitals has been the paging system. In the era of digital communication, smartphones have been adopted by hospitals seeking to modernize processes and offer real-time, two-way communication to increase efficiency.**

Objective: **The aim of this study was to explore physicians' and nurses' perceptions of the impact of smartphones on communication and efficiency.**

Methods: **Mann-Whitney *U*-tests were used to compare differences in item scores between physicians and nurses on 17 questionnaire items relating to smartphone impact on interpersonal relationships and communication, efficiency and reliability. An open-ended question was used to elicit additional feedback.**

Results: **In total, 43 nurses and 27 physicians participated in the study. Nurses' ratings were significantly higher than physicians' on a number of questionnaire items, including the following: smartphones have a positive impact on efficiency (Mdn = 4.0 vs. 3.0, $U = 321.0$, $p = 0.027$, $r = .33$), smartphones increase my accessibility to physicians (Mdn = 5.0 vs. 3.0, $U = 277.0$, $p = 0.009$, $r = 0.42$) and smartphones reduce interruptions versus pagers (Mdn = 4.0 vs. 2.0, $U = 224.0$, $p > 0.0001$, $r = 0.47$).**

Conclusion: **The findings suggest that smartphone technology may reduce the locus of control for physicians, potentially limiting their ability to prioritize patients' needs and manage workflow efficiently.**

Introduction

The smartphone, a single handheld device, has replaced the use of pagers, cellphones and personal digital assistants in a growing number of hospitals (Al Thomairy et al. 2015). As a communication, clinical information and decision support tool, the smartphone has the potential to enhance care delivery and improve patient outcomes (Al Thomairy et al. 2015). Delivering care in the acute care hospital setting involves physicians, nurses and clinicians from a variety of disciplines, services and specialties. Effective communication and collaboration are essential for safe and high-quality patient outcomes and physician and nurse satisfaction (Bowles et al. 2016). In particular, effective communication between physicians, who have direct responsibility for their patients, and nurses, who monitor patients around the clock, is an essential component in providing highly reliable patient care (Bowles et al. 2016).

Pagers have been a useful method of communication between healthcare professionals, albeit now outdated and inferior to other tools (Webb et al. 2016). Pagers were at one time the dominant method of communication until recently, with the use of smartphones being adopted at a rapid pace (Webb et al. 2016). Pagers are a one-way communication tool, signalling that a callback is required (Przybylo et al. 2014). Therefore, a nurse who required collaboration with a physician was able to page the physician but would have to wait for a return response. Salehi (2018) suggested that ineffective communication, such as delayed callback, can compromise safe and effective patient care. According to Salehi (2018), "[S]afe and effective patient care demand interdisciplinary collaboration and communication among health care providers" (p. 1).

Humber River Hospital (HRH) implemented smartphone technology to support communication between nurses and physicians (Wels-Maug 2016). The smartphone technology used at HRH allows access to medical information and serves as a communication system between nurses and physicians (Przybylo et al. 2014; Wels-Maug 2016). Previous studies have examined different methods of communication, with findings that revealed the advantages and disadvantages of various communication methods and tools (Wu et al. 2013). The findings from one study that examined numerical and alpha-numerical pagers and smartphones revealed that when pagers were used, responses were often delayed or ignored and there were callback number errors, resulting in an inability to return calls (Wu et al. 2013). These deficiencies in the pager communication system created frustration among staff members (Wu et al. 2013). Although smartphones were found to reduce some of these issues, users found them highly disruptive as direct phone calls require an immediate response (Wu et al. 2013). Additionally, with the use of smartphones, all direct phone calls might be assumed to be urgent, resulting in frustrated users if they are interrupted during a task for a non-urgent matter (Wu et al. 2013). According to Ghahramanian et al. (2017), "In the domain of internal communications, disrupted communication between nurses and physicians can also hinder teamwork and consequently endanger the safety and quality of care" (p. 169). The aim of this study was to explore the perceptions of physicians and nurses regarding the impact of smartphones on communication and interprofessional relationships, as well as efficiency and reliability.

HUMBER RIVER HOSPITAL is one of Canada's largest community acute care hospitals, serving a population of more than 850,000 people in the north-west Greater Toronto Area. The multi-site hospital currently operates out of its Wilson Avenue acute care site and Finch and Church Street reactivation care centres with a total of 722 beds, just over 3,800 employees, approximately 700 physicians and over 1,000 volunteers.

Affiliated with the University of Toronto and Queen's University, Humber River Hospital is North America's first fully digital hospital. Part of Humber River Hospital's digital infrastructure includes completely automated laboratory services, robots sorting and mixing medications, electronic health records, tracking systems, for patients undergoing surgery, that update families through their cellphones and patient bedside computer terminals – all varieties of technologies that automate information, eliminate paper and provide a connected experience for patients, staff and families.

Humber River Hospital was awarded Accreditation with Exemplary Standing in 2018 and, since its opening in 2015, has received numerous awards and accolades for technological advancements and innovation (www.hrh.ca).

Methods

Study design and sample

A cross-sectional and descriptive study design was carried out at HRH. Survey participants consisted of two groups of clinicians: physicians and nursing staff, including part-time and

full-time staff. The inclusion criteria were nurses and physicians who were employed at HRH for at least 6 months, provided direct care to patients and used the hospital smartphone as part of their daily practice. Informed consent was obtained from all participants, and ethics clearance was granted by Veritas IRB, an external Research Ethics Board.

Data collection and instruments

Participant responses were collected between November and December 2019 through an online questionnaire. Relevant questionnaire items were compiled from a systematic review of the literature (Lo et al. 2012; Patel et al. 2016; Quan et al. 2013; Wu et al. 2011, 2015) for perceptions of smartphone use within a hospital setting. The questionnaire was reviewed by clinicians and modified based on their feedback. The final survey instrument was composed of 17 items relating to interpersonal relationships and communication, efficiency and reliability. Each item was measured using a 5-point numerical rating scale (1 = strongly disagree to 5 = strongly agree). The questionnaire also collected information about the participants' age, gender, years of work experience in their field and years of work experience at HRH. Additionally, participants were asked if they had any further information they wanted to provide about the hospital smartphone through an open-ended question contained in the questionnaire. Participation in the study was voluntary, and all responses were anonymous.

Data analysis

Participant demographic data were summarized using descriptive statistics. Inspection of the data using Kolmogorov–Smirnov tests showed that all measures were not normally distributed; therefore, non-parametric tests were used for analysis. A series of Mann-Whitney *U*-tests were used to compare differences in item scores between physicians and nurses. *P*-values were adjusted using the Benjamini-Hochberg procedure to address multiple comparison and reduce false positive results. A p-value < 0.05 was considered significant. Statistical analyses were conducted using SPSS version 25. Free text comments were analyzed thematically.

Results

Participant characteristics

Seventy participants completed the questionnaire, including 43 nurses and 27 physicians. Participant characteristics are presented in Table 1. The majority of nurse participants were female (86.0%) and between the ages of 25 and 34 years (39.5%). Most nurse participants had more than 10 years of experience in their field (55.8%) and over 10 years of experience working at HRH (34.9%). The majority of physician participants were male (88.9%) and between the ages of 35 and 44 years (48.1%). Most physician participants also had more than 10 years of experience in their field (55.6%) and over 10 years of working experience at HRH (44.4%).

Interprofessional relationships and communication

The results of the Mann-Whitney *U*-tests are presented in Table 2. The ratings of the nurses were higher than those of physicians on measures of interprofessional relationships and communication. Nurses' ratings were significantly higher than physicians' ratings on three of the five items: positive impact on interprofessional collaboration (Mdn = 4.0 vs. 3.0, $U = 336.5$, $p = 0.038$, $r = 0.29$), increasing accessibility to physicians (Mdn = 5.0 vs. 3.0, $U = 277.0$, $p = 0.009$, $r = 0.42$) and increasing accessibility to nurses (Mdn = 4.0 vs. 3.0, U = 307.0, $p = 0.021$, $r = 0.35$).

Efficiency

On measures of efficiency, nurses also generally rated the items higher than the physicians. Nurses' ratings were significantly higher than the physicians' ratings on three of the five items: positive impact on efficiency (Mdn = 4.0 vs. 3.0, $U = 321.0$, $p = 0.027$, $r = 0.33$), experiencing less "phone tag" than pagers (Mdn = 4.0 vs. 3.0, $U = 332.0$, $p = 0.034$, $r = 0.31$) and reducing interruptions versus pagers (Mdn = 4.0 vs. 2.0, $U = 224.0$, $p > 0.0001$, $r = 0.47$).

Reliability

On measures of reliability, nurses' ratings were significantly higher than the physicians' ratings on only two of the seven items: helping to convey the patient's status quickly (Mdn = 4.0 vs. 3.0, $U = 290.0$, $p = 0.021$, $r = 0.35$) and not experiencing a lack of response to messages (Mdn = 4.0 vs. 3.0, $U = 324.5$, $p = 0.034$, $r = 0.31$).

Written feedback from participants

Of the total sample, 32 participants (45.7%), including 14 physicians and 18 nurses, provided responses to the open-ended question regarding the hospital smartphone. Comments from nurse participants were strongly focused on technical issues. Poor reception and poor battery life were the most frequently mentioned concerns, which included dropped calls, muffled voice sounds and battery life that did not last through their shift. Nurses also reported "alarm fatigue," touch sensitivity issues and frozen or unresponsive screens. Nurses stated that their experience would be ameliorated if technical issues were resolved as the smartphones provided the benefit of having a direct line of communication to the physician. One nurse commented:

> [The smartphone] can be a great resource if it had less technical difficulties, better battery life and less steps in

TABLE 1.
Demographic data and characteristics of survey participants

	Total (%) (*n* = 70)	Nurse (%) (*n* = 43)	Physician (%) (*n* = 27)
Gender			
Female	40 (57.1%)	37 (86.0%)	3 (11.1%)
Male	28 (40.0%)	4 (9.3%)	24 (88.9%)
Gender diverse	2 (2.9%)	2 (4.7%)	0 (0.0%)
Age group			
18–24	1 (1.4%)	1 (2.3%)	0 (0.0%)
25–34	18 (25.7%)	17 (39.5%)	1 (3.7%)
35–44	24 (34.3%)	11 (25.6%	13 (48.1%)
45–54	15 (21.4%)	10 (23.3%)	5 (18.5%)
55–64	9 (12.9%)	4 (9.3%)	5 (18.5%)
65–74	2 (2.9%)	0 (0.0%)	2 (7.4%)
75+	1 (1.4%)	0 (0.0%)	1 (3.7%)
Years of experience			
1 to < 3 years	5 (7.1%)	3 (7.0%)	2 (7.4%)
3 to < 5 years	9 (12.9%)	5 (11.6%)	4 (14.8%)
5 to < 10 years	17 (24.3%)	11 (25.6%)	6 (22.2%)
10+ years	39 (55.7%)	24 (55.8%)	15 (55.6%)
Length of time at HRH			
6 months to < 1 year	5 (7.1%)	4 (9.3%)	1 (3.7%)
1 to < 3 years	7 (10.0%)	5 (11.6%)	2 (7.4%)
3 to < 5 years	16 (22.9%)	11 (25.6%)	5 (18.5%)
5 to < 10 years	15 (21.4%)	8 (18.6%)	7 (25.9%)
10+ years	27 (38.6%)	15 (34.9%)	12 (44.4%)

> the sign in process. Overall, it has improved communication with physicians and getting orders in a more timely manner.

Comments from physician participants were mostly unfavourable and were strongly focused on increased interruptions and disruption to their workflow. Physicians stated that having to immediately answer calls was time consuming and potentially disruptive to patient care. Physicians also indicated that the increased accessibility that the smartphone provided had resulted in an increase in non-urgent calls from other health professionals. As a result, many physician participants indicated a stronger preference for the paging system than the smartphone. One physician commented:

> Highly interruptive technology for physician: real-time communication where the nurse controls when and how is very difficult for physicians and disrupts patient care.

TABLE 2.
Mann-Whitney *U*-test comparing the ratings of nurses and physicians on measures of interprofessional collaboration and communication, efficiency and reliability of smartphones within the hospital

Questionnaire item	Median		*n* (nurses/ physicians)	*U*	r[§]	Benjamini-Hochberg adjusted *p*-value
	Nurses	Physicians				
Interprofessional relationships and communication						
1. The hospital smartphones have a positive impact on interprofessional collaboration	4.0	3.0	39/26	336.5	0.29	0.038*
2. The hospital smartphones increase communication	4.0	3.0	39/27	392.5	0.22	0.092
3. The hospital smartphones do not decrease face-to-face communication	3.5	3.0	38/27	494.0	0.03	0.793
4. The hospital smartphones increase my accessibility to physicians	5.0	3.0	39/27	277.0	0.42	0.009*
5. The hospital smartphones increase my accessibility to nurses	4.0	3.0	38/27	307.0	0.35	0.021*
Efficiency						
6. The hospital smartphones have a positive impact on efficiency	4.0	3.0	38/27	321.0	0.33	0.027*
7. The hospital smartphones speed up my daily work tasks	4.0	3.0	38/27	389.5	0.21	0.112
8. The hospital smartphones do not bog me down with non-urgent messages	3.0	3.0	38/27	360.5	0.26	0.070
9. The hospital smartphones result in less "phone tag" than pagers	4.0	3.0	38/27	332.0	0.31	0.034*
10. The hospital smartphones reduce interruptions versus pagers	4.0	2.0	36/27	224.0	0.47	0.000**
Reliability						
11. The hospital smartphones do not experience frequent technical issues	3.0	3.0	37/27	449.0	0.09	0.507
12. The hospital smartphones help convey the patient's status quickly	4.0	3.0	36/27	290.0	0.35	0.021*
13. The hospital smartphones are beneficial for communicating complex issues	4.0	3.0	38/27	370.5	0.24	0.077
14. I do not frequently experience a lack of response to my messages[a]	4.0	3.0	37/27	324.5	0.31	0.034*
15. Responses to my messages[a] are sufficiently detailed	3.0	3.0	36/27	348.5	0.25	0.077
16. I do not frequently experience a delayed response to my messages[a]	3.0	3.0	36/27	379.5	0.19	0.138
17. The receiver is able to realize that my messages[a] require urgent attention	4.0	3.0	37/27	366.5	0.23	0.089

[a] Refers to messages of a callback location and time. *Statistically significant at $p < 0.05$. **Statistically significant at $p < 0.001$. [§]A common effect size statistic for the Mann–Whitney test is r, which is the Z value from the test divided by the total number of observations. As written here, r can vary from 0 to nearly 1.

These issues suggested that smartphones could have the potential to negatively impact interprofessional relationships. Some physicians indicated that these issues could be improved if the smartphone had voicemail capabilities, which would allow physicians to answer a call if they were free to but also to identify priorities based on the urgency of the voice message. Additionally, a directory listing on the smartphone that provides the physician with the phone number of the nurse providing care to their patient for that day was considered critical for successful team communication.

Discussion

Our study revealed that nurse participants rated smartphones as having a positive impact on interprofessional collaboration and accessibility to physicians and other nurses – significantly higher than physician participants did. Previous research has suggested "that physicians and nurses have fundamentally different perceptions and interpretations of interprofessional collaboration" (Bowles et al. 2016: 655). In part, this may account for the significant difference in nurses' versus physicians' perceptions of the impact of smartphones in our study. Similar to previous studies, our findings suggested that smartphone interruption in the process of physician care delivery was a major source of frustration (Ghahramanian et al. 2017; Wu et al. 2013). Nurses are on the sending end of smartphone technology, so their positive perceptions, particularly as they relate to accessibility to physicians, are not surprising. Nurses' unilateral control of the smartphone communication functionality might create pressure between physicians and nurses, which may compromise interprofessional relationships. According to Henkin et al. (2016), "Collaboration between physicians and nurses is essential for providing quality health care, and breakdown in this area is a major root cause of sentinel events" (p. 201). Interruption during the process of physician care because of smartphone communication has been identified in other studies as an erosion of patient-centredness (Al Thomairy et al. 2015; Webb et al. 2016). As suggested by Wald et al. (2014), concerns from the medical community are centred on the impact technology may have on the physician–patient relationship. Physician perceptions of this interference in their relationship with patients may have contributed to their lower rating of the positive impact of smartphones on interprofessional collaboration. Modifications to the smartphone technology that enable physicians to prioritize return calls and minimize workflow disruption need to be considered to foster and sustain effective interprofessional collaboration.

For the variables we explored in relation to efficiency, nurse participants rated smartphones higher than physicians did on positive impact on efficiency, experiencing less phone tag than pagers and reduced interruptions versus pagers. Again, these findings are not surprising given that the smartphone technology at HRH provides nurses with the unilateral control for the timing of calls based on their practice and workflow needs. Our findings align with other research suggesting that smartphones might pose more of a hindrance than a help to physicians (Al Thomairy et al. 2015; Webb et al. 2016). Conversely, the results from this study are contrary to other findings from previous research suggesting that smartphones improved the speed of communications between hospital clinicians and medical colleagues, improved time management and enhanced the ability to better coordinate care (Al Thomairy et al. 2015; Salehi 2018; Webb et al. 2016). Our findings suggest that smartphone functionality may not be configured to meet the workflow needs of physicians. Al Thomairy et al. (2015) suggested that smartphones have different operating systems that are open and thus encourage application development. Achieving efficiency by using smartphone technology, from the physicians' perspective, will require modifications to the software and applications. Potentially, a two-way communication feature that enables clinicians to exchange information and make decisions in the moment could increase efficiency. This might be accomplished through a secure text messaging function that is integrated with the patient electronic medical record. In this way, both physician and nurse needs are met through the automated process of requesting and delivering orders during the communication exchange between them.

Nurses in this study rated the use of smartphones to help convey patients' status quickly and the infrequency with lack of response to messages higher than physician participants did. A significant benefit of the smartphones and their implementation at HRH is that they provide an alarm system to nurses with the ability to view critical lab results and various telemetry readings. This display of clinical information permits nurses to prioritize their activities based on the urgency of patients' needs. A similar function has not been implemented for physicians except for assigned code physicians. The issue of alarm fatigue must be considered if smartphone application is enhanced to include this function. Alarm fatigue results from excessive and misleading alerts, which distract and desensitize clinicians from responding appropriately (Jones 2014). Achieving the right balance of alarm notification can be challenging.

Smartphone "messages" at HRH refer to a callback location and time versus a voicemail message. Not surprisingly, nurses stated that they do not frequently experience a lack of response to their messages, likely because, as previously described, the smartphone technology at HRH provides nurses with unilateral control for the timing of calls based on their practice and workflow needs. Physicians' rating of not frequently experiencing a lack of response to their messages was lower than that of nurses. Possibly, as the primary receiver of

calls, without voicemail functionality, physicians are more compelled to respond immediately to messages to avoid the risk of failing to intervene in urgent circumstances. Our findings suggest that physicians' smartphone technology at HRH has reduced the locus of control for physicians, potentially limiting their ability to prioritize, organize and gain workflow efficiency. Our findings highlight the need to balance the degree of control that clinicians have over their information and communication needs to enable prioritization of patients' needs and manage workflow efficiently.

Several limitations should be considered when interpreting the results of the study. The study outcome was limited to nurses' and physicians' perceptions of smartphone technology; patient perceptions were not obtained regarding disruptions to patient care. Survey administration by hospital staff may have resulted in reporting and social desirability bias occurring. A single-site setting and comparatively small sample size present further limitations in this investigation.

Conclusion

The smartphone has the potential to enhance care delivery and improve patient outcomes (Al Thomairy et al. 2015). Smartphone technology used at HRH allows access to medical information and serves as a communication system between nurses and physicians. Effective communication and collaboration are essential for safe and high-quality patient outcomes and physician and nurse satisfaction (Bowles et al. 2016). Our study revealed that nurse participants rated smartphones as having a positive impact on interprofessional collaboration and accessibility to physicians and other nurses – significantly higher than physician participants did. Possibly, nurses' unilateral control of the smartphone communication functionality may contribute to pressures between physicians and nurses, which may compromise interprofessional relationships. To foster and sustain effective interprofessional collaboration, smartphone technology needs to enable physicians to prioritize return calls and minimize workflow disruption. Our findings also suggested that smartphone functionality might not be configured to meet the workflow needs of physicians. Potentially, a two-way communication feature that enables clinicians to exchange information and make decisions in the moment could increase efficiency. A significant benefit of the smartphones and their implementation at HRH is that it provides an alarm system to nurses with the ability to view critical lab results and various telemetry readings. If this functionality is to be broadened for physician use, then the issue of alarm fatigue must be considered. Finally, our study highlighted the need to balance the degree of control that clinicians have over their information and communication requirements to enable prioritization of patients' needs and manage workflow efficiently.

What We Learned:

1. Similar to previous studies, our findings suggest that smartphone interruption in the process of physician care delivery was a major source of frustration, potentially contributing to physicians' lower rating of positive impact of smartphones on interprofessional collaboration.

2. Nurse participants rated smartphones higher than physicians did on positive impact on efficiency, experiencing less "phone tag" than pagers and reduced interruptions versus pagers. These findings are not surprising given that the smartphone technology at HRH provides nurses with the unilateral control for the timing of calls based on their practice and workflow needs.

3. Our findings suggest that smartphone technology at HRH has reduced the locus of control for physicians, potentially limiting their ability to prioritize, organize and gain workflow efficiency. These findings highlight the need to balance the degree of control that clinicians have over their information and communication needs to enable prioritization of patients' needs and efficiently manage workflow.

References

Bowles, D., G. McIntosh, R. Hemrajani, M.S. Yen, A. Phillips, N. Schwartz et al. 2016. Nurse–Physician Collaboration in an Academic Medical Centre: The Influence of Organisational and Individual Factors. *Journal of Interprofessional Care* 30(5): 655–60. doi:10.1080/13561820.2016.1201464.

Ghahramanian, A., T. Rezaei, F. Abdullahzadeh, Z. Sheikhalipour and I. Dianat. 2017. Quality of Healthcare Services and Its Relationship with Patient Safety Culture and Nurse–Physician Professional Communication. *Health Promotion Perspectives* 7(3): 168–74. doi:10.15171/hpp.2017.30.

Henkin, S., T.Y. Chon, M.L. Christopherson, A.J. Halvorsen, L.M. Worden and J.T. Ratelle. 2016. Improving Nurse–Physician Teamwork through Interprofessional Bedside Rounding. *Journal of Multidisciplinary Healthcare* 9: 201–05. doi:10.2147/JMDH.S106644.

Jones, K. 2014. Alarm Fatigue a Top Patient Safety Hazard. *CMAJ* 186(3): 178. doi:10.1503/cmaj.109-4696.

Lo, V., R.C. Wu, D. Morra, L. Lee and S. Reeves. 2012. The Use of Smartphones in General and Internal Medicine Units: A Boon or a Bane to the Promotion of Interprofessional Collaboration? *Journal of Interprofessional Care* 26(4): 276–82. doi:10.3109/13561820.2012.663013.

Patel, B., M. Johnston, N. Cookson, D. King, S. Arora and A. Darzi. 2016. Interprofessional Communication of Clinicians Using a Mobile Phone App: A Randomized Crossover Trial Using Simulated Patients. *Journal of Medical Internet Research* 18(4): e79.

Przybylo, J.A., A. Wang, P. Loftus, K.H. Evans, I. Chu and L. Shieh. 2014. Smarter Hospital Communication: Secure Smartphone Text Messaging Improves Provider Satisfaction and Perception of Efficacy, Workflow. *Journal of Hospital Medicine* 9(9): 573–78. doi:10.1002/jhm.2228.

Quan, S.D., R.C. Wu, P.G. Rossos, T. Arany, S. Groe, D. Morra et al. 2013. It's Not about Pager Replacement: An In-Depth Look at the Interprofessional Nature of Communication in Healthcare. *Journal of Hospital Medicine* 8(3): 137–43. doi:10.1002/jhm.2008.

Salehi, H.P. 2018. Smartphone for Healthcare Communication. *Journal of Healthcare Communications* 3(3): 34. doi:10.4172/2472-1654.100144.

Thomairy, N., M. Mummaneni, S. Alsalamah, N. Moussa and A. Coustasse. 2015. Use of Smartphones in Hospitals. *The Health Care Manager* 34(4): 297–307. doi:10.1097/HCM.0000000000000080.

Wald, H.S., P. George, S.P. Reis and J.S. Taylor. 2014. Electronic Health Record Training in Undergraduate Medical Education: Bridging Theory to Practice with Curricula for Empowering Patient- and Relationship-Centered Care in the Computerized Setting. *Academic Medicine* 89(3): 380–86. doi:10.1097/ACM.0000000000000131.

Webb, C., S.P. Spina and S. Young. 2016. Integrating Smartphone Communication Strategy and Technology into Clinical Practice: A Mixed Methods Research Study. *Health Policy and Technology* 5(4): 370–75. doi:10.1016/j.hlpt.2016.07.004.

Wels-Maug, C. 2016, June 6. Humber River Hospital Is Oh So Smart. Retrieved March 19, 2020. <https://healthcare-in-europe.com/en/news/humber-river-hospital-is-oh-so-smart.html>.

Wu, R.C., V. Lo, D. Morra, B.M. Wong, R. Sargeant, K. Locke et al. 2013. The Intended and Unintended Consequences of Communication Systems on General Internal Medicine Inpatient Care Delivery: A Prospective Observational Case Study of Five Teaching Hospitals. *Journal of the American Medical Informatics Association* 20(4): 766–77. doi:10.1136/amiajnl-2012-001160.

Wu, R., P. Rossos, S. Quan, S. Reeves, V. Lo, B. Wong et al. 2011. An Evaluation of the Use of Smartphones to Communicate between Clinicians: A Mixed-Methods Study. *Journal of Medical Internet Research* 13(3): e59. doi:10.2196/jmir.1655.

Wu, R., V. Lo, D. Morra, E. Appel, T. Arany, B. Curiale et al. 2015. A Smartphone-Enabled Communication System to Improve Hospital Communication: Usage and Perceptions of Medical Trainees and Nurses on General Internal Medicine Wards. *Journal of Hospital Medicine* 10(2): 83–89. doi:10.1002/jhm.2278.

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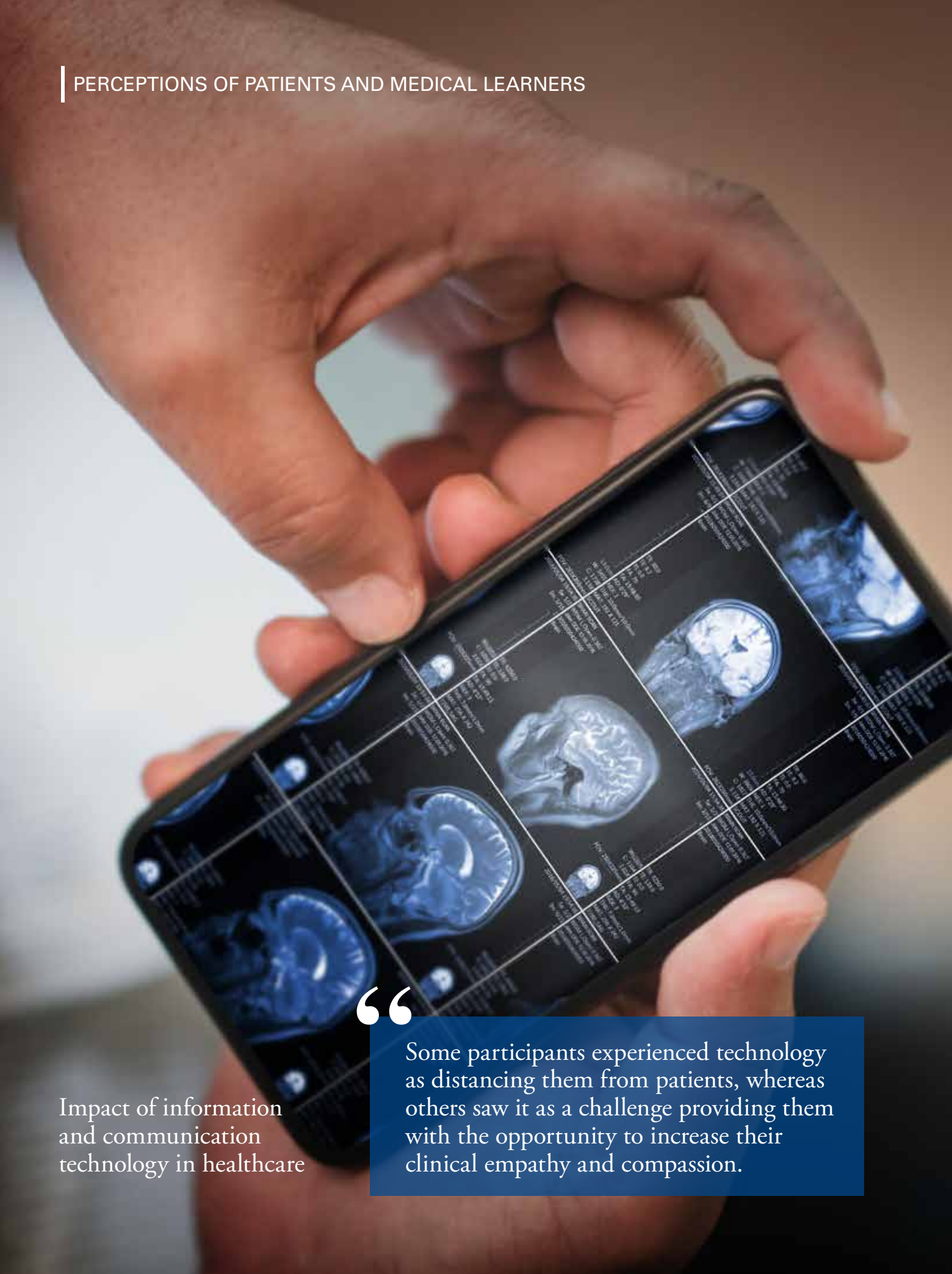

Impact of information and communication technology in healthcare

> Some participants experienced technology as distancing them from patients, whereas others saw it as a challenge providing them with the opportunity to increase their clinical empathy and compassion.

A Narrative Study on the Impact of Information and Communication Technology on the Relationship between Patients and Medical Learners

Ethan Miller, Vanessa Burkoski, Jennifer Yoon and Shirley Solomon

Abstract

Background: **Current medical learners are immersed in an era of tremendous technological advancements. Consequently, the use of information and communication technologies (ICTs) might impact entrustable professional activities (EPAs), such as interpersonal and communication skills between learners and patients.**

Objective: **The aim of this study was to explore medical learners' perspectives on ICTs and its impact on the relationship between them and their patients.**

Methods: **Semi-structured interviews were conducted with medical learners to elicit their perspectives regarding ICTs in a clinical setting. Interviews were recorded, transcribed and analyzed to identify key themes.**

Results: **Participants reported that ICTs implementation improved quality of care by allowing for rapid access to patient information and facilitating clinical decision making. However, technology use created a potential challenge to forging empathy toward patients and developing a rapport with them.**

Conclusion: **It is paramount to devise safeguards or milestone requirements in student evaluations for graduation.**

Introduction

Medical learners are entering training in an era of enormous technological advancements that has benefitted the science of medicine (Post et al. 2014). As the practice of medicine transitions from the information age to the age of artificial intelligence, medical learners will be required to develop new skills and expertise to ensure their readiness for successful practice (Wartman and Combs 2019). In technologically advanced practice settings, medical learners will need to understand the practice of medicine in partnership with other physicians, healthcare professionals, technology and patients (Wartman and Combs 2019).

One of the potential unintended consequences of technology integration in healthcare settings is the negative effect it may have on medical learners' development and integration of entrustable professional activities (EPAs) (Caceres and DiCorcia 2018) that allow medical learners to be entrusted with responsibilities once sufficient competence is reached. Importantly, interpersonal and communication skills (ICSs) competencies are incorporated across all the core EPAs (Caceres and DiCorcia 2018). According to Caceres and DiCorcia (2018), "It is this domain of competence [ICS] that technology in medicine may have its greatest unintended influence and require specific intervention by preceptors and residents to prevent delayed development of multiple EPA skills sets in the medical student" (p. 248).

Medical learners are required to achieve core competencies in empathy and compassion (Royal College of Physicians and Surgeons of Canada 2015). Patel et al. (2019) stated, "Empathy and compassion are foundational elements of the practice of medicine and vital cornerstones of high quality health care" (p. 2). The EPA behaviour of "anticipating, reading and reacting to emotions in real time with appropriate and professional behaviour in typical medical communication scenarios" might be compromised by being overly focused on computer screens versus making eye contact with patients (Caceres and DiCorcia 2018: 248). Assimilating this EPA is necessary to demonstrate empathy and compassion toward patients (Caceres and DiCorcia 2018).

Humber River Hospital (HRH), one of the largest community hospitals in Ontario, has implemented several healthcare technologies and is considered the first digital hospital in North America. For medical learners, it is a unique practice environment in which to build and strengthen EPA behaviours and core competencies. Empathy and compassion are core competencies that medical learners are required to demonstrate in their pursuit of a medical degree (Royal College of Physicians and Surgeons of Canada 2015). This study explored medical learners' perspectives about the effect of healthcare technology on their relationship and interactions with patients.

HUMBER RIVER HOSPITAL is one of Canada's largest community acute care hospitals, serving a population of more than 850,000 people in the northwest Greater Toronto Area. The multi-site hospital currently operates out of its Wilson Avenue acute care site and Finch and Church Street reactivation care centres with a total of 722 beds, just over 3,800 employees, approximately 700 physicians and over 1,000 volunteers.

Affiliated with the University of Toronto and Queen's University, Humber River Hospital is North America's first fully digital hospital. Part of Humber River Hospital's digital infrastructure includes completely automated laboratory services, robots sorting and mixing medications, electronic health records, tracking systems, for patients undergoing surgery, that update families through their cellphones and patient bedside computer terminals – all varieties of technologies that automate information, eliminate paper and provide a connected experience for patients, staff and families.

Humber River Hospital was awarded Accreditation with Exemplary Standing in 2018 and, since its opening in 2015, has received numerous awards and accolades for technological advancements and innovation (www.hrh.ca).

Methods

Study design and participants

This qualitative study explored medical learners' perspectives on how information and communication technology (ICTs) has impacted their relationships with their patients. A narrative approach was employed to elicit detailed accounts of personal experiences. Descriptive accounts were analyzed, and key themes were identified. Eligible criteria for medical learner participation included those who worked at HRH for a minimum of 1 month, native English speakers and those who were 18 years of age or older. Participants also possessed the capacity to consent. This study was proposed to an independent Research Ethics Board for approval prior to conducting the study.

Data collection

Semi-structured, in-depth interviews were conducted from November 2019 to January 2020 at HRH to collect data. Study participants were interviewed in a one-on-one session or in a focus group setting according to their preference. One-on-one interviews lasted approximately 20 minutes, whereas focus group interviews lasted approximately 30 minutes. Demographic data and informed consent were obtained immediately prior to conducting the interviews. Members of the research team were responsible for leading the interviews. Once data saturation was reached, the interviews were no longer continued. A qualitative study using narrative inquiry was used to explore the generational differences and similarities of adapting to technology. Narrative research provides valuable insights into how participants construct meaning through storytelling (Riessman 1993).

Data analysis

Interview transcripts were analyzed to identify common themes using a categorical-content approach (Lieblich et al. 1998). Each transcript was read by two analysts, and common themes were identified with a focus on participants' own words. Two main categories were identified.

Results

There were five participants in this study: three male and two female. Each theme is described below and supported by verbatim quotations from the participants.

Theme: Information available in the moment

One theme that emerged from the data was that technology enabled medical learners to have easy access to information. This access was seen as essential to ensuring that medical learners were able to obtain needed health information. One medical learner explained:

> Usually, when I come in in the morning, I can pull up my patient lists and look at all the different notes or blood work that came in since I looked the day before. It's a lot easier than going around to all the paper charts one at a time and just get a quick look before I … see the patients and know if they had any issues overnight. Then I … see them and then come back and write a note, and I can look up anything I need to look up – different resources, … everything. And [I] come up with a plan and write it all out on my note so [that] when it's time to present, then I'll have everything that I need.

In addition, ease of access to information was seen as a positive addition to providing care as it also helped reduce barriers and facilitate more efficient communication between learners and patients. One medical learner shared her experience of technology providing her with the ability to quickly access interpreter services through a portable tablet so that she could communicate important information with the patient:

> One of the other technology things that I used was the translator on the screen, where you can videoconference in. That's super handy. I can just get one from the basement. I had a patient who only speaks Portuguese, and her relatives weren't there when I wanted to interview her. So I just got the translator and was able to do that, and the patient was perfectly happy with it. … [S]he could see the person, and the person could see her. And it was all fine.

Another participant commented that direct access to patient information had a positive effect on the quality of communication. As gathering information was often difficult due to time limitations, technology was able to facilitate the exchange of information and develop dialogue between patients, their family members and healthcare providers:

> I was on Pediatrics [when] a child came in, quite sick, and we saw from previous notes that there were some previous admissions. ... In all my interactions that I've had with patients, technology has helped. Without those previous notes and records, you'd have to spend a lot of time doing detective work with family, and often times they wouldn't know to answer the specific dates, or what happened, or the hospital course or what was given in the [emergency room] back then. So it definitely helped in all my patient encounters.

Convenience of information was also seen as important for the patient as technology offered greater depth of information to patients, thus empowering them:

> [Patients] can actually access their records … more easily. As we try to move to more streamlined processes for accessing information between hospitals, I think that's going to empower patients. And it also empowers them in that there's a more seamless transition of communication between hospitals.

> I think technology has increased patient empowerment because [there are] options for the patients to view results [and] see doctor's notes, which they can access online through the patient portal. So they're kept in the loop, and the likelihood of their care slipping through

> the cracks [is] a lot less likely to happen with them being advocates for their own care. It keeps providers on their toes as well.

Theme: Maintaining the patient–physician relationship

A second theme emerging from the interviews was the issue of maintaining the patient–physician relationship. Technological advancements were seen as having the possibility to increase the psychological distance between doctors and patients. As participants explained:

> Well, there is a risk … that it could definitely get in the way. … [I]f you're looking at a computer the entire time you're talking to a patient, then that might hinder the relationship between the doctor and patient.

> When you have all these technologies available to you, you may be tempted to not ask or spend as much time with the patient because you already have all their information online. There are opportunities … to bypass a lot of the communication that's done face-to-face.

Interestingly, several participants did not perceive that the patient–physician relationship would be at risk given the advanced technology of clinical environments. Instead, participants viewed this element as a positive challenge to increase their clinical empathy. Participants recognized that it was essential to connect with patients through continuous communication to build that bond of compassion and trust. Participants stated:

> I'm talking to all my patients every day ... I'll look for any changes in their notes or their blood work and then talk to them: "So, do you have any constipation or anything?" Things you can't really see in the blood work. Or if there's something weird in the blood work, [I'll] ask them about symptoms that might be related to that. So it's all part of the puzzle. And I feel like you can't just do half.

> It's important to take the time to talk to patients instead of just trying to figure everything out based on their labs and blood works. I guess [that] having all the information in front of you, … it's easy to [say], "Oh, I don't need to talk to the patient." But, really, it's good to, even if you already have an idea [of] what's going [on], because they'll definitely have more to add, and then they just feel like they're being heard.

Another participant rationalized that engaging with a patient is no different in traditional hospitals using conventional paper records as physicians may still avoid eye contact and interactions with the patient:

> It comes down to the individual physician and how they use [technology]. Because they could be staring at a computer screen, or they could just be staring at a paper chart the whole time as well. In that instance, I wouldn't say it's the technology as much as it's … the physician not being attentive. So it's about ensuring [that] you use [technology] ... in ways that could enhance the relationship with the patient.

Discussion

Our study explored medical learners' perspectives about the effect of healthcare technology on their relationship and interactions with patients at one large community, digital hospital. Two themes emerged: information available in the moment and maintaining the patient–physician relationship. Access to point-in-time patient information and resources was experienced as a positive outcome of technology integration by medical learners participating in this study. Similar to previous studies, we found that rapid access to patient records and medical information, along with resources and tools to support clinical decision-making, was viewed as reducing barriers and creating facilitators for effective communication with patients (Tierney et al. 2013). Snyderman and Gyatso(2019) suggested that medical learners' ability and desire to provide compassionate care are diminished by a rigid healthcare delivery system focused on volume, which leaves little time for meaningful engagement with patients. Our findings suggested that the efficiency gained by immediate access to patient information and resources may allow medical learners to sustain their focus on developing skills associated with ICS competencies because they have the time to do so. Conversely, Caceres and DiCorcia (2018) suggested that medical learners who become accustomed to templates and prompted order sets might not successfully acquire the core physician competency of knowledge for practice. According to Caceres and DiCorcia (2018), "This [templates and prompted orders] affects their [medical learners'] ability to communicate their rationale for recommendations and treatments for patients and to engage in clinical discussion that go beyond the templated note or the structured order sets" (p. 248).

Based on our results, there is reason to suggest that in the digital healthcare setting, medical learners' integration of two core competencies, ICS competencies and knowledge for practice, might be impacted. With the growing presence of technology in many healthcare settings, medical learners will need to incorporate technology into their workflows

and interactions, and this may come at the risk of insufficient skill and knowledge acquisition. Our findings support the concept suggested by previous authors that adequate exposure to direct patient and preceptor encounters must be maintained to maximize the potential for medical learners to develop fundamental therapeutic communication and clinical reasoning skills (Caceres and DiCorcia 2018; Post et al. 2014; Tierney et al. 2013).

The views of medical learners participating in this study about the influence of technology on the patient and physician relationship were mixed. Some participants perceived that technological advancements had the possibility of distancing them from patients. Interestingly, however, several participants experienced the integration of technology in healthcare as a positive challenge to increase their clinical empathy. Similar to previous research, some participants in this study perceived that the use of technology might distract from face-to-face interactions with patients and the expression of attentiveness, empathy and concern through body language. As stated by Post et al. (2014), "The electronic health record replaces the jotting of notes by hand in a face-to-face interaction with the patient, with eye-gaze-and-search on a monitor seeking the right screens, typing or clicking on drop downs" (p. 877).

Potentially, healthcare technology may stimulate the conditions by which the dialogue between patients and medical learners is reduced (Caceres and DiCorcia 2018; Post et al. 2014; Tierney et al. 2013; Wald et al. 2014). Effective and focused communication between medical learners and patients is essential for building relationships and developing empathetic and compassionate care (Sinclair et al. 2016). Sinclair et al. (2016) found that healthcare providers felt that approaching and understanding the patient as a fellow human being was a critical aspect of compassionate care (p. 6). Our findings emphasize results from previous studies that suggested communication and engagement of patients must be fostered to support the development of compassionate care delivery, elevate quality and enhance satisfaction (Post et al. 2014; Snyderman and Gyatso 2019). The consequence of medical learners lacking the skills and behaviours necessary to deliver empathetic and compassionate care is a healthcare environment of the future that reduces the potential for improved patient outcomes. According to Post et al. (2014), "Patient experience of compassionate care correlates positively with both prevention and disease management" (p. 878).

Wald et al. (2014) suggested that medical learners are concerned about their capability of integrating healthcare technology in clinical encounters without compromising the patient–physician relationship. Conversely, the findings from our study suggest that the growth and spread of healthcare technology might be a challenge that can be met with the opportunity to reinforce the benefits associated with the delivery of empathetic and compassionate care. One participant made the poignant comment that irrespective of practising in the paper or electronic setting, it is ultimately the individual physician's attentiveness to the patient that fosters effective patient relationships. This suggested to us that ensuring that healthcare is practised with empathy and compassion goes beyond identifying the potential barriers to effective patient–physician interactions, such as technology, to the foundational skills and knowledge that are necessary to stimulate compassionate practice. According to Burridge et al. (2017), "[T]he current culture of health care has framed the practising of healthcare with compassion as an aspirational ideal rather than the foundation of care" (p. 86). Patel et al. (2019) suggested that a "compassion crisis" exists in healthcare in which physicians focused on biomedical inquiry are missing opportunities to show empathy and compassion. Patel et al. (2019) further stated that "empathy and compassion are not simply inherent traits, which health care providers intrinsically either do or do not possess, but can be enhanced through training interventions" (p. 2). We agree with previous studies that suggested the need to develop specific competency- and EPA-based expectations for medical learners that incorporate technology into patient encounters to ensure empathetic and compassionate practice (Caceres and DiCorcia 2018; Post et al. 2014; Tierney et al. 2013; Wald et al. 2014).

Limitations

Although the study provided insights for the subject matter, there were some limitations. The results were based on data collected from in-person interviews, which may lead to social desirability bias. As well, the small sample size and the restriction to a single hospital site preclude generalizability.

Conclusions

One of the potential unintended consequences of healthcare technology integration is the negative effect it may have on medical learners' development and integration of EPAs, specifically, ICS competencies. This study explored medical learners' perspectives about the effect of healthcare technology on their relationship and interactions with patients. Two themes emerged: information available in the moment and maintaining the patient–physician relationship. Participants experienced the positive outcome of technology integration, similar to previous research, that rapid access to patient records and medical information, along with resources and tools to support clinical decision-making, reduced barriers and created facilitators for effective communication with patients (Tierney et al. 2013). However, electronic templates and prompted order sets might impede medical learners' ability to acquire the core physician competency of knowledge for practice (Caceres and DiCorcia 2018). We found mixed views of medical learners participating

in this study about the influence of technology on the patient and physician relationship. Some participants experienced technology as distancing them from patients, whereas others saw it as a challenge providing them with the opportunity to increase their clinical empathy and compassion. Empathetic and compassionate physician practice requires training and education. Our study aligns with previous research suggesting that specific competency- and EPA-based expectations must be created to safeguard the development of empathetic and compassionate physician practice in the future.

Acknowledgement

We would like to acknowledge Dr. S. Gaind for his insightful review of and reflection on this study.

What We Learned:

1. The efficiency gained by immediate access to patient information and resources through ICTs may enable medical learners to sustain their focus on developing skills associated with interpersonal and communication competencies because they have the time to do so.

2. In the digital healthcare setting, medical learners' integration of two core competencies, ICSs and knowledge for practice, might be impacted. Similar to previous studies, our findings suggested that adequate exposure to direct patient and preceptor encounters must be maintained to maximize the potential for medical learners to develop fundamental therapeutic communication and clinical reasoning skills.

3. Based on our findings, the growth and spread of healthcare technology might be a challenge that can be met with the opportunity to reinforce the benefits associated with the delivery of empathetic and compassionate care.

References

Burridge, L. H. S. Winch, M. Kay and A. Henderson. 2017. Building Compassion Literacy: Enabling Care in Primary Health Care Nursing. *Collegian* 24(1): 85–91. doi: 10.1016/j.colegn.2015.09.004.

Caceres, J.W. and M.J. DiCorcia. 2018. The Impact of Technology on the Development of Core Entrustable Professional Activities (EPAs). *Medical Science Educator* 28(1): 247–49. doi: 10.1007/s40670-017-0495-0.

Lieblich, A., R. Tuval-Mashiach and T. Zilber. 1998. *Applied Social Research Methods, Vol. 47. Narrative Research: Reading, Analysis, and Interpretation*. Thousand Oaks, CA: SAGE Publications, Inc.

Patel, S., A. Pelletier-Bui, S. Smith, M.B. Roberts, H. Kilgannon, S. Trzeciak et al. 2019. Curricula for Empathy and Compassion Training in Medical Education: A Systematic Review. PloS One 14(8): e0221412. doi: 10.1371/journal.pone.0221412.

Post, S.G., L.E. Ng, J.E. Fischel, M. Bennett, L. Bily, L. Chandran et al. 2014. Routine, Empathic and Compassionate Patient Care: Definitions, Development, Obstacles, Education and Beneficiaries. *Journal of Evaluation in Clinical Practice* 20(6): 872–80. doi: 10.1111/jep.12243.

Riessman, C.K. 1993. *Narrative Analysis* (Vol. 30). Newbury Park, CA: SAGE Publications, Inc.

Royal College of Physicians and Surgeons of Canada. 2015. CanMEDS 2015 Physician Competency Framework. Frank, J.R., L. Snell, J. Sherbino, eds. Ottawa, ON: Author.

Sinclair, S., J.M. Norris, S.J. McConnell, H.M. Chochinov, T.F. Hack, N.A. Hagen et al. 2016. Compassion: A Scoping Review of the Healthcare Literature. *BMC Palliative Care* 15(1): 6. doi: 10.1186/s12904-016-0080-0.

Snyderman, R. and T. Gyatso. 2019. Compassion and Health Care: A Discussion With the Dalai Lama. *Academic Medicine* 94(8): 1068–70. doi: 10.1097/ACM.0000000000002709.

Tierney, M.J., N.M. Pageler, M. Kahana, J.L. Pantaleoni and C.A. Longhurst. 2013. Medical Education in the Electronic Medical Record (EMR) Era: Benefits, Challenges, and Future Directions. *Academic Medicine* 88(6): 748–52. doi: 10.1097/ACM.0b013e3182905ceb.

Wald, H.S., P. George, S.P. Reis and J.S. Taylor. 2014. Electronic Health Record Training in Undergraduate Medical Education: Bridging Theory to Practice With Curricula for Empowering Patient-and Relationship-Centered Care in the Computerized Setting. *Academic Medicine* 89(3): 380–86. doi: 10.1097/ACM.0000000000000131.

Wartman, S.A. and C.D. Combs. 2019. Reimagining Medical Education in the Age of AI. *AMA Journal of Ethics* (21)2: 146–52. doi: 10.1001/amajethics.2019.146.

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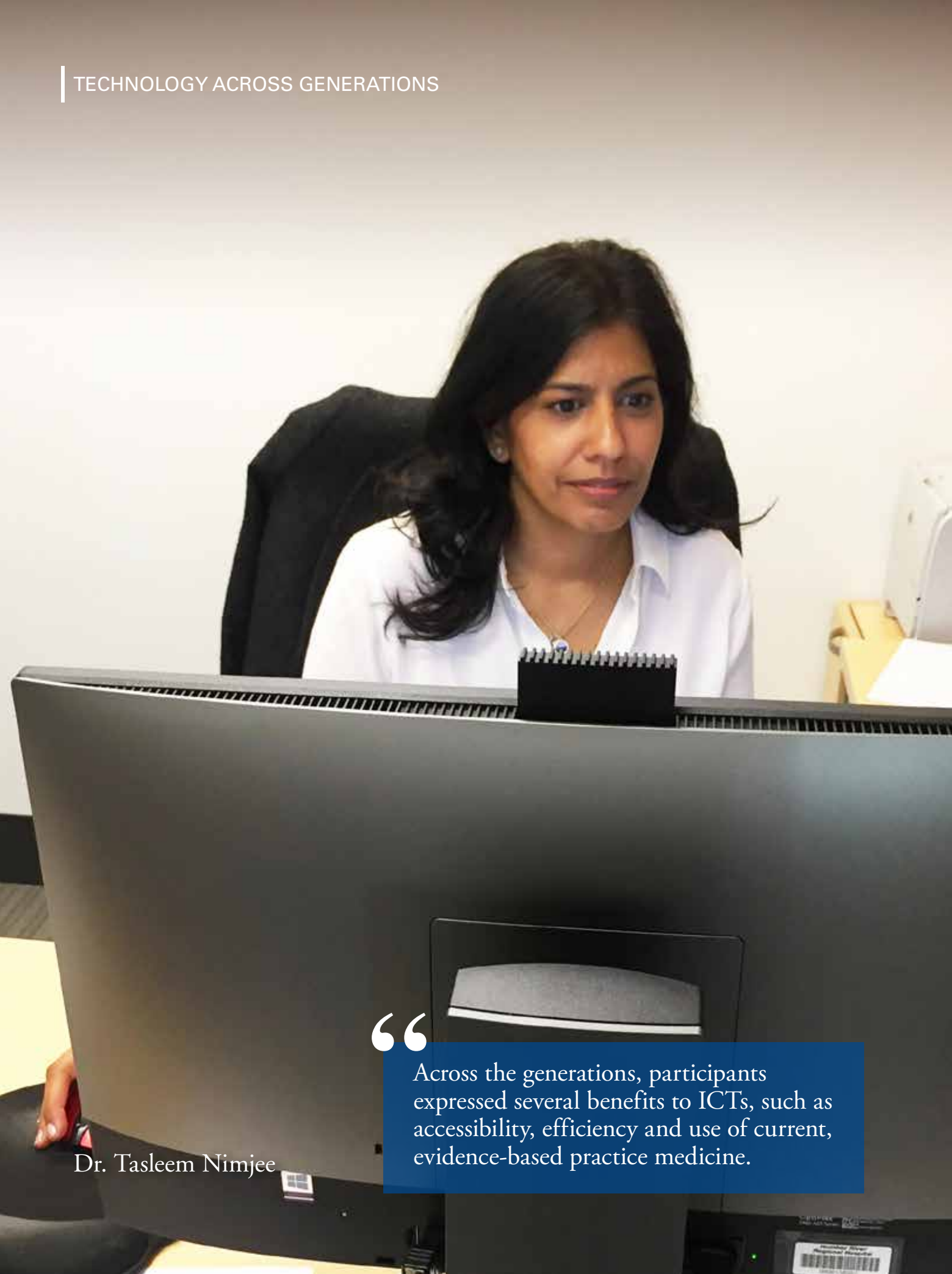

> “Across the generations, participants expressed several benefits to ICTs, such as accessibility, efficiency and use of current, evidence-based practice medicine.

Dr. Tasleem Nimjee

Exploring Generational Differences in Physicians' Perspectives on the Proliferation of Technology within the Medical Field: A Narrative Study

Tasleem Nimjee, Ethan Miller, and Shirley Solomon

Abstract

Background: **The development and advancement of information and communication technologies (ICTs), such as electronic libraries, electronic medical records and computerized physician order entry systems, have made learning and acquiring vast medical knowledge feasible. However, there are limited data pertaining to the navigation of such technologies among physicians of varying generational cohorts.**

Objective: **The aim of this study was to explore physician experiences and perspectives influencing the adoption of ICTs, with an emphasis on generational differences.**

Methods: **Semi-structured interviews with focus groups or individual physicians were conducted, recorded and transcribed to elicit key themes.**

Results: **Across the generations, participants expressed several benefits to ICTs, such as accessibility, efficiency and use of current, evidence-based practice medicine. Common problems encountered included usability issues, downtimes, alarm fatigue, and administrative tasks. There were differences between generations regarding adaptability, perceived benefits and drawbacks and perceptions of other generations' ability to adapt.**

Conclusion: **Physicians from various generations recognized the overall benefits of implementing ICTs. Although some drawbacks were reported, all participants understood the necessity of ICTs. Furthermore, implementation should be tailored to physician working style and learning needs.**

Introduction

As scientific research progresses, more information is acquired. Medical knowledge constantly expands, and there is a plethora of information that physicians must continuously learn (Hardyman et al. 2013). Consequently, physicians must find ways to acquire relevant information in order to provide the most evidence-based and temporally appropriate medical care. Biomedical research data doubles every 20 years; thus, medical professionals must be able to constantly review material and update their knowledge base (Davies 2007). This is most effectively done through the use of electronic libraries and digital information-sharing platforms (Davies 2007). According to Weightman and Williamson (2005), access to library services positively impacts overall patient care, diagnosis, testing, therapy and length of hospital stay.

Electronic medical records and computerized physician order entry (CPOE) systems have been developed to enhance healthcare delivery and reduce medical errors and patient harm (Øvretveit et al. 2007). Prescription medication errors decreased significantly following the implementation of electronic prescribing modalities when compared to manually written prescriptions (Ancker et al. 2012). Furthermore, systematic reviews have concluded that health information technology improved the quality of healthcare by reducing medical errors, improving disease surveillance and enhancing adherence to medical protocols or guidelines (Chaudhry et al. 2006).

Although the benefits of implementing information and communication technologies (ICTs) have been outlined by others, the challenges of implementing these systems and transitioning to their use are ongoing. According to a systematic review conducted by Gagnon and colleagues (2012), there are several factors that have hindered the adoption of ICTs in the clinical setting. Various factors include a lack of perceived benefits, ease of use, familiarity with ICTs, poor support and increased time consumption (Cekada 2012). Moreover, there is a debate over the "digital divide" and generational differences in the adoption of ICTs (Hillman n.d.). Generational cohorts exhibit varying degrees of technological competence. The current workforce is composed of individuals from the Silent Generation (born 1933 to 1945), baby boomers (born 1946 to 1964), Generation X (born 1965 to 1980) and millennials or Generation Y (born 1981 to 2000) (Cekada 2012). Millennials are said to possess expertise regarding technology and generally navigate technology seamlessly (Cekada 2012). Generation X members also use technology and are "more comfortable" with its use in a work environment (Cekada 2012). The Silent Generation and baby boomers did not grow up with pervasive use of technology in everyday life and as a result tend to be more reluctant to adopt its use (Cekada 2012). The aim of this study was to explore various physicians' experiences with using and navigating ICTs, with a unique emphasis on the generational differences.

HUMBER RIVER HOSPITAL is one of Canada's largest community acute care hospitals, serving a population of more than 850,000 people in the north-west Greater Toronto Area. The multi-site hospital currently operates out of its Wilson Avenue acute care site and Finch and Church Street reactivation care centres with a total of 722 beds, just over 3,800 employees, approximately 700 physicians and over 1,000 volunteers.

Affiliated with the University of Toronto and Queen's University, Humber River Hospital is North America's first fully digital hospital. Part of Humber River Hospital's digital infrastructure includes completely automated laboratory services, robots sorting and mixing medications, electronic health records, tracking systems, for patients undergoing surgery, that update families through their cellphones and patient bedside computer terminals – all varieties of technologies that automate information, eliminate paper and provide a connected experience for patients, staff and families.

Humber River Hospital was awarded Accreditation with Exemplary Standing in 2018 and, since its opening in 2015, has received numerous awards and accolades for technological advancements and innovation (www.hrh.ca).

Methods

Study design and participants

Humans frequently use stories as a tool to transfer knowledge (Riessman 1993). A narrative inquiry approach was used to generate in-depth understanding of physician experiences in a technology-driven healthcare environment, with a special emphasis on generational differences or similarities. Detailed descriptions were elicited from physicians and subsequently interpreted to extract key themes. Eligible physician participants included physicians employed at Humber River Hospital (HRH) for a minimum of 1 year, legal adults and those who are able to converse fluently in the English language. In addition,

participants possessed the capacity to consent. Veritas IRB, an independent Research Ethics Board, approved the study.

Data collection

Data were gathered through semi-structured, in-depth interviews with eligible physician participants at HRH in November and December 2019. Participants were interviewed in a one-on-one session or focus group setting. Interview setting was based on participant preference and availability. Focus group settings lasted approximately 45 minutes, and one-on-one sessions ranged from 15 to 20 minutes in duration. Informed consent and demographic information were obtained at the time of the interview. Trained research team members conducted the interviews until sufficient data were obtained.

Data analysis

The interview text was coded and analyzed by using a categorical-content approach (Lieblich et al. 1998). This approach allowed the researchers to focus on the content of participants' stories and highlight key themes in the interview. The process involved an ongoing analysis to refine each theme and selection of compelling text to highlight them. Descriptive statistics were generated for the demographic survey data.

Results

Four themes emerged from the analysis of the narrative accounts: adaptability, benefits and drawbacks, responses to technological change and perceptions of other generations. The demographic characteristics of participants are presented in Table 1.

TABLE 1.
Demographic characteristics of physician study participants, *n* =11

Generation	*n*	%
Millennial	3	27.3%
Generation X	2	18.2%
Baby boomer	5	45.5%
Silent Generation	1	9.1%
Gender		
Male	9	81.8%
Female	2	18.2%
Gender diverse	0	0.0%
Years of experience as a physician		
3 to < 5 years	2	18.2%
5 to < 10 years	1	9.1%
10+ years	8	72.7%
Length of time at Humber River Hospital		
1 to < 3 years	1	9.1%
3 to < 5 years	2	18.2%
5 to < 10 years	4	36.4%
10+ years	4	36.4%

Adaptability

Participants spoke about their ability to learn and adapt to information systems and the technological environment. Participants of all generations acknowledged that there was some adjustment period, but, ultimately, they did not have major difficulties navigating technologies within the medical field:

> [I adapted] very quickly, just because I was so receptive. If I was not receptive, I wouldn't have done it. I'm actually computer illiterate. But once I know which buttons to type, I'm okay. (Silent Generation participant)

> So order entries, online ordering, electronic charts – that was a bit of adaptation. It wasn't horrible, but in the past, we had paper charts on the floor. [With the] paper chart, you physically write your note in the chart, and when you make rounds, you carry around … 15 charts and you have to go and sit down and do all these notes. And when they introduced paperless charts, there was a huge pushback, as if that was such a great system that we were leaving behind! [Laughs] It was a horrible system. And it just took a little while to realize, to get comfortable, and then it was so much better. (baby boomer participant)

> … I'm independent enough that I could figure everything out for myself; it's not hard. But you do have to sort of sit down and play with it sometimes to figure out what the constraints of the system are and how to get it done. (Generation X participant)

> [Adapting to new technology] was okay – probably better than [for] some of the colleagues that are not as used to computers, but not as well as I thought I

would, given that I was a proponent of digital charting before I became staff. (millennial participant)

Benefits and drawbacks

Participants generally embraced ICTs, citing access to real-time, evidence-based clinical information as a key benefit. Significant time savings, better patient health outcomes, faster workflows and accessible and easily retrievable data were also perceived as benefits of technology:

> Everything is sort of easy to access, whereas before we had to take our own X-rays and slap them on the screen, and by the time they came from Radiology, it was very slow. Now, as soon as they take an X-ray, it's there. (Silent Generation participant)

> Technology is reaching … the point, getting to the point, where you can use your phone as a screen and do an ultrasound at the bedside that way. So that's what I'm … waiting for. Just walk around with a transducer; it's going to replace the stethoscope. So the drain on resources will be much … less of a drain, and [there will be] more timely diagnosis. (baby boomer participant)

> Electronic medical records make things a lot easier. [An] easy example would be [that] before, if you wanted to check an old X-ray, you had to go downstairs to the radiology lab, ... you would have had to go downstairs to a place, request records, wait maybe a day before you could get them and then … find another place where you could actually flip through these pages and pages of papers and look. And right now, all of that is done in a matter of seconds on the computer. Huge difference. (Generation X participant)

> It really has changed my workflow significantly. It's nice to have all the information … in one place; it's nice to have something that's legible. And I don't need to worry about who has the chart when I need the patient's chart to access something. That has made it easier for sure. (millennial participant)

However, participants also described experiencing less positive encounters with technology. For example, many encountered usability issues, system downtime, alarm fatigue, heavy administrative workloads and having to invest additional time in online documentation:

> It gets really bad when the system is down [because] you've become 100% dependent on [technology]. (baby boomer participant)

> Now we have a lot more alerts than we used to have that are invalid – that we just ignore. With the CPOE, when there's something that's ordered that should not have been ordered, … that should be prompted. But because we prompt everything else, we just ignore it. I think that makes it a bit worse. (millennial participant)

Responses to technological change

The response to technological change was a theme that continuously emerged throughout the interviews. Participants described both excitement and thresholds for adopting technology. For example, one participant from the baby boomer generation noted that they valued and were open to change but found that not all technological changes were suitable later in their career:

> When you get older, adapting [to] a new technology is probably not beneficial in the long run. Because I'm maybe going to work another 4, 5 years. Who knows? I don't know. But if I was starting, I'd be very interested in [learning a new technique]. When I started my career, I wasn't doing half the stuff I'm doing [a surgical technique], and I just learned it as I was going. So you need to be open to that. But when you get older, if you're not going to be using it for 20 years, then ... why bother going through the whole hassle? ... But if somebody comes up to me asking, "Do you do the [new technique]", I [say] "No, but I have a guy I can send you to." You have to be ready to let go.

The following participant from the Silent Generation expressed optimism about continuing to learn new technology but also indicated that they would continue to use paper documentation in addition to electronic documentation as they found it to still be valuable to their practice:

> The way the computerization is working in the hospital – I'm very optimistic. It's only going to get better. Even I'm learning how to do it quicker. Organize my material. But I think I'm still going to walk around with a clipboard in my hand.

One participant from Generation X recounted feeling excitement during the dot-com bubble, a period of massive growth in the use of the Internet:

> ... [T]his is what I grew up with: the invention of the Internet. I remember when I was in high school, the Internet, email, was amazing. My first year of university, there was a great thing called email. Oh, my god, I'm talking to people for free. It was crazy. But those were the formative years, where you become more functional

> as a student, transitioning into a career, and then all this technology is coming in and you're just soaking it all in. So it's all second nature to my generation.

Lastly, one millennial participant illustrated what is known as the digital divide, an uneven distribution in the access or use of modern technology between demographics and geographical regions, through the following narrative:

> I'm from a small town, so everything came later to us. We were the last one to get computers, so I lived through that transition. I had to go up on the roof to change the antenna to listen to a different channel. And now I live in a world where I drive an electric car and my phone controls my whole house. I've transitioned. [Laughs]

Perceptions of other generations

An additional recurrent theme was participants' perception of how other generations of physicians were adapting to learning new technology. Only some participants noted that they perceived there was a gap in adopting technology between older and younger physicians, whereas others felt that there were no drastic differences in attitudes and adoption of technology between the generations of physicians in the hospital:

> I found that some of the older folks – not that I'm a screaming youngster – but I found that ... for those that were complacent –"Well, in my day, [it] used to be like this" – they didn't really want to have any part of it, and then they wouldn't order things properly, and then it caused it all kinds of different problems. The drawback to technology is that there has to be buy-in by all of the end-users. … [B]ut to be fair, I could just think of one or two examples of that. It certainly wasn't widespread in my opinion. (baby boomer participant)

> The generation before me probably has a lot more [difficulty] picking up some of the technology aspects. [One physician I know] actually … bought typing programs because he didn't know how to type. So he had to learn how to type on a computer. ... [P]retty much at my generation and afterwards, there's nobody who doesn't know how to type. Older generations definitely have a more difficult time. (Generation X participant)

> There's a certain number of them who are going to be negative about it. You're not going to get 100% of them agreeing on anything. So some of the doctors are very "anti" – … they say it takes too much time. So there's always somebody complaining about something or other. (Silent Generation participant)

> I find the younger generations are asking, "Well, why isn't this working this way? This doesn't make any sense." Meanwhile, some of my colleagues who can't even get their phones to do group texting are adapting quite quickly. So I was actually surprised by how some of my younger colleagues struggled way more than I would have expected them to, and vice versa. I thought that a lot of my colleagues from older generations would struggle far more than they actually do. (millennial participant)

Discussion

In this study, we explored physicians' experiences with using and navigating ICTs and focused our exploration on the generational differences in their experiences. The findings from this study revealed that in terms of adapting to ICTs, all generational cohorts of physicians experienced adjustments. For the Silent Generation physicians who participated in our study, "which buttons to type" was the prevailing sentiment, highlighting the key working-style attribute of the Silent Generation to adapt to versus rebel against changes in the workplace (Evans et al. 2016). The baby boomer participants in this study were confronted with the new norm of paperless practice. In keeping with the notion of the "digital immigrant," whereby the baby boomer generation had limited technology exposure, participants in this study suggested that once they realized the potential benefits of ICTs and became comfortable with it, then technology adaptation was much better (Autry and Berge 2011). In the Generation X participants, the findings from this study suggested that adaptation was experienced as unperturbed. This aligns with the top most self-reported generational distinction of Generation X as technology users (Stewart et al. 2017). Millennials in our study suggested that they experienced a smoother adaptation to ICTs than their colleagues did. However, the experience of millennial adaptation to ICTs was surprisingly not as easy as they had anticipated given their "digital native" status as being "hardwired to think from a technology perspective" (Autry and Berge 2011: 464).

Relatively few studies have examined how different generations accept and embrace change, yet acceptance of change is fundamentally dependent on the support and enthusiasm of people (Ludviga and Sennikova 2016). Ludviga and Sennikova (2016) suggested that the response to change is different depending on the generation and, in particular, when it involves ICTs. Engagement, one of the key factors in successful change management, is critical in the introduction of healthcare ICTs (Ludviga and Sennikova 2016). The findings from this study suggested that the variation in adaptation to ICTs across

generational cohorts requires thoughtful change management planning and execution.

Physicians who participated in this study experienced several benefits and drawbacks of healthcare ICTs. All generations expressed the benefits of ICTs in terms of time savings, faster workflows, accessibility and ease of information retrieval and availability of real-time, evidence-based practice information. Participants from the Silent Generation and Generation X viewed time saving as a main benefit of healthcare ICTs. For the baby boomer participants in this study, the benefits of healthcare ICTs were expressed as the optimistic anticipation of further advancements in ICTs that would support physician practice. Millennials valued most the benefit of ICTs as improving workflow and enabling information that is legible and easily accessible as it is all in one place.

Given the variation in benefits of ICTs experienced across the generational cohorts of study participants, the planning and implementation of ICTs could be strengthened by a value proposition that incorporates the primary benefits of ICTs as conveyed by the predominant users of the system. According to Tantalo and Priem (2016), "[V]alue creation is essential for strategic success" (p. 314). In our hospital, physicians across the generational groups experienced time saving, continuous advancement of ICTs and improved workflow as key benefits. Although much of the foundational ICTs have already been implemented at HRH, future ICTs planning and implementation should consider the alignment of these core benefits with the decisions made regarding the type of ICTs selected for implementation and approach by which it would be implemented. In the case of hospitals that are at the beginning of ICTs planning and implementation, an understanding of physician end-users' expected benefits of ICTs may support enhanced acceptance and adaptation.

In general, physician participants across all generations experienced drawbacks of ICTs in the form of usability issues, downtimes, alarm fatigue and heavy administrative burden. Interestingly, baby boomer participants experienced the most discomfort with downtimes, expressing a clear dependency on the technology and a heavy reliance on ICTs in their practice. This suggests to us that once baby boomers buy into ICTs, they are all in. As previously mentioned, baby boomer participants in this study viewed the continuous advancement of ICTs with optimistic anticipation. Both experiences conveyed by baby boomer participants suggest that this generational cohort may be a key influencer in the process of managing and steering change because of their potential to shepherd those in other cohorts through the period of resistance that they themselves overcame to achieve ICTs acceptance. Potentially, resistance can play an important role in organizational change when leveraged as an opportunity to gain a better understanding of the issues inhibiting a successful change process (Downs 2012; Gonçalves and da Silva Gonçalves 2012).

In this study, the perceptions of physician participants across generational groups were sought regarding how they viewed other generations' adaptation to ICTs. Those from the Silent Generation held the view that essentially all other generations needed to get on with it and stop complaining. In contrast, the baby boomer generation suggested that buy-in was essential across all generational groups to achieve acceptance and foster ICTs adaptation. Generation X participants perceived that empathetic understanding was necessary for all other generational groups if ICTs adaptation was to be successful. Finally, the millennial generation participants suggested that ICTs should be configured to fit with their unique workflow and informational needs. Similar to previous studies, our findings align with the working-style attributes of each of the different generational groups (Blevins 2014; Evans et al. 2016; Ludviga and Sennikova 2016; Stewart et al. 2017). Our findings suggest that there is a need to reduce the disconnection between ICTs education and generational requirements based on working-style attributes and learning needs.

Limitations

This study has some limitations that must be addressed. Social desirability bias and selective memory may have influenced the participants' narratives. As well, the narratives elicited in this study may not cover the whole range of experiences of physicians from all generations. Furthermore, recruitment included a small sample of interviews from a single hospital site, which limits the generalizability of the findings. These findings are considered to be hypothesis-generating observations.

Conclusions

The implementation of ICTs in healthcare delivers both benefits and challenges for hospitals and clinicians (Cekada 2012). The digital divide and generational differences in physician adoption of ICTs (Hillman n.d.) have not been broadly studied. The aim of this study was to explore various physicians' experiences at HRH with using and navigating ICTs, accentuating the generational differences. Similar to previous studies, physicians who participated in this study experienced several benefits and drawbacks of healthcare ICTs (Cekada 2012; Gagnon et al. 2012). All generations of physicians who participated in this study expressed the benefits of ICTs in terms of time savings, faster workflows, accessibility and ease of information retrieval and availability of real-time, evidence-based practice information. Respondents across all generational cohorts reported drawbacks such as usability issues, downtimes, alarm fatigue and heavy administrative burden. Generational differences were found in the adaptation to ICTs, perceived benefits and drawbacks of ICTs and views about how other

generations adapt to ICTs. Our findings suggest that there is a need to reduce the disconnection between ICTs education and generational requirements based on working-style attributes and learning needs. Since baby boomer participants in this study viewed the continuous advancement of ICTs with optimistic anticipation, there is the potential for this generational cohort to be a key influencer in the process of managing and steering change.

What We Learned:

1. The variation in adaptation to ICTs across the generational cohorts requires thoughtful change management planning and execution. For hospitals at the beginning of ICTs planning and implementation, an understanding of physician end-users' expected benefits of ICTs may support enhanced acceptance and adaptation.

2. The variation in the benefits of ICTs experienced by different generational cohorts suggests that planning and implementation of ICTs could be strengthened by a value proposition that incorporates the primary benefits of ICTs as conveyed by the predominant users of the system.

3. The baby boomer generational cohort may be a key influencer in the process of managing and steering change because of their potential to shepherd those in other cohorts through the period of resistance that they themselves overcame to achieve ICTs acceptance.

References

Ancker, J.S., L.M. Kern, E. Abramson and R. Kaushal. 2012. The Triangle Model for Evaluating the Effect of Health Information Technology on Healthcare Quality and Safety. *Journal of the American Medical Informatics Association* 19(1): 61–65. doi:10.1136/amiajnl-2011-000385.

Autry, A.J. Jr and Z.L. Berge. 2011. Digital Natives and Digital Immigrants: Getting to Know Each Other. *Industrial and Commercial Training* 43(7):460–66. doi:10.1108/00197851111171890.

Blevins, S. 2014. Understanding Learning Styles. *Medsurg Nursing* 23(1): 59–60.

Cekada, T.L. 2012. Training a Multigenerational Workforce: Understanding Key Needs & Learning Styles. *Professional Safety* 57(3): 40–44.

Chaudhry, B., J. Wang, S. Wu, M. Maglione, W. Mojica, E. Roth et al. 2006. Systematic Review: Impact of Health Information Technology on Quality, Efficiency, and Costs of Medical Care. *Annals of Internal Medicine* 144(10): 742–52.

Davies, K. 2007. The Information-Seeking Behaviour of Doctors: A Review of the Evidence. *Health Information and Libraries Journal* 24(2): 78–94. doi:10.1111/j.1471-1842.2007.00713.x.

Downs, A. 2012. Resistance to Change as a Positive Influencer: An Introduction. *Journal of Organizational Change Management* 25(6): 780–83.

Evans, K.H., E. Ozdalga and N. Ahuja. 2016. The Medical Education of Generation Y. *Academic Psychiatry* 40(2): 382–85.

Gagnon, M.P., M. Desmartis, M. Labrecque, J. Car, C. Pagliari, P. Pluye et al. 2012. Systematic Review of Factors Influencing the Adoption of Information and Communication Technologies by Healthcare Professionals. *Journal of Medical Systems* 36(1): 241–77. doi:10.1007/s10916-010-9473-4.

Gonçalves, J.M. and R.P. da Silva Gonçalves. 2012. Overcoming Resistance to Changes in Information Technology Organizations. *Procedia Technology* 5: 293–301. doi:1016/j.protcy.2012.09.032.

Hardyman, W., A. Bullock, A. Brown, S. Carter-Ingram and M. Stacey. 2013. Mobile Technology Supporting Trainee Doctors' Workplace Learning and Patient Care: An Evaluation. *BMC Medical Education* 13(1): 6. doi:10.1186/1472-6920-13-6.

Hillman, S. n.d. *Online Usability Testing with Different Generations: Digital Natives and Digital Immigrants in the Online Usability Space*. Retrieved March 18 2020. <http://clab.iat.sfu.ca/pubs/DigitalNativesTechReport.pdf>.

Lieblich, A., R. Tuval-Mashiach and T. Zilber. 1998. *Applied Social Research Methods, Vol. 47. Narrative Research: Reading, Analysis, and Interpretation*. SAGE Publishings, Inc.

Ludviga, I. and I. Senikova. 2016. Organisational Change: Generational Differences in Reaction and Commitment. Presented at the 9th International Scientific Conference Business and Management, May 12–13, 2016, Vilnius, Lithuania. Retrieved March 18, 2020. <http://bm.vgtu.lt/index.php/verslas/2016/paper/viewFile/11/11>.

Øvretveit, J., T. Scott, T.G. Rundall, S.M. Shortell and M. Brommels. 2007. Improving Quality through Effective Implementation of Information Technology in Healthcare. *International Journal for Quality in Health Care* 19(5): 259–66. doi:10.1093/intqhc/mzm031.

Riessman, C.K. 1993. *Narrative Analysis* (Vol. 30). Newbury Park, CA: SAGE Publishings, Inc.

Stewart, J.S., E.G. Oliver, K.S. Cravens and S. Oishi. 2017. Managing Millennials: Embracing Generational Differences. *Business Horizons* 60(1): 45–54.

Tantalo, C. and R.L. Priem. 2016. Value Creation through Stakeholder Synergy. *Strategic Management Journal* 37(2): 314–29.

Weightman, A.L. and J. Williamson. 2005. The Value and Impact of Information Provided through Library Services for Patient Care: A Systematic Review. *Health Information & Libraries Journal* 22(1): 4–25. doi:10.1111/j.1471-1842.2005.00549.x.

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