> “...technology adoption across Generation Y, Generation X, and baby boomer nurses was not influenced by the era in which they had been socialized to computerization.

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 computer bedside 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).

Generational Differences in Hospital Technology Adoption: A Cross-Sectional Study

Vanessa Burkoski, RN, BScN, MScN, DHA
Chief Nursing Executive & Chief,
People Strategy
Humber River Hospital
Toronto, ON

Jennifer Yoon, RN, BScN, MSc (QI/PS)
Senior Director
Professional Practice,
Quality & Patient Safety
Humber River Hospital
Toronto, ON

Derek Hutchinson, RN, BScN, MN
Director, Professional Practice
Humber River Hospital
Toronto, ON

Trevor N.T. Hall, RN, BComm, BScN, MSc
Director, Quality & Patient Safety
Humber River Hospital
Toronto, ON

Shirley Solomon, BA, MSc
Research Assistant
Humber River Hospital
Toronto, ON

Barbara E. Collins, RN, BScN, MBA
President & CEO
Humber River Hospital
Toronto, ON

WHAT WE LEARNED:

1. To our surprise, the study results indicate that in combination with previous exposure to many of the technologies at HRH, longer duration of employment at HRH was associated with a higher technology competency skills score. Generational cohort did not play a role in the perception of nurses' technology competency at HRH.
2. Not only should nurse leaders plan for sufficient time and exposure to technology, but they also need to ascertain the meaning of technology with respect to nurses' values to develop appropriate educational programs that support maximum adoption, regardless of the generational cohort.
3. Although the literature suggests that Generation X and Generation Y are technologically skilled, our findings did not concur with previous studies that baby boomers were less technologically skilled. At HRH, nurses in the baby boomer generation were no less technologically skilled and just as proficient with the technology as other generations.

Abstract

Background: The advancement of technological change within healthcare means that it is essential for nurses to have the necessary technological skills to deliver safe and efficient nursing care. Few studies have examined whether generational differences affect the adoption of technology within the healthcare system.

Aim: The primary purpose of this study was to explore predictors that influence the adoption of technology.

Methods: In this cross-sectional study, nurses were asked to rate their level of competency on 20 key skills related to clinical technological devices (CTDs) in a self-administered questionnaire. Participants' demographic data and level of proficiency related to personal computer skills were also collected. Multiple linear regression analysis was used to examine whether demographic characteristics and personal computer skills predicted higher scores related to CTDs.

Results: Sixty-three nurses completed the questionnaires. Overall mean score for skills related to CTD was high at 3.74 (SD = 0.75) out of 5. Length of employment at the hospital and previous exposure to the technology used at the hospital ($\beta = 0.06$, $p = 0.021$; $\beta = 0.054$, $p = 0.011$, respectively) were the only variables significantly associated with higher CTD skills scores. Generational cohort, gender, years of nursing experience and self-rated proficiency related to personal computer skills were not related to higher CTD skills scores.

Conclusion: The results of this study emphasize that consistent exposure to technology enhances its adoption. Generational cohort did not play a role in the perception of nurses' technology competency at Humber River Hospital.

In the midst of rapid technological advancement, nurses are confronted with adopting a computerized system to deliver and document nursing care. This trend has led hospitals to critically evaluate the manner in which staff are prepared to practise in the changing healthcare environment. As Humber River Hospital (HRH), a large community hospital in Toronto, leverages the latest technology to enhance patient care, nurses, the primary technology users, will need to be equipped to meet this challenge.

Studies have shown that health information technology interventions have a direct impact on patient safety outcomes (Kutney-Lee and Kelly 2011; Waneka and Spetz 2010). Nurses' adoption of newly introduced technologies is essential to delivering efficient nursing care and reducing medication administration errors, infection rates, stroke incidence and mortality (Brenner et al. 2016). Yet, as of 2019, although the Canadian Association of Schools of Nursing outlines entry-to-practice competencies specific to nursing informatics (https://www.casn.ca/2014/11/nursing-informatics-entry-practice-competencies-registered-nurses/), nursing baccalaureate programs in Ontario may be reviewing opportunities for health information technology courses as part of their required course curriculum. To address this gap in knowledge and ensure the ongoing success of computerized system integration, HRH has incorporated extensive on-site healthcare technology training into staff orientation of new hires.

Recent investigations in other fields have suggested that generational cohort membership, years of experience and degree of comfort with technology are all factors that affected the successful adoption of technology (Gilakjani 2013; Hezaveh et al. 2014; Wood et al. 2005;). Research studies have highlighted differences in the ease with which technology is adopted on the basis of generational cohort. For example, Generation Y or millennials (born between 1981 and 2000) are most likely to be adept at using technology and have integrated technology into their daily life (Cekada 2012). Generation X'ers (born between 1965 and 1980) are generally considered to be technology literate as they were introduced to digital technology through the workforce (Cekada 2012). Finally, baby boomers and the silent generation (born between 1946 and 1964 and 1933 [and] 1945, respectively) have not grown up with technology and tend to be classified as "digital immigrants" (Cekada 2012).

The lack of experience using technology was also cited as a barrier to learning and using technology. In a study of teachers' information and communication technology adoption in Italy, researchers found that technical skills and competency level affected teachers' use of technology for educational purposes (Peralta and Costata 2007). Lastly, newly graduated nurses would be expected to experience a

slower adoption of health information technology as they are not only tasked with learning new technologies but also building their clinical knowledge and managing workload demands (Hezaveh et al. 2014).

There is limited knowledge regarding the effects of generational differences in nurses' adoption of health information technology (Gagnon et al. 2012). Training and education leaders must possess an understanding of the unique learning needs of its multigenerational staff and develop innovative teaching strategies to ensure successful adoption of technology among all staff members. The primary aim of this study was to investigate whether generational differences influenced technology adoption by nurses. The secondary aim of this study was to explore predictors that influence the adoption of technology. The results of this study will enable HRH to adjust its teaching philosophy to meet the identified learning needs of its workforce.

Methods

Development of training

HRH integrated health information technology training into the orientation session for all incoming nursing staff. The two-week in-person training was delivered by three staff and focused on improving technological competence using a variety of teaching strategies, including didactic instruction, problem-based learning, case studies, simulation room training and computer laboratory exercises. Online learning modules were available through the staff portal of the hospital website for staff to provide additional resources and a broader range of learning tools for new hires.

Study design and sample

A cross-sectional survey was conducted between October and November 2018. Permission to carry out the study was obtained from the Institutional Review Board at HRH, and informed consent was obtained from all participants. Participation in the study was voluntary, and subjects were assured of the anonymity of their responses. All eligible nurses were invited to complete either an online or paper-based anonymous questionnaire. Participants were considered eligible for inclusion if they had been employed at HRH for a maximum of 12 months, used technology in their nursing practice on a daily basis and provided direct care to patients.

Data collection

Data were collected through a self-administered questionnaire. Participants were asked to rate their level of competency for each of the 20 key skills related to clinical technological devices (CTDs) at HRH using Benner's (1984) stages of clinical competence (novice, advanced beginner, competent, proficient, expert). A sixth

option of "not applicable" was provided. A composite score was created for each participant by averaging the competency ratings for the 20 items related to CTD skills, with higher scores reflecting greater competence. The CTD skills scale demonstrated high internal consistency with a Cronbach's alpha of 0.96.

The questionnaire also collected information about participants' age group, gender, years of experience as a nurse and length of time working for HRH. Age group values were converted to generational cohort variables to explore generational differences. Additionally, participants were asked to rate their level of proficiency related to personal computer skills on a five-point Likert-type scale (1 = novice to 5 = expert) and whether they had previous exposure to the technology used at HRH on a four-point Likert-type scale (1 = no, none to 4 = yes, many).

Data analyses

Descriptive statistics were computed for each of the variables analyzed. The associations between independent variables (generational cohort, female gender, years of experience as a nurse, number of months employed at HRH, personal computer skills and previous exposure to the technology used at HRH) and CTD skills scores 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 determine the most significant factors associated with high CTD skills score.

Regression assumptions of linearity, multicollinearity, normality of residuals and homoscedasticity of residuals were assessed, and all assumptions were met. Collinearity diagnostics were examined to assess multicollinearity of variables, and no multicollinearity was present in the final model. All statistical analyses were performed with SPSS version 25. A p value of < 0.05 was considered statistically significant.

Results

Participant characteristics

In total, 63 (30.7%) of the 205 eligible nurses completed the questionnaire. Descriptive statistics are presented in Table 1. The majority of participants were female (88.5%) and millennials (80.4%). Nearly one third (31.1%) of participants had between one and three years of nursing experience, and many did not have any previous exposure to the technology used at HRH (41.8%). The median duration of employment at HRH for participants was 8.5 (SD = 4.1) months.

Most participants rated their level of proficiency in personal computer skills highly, with 35.7% identifying as "competent," 41.1% identifying as "proficient" and 17.9% identifying as "expert"; none identified as "novice," and only 5.4% identified as "advanced beginner."

Table 1. Characteristics of participating nurses.

Characteristic	*n*	%
Age	*N* = 61	
19 to 29 years (Generation Y/millennials)	22	36.1
30 to 39 years (Generation Y/millennials)	27	44.3
40 to 54 years (Generation X)	9	14.8
55 to 69 years (baby boomers)	3	4.9
70+ years (traditionalist/silent generation)	0	0
Gender	*N* = 61	
Female	54	88.5
Male	7	11.5
Years of nursing experience	*N* = 61	
< 1 year	15	24.6
1 to < 3 years	19	31.1
3 to < 5 years	6	9.8
5 to < 10 years	8	13.1
10+ years	13	21.3
Proficiency related to personal computer skills	*N* = 56	
Novice	0	0
Advanced beginner	3	5.4
Competent	20	35.7
Proficient	23	41.1
Expert	10	17.9
Previous exposure to technology used at HRH	*N* = 55	
No, none	23	41.8
Yes, a few	10	18.2
Yes, some	9	16.4
Yes, many	13	23.6

Factors associated with higher perceived CTD score

Overall, the mean CTD skills score for all participants was 3.74 ($SD = 0.75$) out of 5. The results from the simple linear regression analyses between potential predictors and CTD skills score are presented in Table 2. Longer duration of employment at HRH, previous exposure to the technology at HRH ("many" compared to "none") and greater proficiency in personal computer skills ("proficient" and "expert" compared to "advanced beginner"/"competent") were significantly associated with a higher CTD skills score. In the final multiple regression analysis, only longer duration of employment and previous exposure to the technology at HRH ("many" compared to "none") were associated with a higher CTD skills score ($R^2 = .25$, $F[2,10.33]$, $p < 0.001$). Self-rating of

"proficient" and "expert" in personal computer skills (compared to "advanced beginner"/"competent") was not associated with higher CTD skills score in the final model.

Table 2. Linear regression of CTD skills and potential predictors.

Characteristic	Simple regression		Final multiple regression $N = 55$	
	β (95% CI)	*p* value	β (95% CI)	*p* value
Duration of employment at HRH	0.07 (0.02 to 0.11)	**0.009**	0.06 (0.01 to 0.10)	**0.021**
Generation				
Generation Y/millennials	Reference			
Generation X	-0.38 (-0.95 to 0.18)	0.181		
Baby boomers	-0.88 (-1.95 to 0.19)	0.107		
Female gender	-0.37 (-0.96 to 0.21)	0.209		
Years of nursing experience				
< 1 year	0.27 (-0.30 to 0.83)	0.352		
1 to < 3 years	0.18 (-0.36 to 0.72)	0.509		
3 to < 5 years	0.23 (-0.54 to 1.01)	0.552		
5 to < 10 years	0.05 (-0.67 to 0.78)	0.882		
10+ years	Reference			
Proficiency related to personal computer skills				
Advanced beginner/competent	Reference			
Proficient	0.51 (0.11 to 0.91)	**0.005**		
Expert	0.74 (0.22 to 1.25)	**0.012**		
Previous exposure to technology used at HRH				
None of them	Reference			
A few of them	-0.14 (-0.67 to 0.40)	0.617		
Some of them	0.35 (-0.21 to 0.90)	0.220		
Many of them	0.63 (0.13 to 1.12)	**0.014**	0.54 (0.13 to 0.95)	**0.011**

Note: Unstandardized regression coefficients are reported.

Discussion

The results of this study indicate that, contrary to the study's hypothesis, nurses' generational differences did not influence technology adoption. In contrast and to our complete surprise, the findings indicated that in combination with previous exposure to many of the technologies at HRH (compared to none), longer duration of employment at HRH was associated with a higher CTD skills score. Additionally, a greater number of years of work experience as a nurse was also not associated with a higher CTD skills score.

The findings from this study revealed that technology adoption across Generation Y, Generation X, and baby boomer nurses was not influenced by the era in which they had been socialized to computerization. These findings are in opposition to other studies that suggest technology adeptness was influenced by generational cohort, with Generation Y being the most adroit and baby boomers the least proficient (Czaja et al. 2006). In alignment with findings from the current research, some studies have suggested that older generational cohorts are increasingly adopting technological skills generally ascribed to millennials (Morris and Venkatesh 2000).

Previous studies have found that a lack of confidence with computer skills may be a barrier to nurses' adoption of technology (Hogarty et al. 2003; Peralta and Costata 2007). However, the results of this study indicated that only nurses' previous exposure to HRH technology and longer duration of employment at HRH were associated with a greater level of perceived technological skills competency. This evidence is consistent with a similar study by Litchfield and Matteis (2016) that identified adequate time for practice using technology in the delivery of nursing curriculum as necessary to strengthen the adoption of technology.

Implications

The findings from this study suggest that nurses, regardless of generational cohort, require sufficient time and consistent exposure to computerized systems of nursing care delivery and documentation to enhance adoption. This is an important finding given that previous studies suggest that younger generations, Y and X, are naturally more technically skilled and adaptable. Although this inference may still be true, upon reflection, our results instead highlight the assumption that older generations are not technically proficient. Our study found that each generation of nurses employed at this completely digital hospital is adaptable and functioning appropriately within nursing workflows that integrate multiple technologies. Healthcare organizations can be reassured based on our findings, that across the spectrum of generational cohorts that may exist in their organization, all nursing staff are capable of technology adoption and proficiency over time.

The results from the current study may help ensure that training across all generational cohorts of nurses supports consistent exposure to technology and is sufficient in duration to maximize adoption. Our study provided an excellent opportunity to reflect on the meaning of technology and its adoption into nurses' professional practice. Education to socialize nurses to the concepts of nursing informatics and provide them with the opportunity to ponder the meaning of technology may be accomplished through the application of Mezirow's

transformative learning paradigm. Not only is sufficient exposure and duration necessary, but we also need to provide nursing staff with the space and opportunity to capture the meaning of the new technological changes to their own nursing practices (Christie et al. 2015).

One of the most important discourses that occurs at HRH when designing education for nurses practising in the fully digital environment is associated with the following questions: "How does this tool impact my practice?" and "How do I explain what I am doing with this tool to my patients?" The responses to these two questions will direct the nature of the education and training that are necessary to support nurses' adoption of new and enhanced technology. Nurse leaders need to support staff and educators to surface any dilemmas that arise based on the responses to these questions as these questions will reveal the values nurses espouse. These values will inevitably support or pose challenges for nurses in their adoption of the technology (Christie et al. 2015). For example, if nurses' most important value is safety, then adoption of technology should be positioned against the safety aspects of the initiative. In fact, our phenomenological analysis of nurses' experience in the digital hospital environment has provided HRH with the key terminology that we need to use to frame our conversation (i.e., safety, time, teamwork, technology failure, patient response and adoption) when designing education for new and enhanced technology integration to maximum uptake and adoption (Burkoski et al. 2019). The experience of nurses at HRH may support the opportunity for other organizations introducing and expanding on their digital platform to develop more robust and meaningful educational programs.

Limitations

There are limitations that must be taken into account when interpreting the results presented in this study. The small study sample size provided insights into the issue of generational learning and adoption of technology. The findings may be considered hypothesis-generating observations. Second, there was no representation of nurses from the silent generation and only a few nurses from the baby boomer generation, which may have resulted in sample bias. Additionally, the results are based on self-reported data, which may be subject to reporting and social desirability bias. As well, given the cross-sectional design of the study, causality cannot be inferred. Finally, the present study did not take into account psychosocial factors such as self-efficacy and perceived usefulness of technology (Buchanan et al. 2013), which may have an impact on technology adoption.

Conclusion

Nurses' adoption of newly introduced technologies is essential to delivering safe, high-quality care. Previous studies have highlighted differences in the ease with which technology is adopted on the basis of generational cohort. Contrary to this study's hypothesis, the results indicate that nurses' generational differences did not influence technology adoption. In contrast, the findings from this study indicated that in combination with previous exposure to technologies at HRH, longer duration of employment at HRH was associated with a higher CTD skills score. This is an important finding because previous studies suggest that younger generational cohorts are naturally more technically skilled and adaptable. The findings from the current study may support improved training that, regardless of generational cohort, ensures that nurses receive sufficient time and exposure to computerized systems of nursing care delivery and documentation to enhance adoption.

Acknowledgements

We are grateful to all clinical practice leaders and professional practice leaders for recruiting participants and supporting this work.

Correspondence may be directed to: Dr. Vanessa Burkoski, Humber River Hospital, 1235 Wilson Avenue, Toronto, ON, M3M 0B2; email: vburkoski@hrh.ca.

References

Benner, P. 1984. *From Novice to Expert: Excellence and Power in Clinical Nursing Practice*. Menlo Park, CA: Addison-Wesley.

Brenner, S.K., R. Kaushal, Z. Grinspan, C. Joyce, I. Kim, R. Allard et al. 2016. "Effects of Health Information Technology on Patient Outcomes: A Systematic Review." *Journal of the American Medical Informatics Association* 23(5): 1016–36.

Buchanan, T., P. Sainter and G. Saunders. 2013. "Factors Affecting Faculty Use of Learning Technologies: Implications for Models of Technology Adoption." *Journal of Computing in Higher Education* 25(1): 1–11. doi:10.1007/s12528-013-9066-6.

Burkoski, V., J. Yoon, D. Hutchinson, S. Solomon and B. Collins. 2019. "Experiences of Nurses Working in a Fully Digital Hospital: A Phenomenological Study." *Canadian Journal of Nursing Leadership* 32 Special issue: 72–85.

Cekada, T.L. 2012. "Training a Multigenerational Workforce." *Professional Safety* 57(3): 40–44.

Christie, M., M. Carey, A. Robertson and P. Grainger. 2015. "Putting Transformative Learning Theory into Practice." *Australian Journal of Adult Learning* 55(1): 9–30.

Czaja, S.J., N. Charness, A.D. Fisk, C. Hertzog, S.N. Nair, W.A. Rogers et al. 2006. "Factors Predicting the Use of Technology: Findings from the Center for Research and Education on Aging and Technology Enhancement (CREATE)." *Psychology and Aging* 21(2): 333–52.

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.

Gilakjani, A.P. 2013. "Factors Contributing to Teachers' Use of Computer Technology in the Classroom." *Universal Journal of Educational Research* 1(3): 262–67. doi:10.13189/ujer.2013.010317.

Hezaveh, M.S., F. Rafii and N. Seyedfatemi. 2014. "Novice Nurses' Experiences of Unpreparedness at the Beginning of the Work." *Global Journal of Health Science* 6(1): 215–22. doi:10.5539/gjhs.v6n1p215.

Hogarty, K.Y., T.R. Lang and J.D. Kromrey. 2003. "Another Look at Technology Use in Classrooms: The Development and Validation of an Instrument to Measure Teachers' Perceptions." *Educational and Psychological Measurement* 63(1): 139–62.

Kutney-Lee, A. and D. Kelly. 2011. "The Effect of Hospital Electronic Health Record Adoption on Nurse-Assessed Quality of Care and Patient Safety." *Journal of Nursing Administration* 41(11): 466–72.

Litchfield, J.M. and M. Matteis. 2016. "Faculty Experiences with Technology, Millennials versus Baby Boomers." *On-Line Journal of Nursing Informatics* 20(1).

Morris, M.G. and V. Venkatesh. 2000. "Age Differences in Technology Adoption Decisions: Implications for a Changing Work Force." *Personnel Psychology* 53(2): 375–403.

Peralta, H. and F.A. Costata. 2007. "Teachers' Competence and Confidence Regarding the Use of ICT." *Sísifo-Educational Sciences Journal (*3): 75–84.

Waneka, R. and J. Spetz. 2010. "Hospital Information Technology Systems' Impact on Nurses and Nursing Care." *Journal of Nursing Administration* 40(12): 509–14.

Wood, E., J. Mueller, T. Willoughby, J. Specht and T. Deyoung. 2005. "Teachers' Perceptions: Barriers and Supports to Using Technology in the Classroom." *Education, Communication & Information* 5(2): 183–206.

HUMBER RIVER HOSPITAL

ACCREDITED WITH COMMENDATION
ACCREDITATION AGRÉMENT CANADA

BPSO
RNAO BEST PRACTICE SPOTLIGHT ORGANIZATION CANADA

Leading technology & innovation integration in nursing

Volume 31, Number 4 • 2018 www.nursingleadership.net

Canadian Journal of Nursing Leadership

Nursing Leadership

Leadership in Nursing Management, Practice, Education & Research

NURSING LEADERSHIP – PERSPECTIVES AND INSIGHTS

Politics • Policy • Theory • Innovation

ACEN ACDSI

Covering politics, policy, theory and innovations that contribute to leadership in nursing administration, practice, teaching and research.

www.nursingleadership.net