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ORIGINAL RESEARCH

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Real time location systems: Is it big brother or a big opportunity for professional practice?

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ABSTRACT

Purpose: Real Time Location Systems (RTLS) is an emerging health care technology with the potential to capture data that can be used to improve professional practice and patient outcomes. However, there is a paucity of literature in this area to guide health professionals and leaders in both the implementation and use of RTLS data. To address this gap in the literature, this qualitative study was designed to explore how staff perceive and experience RTLS, and how health care providers anticipate using RTLS data for professional practice and clinical decision making.

Results: Interviews and focus groups were conducted with 31 health care professionals who work in a community hospital in Canada. There was variation between the participants in terms of the experience of being monitored, the intensity of emotions related to RTLS and being monitored, the degree to which RTLS influenced clinical decision making and reflection, and the perceptions of usefulness of RTLS data for professional practice. Three key themes emerged from the data: (1) the experience of being monitored, (2) anticipating using the data and (3) claiming the data for professional practice.

Conclusions: Supports are vital to the successful adoption of RTLS and to enable health care professionals to claim and use RTLS data for professional practice and clinical decision making. During the implementation and use of RTLS data, it is crucial to recognize that RTLS data only represent the time spent in a location, and not the professional or knowledge-based practice of health professionals. Further research is required to understand the leadership strategies to guide the use of RTLS data.

Key Words: Real time location systems, Informatics, Nursing, Professional practice, Leadership, Technology

1. INTRODUCTION

The use of radiofrequency identification (RFID) microchips can enable real-time location systems (RTLS) to identify a staff member's location in a facility and the length of time they spend at each location. RTLS is an emerging health care technology with the potential to capture data that can be used to design and evaluate patient care strategies, quality improvement initiatives, and staff development. The possibilities of using RTLS data to improve the patient experience and patient outcomes has generated significant interest within the health sector, yet there is a paucity of literature in this area. This study was designed to address the gap in literature related to how staff perceive and experience RTLS, and how these data could be claimed and used by health professionals for professional practice and clinical decision making. The aim of this study is to develop knowledge to support further use of RTLS generated data by the health professions.

Background

RTLS is a location tracking technology that uses radiofrequency identification chips (RFID) embedded into staff identification badges that network with sensors located in all

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areas of the hospital. As staff members move about the hospital, the sensors continually receive data on their movements. These sensors send the time and location data to computer systems which can generate real time or retrospective time and location reports. Real time reports can be used for staff safety (e.g. staff location in a crisis) or to quickly locate a colleague for consultation or collaboration. Retrospective reports can provide data on time and location during an entire shift, call bell response times, and hourly rounding frequency for individuals or groups. RTLS provides unprecedented access to time and location data and raises issues including privacy and interference in autonomous professional practice and clinical decision making. Understanding RTLS from a sociological and professional perspective can assist health professionals and managers to optimize the use the data for clinical practices, and to avoid a purely technological or managerial accounting logic.[1]

The existing literature on the use of RTLS in health care demonstrates various applications such as monitoring of hand hygiene compliance rates,[2–5] contact tracing between infected persons and staff,[6,7] and monitoring patient movements and wait times.[8–10] Studies have shown that RTLS is an accurate method to quantify time spent by staff with patients at the bedside.[11,12] Studies have also shown that RTLS can be used for equipment tracking.[13–15] There is, however, limited research describing health professionals experience with RTLS with the exception of Norten.[16] He found that nurses' intent to engage with RTLS was linked to their attitudes and perceptions of control over how the data would be used. Norten found that attitudes, social pressure, and nurses' beliefs in their ability to use the technology were most predictive of actual use of RTLS. We found no literature that explored how RTLS data can be used to reflect on or change professional practice.

Guiding frameworks

Norten[16] used the Technology Acceptance Model (TAM) with other elements to explore attitudes and intensions to use RTLS data. The TAM, which was initially developed by Davis[17] has been widely used and tested in a variety of settings and with a variety of technologies. TAM involves two primary predictors of the intent to use a technology: perceived ease-of-use and perceived usefulness. A statistical meta-analysis by King and He[18] concluded that TAM is a credible, valid and robust model to explore intention to use technology. The TAM and Norten's research indicate that staff attitudes and experiences are important factors to consider when exploring the use of RTLS in professional practice. As such, the TAM was used to guide our exploration of experiences with RTLS.

Professional practice frameworks such as Tanner's[19] clinical decision making and Schön's[20] reflective practice models are helpful to explore how RTLS data could be used to inform professional practice. A central feature of professional practice is the need to make clinical decisions in highly complex situations and to be accountable for the outcomes of these decisions. Tanner[19] explains that clinical decision making is influenced by the context in which care is provided, engagement with the patient and the sources of data to support decisions and reflection. RTLS and being monitored may influence the practice context and decision making. Schön[20] describes reflection-on-action and reflection-in-action as two ways that professionals can think about their practice. Both types of reflection involve exploring and evaluating one's understanding of a problem rather than simply trying to solve it. Reflection-on-action refers to retrospective thinking to learn from these past actions. This kind of reflection increases a person's knowledge and assists the person to challenge assumptions, theories and concepts and how these influenced actions. RTLS data, such as time and location data, may enable practitioners to reflect on how they used their time to explore their professional practice. Reflection-in-action on the other hand, refers to the thinking while one is engaged in activity. This gives the practitioner a chance to redesign what is being done while it is being done.[20] The collection of RTLS data may influence reflection-in-action, as staff could be influenced by knowing that the system is tracking their time and location. As RTLS monitoring becomes part of the work context and RTLS data become new source of information, Tanner's model and Schön's are useful to conceptualize how RTLS could be considered as sources of information for reflection and clinical decision making.

Considering the literature on RTLS and the three models discussed above (TAM, Tanner, & Schön), an assumption is that the perceptions and experiences with RTLS will influence the uptake of it by health professionals. Furthermore, the depth of reflection and the degree to which the reflection advances clinical practice are influenced by the sources of information/data available and the engagement of the person reflecting.[19,20] As such, the focus of this research was to explore how health professionals and leaders experience RLTS and how these experiences are mediated by the context in which RTLS is implemented and how participants anticipate using RTLS data.

2. METHODS

This study used qualitative research methods which were approved by the research ethics boards (REB) of the authors' academic institution and the hospital REB where the research was conducted. The study was designed to answer

the following research questions:

1) How do health professionals and leaders experience RLTS?
2) How does RTLS data influence reflection on professional practice?
3) What are the barriers and enablers to clinicians using RTLS data to support professional practice?
4) What are the barriers and enablers for leaders using RTLS data to support leadership and operational decision making?

2.1 Participants

The participants were recruited using a variety of methods including emailed invitations, posters placed on the units and word of mouth/snowball sampling. We recruited a convenience sample from staff from units at a large community hospital in Canada where RTLS had implemented on several units. Nursing staff, unregulated care providers, allied health professionals and managers were included. Participants were given the option to participate in either one single interview or one focus group. The interviews lasted on average 40 minutes and the focus groups 60 minutes. This sampling method proved to be effective as we were able to obtain a good representation of different types of health care providers in both the focus groups and interviews. As such, we were not required to engage in any directed recruitment. Physicians were excluded as they were not monitored through RTLS and clerical staff were excluded as the focus of the study was on professional practice.

After consent was obtained, interviews and focus groups were facilitated using semi-structured questions and interview techniques. The guiding frameworks were used in the development of the interview and focus group questions. Questions such as: How do you think the RTLS data could be used by you? What would help you to use RTLS data? What are the barriers to your use of it? (TAM[17]) If you could have a report showing how much time you spent in each location of your shift, what do you think this would tell you about your practice? (clinical decision making model[19]) How do you think you could use this information to change your practice? (reflective practice model[20]).

2.2 Analysis

Preliminary analysis conducted on the first eight interviews informed the focus groups and subsequent interviews. During the entire data collection phase, the researchers communicated regularly with each other to ensure consistency in the interview process and early identification of emerging themes. An underlying assumption of qualitative data is that the meaning a person gives to an experience, and the words they use to describe it, are empirical data for research. The

language (including symbolic language) used by informants was analyzed through content analysis to explicate themes and patterns, and assist the researcher to understand the lived experience and the experience itself.[21]

The interviews and focus groups were audio recorded and transcribed verbatim. Conventional content analysis[21] was used to examine the data for themes and patterns related to perceptions and experiences with RTLS. The researchers engaged in independent analysis to start. The transcripts were read and re-read to identify experiences and the meanings attributed to these experiences by the participants. During this analysis, key phrases were identified, grouped and sorted so that they could later be used as evidence to support analytical discussions between the researchers. Analysis continued until consensus was reached on the main findings. Insecurities in analysis or differences in interpretation were addressed by returning to the original transcripts/data. Then, a deeper analysis was used to determined how social process, such as professional practice, professional identity and clinical decision making were influenced by RTLS. The data were also explored to understand how the context of health care, including models of care and professional regulation, framed the experiences and patterns that were detected in the data.

The 31 participants represent a mixture of health care providers and managers (see Table 1). Fifteen health care providers participated in a one to one interview and 16 other health care providers participated in one of the three focus groups. Fifty-five percent of the sample were regulated nurses (either registered nurses or practical nurses [Practical Nurse refers to licensed practical nurse and registered practical nurse]) and 45% were allied health or unregulated care providers (Due to the small sample size of allied health professional and unregulated workers, they were grouped into one category to protect confidentiality). Sixty-six percent were college/diploma prepared and 33% were university degree prepared. Years of experienced ranged from six to 20 years for most participants and most were between the ages of 30 & 49 years old. Each participant was assigned a unique identifier code in order to protect confidentiality.

3. RESULTS

Being monitored and the concept of RTLS influenced all the participants in varying ways, indicating that RTLS is not a neutral technology. There was variation between participants in the intensity of emotions related to RTLS and being monitored, the degree to which RTLS influenced clinical decision making and reflection, and the ideas on how RTLS data could impact professional practice. Three key themes emerged from the data: (1) the experience of being monitored, (2) anticipating using the data and (3) claiming

the data for professional practice. The following section provides insights into the experiences of the participants and a description of the social processes that influenced these experiences.

3.1 Experience of being monitored

All participants described having negative feelings when RTLS was initially implemented. Most of the negative feelings came from the experience of being surveilled and the uncertainty over how the surveillance data would be used. The negative feelings from being surveilled were also linked to a sense of de-professionalization and to perceptions that monitoring was futile. Participants who perceived RTLS as futile were confident that they were working hard and doing their job, that nothing could happen to them as a result of being monitored and that the data would not provide useful information. In essence, they viewed the implementation of RTLS as pointless and a waste of time and money as they were confident in their clinical practice. The following exemplars from the data illustrate common experiences with RTLS. "A lot of people are paranoid about it, which creates an uncomfortable atmosphere at times; worried this will be used for evil as opposed to good (P01)"; "being tracked does make me feel a little paranoid. I am aware that I'm being tracked and I don't really know what they're doing with the information or how it will be used (P03)." "I went to school for years and I'm a professional and you're watching where I am at any given moment? (P05) and "I feel like somebody is catching my time but not my professional work (P02)." Participant 06 made a typical statement related to perceptions of futility: "I'm not going anywhere I'm not supposed to; so what does it matter?"

Table 1. Participant demographics

Participants N = 31	Interviews = 15 Focus Groups = 16
Designation	55% = Regulated Nurses (RNs and Practical nurses) 45% = Allied health and support staff
Education	66% = college/diploma prepared 34% = university/degree prepared
Years of experience	33% = less than 5 years 65% = between 6-20 years
Age	Majority fell between the age range of 30 & 49 years old

For the most part, participants stated that the education provided by the organization to prepare them for RTLS was well organized and delivered, however, they attributed some of their negative experiences to the information that was not covered during the education sessions. This quote captures how the education influenced the experience:

> The education was really well done but it didn't take me long to read and find that they could track my location and use this information for other reasons. I think they should have said how they can use it. Knowing how they can use it and the fact that they did not talk about it makes me feel a little unsure. I would rather hear: here's the system, here's how it can be used and this is what we will do with it here at this facility (P03).

Participants said that the education sessions focused primarily on how RTLS could be used to locate staff during an emergency. However, participants used the internet and quickly realized that it could also track their movements to create time and location reports which could be used for surveillance, performance management and so on. The lack of transparency and full disclosure created uncertainty.

Modifiers to the experience

To varying degrees, the negative feelings from surveillance were modified by the passing of time and the type of activity staff engaged in. The intensity of negative feelings toward RTLS diminished as participants became accustomed and desensitized to RTLS. These quotes illustrate the pattern: "so I knew that it would settle down after a couple of weeks and we will be back to our usual day to day (P15)." "I think almost everybody is pretty much over it now. It really hasn't affected anybody. Everybody was really worried about it, but I guess because nobody has seen any repercussions because of RTLS, it hasn't become such a big deal (P15)." and

> I don't really pay attention. I used to, like at first, it was like a privacy issue. I was wondering, why did they need to monitor me? But now I'm like, you know what, if you're doing your job properly, why does it matter? (P12)

The type of work activity also had an impact on the feelings of surveillance. When staff were engaged in indirect care

activities such as charting, or if they were in one location for a noticeable period of time, the feelings of surveillance were more acute. Participant P02 explains: "sometimes I think: I have been sitting here for an hour charting and it must be showing on the screen that I've been sitting here for an hour. Is anybody wondering why am sitting there for an hour?" Another participant provided more detail on this perspective:

> if I'm standing talking to someone for 10 minutes, I know that the system is tracking that I have not moved for 10 minutes. There is always this niggly thing at the back of your mind. I've always been conscious of how much time I spend and now that I know it's tracking me, I get up and walk around even though I might still have charting to do. I get up and do something. (P03)

By contrast, when participants were providing direct patient care and in patient rooms, they stated that they totally forgot about the RTLS system and being monitored. Participants attributed this difference to the importance placed on bedside care by the profession and the hospital.

3.2 Anticipating how the data would be used influences experience

During the interviews and focus groups, participants were asked about how they imagined using the data. In response to this question, few participants could see professional practice applications for RTLS beyond the staff location feature, however, they could envision how the data could be used for performance management and discipline. To facilitate discussion on professional practice, participants were asked about how they might use or claim the data to reflect on professional practice. They were asked if they could consider how capturing the amount of time spent in a patient's room could represent the intensity of patient care requirements, or if time and location or hourly rounding reports could provide insights into clinical decision making. From these discussions, some participants were able to imagine how RTLS could be used for reflection on professional practice and as a result participants became more enthusiastic about the possibilities of RTLS.

Participants expressed varying levels of wariness at the prospect of management using the data. Some participants stated they were choosing to ignore the RTLS altogether and not form opinions until the data were actually used. Whereas some participants could anticipate how the data could be used for performance management, and they were concerned by this. Participants had recommendations on how to use the data to ease privacy and other concerns. For instance, some

participants thought that receiving individual data in private would be fine, whereas providing identified data to the team was an uncomfortable prospect. Participant 07 explains: "if you gave data to a group of people as opposed to the individual, I think it could create some conflict." Participant 08 specified:

> I wouldn't want to see the data be used to penalize our hospital or the staff. But I would hope that it would be used for patient care, staff, and for more understanding of the amount of work being done by the staff every day. Workload and that kind of stuff.

Many participants wondered if the implementation of RTLS was best use of scarce funding and resources. To reconcile these feelings, participants stated that it would be very important that leaders use the data to improve professional practice and patient outcomes. A participant in a focus group explained:

> I almost feel a bit disgruntled that they spent all of this money on the system and there are so many other things that are lacking. I just think that they could have dedicated that money to a different area which would've improved patient care better than this. (P16)

The examplars shared here indicate that monitoring and collection of data without returning the data or having access to the data impacts the perception and experiences with RTLS.

3.3 Claiming the data for clinical decision making and professional practice

Social processes, such as attitudes and engagement, help to explain the varying perceptions of utility and willingness to use RTLS for clinical decision making and professional practice. For instance, participants are more willing to use RTLS data for professional practice than they were for performance management. This phenomenon was observable during a robust discussion during a focus group where participants thought that the system was implemented to fault the nurse and to show how nurses contribute to patient incidents. This fault-finding perceptions shaped negative attitudes and resistance to using RTLS for professional practice. However, as the discussion unfolded, participants started to see how the opposite could also be possible - that the same data could be used to support nurses. For instance, participants realized that if a patient complained that no nurse had been in their room all day, RTLS data could show exactly when and who entered and left the room. These data could be used to substantiate the nurses' version of the story. Further, participants realized that RTLS data could show what a nurse

was doing during a patient incident such as a fall, and show that the nurse was with another patient and unable to answer a call bell or prevent the fall. As these types of discussions unfolded, participants conveyed a feistiness and confidence in their ability to claim the data to validate the anecdotal comment "it was busy", to substantiate their claims of being overworked and to explain the intensity of patient care needs. Participant 13 explains: "we always use the word busy but what does that word mean? RTLS data would let us quantify things we couldn't before. To be able to put time in a room will be very interesting."

3.3.1 *Professional practice*

Several participants believed that being monitored prompted people to engage in activities such as answering call bells more quickly or performing more frequent hourly rounding checks. The participants demonstrate how RTLS and being monitored enters into clinical decisions, including how one spends time and the sequence of clinical care. One participant stated: "feeling monitored does make you think about how you are spending your time (P11)." Participants concurred though, that until the data are used, there can be little impact on professional practice. The need to contextualize RTLS data and be guided in its use can be see through the following quotes. Participant 13 clarified: "I only think that monitoring will make a difference to professional practice when we start using the data... Once we have data we can do month after month comparisons on certain metrics such as rounding, call bell response time and so on". Participant 11 further explains:

> If I had my data I could probably look at how much time I was actually spending providing care for the patient on the floors. We could see the workload and I think it would give me an opportunity to get more organized to see problems. I think it could show us for example, we need more supplies or equipment on the floor or better system to store equipment so that we don't spend so much time looking for it.

During one of the focus groups (FG2), there was consensus that having that data would be particularly helpful on days when staff are totally run off their feet and feel like they are not accomplishing anything. They could anticipate that RTLS data would provide a point of reflection, to support contemplation about how time was spend and to find ways to become more organized and efficient.

3.3.2 *Clinical decision making*

Participants suggested that RTLS data could be used for clinical decision making and professional practice in areas such

as understanding workload and quantifying the term busy, examining workflow including busier times of day to support effective planning, determine ideal staffing ratios, risk assessment by linking time in room with other metrics such as fall rates and creating patient assignments that are specific to the care requirements. Time in room data could show how much time staff spend in individual patient rooms and act as a proxy to identify the intensity of patient care needs. Participants imagined that the data could assist them to make patient assignments in ways that reflect actual patient care needs, rather than evenly dividing the number of patients between nurses. Participant 11 stated: "I think it would also show us how certain patients require a lot more care than others and put patient ratios into perspective. Participant 13 added: "we could use the [RTLS] data to look at the amount of time people are in a room and that will help us to understand the patient care requirements." Another participant stated "I can pull a report and see that there were two registered staff in a room with an acute patient for this amount of time and [ask]: does this put other patients at risk?" Participant 15 explained how RTLS data could "identify the busier parts of the day in terms of patient care needs and show which patients actually need more nursing care versus patients whose [care needs] can be primarily addressed by Personal Care Assistants". Participants could also see that the data could be used for patient safety monitoring by drawing a connection between time in room with other metrics such as falls, pressure ulcers, or med errors.

3.3.3 *Need help to use the data*

Participants recognized that they would require assistance to use the data. Participant 06 suggested: "maybe our manager or leader could help us use the data. If we could get our manager to put the data together and tell us that these are places where we could make some improvements." Another participant stated: "I think if the manager looked at where we spend most of our time we could start to see it and what it means to us". Participant 08 explained: "absolutely, people would need coaching and mentoring on how to use the data. I would need help on how to decipher it." Leaders specified that they would require education on strategies such as data dissemination, visualization and leadership strategies to support technology adoption and data utilization.

4. DISCUSSION

While there was variation in the experience and intensity of emotions related to being monitored, the analysis of participant data indicates that RTLS is not a neutral technology and that it impacts people and professional practice.

The experience of RTLS (Research Question 1)

Understanding feelings from being monitored and how these

feelings can be modified can guide the successful implementation of RTLS. Attitudes toward RTLS are important to consider as they impact engagement with a technology.[17] Sassen[22] encourages a focus on three sociological perspectives when considering the implementation of a technology. Specifically, focusing on the complex interactions between the digital and the material world, the cultures within the workplace that influence the relationship between technology and the user, and lastly the destabilizing of existing social relations and hierarchies that result from the implementation of the technology. These three sociological perspectives were used to consider how people experience RTLS and in turn, how this experience influences the ideas about using RTLS for professional practice.

Participants explained how skepticism mounted when they realized that the education only addressed some of the features of RTLS. Transparency in how the data can and will be used can promote trust and provide opportunities to reflect on possible ways that the data can be meaningfully used for professional practice. This finding is similar to Norten,[16] who reported that perceptions of RTLS and transparency in how the data would be used (punishment or professional development) impacted attitudes towards RTLS.

While there were initial negative feelings arising from the surveillance features of RTLS, these negative feelings changed over time. Understanding the mediators of these feelings can guide successful implementation and adoption of RTLS.[16, 17] For instance, addressing privacy concerns, questions about why the hospital felt the need for monitoring and what the hospital would do with the data could be helpful. These similar concerns were raised by participants in Fisher and Monohan[23] when they studied RFID monitoring. Once participants understood the possible uses of RTLS data for professional practice, their attitudes towards being monitored became more favourable and engaged. Furthermore, understanding that the negative feelings from being surveilled are intensified during indirect care activities such as charting can be addressed during the implementation of RTLS. Assisting staff to consider the time they spend in indirect care as an extension of professional practice might ease feeling of being monitored.

Reflection on professional practice (Research Question 2)

The majority of the participants anticipated that the data would be used by themselves and by the hospital. Already, they could see that being monitored by RTLS influenced their clinical decisions and caused them to do things differently while at work, such as increasing diligence with hourly rounding and spending less time sitting in one place. There were some participants though, who indicated that RTLS had no impact on them, as they were confident they were doing a good job and this shielded them from any concerns.

Each type of experience points to the need for careful assistance to guide the use of RTLS so that health care providers can claim and use the data for professional practice. Tanner[19] and Schön[20] both explain that the sources of data to support decisions and reflection must be contextualized. As Tanner explains, clinical reasoning and decisions require various types of knowledge and data/information must be contextualized and linked to practice. The recognition that RTLS data only represents the time spent in a location, and not the professional or knowledge based practice conducted during that time is crucial information to highlight during the implementation and use of RTLS data. To guide the use of RTLS data for professional practice and clinical decision-making, coaching and well-designed process improvement initiatives are needed. Purposeful leadership and data dissemination strategies to make sense of the RTLS data are also paramount. Schön's reflection in and on action can provide structure to assist health care providers to consider how RTLS data can be used to consider and examine practice and practice related decisions.

Enabler and barriers to using RTLS data (Research Question 3 and 4)

The initial challenge to identify uses for RTLS data were not entirely surprising as reports had not yet been generated or used by managers. Earlier consideration of data use strategies and the communication of these could support early adoption and positive attitudes towards RTLS. Specific coaching for instance, to assist health providers to contextualize the RTLS metric of time-in-room to a professional activity such as nurse surveillance would be beneficial. Linking the literature of greater nurse surveillance to enhanced patient safety outcomes such as falls and failure to rescue[24–27] and showing how RTLS data can be used to reflect on clinical decisions and professional practice could be a powerful aid in promoting reflective practice. Further research is needed to understand which coaching strategies are perceived as useful for staff engagement in data utilization and how RTLS data can impact patient care outcomes.

5. CONCLUSION

This study provides useful insights into the experiences of being monitored, how the types of activity (direct vs indirect care) influence these experiences and how considering possible uses of the data influence engagement with RTLS. Using this understanding during the implementation and eventual usage of RTLS data can help to ensure that RTLS data are optimized to support professional practice and patient out-

comes. Supporting the transition in thinking about RTLS as a surveillance tool, to a technology that can generate data for professional practice and reflection can assist health professionals to claim RTLS data as clinical data that in turn, can be used to enhance practice and patient outcomes. Understanding and addressing the mediators to the experiences and attitudes can support engagement in clinical initiatives that include RTLS data.

A key contribution of this study is the knowledge that RTLS can be oriented to professional practice rather than managerial or performance management. Re-conceptualizing RTLS metrics, such-as-time in room to a professional practice activity such as nurse surveillance could assist nurses to consider RTLS data along with nurse sensitive patient outcomes. Given the increasing use of RTLS in health care facilities and the opportunities to use RTLS data for professional practice, there is an urgent need for additional research on RTLS and how it impacts health care providers and patient outcomes.

5.1 Recommendations for practice

1) Transparency during the pre-implementation education and implementation of RTLS.
2) Clear plans and communication strategies on how the data will be used. 3) Leadership development on specific strate-gies to assist staff to use RTLS data for professional practice and clinical decision making.
4) Well-designed strategies and projects that assist staff and managers to use the data for professional practice in ways that enhance links between RTLS data and to patient outcomes.
5) Further research on the exact types of leadership strategies that assist staff to have a positive attitude towards the RTLS data and to then use the data for professional practice.

5.2 Limitations

Although the study addresses a gap in the existing research in this area, there are known limitations to this study. The participants were drawn from a single hospital which may limit the ability to generalize the results beyond the experiences of these participants. The paucity of published research regarding this topic did not allow for many comparisons to our findings.

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CONFLICTS OF INTEREST DISCLOSURE

No conflicts of interest to declare.

REFERENCES

[1] Laughlin R. Accounting systems in organisational contexts: A case for critical theory. Accounting, Organization and Society. 1987; 479-502. https://doi.org/10.1016/0361-3682(87)90032-8

[2] Baslyman M, Rezaee R, Amyot D, et al. Real-time and location-based hand hygiene monitoring and notification: Proof-of-concept system and experimentation. Personal and Ubiquitous Computing. 2015; 19(3-4): 667-688. https://doi.org/10.1007/s00779-015-0855-y

[3] Radhakrishna K, Waghmare A, Ekstrand M, et al. Real-time feedback for improving compliance to hand sanitization among healthcare workers in an open layout ICU using radiofrequency identification. Journal of Medical Systems. 2015; 39(6): 68. PMid:25957165 https://doi.org/10.1007/s10916-015-0251-1

[4] Marra AR, Edmond MB. New technologies to monitor healthcare worker hand hygiene. Clinical Microbiology and Infection. 2014; 20(1): 29-33. PMid:24245809 https://doi.org/10.1111/1469-0691.12458

[5] Srigley JA, Furness CD, Baker GR, et al. Quantification of the Hawthorne effect in hand hygiene compliance monitoring using an electronic monitoring system: A retrospective cohort study. BMJ Qual Saf. 2014; 23(12): 974-980. PMid:25002555 https://doi.org/10.1136/bmjqs-2014-003080

[6] Hellmich TR, Clements CM, El-Sherif N, et al. Contact tracing with a real-time location system: A case study of increasing relative effectiveness in an emergency department. American Journal of Infection Control. 2017; 45(12): 1308-1311. PMid:28967513 https://doi.org/10.1016/j.ajic.2017.08.014

[7] Vanhems P, Von Raesfeldt R, Ecochard R, et al. Emergence of Ebola virus disease in a french acute care setting: A simulation study based on documented inter-individual contacts. Scientific Reports. 2016; 6: 36301. PMid:27827383 https://doi.org/10.1038/srep36301

[8] Dorrell RD, Vermillion SA, Clark CJ. Feasibility of real-time location systems in monitoring recovery after major abdominal surgery. Surgical Endoscopy. 2017; 31(12): 5457-5462. PMid:28593407 https://doi.org/10.1007/s00464-017-5625-7

[9] Bougueng TR. Location-Aware Business Process Management for Real-time Monitoring of Patient Care Processes [Doctoral dissertation]. Université d'Ottawa/University of Ottawa: 2013.

[10] Chen JC, Collins TJ. Creation of a RFID based real time tracking (R-RTT) system for small healthcare clinics. Journal of medical systems. 2012; 36(6): 3851-3860. PMid:22562667 https://doi.org/10.1007/s10916-012-9858-7

[11] Jones TL, Schlegel C. Can real time location system technology (RTLS) provide useful estimates of time use by nursing personnel? Research in Nursing & Health. 2014; 37(1): 75-84. PMid:24338915 https://doi.org/10.1002/nur.21578

[12] Fahey L, Lopez KD, Storfjell J, et al. Expanding potential of radiofrequency nurse call systems to measure nursing time in patient rooms. Journal of Nursing Administration. 2013; 43(5): 302-307. PMid:23615373 https://doi.org/10.1097/NNA.0b013e31828eebe1

[13] Youssef A. Deploying a Real-Time Location System at a Michigan Health System. Biomedical Instrumentation & Technology. 2016; 50(s6): 54-56. PMid:27854503 https://doi.org/10.2345/0899-8205-50.s6.54

[14] Guédon ACP, Wauben LSGL, De Korne DF, et al. A RFID specific participatory design approach to support design and implementation of real-time location systems in the operating room. Journal of Medical Systems. 2015; 39(1): 168. PMid:25503417 https://doi.org/10.1007/s10916-014-0168-0

[15] Anderson J. Real time location system: Do you know where your equipment is? Nurse Leader. 2011; 42-44. https://doi.org/10.1016/j.mnl.2010.07.002

[16] Norten A. Predicting nurse's acceptance of radiofrequency identification technology. Computers Informatics Nursing. 2012; 30(10): 531-537. PMid:22805120 https://doi.org/10.1097/NXN.0b013e31825e1eef

[17] Davis F. Perceived usefulness, perceived ease-of-use, and user acceptance of information technology. MIS Q. 1989: 133: 319-339. https://doi.org/10.2307/249008

[18] King W, He J. A meta-analysis of the technology acceptance model. Information and Management. 2006; 43: 740-755. https://doi.org/10.1016/j.im.2006.05.003

[19] Tanner C. Thinking like a nurse: A Research-based model of clinical judgment in nursing. Journal of Nursing Education. 2006; 45(6): 204-211. PMid:16780008 https://doi.org/10.3928/01484834-20060601-04

[20] Schön DA. The reflective practitioner: How professionals think in action. Basic books; 1984 Sep 23.

[21] Van Manen M. Phenomenology of Practice: Meaning-Giving Methods in Phenomenological Research and Writing. 2014. Routledge.

[22] Sassen S. Towards a sociology of information technology. Current Sociology. 2002; 50: 365-388. https://doi.org/10.1177/0011392102050003005

[23] Fisher J, Monahan T. Tracking the social dimensions of RFID systems in hospitals. International Journal of Medical Information. 2008; 77: 176-183. PMid:17544841 https://doi.org/10.1016/j.ijmedinf.2007.04.010

[24] Dresser S. The role of nursing surveillance in keeping patients safe. JONA: The Journal of Nursing Administration. 2012; 42(7/8): 361-368. PMid:22832411 https://doi.org/10.1097/NNA.0b013e3182619377

[25] Shever LL. The impact of nursing surveillance on failure to rescue. Research and Theory for Nursing Practice. 2011; 25(2): 107-126. PMid:21696091 https://doi.org/10.1891/1541-6577.25.2.107

[26] Manojlovich M, Sidani S, Covell CL, et al. Nurse dose: Linking staffing variables to adverse patient outcomes. Nursing research. 2011; 60(4): 214-220. PMid:21691239 https://doi.org/10.1097/NNR.0b013e31822228dc

[27] Kutney-Lee A, Lake ET, Aiken LH. Development of the hospital nurse surveillance capacity profile. Research in Nursing & Health. 2009; 32(2): 217-228. PMid:19161172 https://doi.org/10.1002/nur.20316