Understanding the Effect of Real Time Location Systems (RTLS) on Nurse Workloads and Retention Rates In Healthcare Systems

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

With the disruptions caused by the COVID-19 pandemic, healthcare has seen many changes to its operations in an effort to continue to provide high quality patient care. Issues such as increased patient demand, staffing shortages, and risk of infectious exposure have forced many healthcare institutions to restructure aspects of their organization to ensure that patients and employees remain safe both physically and mentally. These changes have shown that there is still a long way to go to improve the resiliency and efficiency of such environments while also supporting the complex needs of patients, nurses, and doctors. One such technology with the capability to improve patient care and provider experiences is Real Time Location Systems (RTLS), which use a variety of methods to accurately determine an asset or individual's location. RTLS technology records time and location based data through the use of Radio Frequency Identification (RFID) tags, which can be incorporated into objects such as nurse badges (Jones, 2014). This data is then logged inside an Electronic Medical Record system (EMR) for later access and analysis. This paper will discuss the impact of RTLS technology on healthcare both before and after the COVID-19 pandemic, with a specific focus on its impact on nurses workloads, mental health, and retention rates.

Methodology

The field of nursing includes a diverse range of individuals to consider when addressing how RTLS technology impacts their workloads. Some nurses are seasoned veterans who have been working in healthcare for a majority of their lives, while others are just entering the workforce. Some seasoned nurses go on to become nurse coordinators or clinic managers as

well, using their prior experience to ensure facilities run smoothly. Each nurse designation has a different set of personal and professional experiences, one of which is technological literacy and adaptability. As nurses - and humans in general - grow older, “they respond more slowly to simple stimuli and take longer to learn new material, thus potentially decreasing their ability to adapt” (Fisher, 2000). Therefore, ensuring new technologies are easily accessible and comprehensible is essential for easing transitions and promoting adaptability for veteran nurses, while also having the added benefit of ensuring newer inexperienced nurses can be onboarded into their new roles in a more efficient manner. These younger and less experienced nurses are especially relevant to this project, as not only are they the future of the workforce, as the older nurses begin to retire from the profession, making them the primary concern of nurse retention, they are also the nursing demographic that has been most affected by the high workloads due to the pandemic (Martin, 2023, p. 2). These three social groups, experienced nurses, inexperienced nurses, and clinic managers are the primary relevant social groups for my project. These social groups were identified for their presence in the patient flow process of the University Physicians of Charlottesville (UPC) clinic and similar facilities, their association with each other, and their direct usage of the current RTLS and EMR technology in healthcare. The less relevant social groups that I will be leaving out of this analysis are doctors, patients, receptionists, and executives. This is notable because it places the emphasis of a healthcare process on the nurses instead of the patients. This is reasonable because patients do not have any direct contact with the nurses’ RTLS technology or any control over the scheduling and staffing of healthcare facilities. They are tangentially affected by the technology due to its effect on nurses; however, the patients themselves never directly touch this technology in their appointments.

This project will use the Social Construction of Technology (SCOT) framework to assess how EMR systems in conjunction with RTLS support nurses while also accommodating their patients' needs. Developed by Pinch and Bjiker (1984), the Social Construction of Technology framework lends itself to these relationships between social groups and technologies under the basis that humans' wants and needs influence the creation of new technologies. This framework will be helpful when conducting research on nurses and clinic managers. My timeline for researching the effects of RTLS technology on nurses is to start by conducting a comprehensive literature review on the past retention rates and mental health statistics on nurses in the pre- and post-pandemic United States, as well as the historical and current state of RTLS systems in healthcare. Keywords such as real-time location systems, electronic medical records, nursing shortage, burnout, resilience, and COVID-19 will be used when conducting research. I will then use this research to analyze the current state of healthcare and RTLS systems in a post-pandemic United States and discuss avenues to improve retention rates and mental health in the nursing profession. Additionally, I will draw upon knowledge gained through my technical project working with the UPC regarding the benefits and drawbacks of EMR and RTLS technology in a healthcare setting to analyze the impacts of these technologies on the daily operations of a clinic.

Real Time Location Systems

The Beginnings of RTLS Technology in Healthcare

As previously stated, real-time location systems (RTLS) technology, a term which emerged in the 1990s, uses a variety of different methods to determine an asset or person's current location, which can be incredibly helpful in a healthcare space. These systems work by assigning a unique identifier to a tag (which can take a variety of forms depending on the

technology used in the system) and using scanners, other tags, and more to pinpoint the location of the desired tag. Tags can use technology such as "light, camera vision, infrared (IR), sound, ultrasound, Bluetooth, Wi-Fi, RFID (radio frequency identification; RFID tags can be either active, with a small power supply to send out a signal covering a range of up to 100 meters, or passive, with no power supply and activated by a scanning signal, which limits their range of detection to less than a meter), ultra-wideband (UWB), GPS (global positioning system) and Cellular" (Boulos & Berry, 2012). RFID tags are one of the most common types of tags used in RTLS in the healthcare industry due to their versatile nature. They can be easily incorporated into nurse and doctor badges, portable equipment, and patient wristbands. These tags can be either active or passive, as well as include features such as push/toggle buttons to log additional data on top of the item's location. There are many different ways in which RTLS technology can be used in the healthcare space, but the three most common uses are patient tracking, personnel tracking, and asset tracking.

Patient wristbands are an important and necessary component of the patient intake process, as they include identifying information and critical care information. To increase the impact of these wristbands, many RTLS incorporate RFID tags into the wristbands to allow for patient tracking and efficient retrieval of digital patient medical information. Since each RFID tag includes a unique identifier, incorporating these tags into patient wristbands eliminates the risk of lost or swapped patient medical files which can be critical for patient care. Patient tracking can be essential not only from an organizational management standpoint, as this data can be used to identify bottlenecks in the patient flow process, but also from a patient care standpoint. Healthcare institutions, most notably hospitals, are often fairly large and contain multiple departments within their premises. RTLS can be used to monitor a patients' movements

throughout the facility, allowing for staff to more efficiently locate patient's across floors or departments. Additionally, at-risk patients, such as babies or patients with dementia or Alzheimer's, can be tracked using active RFID tags to ensure their safety (Boulos & Berry, 2012). Scanners placed at choke points such as entrances and exits to wards can identify and raise an alarm if an at-risk patient is moved or moving somewhere they shouldn't be.

RFID tags in healthcare professionals, such as doctors and nurses, badges can also help hospitals be more efficient through personnel tracking for both staffing and real-time situations. Using tracking by proximity or room level, management can more easily track the amount of time personnel spend doing different tasks in their workday (for example, time spent with patients), which can assist management with determining the staffing needs of their facility on any given day. Personnel can also use a RTLS to locate other personnel throughout the institution to ensure that time is not wasted searching for a provider in the event of an emergency situation. This can be especially important if the assistance of security is required to ensure the safety of a patient or nurse, as panic buttons incorporated into rooms or personnel badges can immediately identify the doctor or nurses' location down to the exact room they are in (Boulos & Berry, 2012). Lastly, the unique identifiers in the tags contained in personnel badges can be used to quickly log in and access the patients' electronic medical records on the facility's system through a scan of their badge at computers within and outside of patient rooms. This ensures that a patient's health information is secure and access to their records can be monitored, while still ensuring personnel can efficiently complete their tasks from all areas of the facility.

The last major application of RTLS in healthcare is with asset or resource tracking. Knowing both the location and status of assets is essential for a hospital to operate, and RTLS can capture data regarding both portable and stationary assets and communicate them to

healthcare personnel and management. For instance, hospitals have limited portable assets which are shared across the facility. Using a RTLS, a staff member can "log onto the system at a workstation (or using a mobile device), identify where the closest available item is located, and go and get it" (Boulos & Berry, 2012). This can reduce the time nurses spend searching for portable assets, as well as allow hospitals to more accurately predict their needs, as "estimates indicate that hospitals will purchase 10% to 20% more portable equipment than actually required for operational needs, so that staff may find it when needed" (Boulos & Berry, 2012). Not only can the location of portable equipment be tracked, but their location in relation to personnel or patients tags can also be monitored. This allows staff to easily document and monitor the duration a patient spends with equipment such as IVs, which can enhance patient care. Lastly, in addition to portable assets, stationary assets such as hospital beds or equipment can have their statuses monitored through tags that include toggle or push buttons. An asset can have a status "such as 'bed occupied by patient' (hospital bed status) or 'device in need of repair'" (Boulos & Berry, 2012), and these statuses can be used to more efficiently room patients, repair equipment, and assess overall system capacity. There are countless uses for RTLS technology in healthcare spaces, and as this technology improves these systems will become more useful and accurate.

RTLS technology in Post-COVID Healthcare

While RTLS were employed by many facilities before the COVID-19 pandemic, new uses for these systems emerged in 2020 to combat two key challenges: Personal Protective Equipment (PPE) asset tracking and contact tracing. Not only did the pandemic bring many challenges in the form of staffing shortages and increasing patient numbers, it also brought up issues with supply chains and procurement of PPE equipment and supplies. Without robust

RTLS asset management, healthcare facilities were inaccurately tracking supplies, so "healthcare organizations were faced with an unprecedented supply shift with only a handful of clinically approved alternatives available through a small number of trusted sources" (Moralez, n.d.). This posed a major problem for facilities who not only had to ensure the safety of their patients, but also their staff. Many facilities scrambled to adopt RTLS asset management into their systems in the early stages of the pandemic, and those that did found that "employees were able to reallocate their services back to patient care, reduce asset purchase requests and increase equipment supply data accuracy," and facilities managers were able to make "more informed decisions regarding equipment usage and orders" (Moralez, n.d.). These informed decisions were paramount, as many facilities were operating at or above capacity to accommodate the influx of patients due to the virus. In fact, "many hospitals [rented] beds to fill the need" (Moralez, n.d.) created by this increase in demand, so tracking of not only PPE but also equipment such as beds through asset tags became essential for the efficiency of these facilities.

With the knowledge that COVID-19 spreads through particles and droplets, healthcare facilities and the broader world became concerned with masking and social distancing. For individuals in the healthcare system, social distancing was not a viable option while conducting their duties. Therefore, contact tracing became an important method for tracking the spread of the virus and isolating potentially infected patients and employees. RTLS systems significantly improved the accuracy of contact tracing through RFID tags used by staff and patients. An example of the effectiveness of this method can be seen in February 2020, when a junior physician experiencing pneumonia symptoms was suspected of also having contracted the virus. Analysts "extracted data captured through her RTLS tag to objectively determine her contacts over her working duration in the SC" (Ho, 2020). They then compared those contacts with a list

of confirmed COVID-19 cases in the facility, and within minutes determined “she had been within 2 m of a subsequently confirmed COVID-19 patient, for 9 min.” (Ho, 2020). This encounter was also confirmed through the patient’s EMR and CCTV, the recording of which indicated that it was unlikely the physician contracted the virus from the encounter. Procedures such as this are used to identify compromised staff members, who can then be issued leave of absences to reduce the risk of transmission across the facility. This use of RTLS technology can be applied to numerous scenarios such as with COVID-19 and other contagious diseases, and displays the evolving nature of RTLS in healthcare.

Nurses

Prior to the COVID-19 Pandemic

The nursing profession is a diverse and essential component of the healthcare system. With over 4 million registered nurses in 2019, nurses “make up the largest section of the health profession” (Haddad, 2023; Lindner, 2023). Hospitals, clinics, and other healthcare facilities rely on knowledgeable and experienced nurses to administer high quality care to their patients and meet the demands of a rigorous profession. The profession of nursing is demanding for many reasons, such as the long hours, risk of contracting diseases, and physical nature of the job. These demands can place a significant amount of pressure on certain demographics in the nursing profession, such as female and elderly nurses. As of 2019, the majority of nurses are females, with only about 11% of nurses being male, and a quarter of working nurses are over the age of 50 (Haddad, 2023; Lindner, 2023). This primarily female workforce presents the profession with unique challenges, as “ often during childbearing years, nurses will cut back or leave the profession altogether” (Haddad, 2023), which reduces the size of the already insufficient

workforce. Many nurses may choose to work part time or reduce their working hours due to childcare, which diminishes the schedulable hours younger nurses are able to work. Additionally, the large percentage of nurses over the age of 50 indicates that "one-third of the workforce could be at retirement age in the next 10 to 15 years" (Haddad, 2023). This presents an issue for the profession, as even with their vast numbers, the current number of working nurses cannot meet the demands of the healthcare system. This shortage includes a shortage in nurse educators teaching prospective nurses, which further exacerbates the deficit. Therefore, in the coming years the healthcare system was preparing to face many challenges regarding understaffing of nurses; however, this challenge was intensified due to the COVID-19 pandemic.

The Impact of COVID-19 on Nurses

The emergence of the COVID-19 virus had an incredibly negative impact on the healthcare system and brought about numerous challenges for nurses and healthcare workers. Due to an increase in patients, fear of catching COVID, and staffing shortages, nurse retention rates have declined, especially in "nursing care for patients with COVID-19 infection and those working in COVID-19 divisions" (Falatah, 2021). The risks associated with caring for patients with COVID-19 were largely unknown at the beginning of the pandemic, and concerns grew as the increase in hospitalizations and deaths related to the virus arose. These fears were especially high for at-risk nurses, such as the immunocompromised and elderly. Therefore, many more experienced nurses who were planning to retire or leave the profession in the coming years chose to move up their retirement dates to avoid being exposed to the virus. These feelings of anxiety and stress over the virus were also shared by nurses with families at home. Many feared putting their loved ones at risk but bringing the virus out of the workplace, and were thus forced to

isolate themselves from their families during the pandemic. These feelings of isolation, mixed with fears over the virus and exhaustion from working understaffed shifts led to higher levels of burnout, especially among frontline nurses (Jamebozorgi et al., 2022).

As previously mentioned, there are many opportunities for RTLS technology to assist nurses with their daily tasks to lessen the burden of working understaffed shifts and calm fears brought on by the COVID-19 virus. Contact tracing through RFID proximity can diminish the spread of the virus throughout the facility to other patients as well as nurses. Additionally, asset tracking can be used to streamline the procurement of equipment during nurses shifts. Lastly, to combat issues of understaffing, analysis conducted on the data captured by the RTLS can be used to optimize nurse and patient scheduling to reduce the strain placed on frontline nurses. Since RTLS can capture time based data throughout the facility, clinic managers can gain a better understanding of their facilities capacities and needs to best use the nurses available to them. This is especially true for facilities such as the UPC clinic, who can manipulate their daily schedules to accommodate the number of nurses at their disposal. Hospitals with far more patients than nurses staffed (patient-to-nurse ratio) can cause “nurses [to] experience burnout, dissatisfaction, and the patients [to experience] higher mortality and failure-to-rescue rates than facilities with lower patient-to-nurse ratios” (Haddad, 2023). Therefore, using data captured through RTLS to understand and accommodate the needs and limitations of a facility can help reduce feelings of burnout within the nursing staff and improve nurse retention rates in healthcare.

Controversies and Challenges

There are several concerns and challenges that arise when implementing RTLS technology into healthcare systems, and these challenges can differ based on each individual facility. The first challenge is the cost of integrating a RTLS into an existing facility, as the up-front costs of RFID tags, hardware, and equipment can be quite high (Barlow, 2018). This cost can vary greatly based on the desired assets or individuals to track, the precision of the tracking, and the size of the facility. Due to the flexibility of RTLS technology, facilities are able to choose less expensive alternatives such as passive RFID tags instead of active RFID tags; however, these choices diminish the accuracy and timeliness of locating assets within the system. As technology improves, these initial costs will decrease, allowing facilities with less resources to turn to RTLS as a solution to their operational inefficiencies.

Another concern with implementing RTLS technology in healthcare is the security and privacy risks associated with collecting health and location based data. These traceability concerns can extend to the healthcare facility as a whole, or infringe on the privacy of individual patients, nurses, or physicians within the system as "people holding RFID tags could be traced by malicious readers that could lead to invading people's privacy" (Abu Rrub et al., 2012). Additionally, since these systems contain patient health information "the system security has to be compliant with Health Insurance Portability and Accountability Act (HIPAA)" (Abu Rrub et al., 2012). These concerns can be mitigated through the integration of RTLS with a healthcare system's pre-existing security systems that already require periodic assessments for threats and vulnerabilities (Barlow, 2018). Privacy and security are important concerns that can be addressed through proper risk assessments and robust systems, and are already present in healthcare systems.

The last major concern over the use of RTLS in healthcare is inaccurate data collection. The data associated with the readings of tag movements throughout a facility, such as timestamp, location, and identification data can be used when making important operational decisions. These systems can capture a vast amount of information, but if readers miss capturing tag movements or nurses and physicians don't follow the same protocol for swiping their badges, managers can make assumptions regarding facility capacities and cycle times that are not reflected in reality. Analysis conducted using the data captured must account for these inconsistencies, and assumptions must be made to substitute for outlier entries. This concern can be combated by conducting supplementary observational data collection and analysis to identify inconsistencies in the RTLS data before facility capacities are determined.

Conclusion

Real Time Location Systems can be extremely beneficial to healthcare systems through their asset and individual tracking capabilities. The knowledge gained in real time and in future analysis of data captured from the system can help reduce employee workloads and boost nurse retention rates in facilities of all sizes. The assistance of RTLS technology in a healthcare workspace can thus be used to combat the challenges brought on by the COVID-19 pandemic, as these challenges will have long standing effects on the healthcare industry as a whole. To fully understand how much value RTLS technology can bring, further research and studies should be conducted on hospitals and clinics of various sizes, regions, and demographics, because there is no one size fits all solution for the operational and staffing issues these facilities are facing. Additionally, more studies and research should be conducted over the next several years to fully understand the long term effects of the pandemic on the nursing workforce, as most current

research focuses on the immediate impacts of the pandemic that were observed in 2020 and 2021. Overall, RTLS can improve patient/nurse scheduling, assist with asset tracking and supply levels, and reduce the burden on understaffed nurses, and represents the future of healthcare in not just the USA, but globally.

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