

Using a real-time location system to improve clinical efficiency in an academic ambulatory practice

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Abstract In the face of rising consumerism among patients, expectations of more patient-oriented care models and increasing financial pressures for improved ambulatory practice efficiency, the University of Minnesota Health (M Health) implemented a novel Real-Time Locating System (RTLS) in its new consolidated ambulatory clinic building. This paper describes the most salient use cases for this technology in an academic ambulatory practice.

KEYWORDS: Real-Time Locating System (RTLS), operational efficiency, patient experience, care team experience, new patient growth, ambulatory care, outpatient care

BACKGROUND

In February 2016, University of Minnesota Health opened a 342,000 square foot ambulatory facility — the Clinics and Surgery Center (CSC) — which includes 37 adult specialties; laboratory, imaging and diagnostic services; a retail pharmacy; and an ambulatory Surgery and Procedure Center (see Figure 1). The facility accommodates between 2,000 and 2,500 patients on most

days and is the primary practice home of approximately 1,500 clinicians and staff. While large in its overall size, the CSC was designed with approximately 50 per cent fewer exam rooms and shared waiting spaces for patients than the previous clinic facility, and was intended to operate with a modular and efficient ambulatory rooming model.

The use of Real-Time Locating System (RTLS) technology allows these efficiencies



Figure 1: M Health Clinics and Surgery Center
Source: © James Steinkamp Photography.

while enhancing the patient and care team experience. Briefly, RTLS refers to a set of technologies that provide continuous information on the location of people and assets as they move around the facility. In most cases, sensors are placed throughout the building and badges or other ‘tags’ are placed upon items or individuals that need to be located. Historically, the primary use of this technology in healthcare has been for asset management (eg locating a portable X-ray machine at any given time in a hospital) and primarily within inpatient settings for staff or patients. In ambulatory settings, use of this technology has been reported in several single specialty ambulatory facilities. To our knowledge, the CSC is the largest and most robust implementation of this technology within a diverse and large ambulatory facility. In researching solutions, RTLS technologies are still considered new and innovative for daily practice management within healthcare. Moreover, organisations that have implemented RTLS are still discerning how to fully leverage the technology’s capabilities.

METHODS

At the start of a patient visit, a patient concierge checks a patient in for their visit

(see Figure 2) on their handheld tablet and assigns a 1.5” × 2.5” badge to the patient through a bidirectional interface within the electronic health record (EHR). The badge has a clip that the patient can easily attach to his or her clothing. Clinic staff can then locate the patients throughout the building using RTLS monitors and tablets in their workspaces. At the end of the visit, patients drop their badges in a drop box and the badge dissociates from the patient record, which indicates that the patient visit is complete. All care team members, learners, operational leaders and staff are assigned badges to wear when working in the CSC. Important assets (Hoyer lifts, electrocardiography (ECG) machines, interpreter tablets) are also affixed with RTLS badges to make these items easier to find throughout the building.

ENHANCING PATIENT EXPERIENCE AND SAFETY THROUGH RTLS

RTLS technology has allowed many enhancements to the CSC care model that focus on improving the patient experience during their visit. Specifically, this includes managing patient wait time in the lobby and keeping patients informed about the status of their visit in a proactive manner.



Figure 2: Reception desks were eliminated in the main lobby and clinics with the use of RTLS
Source: © Craig Dugan Photography.

As part of the arrival process, a patient is assigned an RTLS badge in the EHR, and a photograph of the patient is taken and loaded into the EHR. The EHR also sends patient appointment information (patient name, medical record number (MRN #), provider name, appointment time and arrival time) to the RTLS system.

Patient wait time is then captured and monitored by the patient concierge staff in the lobby, while also being monitored automatically by the RTLS system. If a patient waits 15 minutes or longer beyond their appointment time, a patient alert is sent to the patient concierge, who then signals the team to connect with the patient and update them as to the expected time until they will be seen. Additionally, once the patient is back in an exam room, an alert appears when the patient has been waiting for more than 10 minutes in the room. Any of the rooming staff can then connect with the provider or registered nurse (RN) and communicate with updates on any delays (see Figure 3).

Importantly, with the combination of the patient photograph in the EHR and RTLS location, clinic staff can easily locate the patient and approach him or her discreetly

to bring them back to the exam room. It also significantly helps employees with personalisation and privacy, as clinic staff are able to locate and address patients directly rather than shouting their name from a central kiosk.

Many of our patients have multiple visits in the same day, often for a complex set of conditions or a single condition requiring multidisciplinary care. For these patients, it can be easy to lose track of their location in the facility. The RTLS technology has provided our clinic staff with real-time information on the patient's location in the facility and who they are seeing. For example, a patient could be undergoing laboratory testing, and our staff have located them in the laboratory and with a specific provider. In this case, clinic staff are able to call down to the laboratory and learn how much longer the patient will be there. The clinic team can then make an informed decision on whether to bring back the next patient or wait until the first patient returns from the laboratory.

At the practice level, the team are able to review wait time reports by clinician, clinic area or time of day. In this way, target evaluations and improvement interventions



Figure 3: Patients are allowed to wait anywhere in the building

Source: © Craig Dugan Photography.

can begin for particular physicians and staff who consistently have delays in care to improve operations in an area — and, ultimately, the patient experience. As an objective system, RTLS allows these conversations to remain very patient-centric and data-driven, rather than driven by anecdote. It also allows the team to be proactive rather than to wait for patient complaints before beginning to address these issues.

Patient and employee safety has also improved in the CSC through the implementation of the RTLS system. On a number of occasions, when a patient or staff member was identified as having a possible communicable illness, the Infection Prevention team have been able to retrospectively analyse the RTLS data and identify the specific time, locations and duration of the index patient visit, allowing the Infection Prevention team to determine whether any employees or patients were exposed. Focusing on the location of the index patient visit allows the Infection Prevention team to develop a specific exposure definition to capture all potentially exposed individuals without casting too wide a net. The precise information also allows

operations to define an appropriate level of risk and take the required actions to ensure that all patients, staff and providers are safe. The implementation of infection prevention and cleaning protocols for badges, and the system to do so, were also important to define at the outset.

ENHANCING OPERATIONAL MANAGEMENT THROUGH RTLS

The consolidation of 37 adult specialties from several clinic spaces into one clinic facility in the move to the CSC resulted in a decrease in the number of examination and procedure rooms from approximately 300 to 180. Three essential tactics allowed M Health to make this transformative leap: 1) expanded hours of clinic operations to 7am–7pm during the week and 8am to noon on Saturdays; 2) a move away from assigning examination rooms to individual providers; and 3) implementation of the First Room Up workflow with the aid of RTLS.

The intent of the First Room Up workflow is to bring the patient to the clinic space as soon as the care team is ready to see the patient and place them in the next available room. The rooming staff bring patients into the intake space (Figure 4) to collect vital signs,

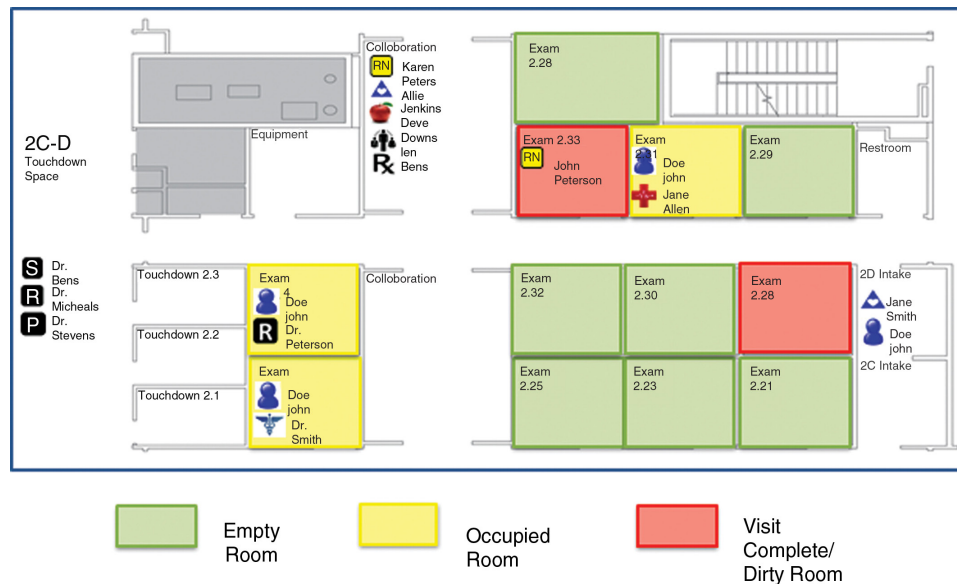


Figure 4: Floor plan of building with RTLS data displayed showing room occupancy

‘pre-room’ patients during busy times, and move them to the examination rooms when the clinical team are ready to begin the clinical encounter — allowing better utilisation of the space for direct patient care.

As part of the First Room Up workflow, each day the clinic manager conducts a daily huddle meeting with clinic staff to prepare and anticipate any potential issues. The daily huddle consists of reviewing the number of scheduled patients for the day, the number of providers and interdisciplinary care team members in the clinic, staffing levels and assignments, and main learnings and room utilisation data from the previous day (Figure 5). Room utilisation is defined as the time that a patient occupied an examination, procedure or consulting room.

The team also identifies a clinic flow coordinator who is responsible for managing the flow and communicating with the care team. Depending on the day, the work of the clinic flow coordinator can be either absorbed by the rooming staff or assigned to a lead staff member for the day. The clinic flow coordinator will also work with the patient concierge staff, who can then notify

arriving patients to communicate wait times when clinicians are experiencing delays. The RTLS system provides the clinic flow coordinator and other clinic staff with a map and list view, which both aid in efficiently managing flow.

The map view is instrumental in the First Room Up workflow (Figure 4) and is displayed on flat screen monitors in the staff workspace or ‘collaboration zone’. The map view also provides the care team with visual cues (green = available, yellow = occupied, red = needs cleaning) that allow the rooming staff to be informed accordingly. As a result, rooming staff can more efficiently perform work, such as rooming a patient in a clean available room instead of cleaning a dirty room prior to rooming the next patient. The map view also allows staff to better collaborate with one another, knowing where other team members are located.

A patient list view (Figure 5) provides the rooming staff with a quick visual as to which patients have arrived and where they are in the lobby area. Many clinics rely on a team-based approach, and the patient remains in the same room while providers

Clinic Patient Centric List View							
Patient Name	Curr Loc	Provider	Arr'l Time	Appt Time	Wait Rm Idle Time	Exam Rm Idle Time	Notes
Bronchi, J	Waiting	Sheldon		10:00		0:30	
Dollen, M	RM 1001	Styke		10:30			cane
Edwards, A	RM 1006	Williams	9:45		0:10		
Golab, H	RM 1002	Osterland	9:30				wheelchair
Jackson, T	Discharge	Styke	9:30		0:20		
Marshall, R	Radiology	Williams	10:00				
Wright, P	RM 1005	Greenfield	10:30			0:15	assist

Figure 5: Example of RTLS display highlighting patients waiting too long

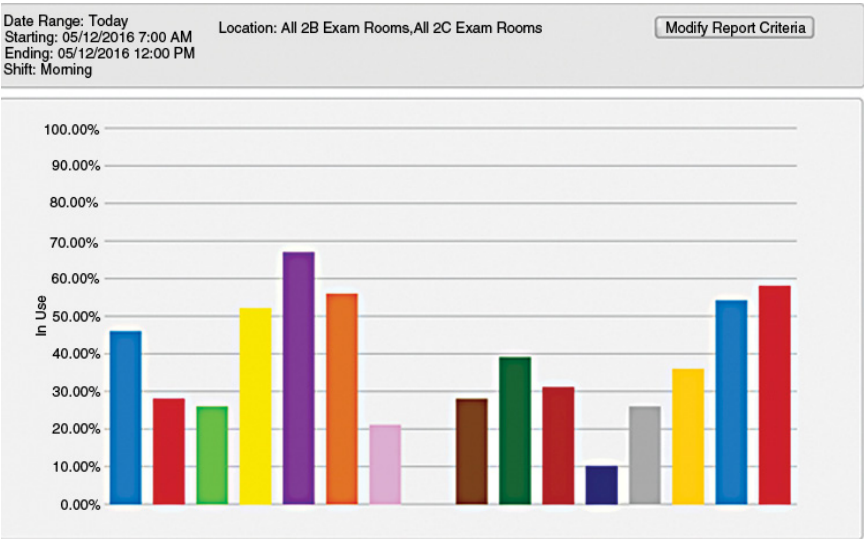


Figure 6: View of room in use data

come to the patient; the list view allows these clinics to know which team members have met with a patient during the course of the patient visit.

The team can then evaluate how the space is being utilised (Figure 6), leveraging directional data from RTLS, to make informed decisions to optimise the workflow on an ongoing basis. Management dyads (medical directors and clinic managers) can proactively plan as they add additional clinic blocks to meet patient demand and balance clinic schedules across all days of the week to best utilise the facility. It is important to note that while RTLS is an important tool and aid, it does not fully replace other process improvement activities that collect complementary data (eg observations and time studies).

ENHANCING CARE TEAM EXPERIENCE THROUGH RTLS

RTLS has provided the opportunity to improve clinician experience through the implementation of a functionality called physician assist. The physician assist capability addresses the problem of time spent looking for staff to assist with patient visits or procedures, or transitioning the plan of care to other staff (eg visit wrap up or patient education). RTLS offers the capability for providers to push a button on their badge, which then sends a notification to the RTLS system that is displayed on the central monitor in the staff collaboration zone. Staff can then meet the provider in the examination or procedure room with the patient and provide the necessary support as defined by that specialty.



Figure 7: Continuous staff working space allows multidisciplinary interaction
Source: © Craig Dugan Photography.

Additionally, the ability for clinicians to search for colleagues in the building increases the opportunities for face-to-face conversations about mutual patients. Creative physical design of the clinics was put in place, whereby specialties that interact often were co-located adjacent to each other in the building, and share a continuous working space that extends through the middle of each clinic space (see Figure 7). Combining this with RTLS technology allows a physician who is seeking a multidisciplinary consult to simply look on a monitor to locate the physician they wish to communicate with and walk to that area to find them. Anecdotally, the authors have heard several stories of patients receiving more coordinated, collaborative care because RTLS facilitates connections between clinicians. These anecdotes also help promote social cohesion among physicians,

the absence of which has been linked to physician burnout.^{1,2}

REDUCTION OF CAPITAL INVESTMENTS AND IMPROVEMENT OF PATIENT EXPERIENCE

When the architectural design of the new CSC was being conceived, a preliminary building space programme was developed on the basis of concept of utilising the same operational model as the old clinics. When this space model was translated into a building, initial calculations estimated the total cost at over US\$200m. A capital investment this high did not yield the financial results the institution desired, as one of the primary reasons for consolidating clinic practices in a new building was to decrease the cost of care. To hit the financial target, the institution and design team were challenged to create a new building that needed to accommodate 40 per cent more patient volume, but in a significantly smaller space. The only way to achieve such a metric was to develop a new operational model that achieved higher utilisation of physical resources. A target was established stating that every examination room had to see between eight and ten patients per day. Many teaching institutions have attempted to achieve this metric with limited success, as it is easy to establish room turn goals, but it is challenging to ensure that one can eliminate waste and improve throughput.

The utilisation of the RTLS system gave leadership the confidence that they could reduce the quantity of examination rooms significantly and have the ability to consistently improve operations to achieve the desired throughput (see Figure 8). By achieving higher throughput, the architects were able to significantly decrease the building footprint and eliminate the construction of a parking structure — which saved US\$67m in capital costs. Early space utilisation data from the RTLS system is already demonstrating justification for



Figure 8: Significantly fewer examination rooms were constructed owing to efficiencies gained
Source: © Craig Dugan Photography.

the reduction in examination rooms. The technology ensures that every patient space is continually in use, decreasing wait times and allowing providers to see 75 per cent more patients per examination room in the CSC versus the previous clinic facilities.

Concerns over patient acceptance of being asked to wear a RTLS badge were quickly put aside when the building opened, as it was found that only rarely would a patient disagree. In cases when this occurs, the patient is allowed to continue their visit in a more 'traditional' manner. Owing to the unique operational changes that have been implemented in the CSC, leadership was very interested in understanding how patient experience was impacted. On top of patient surveys, suggestion boxes were placed in many areas around the building with cards for patients to provide feedback. In the first year of operations, feedback has been very

positive, with three times more compliments than criticisms being submitted.

The RTLS system's contributions to both a positive patient experience and improved operational efficiency suggest a relationship with M Health's expanding market position. Since opening the CSC, M Health has experienced significant new patient growth — up by 14 per cent in 2016 and 12 per cent in 2017 — when compared with the experience in previous years. Moreover, the expanded hours of service daily and over the weekend, combined with operational streamlining from the implementation of RTLS, allow providers to reach more commercial patients to improve payer mix. As a result, overall commercial pay for appointments during expanded hours has increased by 5 per cent.

IMPLEMENTATION CHALLENGES

In addition to the important positives associated with RTLS, there have been a number of challenges — some of which have been solved and several of which are ongoing. The most significant ongoing challenges with RTLS have been related to the badges themselves. First, badge loss among patients has been a significant problem; this is a new technology for patients, and they are not accustomed to returning their badges. It is possible to identify which patients have likely left with their badges based on the interface with the EHR; it does, however, require operational time to contact patients to recover badges. Loss of badges assigned to learners has also been an underestimated challenge, and a handful of physicians continue to decline to wear badges. Both of these issues have required leadership time and attention to correct.

Additionally, because of the type of RTLS technology implemented at the CSC, badge placement plays a crucial role in the effectiveness of the system. Badges generally need to be worn high on

the body, facing out and not covered by clothing. There are times, however, when patients and staff are not picked up by the RTLS system because of where badges are placed on the body, making the data during the time frame of incorrect wear inaccurate — and possibly not useful. The organisation continues to invest time in patient and staff education to build awareness around proper badge placement to solve these issues.

When the building first opened, the system crashed almost daily because the platform did not have the capacity to properly handle the volume or the contemporaneous data for a large building. Eventually, the vendor and information technology (IT) staff were able to stabilise the system after several months. Yet this system instability led care teams to lose trust in the system at the outset of the implementation. This, combined with the new space and workflows, was an unforeseen obstacle, since the system was designed to be an important mechanism to improve operations in the new building. Once stability was attained, a 'refresh' around the RTLS system was performed over several months with clinical teams to re-implement the system.

In addition, reporting analytics is still a challenge as staff work through performance, consistency and validation of reports. Analytics are particularly important, since operational leaders require these data and this insight to provide directional indicators

related to the patient experience, clinic flow and capacity planning.

CONCLUSIONS

In the two years of RTLS system implementation at the new CSC, important lessons have been learned, specifically in relation to the technology's ability to enhance patient and care team experience. Team members can easily determine patient status, receive visual notification regarding patient wait time and alone times, and easily see when examination rooms are ready for the next patient in order to improve the clinic flow and experience for our providers. This has led to less time wasted looking for people and resources, and ultimately more time providing personal attention to patients. Improvements in processes have allowed greater patient volume to be achieved with fewer physical resources, reducing overhead costs. Most importantly, the RTLS system has provided care teams with additional sources of directional data to better foster a culture of continuous improvement about all aspects of the patient and care team experience.

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