FROM NASA TO HEALTHCARE: REAL-TIME DATA ANALYTICS (MISSION CONTROL) IS RESHAPING HEALTHCARE SERVICES

Posted on November 10, 2021 by Matthew

Category: Fall 2021

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Abstract

This is a case study of the implementation of a data and analytics-enabled Mission Control at one of the largest healthcare service providers in the state of Washington. Using data analytics and artificial intelligence, CHI-Franciscan (one of the largest healthcare organizations in state of Washington) is able to coordinate patient care more effectively and efficiently, improving safety for all its patients. This case study demonstrates tangible evidence from quantitative and qualitative analysis for return on investment for such a large project.

Introduction

A revolution in healthcare is occurring as a result of changes in the practice of medicine and in society. These include increasing costs; lack of performance compared to other nations spending less on healthcare as a percentage of the economy; changing demographics and diseases; new tools, techniques and solutions; changes in healthcare delivery; increased patient empowerment and autonomy; an emphasis on outcomes; and changing professional roles. Today, healthcare providers have many complex and unique challenges as well as opportunities to improve the patient care experience.

Coordination of patient care is one of the most complex and important services that every large

healthcare organization needs.[1] This involves deliberately organizing and managing patient care activities, sharing timely information among all of the participants concerned with a patient's care, and making the right decisions in a timely manner. The patient's needs and preferences must be known ahead of time. Conditions are being monitored with live data feeds, and this information must be used intelligently to provide safe, appropriate, and effective care to the patient.

In this paper, we discuss the successful implementation of data analytics in our artificial intelligence-enabled Mission Control at one of the largest healthcare service providers in the state of Washington.

Although the need for care coordination is clear, there are many factors that can either impede or facilitate the work of care coordination:

- Current health care systems and electronic medical records are often disconnected.
- Specialists may have inadequate information on previous tests and treatments.
- Sharing medical records among providers is essential to coordinated care, but the promise of seamless digital exchanges is still far from reality.

Data analytics and artificial intelligence-enabled smart healthcare systems, coupled with electronic

health records (EHRs), live streams of patient data, and the emergent mobile solutions demonstrate unprecedented potential for delivering highly automated, intelligent, and sustainable healthcare services.[2]

From NASA to Healthcare: Mission Control

Inspired by NASA, in 2019, CHI Franciscan launched its Mission Control Center, the first in Washington state and only the fifth globally to use artificial intelligence (AI) and advanced analytics to enhance its services, coordinate and optimize patient care, and increase capacity to serve more patients throughout eight of its acute care hospitals. The 1,300-bed health system, one of the largest in the state, sees nearly 325,000 emergency department visits and over 300,000 inpatient days each year. CHI-Franciscan is part of CommonSpirit Health, the second largest nonprofit healthcare organization in the United States.

Built in collaboration with GE Healthcare, the Mission Control Center collects and harness data with advanced machine learning (ML) and AI algorithms to:

- Coordinate patient care and resources across the entire health system.
- Streamline care delivery.
- Allow care teams to proactively solve problems.
- Reduce patient risk and improve health outcomes.

Core functions of the CHI-Franciscan's Mission Control include:

- Transferring patients between and from outside the facility
- Placing patients in the appropriate bed the first time
- Chasing down care delays to eliminate them
- Providing appropriate staffing across all facilities

The center houses an 18-screen video wall with 12 data analytic tiles, or apps, that provide actionable, real-time data from each hospital. For example, one tile, called Care Progression, scans and detects care activities falling behind schedule. The tile prompts a response without delay and helps to avoid false alarms before alerting the staff.

It is well known that patients with long waits in the emergency department after the decision to admit experience heightened mortality risk.[3] Mission Control analyzes real-time data and address potential delays to reduce the amount of time a patient waits in the emergency department or a post-anesthesia care unit for a bed to be available. Economically, hospital crowding is directly correlated with left without being seen and lost case rates.[4]

Value of Collaborative Intelligence: Physician on Duty + Mission Control

One of the critical success factors for CHI-Franciscan's Mission Control Center is a program called Physician on Duty (PoD). Every day, the center has a practicing physician leader in the providing proactive clinical leadership. Over the 12 months prior to the launch of Mission Control, CHI-Franciscan worked to recruit a team of leaders in hospitals, emergency medicine, and surgical specialties for the PoD role. Core recruiting criteria included:

- High level of trust with medical staff colleagues and nursing staff
- Ten years of clinical experience, preference for current service line medical directors
- System perspective and operational experience
- Willingness to take risks to advocate for the highest quality of clinical care
- Ability to be a good coach in a new department and atmosphere of change

At launch, they had recruited 14 physicians, 12 of whom were divided equally between emergency physicians and hospitalists; the cardiovascular and general surgery service line chiefs took the last two spots. Ten were service line and medical director leaders.

Continuing education is also key because of rapidly changing technology and health service practices. Training was performed over the first three months to determine the correct standard work for the team, with the goal of preventing lost cases, improving patient safety, reducing delays, and balancing system capacity. As of November 2020, they are on the 14th iteration of standard work for this team in the first 16 months of the program. Daily PoD program standard work is:

- *System awareness.* The physician uses current and historical capacity data to make a capacity projection for each hospital for the coming day. This work is done in collaboration with Mission Control Center staff in patient placement, transfer center, and nurse staffing. The team reaches an agreement on what the plan of the day should be in terms of capacity for the next 24 hours.
- *System communication.* From this projection, after verifying the data is correct and with input from the team, the physician notifies all hospitals of available system resources and projected deficits.
- *Lost case prevention.* The physician serves as a clinical resource and facilitator to improve communication among medical staff colleagues.
- *Algorithm looks forward.* The PoD communicates what is happening now and what is going to happen over the next 24 hours. They facilitate additional direct admissions by leveraging collegial relationships.
- *Identifies greatest need of each patient placement team throughout the shift.* This expedites discharges, obtains downgrades, and reduces boarding a care delays.
- *Expert clinical reviews of all transfers into their tertiary and full hospitals* to ensure clinical appropriateness; facilitates equivalent alternative plans (for example, a specialist may see the patient at the sending facility by telemedicine rather than transfer all patients needing consults to the tertiary facility).

- *Reroutes.* The physician actively scans the emergency departments of full hospitals to identify patients who qualify to be admitted at sites who both have capacity and are projected to have space. We take care to anticipate incoming demand of their hospitals so as not to worsen overcrowding.
- *Wait list reviews.* The physician works to ensure that patients are admitted to their hospitals in a timely manner to prevent lost cases.
- *Hospice care facilitation.* When transfers are requested that contain an opportunity to have a goals of care discussion, the physician can facilitate this if it has not yet occurred.
- *COVID-19-specific tasks* include:
    - Lead critical resource triage team drills (abstract patient data, to be used only if resource allocations should become necessary due to scarcity).
    - Patient reviews. All admitted COVID-19 patients are reviewed daily to assist in transfers/cohorting at their designated coronavirus hospital.
    - Facilitate specialty consultations to reduce the risk caused by transferring patients with COVID-19.
    - Facilitate skilled nursing facility discharges of both COVID-19 positive and negative patients.
    - Serve as the expert to answer questions from bed placement and transfer center regarding isolation, testing, bed placement, and stewardship of negative pressure rooms.

Benefits in Less than a Year

With information that is being provided by Mission Control, the team of physicians on duty recorded their daily interventions with medical record numbers in order to quantify and validate their impact. In order to preserve data integrity, a standardized set of inclusion criteria was applied; interventions that did not meet these criteria were not included to prevent lost cases, create tertiary capacity and strategic beds, and improve patient safety.

It is almost impossible to adopt a standard technology to manage healthcare services. Of course, GE's Mission Control technology needed interventions and customizations to be adopted for the CHI-Franciscan's processes. During the first year of implementation, each physician was required to lead a resource capacity-related project in addition to the standard work noted above. Samples of these projects included:

- Tertiary emergency department medical director (also a PoD) temporarily repurposed a part of his emergency department for stress testing when a community hospital's nuclear medicine devices were recalled, preventing outmigration of many additional patients (not counted in official metrics).
- System cardiovascular service line physician director (also a PoD) implemented best practices in same-day discharge of procedural patients after lab procedures. Significantly more same-day discharges were observed throughout the health system for these patients.

- System general surgery chief (also a PoD) reviewed lost surgery cases to identify opportunities and bring feedback to his group.
- Writing and implementing a system transfer back agreement to create tertiary space when patients no longer had a need for their tertiary care center.
- Physician leaders, including the chief of neurosurgery and cardiology, asked Mission Control to contact them, day or night, if a case was going to be lost due in their service line.

As a result of successful co-development, implementation, and management of Mission Control, in less than a year, the following improvements were seen*:

- Through additional admissions and prevention of lost cases alone, the physician-driven program created a contribution margin equal to for 74 percent of its labor cost in the first year of operations.
- When considering the additional tertiary capacity created with transfers and reroutes away from their full tertiary center, if that capacity were entirely utilized, the contribution margin of that capacity creation is estimated at $3.6M, with a total program return on investment of 12:1.
- Writing and validating a unique capacity algorithm for Mission Control, used daily in their operations, that was found to be accurate within 1.9 percent in predicting "tomorrow's demand" at their tertiary sites.
- Lost cases were reduced by 20 percent in the first six months of the year.
- Reduced boarding, on average, by 54 percent, as measured daily at 5 a.m. This data was pulled from two independent data sets, including transfer center capacity data audits and emergency department nurse staffing data.
- Balanced system capacity. Since the launch of Mission Control, we have been able to achieve significant shifts in occupancy from their busiest hospitals into smaller sites with inpatient capacity.
- From a core clinical service perspective, the PoD intervened on 142 critical patient safety cases, highlighting the need for physician leadership at the forefront of complex integrated health systems (see **Table 1**).

Note: Regarding lost cases, boarding data, and admission volumes: Only the first six months of data of the 2019-2020 fiscal year was included, as volumes dropped so precipitously following the COVID-19 pandemic that subsequent changes could not be credibly attributed to interventions at Mission Control.

The leadership team had to two major challenges during this project that needed to be addressed urgently to reach the project goals. Recruiting was a challenge that required investing in people (time) for a full year prior to launch. Physicians already in leadership roles and highly trusted across the organization were being asked to work on their few days off. Regular listening sessions with desired candidates required understanding their ongoing deep concerns about patient safety and system capacity, and presenting them with fact that this role was a real opportunity to improve

patient care. The second challenge was about processes. Standard work was generally known but had to change throughout the initial months of the program. Our team needed to see what should be done and change to meet those challenges. Actively coaching and teaching the other teams in Mission Control (patient placement, transfer center, and staffing in particular) became a core competency. We discovered that successful physicians on duty had to be skilled facilitators and negotiators, advocating for patient care in areas (like nurse staffing) not traditionally involving physicians.

Lessons Learned

CHI Franciscan is not the only health system with a Mission Control—others include Johns Hopkins and Oregon Health Sciences University. University of Pittsburgh Medical Center's SmartRoom technology is another sample analytics and AI-enabled smart healthcare system. This consists of two major components: a patient screen, which lets patients identify their caregivers, see a list of the day's activities (scheduled lab tests, etc.), and access educational materials; and a caregiver screen, which gives clinicians access to essential information, including allergies and medication regimens. This system also lets nurses and aides quickly document vital signs and complete basic tasks on a touch screen. The system is intelligent enough to give different sets of patient data to different categories of providers. For example, an aide responsible for turning a patient would be told that the

patient is allergic to latex and get reminded to put the bed rails up.[5]

There are three areas that any smart hospital (e.g., Mission Control) addresses: operations, clinical tasks, and patient centricity. Operational efficiency can be achieved by employing building automation systems and smart asset maintenance and management solutions, along with improving internal logistics of mobile assets, pharmaceutical, medical device, supplies and consumables inventory, as well as control over people flow (staff, patients, and visitors). Patient flow bottlenecks, when addressed, improve efficiency, allowing more patients to be "processed" through the system and allowing for more revenue opportunities at lower costs.

When we see how many tech giants have made big bets on healthcare and experienced big failures in the past several years (such as Microsoft HealthVault, Google Health, Apple Watch, and IBM Watson Oncology) while trying to disrupt an extremely complex industry, this makes people nervous to co-develop and implement a solution like Mission Control to manage healthcare services.

The key learnings can be summarized as following:

- Hire the best possible technology provider who already has healthcare knowledge and experience.
- Hire the most clinically trusted and influential, organizationally and operationally literate, and verbally articulate physicians possible. Patient care efficiency and safety can be improved, but influencers must be at the helm to ensure new processes keep patients safe.

- Hire people willing to endure and adapt to change. Be willing to change the standard work to adapt to evolving needs. The entirety of Mission Control's COVID-19 related work was developed contemporaneously with the evolution of the pandemic.
- Hire data science engineering and science experts who have healthcare knowledge.[6]
- Hire and cultivate the engagement of physicians who have a "whatever it takes" attitude to provide the best possible health service.
- Learn from each other. CH-Franciscan was very fortunate to have a highly experienced and trusted team of registered nurses, coordinators, and staffing experts in Mission Control with a deep well of clinical, relational, and operational knowledge.

Limitations

As with all case studies and action research, one of the limitations of this study is the examination of a single healthcare organization. There are a number of healthcare organizations working on similar data and analytics-healthcare information management solutions globally. Depending on the types of health services that they provide and the size, each organization may have different needs. Of course, the success of this project depends on people, right processes, and technology that collects, stores, and analyzes data to support right and timely decision making. AI is a growing area that enables decision-making in healthcare.

Conclusions

Many healthcare service providers are working on various data and analytics-enabled solutions to increase outcome of their health services. This is one of the few studies that demonstrates tangible evidence from quantitative and qualitative analysis for return on investment for such a large project. Coordinating patient care with real-time data and being able to take speedy decisions bring so much value to the healthcare services.

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