Quality Improvement

Implementation of Clinical Pharmacy Surveillance Technology and a Pharmacy Practice Model Re-Design Across a Multi-State Health System

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Abstract

Background
Outcomes-directed pharmacy models are necessary to further comprehensive, patient-centric clinical care. This report describes the implementation of clinical surveillance technology and the development of clinical pharmacy metrics to measure outcomes that support return on investment. The overall goal of clinical surveillance technology implementation in this quality improvement project was to extend the pharmacists' reach and to improve patient safety and clinical outcomes with greater operational efficiencies.

Methods
In 2013, a clinical pharmacy surveillance tool was piloted and expanded over the next 2 years to 154 hospitals across the health system. Over the next 6 years, the number of hospitals utilizing the technology, the number of drug therapy modifications, the time to pharmacist intervention, clinical pharmacy metric results, and return on investment were tracked.

Results
From 2015 to 2021, the number of hospitals with clinical surveillance technology implemented grew to 177 hospitals. During this same time, the number of frontline clinical pharmacist drug therapy modifications more than doubled, and the time for pharmacists to respond to alerts decreased from 13.9 to 2.6 hours. Since 2015, the percentage of patients on vancomycin de-escalated by 3 days of therapy has increased by 12% and the percentage of patients with a UTI treated with fluoroquinolone decreased by 25%. Hard and soft dollar savings resulted in an annual return on investment of 1:12.9.

Conclusion
After implementing the redesigned pharmacy services model, pharmacists were more efficient and patient outcomes improved.

Keywords
pharmacy technology; clinical surveillance technology; drug therapy modifications; prescribing practices; pharmacy practice model; pharmacy metrics; pharmacy outcomes measurement; hospital pharmacy departments; pharmacist interventions

Introduction
Pharmacists are uniquely positioned with the training and skills to provide medication management services. Studies have shown that pharmacist-delivered patient care services can improve patient outcomes, increase cost efficiency, and reduce demands affecting the healthcare system.[1,2] However, hospital pharmacy departments often have to balance operational and clinical activities. These competing priorities and responsibilities, coupled with inefficient workflows, dramatically reduce

the amount of time pharmacists are able to dedicate to the patient care process.[3] The Pharmacists' Patient Care Process uses the following principles of evidence-based practice to collect, assess, plan, implement, follow-up, monitor, and evaluate to optimize patient health and medication outcomes in collaboration with healthcare professionals.[3] This consistent approach to patient-centered care was necessary as the profession of pharmacy advances from medication product distribution to clinical patient care services.[3] As recommended in the 2021 American Society of Health-System Pharmacists (ASHP) Pharmacy Forecast, pharmacist development of comprehensive medication management services for patients with high-risk and chronic disease states is key for optimal outcomes.[4]

Pharmacy Practice Model

Our health system's pharmacy practice model is based on core elements necessary to provide patient-centered care. These elements include formulary management, clinical activities, interdisciplinary collaboration, visibility and leadership, safety culture, and practice advancement. Examples of these elements include promoting evidence-based care and knowledge of the current literature, harm avoidance and medication error reporting, participation in committees, and multidisciplinary team training. Pharmacists are expected to have the skill set to support these fundamental core elements, and hospitals are expected to provide this core level of clinical services consistently for all shifts, every day.

To aid in clinical efficiency and support the core elements, a clinical pharmacy surveillance tool was piloted in 2013 (**Table 1**).[5] This technology allowed pharmacists to more efficiently support the operational workflow and provide clinical care. In 2014, 69 hospitals had completed over 545 000 drug therapy modifications. Results informed a health system strategic plan to develop a comprehensive, unit-based,

Table 1. Standardized Clinical Activities Impacting Patient Safety and Quality of Care

Clinical program element	Description	Impact
IV to oral conversion	Alerts pharmacist to a patient on IV medication who is a candidate for conversion to oral medication	• Reduced exposure to nosocomial pathogens via intravenous access site • Reduced risk of phlebitis • Increased patient mobility • Improved patient comfort and convenience • Potential decreased length of stay • Lowered direct and indirect costs
Renal dose adjustment	Alerts pharmacist to a patient on a medication that needs to be evaluated for appropriateness of dose and/or frequency	• Optimized medication benefits • Reduced risk of serious adverse effects
Antimicrobial stewardship	Alerts pharmacist to a patient with specific combinations of culture and sensitivity results and antimicrobial therapy (de-escalation or therapy optimization opportunity)	• De-escalated or optimized medication regimen • Decreased antimicrobial resistance and multi-drug resistant organisms • Reduced waste • Avoided harm
Anticoagulation monitoring	Alerts pharmacist to patients on anticoagulant(s) to ensure appropriate use and monitoring of high-risk medications	• Improved appropriate use of anticoagulant medications • Enhanced monitoring and management of anticoagulant therapy in accordance with evidence-based guidelines, regulatory requirements, and national patient safety goals

clinical pharmacy service model with consolidated, centralized pharmacy operations support in tandem with clinical pharmacy surveillance technology. By 2015, 154 hospitals had implemented the technology. Using baseline drug therapy modification data collected monthly in 2013 and 2014 and comparing it to year-end 2016 data for 160 hospitals, the number of pharmacist drug therapy modifications doubled from baseline for hospitals with 300 or more beds. Hospitals with less than 300 beds increased the number of drug therapy modifications by 200%.

Establishing Strategy and Defining Goals

To successfully accomplish implementation, health system pharmacy leaders had to articulate the vision, strategy, and goals for colleagues and teams to follow. In 2014, a measurement strategy was defined to assess intended outcomes and was launched in 2015 to evaluate clinical pharmacist performance and patient outcomes. Pharmacist interventions were documented and shared with leaders. For example, in one case, within 10 minutes of a positive *Clostridioides difficile* culture result, the pharmacist called the physician to recommend adding appropriate antibiotic therapy and alerted the nurse to initiate infection prevention precautions. Less than 1 hour after the alert, the patient was started on an appropriate antibiotic therapy.

Clinical pharmacy metrics were constructed to measure outcomes using parameters such as laboratory data, barcode medication administration (BCMA) data, and ICD-10 diagnosis codes, rather than only pharmacist intervention documentation. This insight into the objective data contributed to the development and reporting of more meaningful metrics. Each year, fourth quarter data of the previous year is used as a baseline to set goals before the metrics are released. Now, metrics have matured to a scorecard of clinical and medication safety metrics with minimum denominators as appropriate: time to acknowledgment for high-priority alerts (pharmacist response ≤ 4 hours); oral to intravenous (IV) dose ratio for targeted medications; oral to IV opioid dose ratio; opioid reversal percentage; proton pump inhibitor (PPI) and H_2 receptor antagonist (H_2RA) de-prescribing after an intensive care unit (ICU) stay; antimicrobial de-escalation; fluoroquinolone use in urinary tract infections (UTI); vancomycin de-escalation at 3 days; and standardized antimicrobial administration ratio (SAAR)-broad spectrum at hospital-onset to inform antimicrobial stewardship efforts[6] for medical and surgical units.

Setting clear expectations was crucial to engage newly hired pharmacy leaders and staff. Data were used to understand systems and navigate workflow changes, connect measures to improved patient outcomes, and identify education opportunities. These fundamental principles guided the development, implementation and growth of pharmacy services. Metric goals were established using internal benchmark data and performance during a pilot test period. Each year, metric goals were evaluated for updates or retirement, and new metrics were added. For example, in 2021, a new metric was piloted to evaluate appropriate direct oral anticoagulant dosing for patients with atrial fibrillation. This new metric replaced the retired metric that had been in place for 3 years: warfarin and subsequent International Normalized Ratio (INR) greater than 5. Executive pharmacy leadership made the decision to retire the warfarin metric because the majority of hospitals met the goal of 3.5% or less by the fourth quarter of 2020. Additionally, decreased utilization of warfarin over the years also impacted this decision. The scorecard was and will continue to be released annually after review and alignment with the health system's strategic priorities and the previous year's performance.

Implementation and Maintenance

There are many theories on change management including Kotter's Process for Leading Change.[7] Kotter's steps are summarized as: create a sense of urgency, build a guiding coalition, form a strategic vision and initiatives, enlist a volunteer army, enable action by removing barriers, generate short-term wins, sustain acceleration, and institute change. As technology was introduced, it required Kotter's methodical approach to enlist local leadership and their teams to prepare for this change. However, it did not come without challenges. Three main barriers were encountered: pharmacist engagement and adoption of new technology,

physician and nursing buy-in, and consistent training.

Pharmacist engagement and adoption were a challenge in the first group of hospitals as technology was integrated into the existing workflow. This resulted in process inefficiencies and frustration. William Bridges' Transition Model outlines 3 stages of change.[8] The first stage is endings; people are presented with change and learn how to manage loss. The second stage is the neutral zone; people are uncertain and may be skeptical about the initiative but are learning. The final stage is a new beginning; individuals have embraced the new learning and are excited about the possibilities ahead. Using learnings from initial implementations, change management processes were incorporated to assist hospitals during implementation, resulting in a quicker rate of adoption in later implementation hospitals when the workflow was more mature, integrated, and better understood.

Pharmacists spent less time in the ending and neutral stages of the transition because they had heard success stories of positive impact on patient care shared during health system pharmacy leadership calls. Key executive and clinical leaders were included on kick-off implementation calls, and results were shared with them to foster change adoption. As work shifted from operational to clinical activities, provider and nursing buy-in was initially a barrier because hospital staff was not prepared for the increased involvement of pharmacists, which resulted in frustration. Once identified, local pharmacists were provided with talking points to foster critical discussions with providers and evolve the multidisciplinary team culture of care. Today, providers and nurses request more support from pharmacists and interdisciplinary leaders request scorecard measures aligning with health system goals.

Consistent and effective training was a hurdle that initially slowed teams because leaders were trained to teach local teams. This resulted in inconsistent pharmacist competency. To optimize training, operational adjustments, educational user guides, videos, and local and regional accountability were employed. Today, 177 hospitals within the health system use the technology and implementation has decelerated. A refined toolkit provides effective implementation for new hospitals, and just-in-time training is made available by the health system to educate pharmacists about ongoing enhancements.

A governance structure was created to maintain the content of the alerts, and support evidence-based practices. The structure includes a clinical pharmacy advisory board (CPAB) and subgroups. The CPAB has pharmacist members selected from a variety of facilities within the large health system. Subgroups are made up of pharmacist experts in areas of pediatrics, oncology, anticoagulation, critical care, and behavioral health, and these pharmacists provide content recommendations for alerts and functionality. Any health system pharmacist user is able to submit ideas electronically for consideration for new alerts or ways to enhance current alerts and functionality. These ideas are triaged and sent to the appropriate subgroup for expert review. Ideas that do not fit in a subgroup are reviewed by the CPAB. Controversial issues encountered within the subgroups are taken to the CPAB for review, discussion, and voting.

Outcomes

Since the inception of the redesigned workflow and implementation of the technology, the results have been positive (**Table 2**). Accountability and visibility are structured to measure pharmacist bandwidth to care for patients and to justify the return on investment. Comparing 2015 to 2021, the number of frontline clinical pharmacist drug therapy modifications more than doubled, resulting in annual savings. Time for pharmacists to respond to alerts during this same time period decreased from 13.9 to 2.6 hours. Efficiencies gained from alerting pharmacists to potential interventions instead of pharmacists searching manually for intervention opportunities supported clinical patient-centered care activities such as interdisciplinary rounds, formulary management, committee presence, and medication reconciliation.

To determine cost avoidance, inpatient coded adverse drug events (ADEs) and hospital-acquired venous thromboembolism events (VTEs) were tracked before and after clinical surveillance implementation. The baseline rate

Table 2. Select Yearly Clinical Pharmacy Measures and Return on Investment

Year	2015	2016	2017	2018	2019	2020	2021
Hospitals, number	154	160	167	167	172	176	177
Drug therapy modifications, million (M)	1.9 M	2.7 M	3.1 M	3.2 M	3.9 M	3.9 M	4.1 M
Time to pharmacist high-priority alert response, hours	13.9	6.7	4.1	3.9	4.0	4.0	2.6

Return on investment (ROI)

Annual savings type	Measure	ROI
Alert intervention hard dollar savings	Drug spend reduction annually	1:6.7
High-cost drugs/ Financial resiliency	High-cost drugs (eg, alvimopan, calcitonin, epoetin)	1:0.4
Total		1:7.1
Harm prevention: soft dollar savings	Adverse drug event cost avoidance	1:5.4
	Venous thromboembolism cost avoidance	1:0.4
Total		1:5.8
Hard and soft dollar ROI grand total		1:12.9

for each implementation group was calculated separately and combined into the overall baseline rate. This combined baseline rate was then applied to the number of inpatients over the previous 4 quarters to determine the number of coded hospital-acquired ADEs and VTEs if the performance had not changed since baseline. The number of events that would have occurred minus the number that did occur resulted in the number of avoided ADEs and VTEs. The number of avoided ADEs was multiplied by the health system's marginal cost calculation adjusting for primary diagnosis, diagnosis-related group (DRG), and principal procedure in direct variable cost per case for all inpatients discharged with an ADE over 1 year. The same logic was applied for avoided VTEs.

Since 2015, the percentage of patients who are on a PPI or H2RA in the ICU with appropriate discontinuation of the medication upon patient transfer has tripled. Over the last 6 years, oral to IV dose ratio for opioids in medical/surgical units has increased by approximately 12%. Many measures have positively impacted appropriate antibiotic utilization. For example, the percentage of patients on vancomycin de-escalated by 3 days of therapy has increased by 12% since 2015 and the percentage of patients with a UTI treated with a fluoroquinolone decreased by 25% over the same period. As the health system antimicrobial management program matured, and during the COVID-19 pandemic, these measures were trended and determined strategic initiatives to judiciously use antimicrobial agents.

In addition to the scorecard, hospitals may access real-time data on various safety and productivity measures. For example, a hospital may use the technology to run a report by BCMA to determine how many inpatients received anticoagulation in the hospital and subsequently experienced a bleed. This information helps leaders ensure appropriate system prescribing practices and monitoring regimens exist. Examples of productivity measures collected in near real-time and quickly accessible for review and trending at the health system, regional, and hospital level include the number of consults completed, alerts acknowledged, medications converted from IV to oral, and medication histories completed.

Realized Value and Future Enhancements

One of the major advantages of the tool during the COVID-19 pandemic has been the nimbleness of customizing the technology to quickly meet the clinical needs of patients. For example, data were used to guide the appropriate use of high-cost medications such as tocilizumab and remdesivir. When the COVID-19 vaccine first received emergency use authorization (EUA), a screening tool was built to help identify patients who would not be candidates as outlined in the EUA, Centers for Disease Control and Prevention, and Advisory Committee on Immunization Practices recommendations. As recommendations evolved, the screening tool was adapted to keep frontline pharmacists focused on critical patient needs.

The technology has been used in other capacities to meet the needs of clinical pharmacists. Most recently, a pharmacy-led admission medication reconciliation program was launched in 17 hospitals. The tool helps medication history technicians and medication reconciliation pharmacists quickly identify patients 65 years of age and older who may have the following conditions: chronic obstructive pulmonary disorder (COPD), congestive heart failure (CHF), acute myocardial infarction, elective primary total hip or knee arthroplasty, coronary artery bypass graft surgery, stroke, pneumonia, and others that may be at a higher risk for readmission. These patients are prioritized to ensure a safe transition of care.

As discussed, clinical pharmacist surveillance technology has become an integrated tool in the clinical pharmacist workflow. Opportunities remain to customize the tool to prevent medication errors and improve patient care. Areas currently being explored include logic to identify Key Potentially Inappropriate Drugs in pediatrics, incorporation of the American Geriatric Society's Beers Criteria, identification of patients on medications with an increased fall risk, and enhanced alerts for goal-directed therapy in chronic disease states including CHF and COPD.[9,10]

Conclusion

Building a patient outcomes-directed pharmacy model has kept the guiding principle of "do no harm" at the forefront. Our health system successfully redesigned pharmacy services by integrating clinical pharmacy surveillance technology to focus on improving patient outcomes, and optimizing processes to enhance patient-centered care.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Dr Burgess is the Chief Operating Officer and Clinical Officer for VigiLanz, the clinical surveillance technology used by HCA Healthcare discussed in the manuscript.

Dr Kramer is a Clinical and Research Specialist for VigiLanz, the clinical surveillance technology used by HCA Healthcare discussed in the manuscript.

Drs Burgess, Warren, and Wiggins are employees of HCA Healthcare Management Services and Dr Kramer is a retired employee of Clinical Sevices Group, HCA Healthcare, an organization affiliated with the journal's publisher.

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