Context Sensitive Health Informatics and the Pandemic Boost
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Navigating Infection Control Processes in a COVID-19 Only Safety-Net Hospital at the Height of the Pandemic

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Abstract. Hospitals faced extraordinary challenges during the pandemic. Some of these were directly related to patient care—expanding capacities, adjusting services, and using new knowledge to save lives in a dynamically changing situation. Other challenges were regulatory. The COVID-19 pandemic significantly disrupted routine hospital infection control practices. We report the results of an interview study with 13 individuals associated with infection control in a small independent hospital. We employed the Systems Engineering Initiative for Patient Safety (SEIPS) model as a theoretical framework and as a basis to analyze data. The findings revealed how routine practices and protocols were displaced in notable ways. Due to COVID-19, clinical activities were modified, and the increased demands of regulatory reporting became laborious, and punitive if reports were late. Strategies are needed to mitigate increases in healthcare-associated infections. Our examination of the information flows, transformation, and needs shows areas in which digital tool creation and the use of a trained informatics workforce could ameliorate and automate many processes.

Keywords. clinical information systems, COVID-19, qualitative methods, workflow

1. Introduction

COVID-19 has revealed vulnerabilities across the US healthcare system regarding its ability to provide effective disaster medicine and maintain system resilience. In the first phase of the pandemic, New York City was the epicenter of the pandemic overtaxing many hospitals with an onslaught of severely ill patients suffering from a poorly understood disease. The University Hospital of Brooklyn (UHB) at SUNY Downstate Health Sciences University is a tertiary care academic medical center and safety-net hospital serving central Brooklyn, an area that was particularly hard hit by the first phase of the pandemic [1]. In early June 2020, the death rate in the catchment area was 2.9 deaths per thousand, 62% greater than the NYC average, and a positivity rate of 40% [1]. Early in the pandemic, UHB was designated as a COVID-19 only treatment facility.

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Certain institutions have been able to marshal their substantial strengths and expertise to bring informatics solutions to optimize hospital responses [2]. Leveraging information technologies including electronic health records (EHR) to support data acquisition, aggregation and use are essential to every aspect of the response COVID-19 [2]. However, many safety-net hospitals such as UHB may not have the resources or human power to develop the much-needed real-time data-driven solutions and automated reporting capabilities. The paper presented here is part of a multi-institutional collaborative research program to examine local COVID-19 response through the lens of hospital resilience, decision-making, and human factors engineering at a lower-resource, but highly impacted COVID-19 safety-net hospital. The overall objective of the proposed research is to develop an evidence-based approach to supporting emergency management disaster response workflow, specifically HIT-mediated workflow. The first phase of the project addressed a critical barrier to effective pandemic response by (1) identifying information and data needs of local hospital decision-makers and (2) characterizing workflow around decision-making tasks.

2. Methods

We interviewed 52 people, including 33 at UHB, 16 at a larger-networked hospital, and 3 with two external agencies as part of a larger study. Interviews were conducted with hospital leadership, clinical directors, and a wide range of hospital personnel. Interviews typically lasted about 60 minutes and were conducted using Zoom. Questions focused on decisions, work activities, and tasks associated with each activity, and resources used to accomplish those tasks, as well as on institutional goals and challenges during the pandemic. Interviews were transcribed and coded using MAXQDA™ qualitative analysis software, by a total of five coders (working on different transcripts). Coding was reviewed by an independent coder for consistency and iteratively revised.

Table 1. Select concepts from the SEIPS 2.0 models for interview coding.

Concept	Definition
Work System	
Person	Identified persons involved in tasks or processes. Expanded to include hospital departments and units acting as a singular structure.
Organization	Teamwork, coordination, collaboration, and communication; organizational culture and patient safety culture.
Technologies/Tools	EHRs, computerized provider order entry and bar coding medication administration; medical devices; other technologies and tools; human factors characteristics of technologies and tools.
Tasks	Tasks performed, task demands (e.g., workload, time pressure, cognitive load, need for attention).
Internal Environment	Matters specific to the institution.
External Environment	Macro-level societal, economic, ecological, and policy factors outside an organization.
Outcomes	
Patient	Patient safety; quality of care.
Professional	Job satisfaction, stress and burnout; employee safety and health.
Organizational	Turnover; attrition, culture; ability to provide care; overall staffing and supplies management.
Other Codes	
Adaptation	Anticipated/unanticipated, short/long lasting, periodicity.
Barriers	Any challenges, obstacles, or impediments to workflow.
Time	Schedules, deadlines, and temporal processes.

We employed the Systems Engineering Initiative for Patient Safety (SEIPS) model as a theoretical framework and as a basis to analyze data [3,4]. Once interviews were conducted, they were transcribed, cleaned, and coded using a schema based on the SEIPS 2.0 models (Table 1) [3]. Additional concepts were added as needed to capture matters specific to this context. In addition to the coded concepts, we identified 20 domains that were focal to the interviews and the pandemic effort. The domains include departments including emergency management, respiratory therapy, infection control, and supplies and personal protective equipment (PPE). It also includes entities that emerged in response such as contact tracing and vaccination. The focus in this paper is on infection control and we present an analysis of the 13 interviews most focally related to this topic.

3. Results

The results describe the analysis of interviews pertaining to infection control and vaccination workflow. A total of 13 interviews predominantly focused on infection control processes.

Table 2. Illustrative quotes.

Routine Practice	*Surveillance is a big part of what we do for device associated infections like central line bloodstream infection, multi-drug resistant and we report surgical site infections. There are processes in place to mitigate those outcomes.* (Interim Director of Infection Control)
Routine Practice	*The infection control director usually has a team of about three, depending on the size of the hospital, three or four infection preventionists, and their responsibility in general is to monitor the institution, develop rather data, do data collection on a regular basis to assess the infection rate in the hospital make sure policies are up to date and comport with industry standards in the public health sector.* (Hospital Epidemiologist)
Routine Practice	*The short version of what we do is to implement transmission-based precautions to prevent the spread of pathogens within the healthcare setting. Essentially, we look at the pathogen and we look at how it's transmitted, and we then follow the CDC guidelines for the type of transmission-based precautions, be it contact, droplet, airborne, or any combination of those.* (Infection Preventionist)
Post-COVID Practice	*Nobody's analyzing the cases as they come into the hospital. What's their O2 stat in an aggregated way? How sick or they? Are they having fevers? Are they getting discharged? How long has it taken for them to be discharged? I would be really interested in that sort of thing to understand the complexion of the epidemic.* (Infectious Disease Leadership)
Post-COVID Practice	*We have an additional part of it that has to do with reporting that as well, because infection don't go away because of COVID. With COVID, we're reporting exposures, we have to isolate the patients, we have to monitor for the staff any sick calls, anyone that called out sick, anyone that tested positive, we have to do that in addition to report into the state, so it's gotten bigger.* (Interim Director of Infection Control)
Barriers & Adaptations	*I'm talking about central line-associated bloodstream infections, CLABSI, C. Difficile infections, all of MRSA, all of that was driven by the corrective actions and the pushing of those measures to have no bloodstream infections, no catheter-associated blood infections. All of that was being driven by infection control to start, and then we had the pandemic where we had shortages, PPEs and real infection control issues, then on top of that, we had all of this reporting that we had to do.* (Assistant Vice President in charge of regulatory affairs and risk management)
Barriers & Adaptations	*Yes, I would even say that it's inappropriate for an infection preventionist to be spending time every day doing [reporting], they're supposed to be on the floors with the clinical staff making observations about hand hygiene, checking devices, urinary catheters and central lines, and they're supposed to be out there on the units, not sitting at their offices.* (Assistant VP in charge of regulatory affairs and risk management)

Fifty-two segments (each being a few sentences in length) were coded as infection control and linked to information gathering, information reporting, and government concepts. Routine infection control practices were elaborate, complex, and well-planned before the pandemic. The pandemic impacted infection control, creating barriers and necessitating adaptations. COVID-19 not only transformed clinical activities but increased demands of public health regulatory reporting which was the most common theme to emerge. The hospital supported limited data extraction activities. The reporting burden incorporated significant manual information gathering and manual data entry for each patient. Infection preventionists submitted manual reports via phone, email, fax, and employed information that was populated in Excel spreadsheets. The manual effort coupled with PPE/Supplies shortages, created onerous working conditions. The illustrative quotes in Table 2 reflect shifting responsibilities, processes, and burdens associated with reporting and other workflow challenges.

4. Discussion

The pandemic placed a great burden on healthcare institutions throughout the world. UHB is notable for the heroic efforts to coordinate its response to the pandemic while at the heart of the NYC outbreak, and as a specially designated COVID-19-only hospital. Manual data gathering, group huddles coordinated around slides and Excel spreadsheets, reformulation of personnel duties and education for expanded roles were all critical. Our examination of the information flows, transformation, and needs shows many areas in which digital tool creation and the use of a trained informatics workforce could ameliorate and automate many processes. al to the success of the response and the expansion in capacity characteristic of resilience. We can conceptualize the work system into eight subsystems constituted by technologies and groups of individuals. Of particular importance is the outbreak management subsystem including activities for containing the outbreak and surveillance subsystem including internal monitoring of patient census and external monitoring of population trends. Manual extraction and compiling of data from the EMR and other systems took hours of clinical staff time per day, staff time that could otherwise have been used in clinical care or rest. It's been almost three years since the height of the pandemic. In many respects, the hospital workflow has returned to normal, albeit the staffing shortage is now more acute. However, the reporting burden has not been alleviated and it disproportionately impacts infection control. There are significant institutional inequities especially in relation to HIT that impact smaller hospitals' ability to respond to a pandemic and adequately support public health efforts.

Hospital infection control programs play an integral role in the prevention of healthcare associated infections (HAIs) and antimicrobial resistance, both of which continue to grow at alarming rates and are associated with increased risks to patients and economic burden. Active surveillance and the implementation of infection control practices can mitigate and prevent HAIs [5]. Solution strategies can be devised to target subsystems to improve workflow. The hospital is undergoing a significant upgrade to their IT systems which is scheduled to be completed in June 2023. This should have an impact on improving interoperability and providing additional tools for automated reporting. We are exploring a range of options in collaboration with the emergency response management team to improve access to decision-making tools, leveraging dashboards to provide just-in-time information and promote situation awareness. It is

possible that small tractable informatics solutions can yield substantial results in improving pandemic workflow.

5. Conclusions

The challenges faced during the pandemic highlight the importance of routine practices and the integral role of infection control in a hospital, which should be reinforced to prepare for future public health emergencies. Improved interoperability, data extraction and automated reporting is critical to reducing barriers to sustain infection control practices.

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