COMMENTARY

Learning Systems: Managing Uncertainty in the New Normal of Covid-19

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The uncertainty surrounding the first phase of the Covid-19 pandemic in the United Kingdom required health care organizations to learn quickly and act as fast as possible. At the NHS Nightingale Hospital London (a temporary facility to provide expanded capacity set up inside a conference center), we built structures and processes into the operating model that supported learning activities designed to bring the best knowledge to every bedside, and to improve the patient and staff experience day by day. New approaches and changes to standard processes were put into practice using multiple channels, including a novel staff role, the Bedside Learning Coordinator, to both source ideas for improvements in clinical practice and to communicate changes to staff at the bedside. The basic architecture of Nightingale's learning system is applicable to any health care delivery organization and could help providers address both the challenges associated with the novel coronavirus pandemic, and of managing care systems in normal conditions.

The National Health Service (NHS) is not typically known for rapid decision-making. But as the Covid-19 pandemic set upon the United Kingdom, NHS institutions responded swiftly to address the pace and uncertainties associated with a novel disease. The pandemic has been characterized by both high degrees of uncertainty and the rapid evolution of our understanding on multiple dimensions including the pathophysiology and management of Covid-19, the critical interdependencies of our supply chains, and the optimal organization our services. In response, frontline staff were empowered, bureaucracy was reduced, access to senior leaders was made easier, and decision-making was rapid. Teams could not wait for all the information they would like but had to make quick decisions using the best information at the time and change course as new information became available.

At the NHS Nightingale Hospital London, a temporary facility set up to provide expanded capacity for hundreds of ventilated patients, additional challenges were conferred by the institution's pace (built in 9 days and opened April 3, 2020), scale (500 ventilated beds and room for 3,500 more beds), and location (in a conference center). These factors necessitated acknowledging the extensive *unknowns* in the pandemic and deliberately creating a system that gave structure to this new way of working by learning rapidly and putting that learning into action quickly and accurately. We report here on the architecture of the learning system built into the Nightingale operating model and propose that its design could inform the way that other NHS organizations, and providers internationally, transition to the next phase of the pandemic and plan how they will operate in the future.

What is a Learning System?

The term *learning system* has been applied at both the system level (to describe the analysis of aggregate patient data looking for opportunities for improvement[1]) and organizational level (to describe organizational structures, processes, and culture that promote internal learning[2]). Organizational learning systems have several notable design features. They focus on learning from internal experience and study as much as from external published research, and are interested in both problems relating to the design of their product or service and to the effectiveness with which the design is implemented. They integrate qualitative and quantitative data from multiple sources to solve problems in design and execution, and test and modify new approaches rapidly in order to put insight into action. Most important, the ability to learn is embedded in the organization's structure and internal processes at every level, and reinforced through the culture and behavior of staff, including what leaders say and do.

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Few health care delivery organizations are structured as learning systems. Training and accreditation processes primarily focus on individual learning and the model of *evidence-based medicine* is based on the presumption that new knowledge is created through research and implemented into practice by delivery organizations, in part because health care's evidential standards favor randomization and large samples.
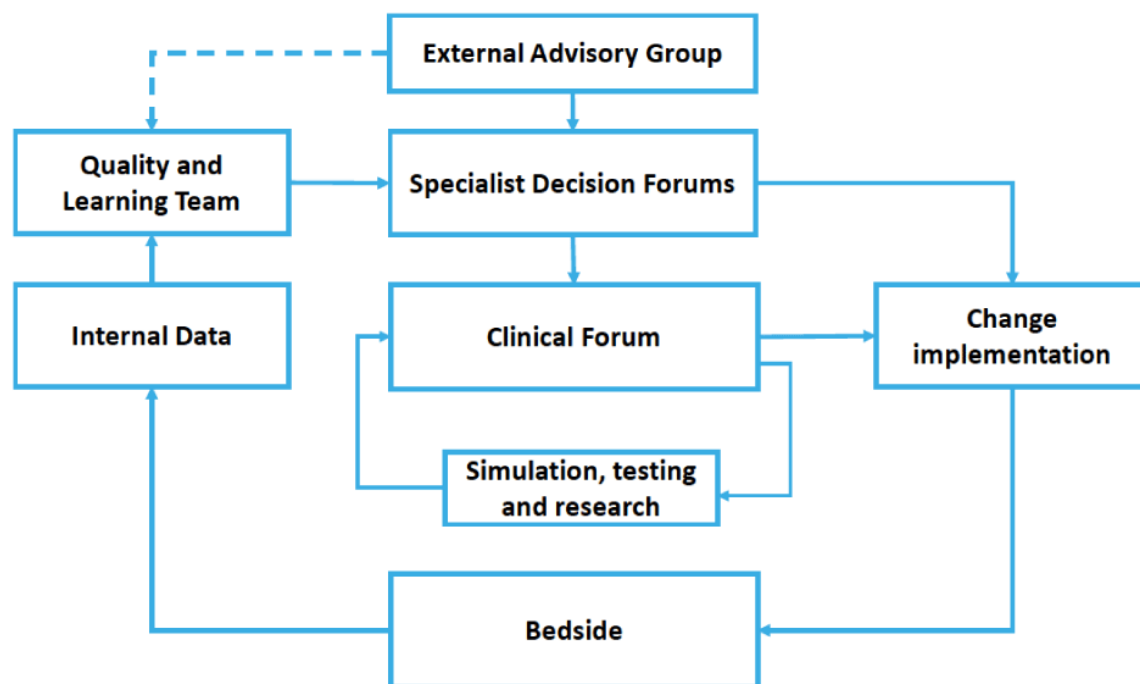
The design of a learning system for the Nightingale not only had to accommodate the rapid pace at which medical evidence was evolving and cope with the onslaught of rumor, unconfirmed hypotheses, and anecdotes delivered daily via social media, but also had to address several practical problems in getting data from, and returning change to, the bedside. For example, the electronic record was limited in scope, writing was difficult when wearing full personal protective equipment, and infection control requirements meant that no paper could leave the ward. Furthermore, the staff was made up of those sent on a temporary basis from Intensive Care Units (ICUs) from various organizations all over London and volunteers with and without clinical

training, with many confronted by unfamiliar equipment and clinical routines. Some of these problems were unique to the Nightingale because of its rapid build, temporary design, and the physical constraints of providing care in a conference center, and others were specific to managing a pandemic. But the Nightingale also faced constraints common to "peace time" health care organizations that have often struggled to learn rapidly in the face of bureaucratic decision-making processes. Figure 1 represents the ultimate design of the Nightingale learning system.

FIGURE 1

The Learning System at NHS Nightingale Hospital London

The learning system components and structure were created to facilitate rapid analysis of internal and external experience of treating Covid-19 and the implementation and assessment of changes. From start to finish, discrete problems could be identified and addressed on a 24-hour cycle.

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Components of the Nightingale Learning System

Structural and process components of the Nightingale learning system were designed to do five things: create a rich data stream, analyze and test insights, make redesign decisions, rapidly implement planned changes, and close the loop by checking reliability and effectiveness.[3]

Table 1.

Data Source	Type of information	Time frame
Incidents	Details of incidents reported: categorized into low or medium harm, or near-miss, including the time, date, and location of the incident, and detailed account from the reporting staff member	Daily, immediate notification for medium-harm or near-miss
Bedside Learning Coordinator	Observations from the floor of areas for improvement: directly observed and/or recommended by staff during a shift	Daily
Staff survey	Staff responses to an anonymous survey after the shift: focus on whether they felt safe, supported, and physically and mentally able to do their shift	Daily
Staff suggestions	Staff recommendations for improvements: via suggestion cards at staff debrief areas or through an app	Daily
Clinical forum	Recommendations and reflections raised by staff during the daily 4pm meeting that are additional to those captured in formal data channels	Daily
Hospital performance dashboard	Performance metrics across patient activity, incident reports, staff sickness and staffing levels (from the staff rostering data)	Weekly, with daily metrics for patient numbers and staffing
External evidence	Review and synthesis of the published literature, national audit data, and reported critical care experience from national and international clinicians, distilled into 2–3 pages of key points relevant to the unit	Weekly and on request for specific topics
Clinical audit	Patient outcomes and clinical care data reported for the unit and, benchmarked against patients with the outcomes from other similar patients, and other similar units' clinical audits, through participation in the national audit program: Intensive Care National Audit and Research Centre (ICNARC)	Weekly
Mortality reviews	Structured review of patient deaths, including case notes review, to identify areas for improvement	Ad hoc
Complaints	Notification of reported complaints, either from family or patients or from staff; these are incorporated into the 24-hour incident reporting cycle.	Ad hoc

Data and insights flowed into the learning system from multiple sources, some internal and others external to the Nightingale Hospital London. Source: The authors

Data collection

A small Quality and Learning team with expertise in innovation, improvement and governance received inputs from multiple data sources (Table 1).

Some data — incident reports and clinical audit data — were entered directly into the electronic record and addressed through standard governance systems inherited from the parent organization. However, we were equally concerned to capture qualitative data from staff: their insights into better ways of delivering care under difficult circumstances, personal reports of their own physical and psychological wellbeing, and their observations of patterns in the novel disease. Research suggests staff routinely keep such insights to themselves, only rarely elevating them to a point in the organization at which generalizable solutions can be developed.[4] Thus, to capture this harder-to-access data, we created a new role, the Bedside Learning Coordinator. BLC staff, who were rostered on the same shift pattern as the nursing teams, were drawn from many disciplines including nurses, allied health professionals, doctors, and pharmacists. They engaged with staff as they went about their work asking questions about what was going well or badly and used a structured data collection form to record perspectives, ideas, safety concerns, and observations, and occasionally provided assistance. All staff could also use a commercially available app to both report their experience on each shift and log their suggestions for improvement. Finally, staff debriefed at the end of their shifts as they were leaving the contaminated zone and were also provided with feedback forms. This data collection was part of a wider set of interventions designed to maximize both psychological and physical staff welfare at Nightingale.[5]

Table 2.

Category	Definition	Example
Fix	Resolve problems in reliably doing what we said we would do. These were usually issues that could be resolved with rapid operational changes.	Installing mirrors into the donning area to improve the safety and reliability of donning, particularly for non-clinical staff. Ensuring contact telephone numbers were correct and prominently displayed on the ward. Ensuring adequate stock levels and visible storage of drugs and key supplies.
Improve	Find better ways of delivering standard care; improve what is currently being done.	Introducing a Day Zero simulation training day ahead of individuals' first shifts to improve readiness of staff for the floor and clinical environment (staff came from different hospitals, clinics, or organizations that had different ways of working and different equipment). Streamlining the donning process at shift handover: reduce the time for staff to put on PPE and ensure PPE correctly worn before entering the clinical area.
Change	Significant changes in clinical or operational practice.	The adoption of a venous thromboembolism (VTE) protocol based on United Kingdom ICU consultant consensus. Developing the extubation protocol.

When a challenge arose, the Quality and Learning Team would define the problem by synthesis across relevant data sources, then categorize and triage the problem. Next, the appropriate Specialist Decision Forum would review and either decide on a change to be implemented or pass along to the daily Clinical Forum for a decision on a change or, if appropriate, to designate for simulation, testing, and research. Source: The authors

These internally sourced data were complemented with external insights. To accommodate the rapidly developing international and local experience, and to address the volume and variable quality of external reports, we partnered with UCLPartners (UCLP), a partnership of academic and clinical research centers and NHS organizations that works with industry and others to harness research and innovation for better patient care and a healthier population. UCLP both served as an external clinical academic advisory group and provided a weekly review and synthesis of the published literature, national audit data, and reported critical care experience from national and international clinicians.

Analysis

Data were collated and evaluated by the Quality and Learning team, which included the Clinical Governance group. Although reportable incidents were addressed individually, they were also triangulated with the BLC data and staff reports to look for common themes and patterns. Responses to problems identified were triaged into three categories: fix, improve, and change (Table 2).

Most fixes needed little or no further evaluation and testing: They were passed directly to the operations and nursing groups for immediate implementation. Improvements and changes were subject to further testing and peer review by one of the four specialist decision forums (operations, nursing, workforce, and medical) that met daily or every two days. Items were tracked while they remained open and until a reliable solution had been successfully implemented or agreed that no change was needed.

Decision-making

A daily *Clinical Forum* with multi-professional attendance across clinical, operational, and workforce teams gave a rhythm to the hospital management system. It encouraged learning and

change by making leadership accessible and facilitating rapid collaborative decision-making. It focused on areas for cross-team collaboration and was the setting in which changes and improvements were recommended, discussed, and actioned. These included all changes and any fixes and improvements that might require cross-disciplinary coordination. The operations, clinical, and workforce sub-groups could act directly or process relevant issues before they were brought to the Clinical Forum for discussion as appropriate, or to highlight that they had been successfully addressed, but to support a learning culture anyone was permitted to raise a new issue at the Forum. Most improvements and changes were agreed immediately, but some issues were assigned a task and finish group, or returned to the originating sub-group or recommending staff group for further evaluation (key fixes that had already been implemented were brought as *for your information* updates). In this way the new insights that drove improvements and solutions to problems were put into action at the bedside within a matter of days (Figure 2).

FIGURE 2

The Daily Rhythm of the Learning System: Change Delivered at Pace

A total of 366 items were raised and actioned on the Quality and Learning tracker during the time the hospital was operational. Given the start-up nature of the hospital, more than half were fast-turnaround fixes. Over time we would expect there to be fewer "fixes" as new operational systems stabilized and the focus to shift to "improvements" and "changes," which are likely to take longer to test, implement, and audit than the rapid turnaround witnessed for fixes at NHS Nightingale Hospital London.

Total number of items added to the NHS Nightingale Hospital London tracker by category from April 13 to May 1, 2020, and percentage of total items by category.

Change
3%
11

Improve
42%
152

Total
366

Fix
55%
203
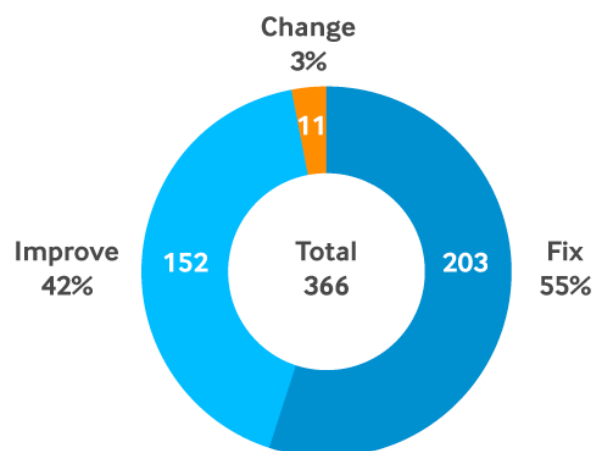
Source: The Authors
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Implementation into action at the bedside

Health care is notorious for its slow pace and unreliability of innovation adoption[6] and a key challenge in any learning system is getting change into practice as soon as possible. By design, the Nightingale learning system included multiple channels for communicating and implementing change. Although the paper-based and electronic clinical protocols and operational standard operating procedures could be quickly updated, most of the effort focused on ensuring that staff were made aware of revised procedures or protocols. Education and communication processes were also the subject of learning and testing as keeping pace with the rate of change and ensuring consistency of messaging remained challenging.

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Because of the rapid pace of change and the expected turnover of staff loaned to the hospital for only a finite period, communication was vital to ensure that everyone was aware of the changes being made. Once new processes were approved by the Clinical Forum, the Education and Training team updated the Nightingale's training programs, including the new staff induction program and the *Day Zero* simulation that staff underwent before starting their first shift to prepare them for work on the ward. The on-going education provided for existing staff on the ward during the shift was also updated. Notifications were sent to some staff groups via email and WhatsApp groups, and placed on electronic message boards throughout the convention center and at the entry to the ward. Changes were highlighted during the pre-shift huddle and briefings and SOPs were updated at each bed and updates were highlighted on the intranet. To help staff stay abreast of frequent operational and clinical changes, the BLCs also alerted individual staff members at the bedside to any significant changes as appropriate, and checked staff understanding.

Closure: checking reliability and effectiveness

Finally, a common complaint from staff who are asked to participate in change programs is that although they provide many suggestions for improvements, they don't see changes happening as a result. To address this, staff using the mobile phone app were sent messages when their suggestions had been actioned, and *we said, we did* boards were placed at the entrance to the ward and were updated regularly. BLCs undertook *ad hoc* audits to confirm that changes had been successfully implemented and were having their desired impact and these audit results were presented back to the daily Clinical Forum. For example, a VTE prophylaxis protocol based on insights from the UK ICU community was reviewed by the medical group, recommended for immediate implementation, and then its implementation was tracked. Witnessing the changes on the floor was seen as a powerful motivator for staff to continue to reflect and feed in recommendations to the BLCs and other data sources.

Together, these five components enabled a high level of reporting of problems and incidents. The incident reporting rate at the Nightingale was four-fold higher than at other ITUs in the institution's parent system, and the majority of the 142 incidents recorded over four weeks of operation were low or no harm (97%). The incident rate fell steadily over time, potentially due to the proactive approach to problem solving and learning.

The learning system also engaged staff in improvement without specific training or reference to a formal improvement methodology. In exit interviews, staff reported feeling encouraged to challenge, learn, and change, which enabled them to achieve a rapid turnaround of ideas and actions. Many saw this relentless dissatisfaction with the status quo that the learning system encouraged as a unique characteristic of Nightingale, and a necessary one, because further improvement is always possible.

Embedding Learning Systems into the "New Normal"

NHS delivery organizations already have in place many of the learning system elements described above. What we had the opportunity to do at Nightingale London was knit these together into a closed loop system and to embed them in the institution's organizational structure, daily routines, and the cultural ethos of the staff so that learning became integrated into everyone's work, not simply the activity of one department. Many of the specific tactics we chose to create as a closed loop system were a function of the constraints we faced in the convention center environment or of the opportunity to develop from a relatively blank sheet of paper. Other institutions wishing to create a learning system will have to select their own preferred mechanisms for creating a data flow, searching for patterns and evaluating hypotheses, making design decisions, implementing changes in a more well-established organization, and checking on implementation success and final impact. What is likely most transferrable from the Nightingale example is the learning system's architecture, not the specific implementation tactics.

Learning activities are much more likely to occur in the context of a supportive culture that encourages speaking up, welcomes different points of view, and tolerates experimental failure.[7] Staff willingness to make change depends in part on their confidence in their ability to make corrections should the change not deliver what was intended. Learning behaviors, and the beliefs that underlie them, were reinforced both by organizational structures and daily routines and by such leadership behaviors as openly admitting to uncertainty, publicly seeking others' input, and making data and decision-making processes transparent so that staff can see the fruits of their labors and be convinced that they genuinely have the power to make positive change.

> " *A learning system only functions and supports the necessary learning culture when it is a system not simply an unconnected set of components."*

However, a learning system only functions and supports the necessary learning culture when it is a *system* not simply an unconnected set of components. Although it would be tempting to adopt the

most obvious components, for example the BLC role or the Clinical Forum, it was the interactions among the components that made the system effective. The performance of an individual component may disappoint if it is unsupported by the rest of the system. The alignment of the culture with learning at the Nightingale was enhanced by the wide distribution of the day-to-day work of running the learning processes to all the other functions. The Quality and Learning team itself was small — 4 FTEs — and much of its work was the coordination of the activities of others.

The learning system at the Nightingale touched every aspect of the hospital's management: Operations, workforce, training and education, supply management, diagnostic services, nursing, therapies, and medicine all undertook the work of running the learning system, and felt its impact. To some degree, the learning system became the way the institution as a whole was managed because the model integrated learning with clinical and managerial governance.

What then might our experience mean for care delivery organizations as the extraordinary pandemic-related measures dissipate? Is the learning system we employed for a short time at the Nightingale a model only for emergency responses, or does it have broader applicability? Although the first wave of the pandemic is passing, the uncertainty persists, both about the disease itself and about the optimal organization of services that can address the backlog in care while at the same time accommodating the new demands of infection control and sustaining innovations in the way care is delivered. And in dealing with care for which there is little track record, the nimble nature and rapid decision-making of the learning system represents a valuable tool. But the need for learning, both clinically and operationally, is universal and remains essential: not just regarding Covid-19 but also about how to structure and manage care systems in the future. Learning can happen on any scale and at any level in the system — from providers to individual departments to integrated care systems and partnerships. While we built a learning system in an intensive care unit, Intermountain Healthcare based in Salt Lake City has applied similar principles in a system made up of 24 hospitals.[3] The challenge that NHS and other organizations face now is to configure their existing structures, operational processes, and skill sets into a closed loop learning system that can detect, analyze, and act. Repositioning and repurposing traditional functions such as governance, audit, training and education, research, and external insights may support this. Each organization will need to choose its own way of developing its learning system. But, while the system architecture outlined here can guide them, the process must begin by admitting to ourselves that we still to have much to learn.

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