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Improvement Brief

Rapid Development and Deployment of a Learning Management System to Train an Interprofessional Team to Manage Surgery for a COVID-19–Positive Patient

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Background: When the COVID-19 pandemic struck, surgical services had to design and implement a new system to safely manage patients and prevent workforce exposure.

Methods: A team of clinicians and educators rapidly reengineered the surgical care process. An online learning management system (LMS) and authoring tool that supported iterative remote asynchronous communication was used to build a learning module employed to train an interprofessional team to the new care process.

Results: Care process redesign was accomplished in a concentrated effort involving clinicians and educators. Patient flow and the role of each team member at every phase of care was presented in the LMS. The LMS was refined by input from team members provided through the authoring tool directly to the educator on the screens where the edit was applicable. The LMS was deployed after four days to manage their first COVID-19 patient two days later. The number of COVID-19 patients managed was limited, but there were no untoward patient events and no staff exposure.

Conclusion: Care process reengineering and deployment efforts are accelerated by early involvement of educators and use of an LMS with an authoring tool that supports rapid module build and refinement in a socially distant workplace. The LMS enables access on any online platform at a time convenient to the team members who can then learn at their own pace. This reengineering and LMS development approach can be generally applied to speed many care process modification and improvement efforts.

The reengineering and implementation of a new care process is difficult and time consuming. It is particularly difficult when it must be done rapidly, involves an entire interprofessional team, and is constrained by infection control and social-distancing requirements. When the COVID-19 pandemic struck, surgical services stopped all but emergent and urgent cases and had to design and implement a system to safely manage COVID-19–positive patients and patients under investigation (PUIs). In this article, we describe how a multidisciplinary team of clinicians and medical educators restructured a care process, developed a learning management tool, and rapidly deployed it to train the entire surgical team. The methodologies employed and lessons learned have the potential to shorten the time cycle and improve the development and deployment of future care process reengineering efforts.

This report also provides a link enabling others to use the learning management system (LMS) to prepare their surgical team to manage a COVID-19 patient safely through an operation.

Designing the Care Process and Identifying Individual Roles

Surgical Services leadership was instructed by the Hospital Incident Command System to institute the new care process in 4 days. The task group assigned to the job included the operating room (OR) manager, the perioperative manager, and the clinical leaders of anesthesia and surgery, as well as surgical nursing educators. The group was guided by expertise from hospital infection control. The curriculum design program manager of the Department of Medical Education, who has expertise in LMS development, participated from the outset.

The task group started with an existing safe surgery protocol and modified it to address infection control requirements, resource constraints, and the mandate to minimize overall exposure risk to personnel.

Surgery teams have used checklists and safe surgery protocols modeled on the World Health Organization Surgical

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Safety Checklist for years to provide a safe operation and quality patient experience. These protocols provide a high-level description of what the team needs to accomplish as the patient progresses through the phases of care from preoperative, operative, and postoperative to discharge. Institutions use the framework provided by these protocols to define the roles of individuals at each step of the process. The protocols also describe communication that needs to occur between team members, such as briefings, time-outs, and debriefings, to ensure safe care and ongoing care improvement.

The existing safe surgery protocol was not designed to manage exposure to a virus spread by airborne mechanisms and had to be modified to address the required infection control precautions. Policies previously developed for managing the airborne spread of tuberculosis were available for reference. Infection control guidance recommended the use of a negative pressure suite (NPS) for procedures that risked aerosolization of airway secretions, including intubation and extubation. An NPS was situated adjacent to the ORs, and the decision was made to use it for intubation before moving to the positive-pressure OR and for extubation if performed in the immediate postoperative period. The existing protocol also had to be modified to address case scheduling changes, the process for assembly and briefing of the operative and perioperative teams, and the process for preparing the NPS and OR suites for COVID-19 patient care. The various roles of personnel in this new flow then had to be defined.

The task group assembled and, while maintaining appropriate interpersonal distances, mapped the care process, shown in Figure 1. Group members then worked together to define the role of each care provider at each step in the care process, as well as communication requirements between providers. When the role descriptions were drafted, walk-throughs in the actual facilities with frontline personnel were conducted and the role descriptions were refined. In addition to roles, the personal protective equipment (PPE) requirements were defined for each phase and for each individual. The team briefing was emphasized to ensure that all were aware of the plan and their role. Team debriefings were equally emphasized to support cohesion and identify opportunities for improvement. The patient flow and individual role descriptions were reviewed and approved by the hospital infection control specialist and the Hospital Incident Command System.

THE LEARNING MANAGEMENT SYSTEM

After the task group defined the care process and individual roles, all personnel had to be expeditiously trained so that they would be prepared to safely care for any COVID-19-positive patient who needed urgent or emergent surgery. Each member of the surgical team needed to understand their individual responsibilities and the overall flow of the patient through the new care process.

Time constraints and social distancing requirements would not permit the usual educational approach of delivering content in a large group assembly followed by training simulations and walk-throughs. Training logistics were further complicated by intermittent deployment of daytime and off-hours operative and perioperative staff to COVID-19 surge preparation and care roles that rendered them unavailable for the usual educational forums.

The task group chose to employ an online LMS because it could be accessed from anywhere at any time, thereby addressing the above-mentioned training constraints. Development of the training module was an asynchronous iterative process involving the curriculum designer, nursing educator, and surgeon, who worked remote from one another.

The development team used Canvas LMS (Instructure Inc., Salt Lake City) to host its training tool. Canvas includes basic LMS functionality for managing enrollments, sharing documents, submitting assignments, and assigning grades, as well as personalized features for individual students. The training tool itself was developed by the curriculum designer using Articulate Storyline 360 (Articulate Global Inc., New York City), an e-learning authoring software platform that allows for customized and interactive asynchronous learning experiences. The Articulate Storyline 360 platform includes a review function, Review 360, which allowed the development team to review the learning system function and content and place suggested edits directly at the applicable site in the system. The Review 360 feature was used extensively and enabled rapid feedback collection and publication of updated versions of the training tool.

Figure 1 is a view of the initial page of the program. Along with displaying the flow of a patient through the care process, it lists the individual care team members across the bottom. When a team member selects the button corresponding to their role, they are presented with a listing of their assigned tasks at all steps in the process. Team members are also able to highlight a specific step in the flow and then select the button(s) corresponding to their own role to see their PPE requirements and assigned tasks in that step. Figure 2 depicts the display offered when a circulating nurse highlights the OR Intra-Op step to see their role.

Readers may access and explore the training tool at the following link. No sign-in is required: https://mmc.instructure.com/courses/315.

SYSTEM DEPLOYMENT AND TRAINING

The first draft of the LMS module was distributed to leadership and select frontline staff for review. This was accomplished by providing a link in an e-mail and removing any requirement for login to the system. Feedback resulted in
Figure 1: Shown here is the initial page of the learning management system (LMS) used to train the team on the new care process.

Figure 2: The learning management system (LMS) page shown here details the personal protective equipment (PPE) and care process pertinent to the circulating nurse during the intraoperative phase of care.

Changes to tasks assigned to numerous individuals. The system was updated to reflect those changes that same evening employing the review function. The next day, the link was provided to all members of the care team by e-mail. We subsequently placed an icon linking to the LMS on each desktop in the operative and perioperative areas. Use of that link would always lead users to the most up-to-date LMS so that there were no issues with version control. The on-call team members assigned to manage COVID-19–positive or PUI patients were reminded to review their roles at each morning huddle. We did not initially institute the features of the LMS that measured activity or tracked individual trainee use. The decision to drop the requirement for login to facilitate dissemination precluded individual tracking. We subsequently instituted use measurement and noted 391 interactions, about 50% of which occurred in association with use during the second wave of COVID-19. Nursing and tech staff used the LMS proportionally more than did physicians. Physicians accessed the LMS, printed the display of their roles, and posted it in the provider workrooms. Online review by the physician group increased when they realized that posted documents were not the latest versions, but their use was never as robust as other team members. Deployment of the reengineered care process and rollout of the LMS training system was accomplished in four days, and the first PUI case managed two days later. Initial case
deb briefings noted some confusion and minor educational deficiencies, particularly regarding PPE, but there were no significant protocol violations and no staff exposure. Subsequent deb briefings revealed less care process confusion. An operative and perioperative staff of approximately 100 individuals managed six PUI or COVID-19–positive patients over the next four months without a major protocol violation or exposure. No staff became COVID-19 positive during this period. COVID-19 prevalence was low in our region during the first phase of the disease (February–May 2020), and actual case management was a low-frequency, high-risk event to which team members did not become accustomed. The availability of the LMS training system allowed for review in association with the occasional case and thus proved to be a valuable asset in this setting.

**DISCUSSION**

The reengineering of care processes to improve efficiency and safety or adapt to new circumstances is one of the basic competencies of a high-performing and reliable health care team. It is an endeavor, however, that is not easily accomplished. Even mature, well-resourced teams employing rapid-cycle change methodologies have to exert substantial time and effort to redesign care and implement changes. That time and effort is difficult to muster, as process redesign and change implementation routinely compete with the multiple educational needs of a team managing a busy clinical schedule. Methodologies and technologies that make care process improvement more efficient and effective, therefore, have tangible value. In this report, we describe a project that employed standard improvement techniques and learning management software. There is nothing unique about their use, but there were several approaches that fostered speed and addressed the complexity inherent in interprofessional team activity and education that are worth sharing for their general applicability. These include early collaboration of clinical leaders and medical educators and use of an iterative, asynchronous development environment. Features of the LMS itself supported both development and distribution of the education needed for successful and timely implementation.

The early participation of two types of educators clearly guided selection of applicable tools and facilitated deployment. One had in-depth knowledge of learning theory and learning systems as well as the ability to design and program an LMS. The others were responsible for education of frontline staff and were constantly present in and familiar with the work environment. Their interaction resulted in the design and build of an educational modality that was immediately applicable. Their collaboration, including participation in care process mapping, with the clinical leadership team at the outset of the project fostered an early focus on implementation and ensured a solid understanding of content by those developing and deploying the training.

After a concentrated initial interprofessional effort, the process redesign and subsequent refinement and build of the LMS was accomplished in an iterative remote and asynchronous work environment. There was no need to coordinate schedules, convene multiperson meetings, or encounter the usual delays that occur when a synchronous approach is employed. Collaborators responded to e-mail or inquiries in the LMS build environment (see below) during brief interludes in clinical care and pandemic preparedness activity. This approach did require attention to e-mail and periodic responsiveness to inquiries but almost entirely eliminated the need for meetings.

The Review 360 feature of the Articulate Storyline 360 e-learning authoring tool supported the remote asynchronous and iterative build of the training module by enabling the educator to pose questions and have them answered directly in the system. Clinical task group members were able to provide content edits on the very screens where the edit was applicable. The educator was able to see who provided edits and when. He was able to note discrepancies and ask for those to be resolved. This feature clearly improved the efficiency of building and refining the training module.

Use of an LMS for deployment of training materials has clear advantages. While we hope to one day be able to relax social distancing requirements and gather again, it is never easy to assemble a large interprofessional team and effectively deliver educational materials in that forum. The ability of team members to access an LMS–based learning module on any online platform at a time convenient to them is a clear deployment accelerant. Further, the LMS can present materials pertinent to a specific learner and enable them to interface at a pace comfortable for them. The use of an LMS also enables the provision of links to other resources one desires the user to reference. Checklists are an example of such a resource, and a link to several checklists is provided in the Resource section of the LMS. Instructional videos displaying the proper donning and doffing of PPE in the OR setting (which differs from the activity outside the OR) is another example of such a link. Unfortunately, we did not have the time or resources to create such a video and instead employed training by on-site educators in real time. Though the ultimate metric of training effectiveness is competent performance in association with actual cases, use of LMS system testing and grading capabilities could help identify training deficiencies in advance of error and exposure in actual case management. Employment of these LMS features is recommended and is something, in retrospect, we should have taken the additional time to utilize.

The ability to implement process change affecting the activity of an entire team using only an online LMS is limited. Ideally, a comprehensive training deployment would also include team exercises and walk-throughs in the actual or simulated environment. These interventions, akin to assembly, are hard to schedule and conduct in a timely...
If time had allowed, we could have embedded videos of the team interaction in the training module to approximate the educational experience of team exercises. Instead, we chose to employ debriefings and distribution of lessons learned from real-time management of COVID-19–positive or PUI patients. We suggest that use of an LMS enhanced with embedded team videos and team exercises, along with debriefings of actual activity, is likely a more comprehensive and effective manner to implement process reengineering efforts.

**CONCLUSION**

In this report, we describe a care process change that grew out of the need to respond rapidly to a pandemic. It is hoped that similar stimulus to future change is infrequent, but the technology and approaches we employed, along with those we recommend, may prove useful to others who want to expeditiously reengineer and implement care process improvements.

**REFERENCES**

1. Storesund A, et al. Clinical efficacy of combined surgical patient safety system and World Health Organization’s checklists in surgery, a nonrandomized clinical trial. JAMA Surg. 2020 Jul 1;155:562–570.
2. Smedley JK. Modelling the impact of knowledge management using technology. OR Insight. 2010;23:233–250.
3. Sanderson PE. Book review: E-Learning Strategies for Delivering Knowledge in the Digital Age. Internet Higher Educ. 2002;5:185–188.
4. Zhang D, et al. Instructional video in e-learning: assessing the impact of interactive video on learning effectiveness. Information & Management. 2006;43:15–27.