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Infection Control at Massachusetts General Hospital

The situation Benjamin Orcutt, associate director of Admitting Services for Massachusetts General Hospital (MGH), faced on June 14th, 2012 was unfortunately becoming far too familiar. Faced with operational occupancy of nearly 100% for the hospital's inpatient beds, Orcutt followed protocol by issuing a "Code Help" to warn departments throughout the hospital of a looming bed shortage. Upon receiving the "Code Help," Dr. Paul Biddinger, chief of Division of Emergency Preparedness and medical director of operations at the Emergency Department (ED), contacted Orcutt to ask him to expedite requests for inpatient beds that the ED had already submitted. "We are getting slammed with new patients arriving who need resuscitation and evaluation, so we need to be able to move patients who are ready for admission into beds ASAP," Biddinger implored Orcutt.

"We are doing what we can," Orcutt replied, a hint of exasperation in his voice, "but we can't make more beds appear!"

Orcutt noticed that 15 beds in the hospital's semi-private (i.e., two-patient) rooms were closed due to contact precautions—infection control measures taken to keep patients with certain resistant bacteria from exposing other patients. Because they were considered "closed," these beds were not included in the hospital's measure of operational occupancy, but Orcutt knew that opening them would ease the constraints on the system. He called Dr. Erica Shenoy, of the MGH Division of Infectious Diseases and Infection Control Unit, to ask whether any of the 15 patients occupying the beds next to those that were closed were likely to come off contact precautions in the near future. Shenoy had been leading an effort to improve the hospital's procedures for identifying which patients could have contact precautions discontinued.

After reviewing the records of the 15 patients under contact precautions, Shenoy realized that—despite MGH's newly established pilot program that enabled screening of all patients under certain contact precautions in the ED to determine if those precautions could be safely discontinued—most had not been screened at all. Without a screening test, those patients remained on contact precautions because they had tested positive for infection or colonization on a previous visit (sometimes years prior). In fact, Shenoy noticed that even though one of the patients had come to the ED for treatment five times in the prior month, that patient had not been screened once.

Shenoy called one of her colleagues, an attending physician in the ED. "I want you to look out for this patient—he's eligible for screening as part of our pilot program," she asked. "The next time he comes in, can you please run a screening test on him? It will only take a minute." The response that Shenoy received was also, unfortunately, becoming a familiar one: "But he's just going to go home,

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you know. Get discharged, come back, and get discharged. Plus, there are tons of other critical things we need to deal with here."

Puzzled and frustrated, Shenoy realized that she could not offer any good news to Orcutt at that point, but, most importantly, that a new course of action was required to make the program work and improve screening rates.

Massachusetts General Hospital

MGH was founded in 1811 in Boston and served as a primary teaching hospital of Harvard Medical School. MGH was committed to performing cutting-edge research that spanned the entire spectrum of medicine: from basic laboratory investigations and clinical trials of innovative treatments to process improvements related to the safety, timeliness and efficiency of patient care. In 2011, MGH was the largest funding recipient from the National Institutes of Health and administered the largest hospital-based research program in the United States with an annual budget of more than $750 million.

Apart from its research activities, MGH was also a world-renowned provider of clinical care. In 2011, MGH handled approximately 1.5 million outpatient visits. Outpatients received ambulatory care at MGH without staying overnight or being formally admitted. MGH also operated 950 hospital beds for patients receiving either surgical or medical care on an inpatient basis. In 2011, approximately 47,250 inpatients were admitted to MGH. Outpatient and inpatient services evenly contributed to the hospital's net patient service revenue. **Exhibit 1** provides relevant financial information.

Approximately 50% of inpatient cases at MGH entered the hospital following arrival at the ED. Another 35% of inpatients came to the hospital for elective (i.e., scheduled) surgery following referral from a specialist physician or surgeon. The remaining inpatient volume came from hospital transfers or referrals through the front door.

After entering the hospital, patients would visit different departments and centers of MGH to receive care depending on their diagnosis. Examples of such departments included radiology, the operating room (OR), and the post-anesthesia care unit (PACU). Inpatients would be admitted to the hospital and assigned a bed in a particular unit by MGH Admitting Services. Units were dedicated to particular clinical services (e.g., general medicine, general surgery, cardiovascular surgery) and particular levels of patient acuity (e.g., intensive care, step-down care, general care, and observation units).

Admitting Services

The main responsibility of Admitting Services at MGH was to accommodate admission requests submitted by various departments in the hospital, referring providers and outside facilities requesting hospital-to-hospital transfers. Depending on the clinical services an inpatient needed, the associated request was handled by one of four patient access managers (PAMs): the medicine PAM, the surgical PAM, the ortho/neuro/pediatric PAM, and a fourth PAM who handled all transfer patients from other hospitals. Once an admission request was submitted, the responsible PAM needed to identify an available bed in an appropriate unit to which the patient could be assigned. More often than not, a bed was not immediately available, in which case the PAM had to look at the anticipated supply of beds based on planned discharges—as well as the anticipated additional incoming requests—and plan accordingly. Careful timing and coordination were thus of the essence.

The physical layout of MGH posed an additional challenge to bed managers. MGH had a low percentage of private rooms with one bed and a high percentage of semi-private rooms that accommodated two beds, except for specialized units (e.g., the intensive care units) where all beds were private. Beds in private rooms could be assigned to any patient but were typically allocated to patients who either paid a price premium or had a particular clinical need. Priority for private rooms was also given to hospice patients with rapidly deteriorating conditions where death was imminent. On the other hand, patients assigned to a given semi-private room needed to be of the same gender, service type, and acuity level. These additional "cohorting" considerations for semi-private rooms further complicated the assignment challenges facing PAMs.

At the start of each day, Orcutt and the four PAMs would meet to review current bed availability and the anticipated supply of beds throughout that day based on scheduled or possible discharges. On a typical day, between 45 and 50 beds would be "closed" and unavailable for use due to a variety of reasons, including maintenance, infection control requirements (e.g., contact precautions), and safety issues in case patients were under custody by law enforcement. After reviewing the supply of beds, they would consider the demand due to the elective surgeries scheduled for that day. Ultimately, the team had to devise a plan for matching patients with beds, including a plan for cohorting patients to ensure the timely assignment and efficient use of available beds.

What concerned Orcutt's team the most, however, was incoming traffic from the ED. Admission requests submitted by the ED were *a priori* unknown. Though estimates about the anticipated volume and expected patient characteristics were available, any deviation from these estimates or surge in bed requests could wreak havoc with the team's planning. Consequently, the PAMs always had to be aware of both demand and supply issues. Orcutt explained: "It was a timing game. The PAMs were like poker players; calculating multiple variables and trying to make the best decision for the patients. There were other things, too, like caps on the number of patients a clinical team can oversee. In medicine, a physician on a ward could only take so many patients in a certain amount of time."

The performance of Orcutt's team in Admitting Services was measured by the *operational occupancy* of beds throughout the hospital. Operational occupancy was defined as the fraction of available beds (not counting those that were closed) occupied by patients. The team was always aiming for a high operational occupancy; a low figure indicated that available resources were not being utilized and that, perhaps, bed assignment was not being carried out in an efficient manner.

The average operational occupancy at MGH in 2011 was 84.5%. Whenever operational occupancy would reach levels higher than 98%, Orcutt's team knew that a "Code Help"[a] was likely to be triggered soon thereafter. Under "Code Help," MGH needed to move all admitted inpatients out of the ED within 30 minutes—as mandated by the Massachusetts Department of Public Health—to alleviate critical levels of ED crowding and maintain its capacity to accept and manage new patients presenting for emergency care. As part of its "Code Help" planning, MGH instituted a process whereby the ED notified the Admitting Services office, the ORs, and other clinical leaders throughout the hospital when it was nearly reaching the "Code Help" trigger for crowding. As the ED approached "Code Help," Orcutt's team would struggle to adjust bed assignments to keep hospital operations on track while also preventing ED overcrowding that might pose a threat to patient safety. Under such circumstances, patients would remain in the OR, the PACU and other departments of the hospital longer than under normal operating conditions. Congestion, backlogs, and increased wait

[a] At MGH, "Code Help" was called when the ED hit certain pre-specified triggers: (a) acute service was full and no patients could be safely moved to the hallway or another treatment area, and (b) there were more than 5 patients in the waiting room for more than 30 minutes who had been determined to need a monitored bed but could not get one.

times across the hospital were then inevitable. At the same time, everyone in Admitting Services would focus on trying to free up capacity by transferring patients within the hospital (e.g., if two patients who could be cohorted in the same room were occupying two semi-private rooms on their own, reallocating them to the same room would create an empty, available room). This process of "bed moves," however, was not popular among staff or patients and resulted in additional costs.

MGH administration closely monitored operational occupancy, as well as the average wait times of patients across the hospital. Expanding physical capacity (e.g., the number of inpatient beds) at the hospital was both a complicated and expensive approach to relieving congestion, particularly at a time when healthcare costs were increasing and significant public and private efforts were being made to lower them across the industry. Instead, MGH administration encouraged process improvement initiatives that would reduce complexity, mitigate variability, and standardize procedures to improve resource utilization and service quality.

Infection Control and Prevention

Like other large hospitals, MGH was concerned with managing and limiting the spread of infectious diseases (i.e., illnesses caused by bacteria and other microorganisms) via person-to-person transmission or environmental exposure due to contaminated surfaces in the hospital. Many patients were already "colonized" by specific resistant bacteria well before their hospital visit. Being colonized by bacteria, however, simply meant that a patient carried those bacteria on his or her body (i.e., on the skin) and was not suffering from an active infection at the time of admission.

Patients colonized with particular organisms were at higher risk of developing active infection, considered a healthcare-associated infection (HAI) if this occurred in relation to a hospital visit. The risk of shift from colonization to infection was highest when invasive procedures in the hospital created the opportunity for a microorganism to enter the body.[b] Proximity to colonized or infected patients, as well as shared healthcare providers who—if not observing appropriate infection control practices—could transmit the bacteria on their hands, clothing, and stethoscopes, created the opportunity for colonization and infection to spread within a hospital.

According to a 2005 study,[c] approximately two million patients contracted HAIs on an annual basis in the United States, of which more than 100,000 died. The Centers for Disease Control and Prevention (CDC), estimated the direct costs associated with HAIs to be in excess of $30 billion per year.[d] These costs were borne by healthcare providers, as they were not part of any recognized treatment for which additional payment was available.

A bacterium of particular concern to healthcare providers, including MGH, was methicillin-resistant *Staphylococcus aureus* (MRSA). As its name suggested, MRSA was a bacterium that had become resistant to methicillin, an antibiotic commonly used to treat infections caused by *Staphylococcus aureus*. As a result of the development of antibiotic resistance, MRSA infections were harder to treat and posed considerable risks to patients – in fact, some invasive MRSA infections had

[b] For example, patients who required placement of intravenous catheters, urinary catheters or other invasive devices ran the risk, despite sterile insertion techniques, of introducing bacteria on their skin into the body, which could lead to active infection.

[c] McCaughey, Betsy. 2005. "Unnecessary deaths: The human and financial costs of hospital infections." National Center for Policy Analysis White Paper.

[d] Scott, R. Douglas II. 2009. "The Direct Medical Costs of Healthcare-Associated Infections in U.S. Hospitals and the Benefits of Prevention." CDC report. URL: http://www.cdc.gov/HAI/pdfs/hai/Scott_CostPaper.pdf

mortality rates upwards of 30%.[e] At the same time, while incident, hospital-acquired (or nosocomial) MRSA infections had decreased or remained at low levels, the pool of colonized patients was ever-increasing: MGH estimated that approximately 8% of inpatients were flagged as having a history of MRSA prior to admission (see **Exhibit 2**).

The MGH Infection Control Unit (IC Unit) was tasked with prevention and management of the risks associated with HAIs. The IC Unit, led by Dr. David Hooper, was responsible for identifying and keeping track of patients with an active or prior infection with specific organisms, including MRSA. For instance, the IC Unit managed the centralized database that kept track of patients known to be colonized with MRSA, resulting in a prominent, red "P" flag in the electronic medical record—both in the inpatient and outpatient settings. That flag alerted providers and Admitting Services of the need for appropriate accommodations. Following guidelines from the CDC, MGH placed all patients with an active MRSA infection or colonization (or a history of prior infection or colonization) under contact precautions, measures taken to prevent transmissions of organisms that spread by person-to-person contact or via environmental surface contamination.

Contact Precautions at MGH

MGH followed the CDC's recommended approach to CP,[f] which involved multiple adjustments to the procedures used to care for patients with current or prior colonization or infection. First, before approaching any patient under CP, all MGH providers were required to disinfect their hands appropriately and then to put on a sterilized set of gloves and gown, which were immediately disposed of or recycled, respectively, after each use (see **Exhibit 3**). Overall, the time required for a provider to put on, take off, and dispose of a single set of protective garments was approximately one to two minutes.

Second, upon discharging a patient under CP, the bed and room occupied had to go through a specialized cleaning and disinfection procedure, called the "deep clean." The deep clean required 90 minutes to complete, compared to one hour for normal cleaning procedures.

Third, the CDC recommended private accommodations for patients on contact precautions, but allowed for cohorting with similar patients as a second-best alternative. Patients under CP needed to be cohorted in a way that matched them not only on gender, service type, and acuity level, but also on their colonization/infection status. For example, if a male MRSA patient occupied a bed in a semi-private room, the adjacent bed could only be assigned to another male MRSA patient of the same service and acuity level.

The additional cohorting requirement due to CP made it particularly challenging for Admitting Services to match and find available beds for patients under CP. In many situations, patients under CP would occupy a bed in a semi-private room with the adjacent bed remaining empty, as no matching patient could be found. These empty beds would then be designated as closed. The IC Unit estimated that MRSA-related bed closures accounted for approximately 10-15% of all bed closures across the hospital.

The ED also faced challenges with incoming patients under CP. Because it typically took longer for them to be assigned to a bed, these patients commonly remained in the ED awaiting bed assignment longer compared to those who were not under CP, thus contributing to congestion. Data

[e] Pastagia et al. 2012. "Predicting Risk for Death from MRSA Bacteremia." Emerg Infect Dis. 18 (7): 1072–1080.

[f] URL: http://www.cdc.gov/mrsa/prevent/healthcare/precautions.html

collected by the IC Unit demonstrated that, on average, patients requiring CP bed assignments waited 2 hours longer than non-CP patients.

Finally, a growing body of data had supported that CP were associated with reduced quality of patient care, including fewer patient-provider interactions and a higher number of preventable adverse events (see **Exhibit 4**).

Discontinuation of Contact Precautions for MRSA

The majority of patients under CP at MGH only had a documented *history* of MRSA infection or colonization. Consequently, it was possible that these patients were no longer colonized and thus no longer required CP. In fact, recent clinical studies[g] suggested that three months after a positive test for MRSA colonization, nearly 70% of patients had cleared the bacteria and were thus no longer colonized. Based on these and other studies, healthcare providers could selectively screen some of their patients under CP to establish clearance or verify persistent colonization, thereby allowing for an informed decision about whether to discontinue CP.

However, despite publishing specific guidelines about *initiating* CP, the CDC did not provide any recommendations or regulations regarding when to *discontinue* them. Institutions and providers had thus developed different, local screening policies, with some hospitals screening all patients, others screening only patients who last had a positive test result more than three, six or twelve months prior, and some screening no patients, treating them as if colonization were life-long (see **Exhibit 5**).

MGH had developed its own screening policy, which had been in place for about 10 years. Any patient with a history of MRSA, but not with a recent isolate (defined as a positive MRSA culture within the prior 3 months) was eligible for screening. The primary team[h] was responsible for identifying such patients and ordering a series of three nasal cultures. The cultures had to be obtained at least 24 hours apart and in the absence of concurrent antibiotic use. If all three cultures were negative, the primary team could contact the IC Unit to request discontinuation of CP. Unfortunately, a large percentage of inpatients would have already received antibiotics by the time the series of cultures was completed (or indeed initiated), rendering the results uninterpretable for the purposes of documenting clearance of colonization. Each specimen could take up to 48 hours to finalize, and the entire process, from start to finish, could take upwards of four days assuming the team did not wait for each swab result before continuing the series. In practice, the process would typically take five to seven days.

Hooper and Shenoy felt that the screening procedures at MGH were ineffective and failed to detect patients under CP who had, in fact, cleared colonization. Working together with Dr. Rochelle Walensky in the Medical Practice Evaluation Center, they initiated a clinical trial in late 2010, in which patients were randomly split in two groups. For the first group, the nonintervention arm of the trial, the team simply used the standard process. For the second group, the intervention arm of the trial, the team, in communication with other hospital personnel, actively approached MRSA patients who were admitted under CP, and, after obtaining enrollment consent, they ensured that the screening process was initiated in a timely manner and that it took no longer than three days. The

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[g] Robicsek et al. 2009. "Duration of Colonization with Methicillin-Resistant *Staphylococcus aureus*." Clin Infect Dis. 48 (7): 910-913.

[h] The primary team comprised of inpatient providers with primary responsibility for the care of the patient while admitted. This group would include an attending physician, and in most cases, fellow or resident physicians, nursing staff, case managers, and additional personnel as required including physical therapists, occupational therapists, social workers, and nutritionists.

results of the trial revealed that the system was indeed broken: in the nonintervention arm, only 6.6% of patients who were eligible for screening had CP discontinued. In the intervention arm, that figure was 26.6% (see **Exhibit 6**).

Shenoy reflected on the situation: "It was very unsettling from a clinical point of view because we knew that in the population, approximately two-thirds of patients were no longer colonized. So we had a very large percentage of our so-called MRSA colonized patients who were mislabeled and under CP. And we knew the weight of evidence supporting inferior care associated with CP. Further, given our use of cohorting, we knew that these patients were likely to be housed in a semi-private room with another patient who might in fact still be colonized. It was possible the other patient had cleared colonization as well, but it was also possible they had a raging MRSA infection and you just re-exposed the first patient."

A New Screening Method

By the late 2000s, a shift had begun with the development of real-time Polymerase Chain Reaction (PCR) applied to clinical microbiology. This change had come to MRSA screening with the development of PCR tests that could be performed on nasal specimens and promised to increase the sensitivity of detection, while reducing processing time dramatically to less than two hours. The first commercial PCR for detecting MRSA was approved by the FDA in 2008, followed by the entry of competing products beginning in 2010. By the end of 2010, PCR screening machines were commercially available, selling at approximately $250,000, plus $40 per swab used to collect each specimen. Few hospitals rushed to adopt the new technology, however, as it was costly and hospital administrators, clinical microbiologists, and physicians were unsure of how best to use it. Culture, which was relatively cheap but often less sensitive and definitely took more time, had been the gold standard in the diagnosis of infectious diseases for over a hundred years. For the purposes of infection control, specifically, the application of the PCR test for documenting clearance of colonization had not been evaluated.

To study the efficacy of actively identifying patients and screening with PCR, Hooper and Shenoy included the new method in their 2010 randomized control trial as follows. The team screened all MRSA patients in the intervention arm using the PCR method in conjunction with the conventional cultures, again, subject to enrollment consent. The team was truly impressed upon comparison of the fidelity of the two screening methods. A single PCR result was highly predictive of the three sequential cultures; the negative predictive value (i.e., the proportion of patients with a negative PCR test result who also had the "gold standard" of 3 negative cultures) was 97%.[i]

Based on the findings of their trial, Shenoy and her colleagues were convinced that MGH needed to alter its screening procedures and switch to the PCR screening method. She remarked: "We had to do something about this. There was the clinical urgency of knowing the downsides of maintaining the status quo. We knew for a fact that a large proportion of patients were negative for MRSA, and here we were potentially exposing them through false cohorting. This was paired with the urgency related to capacity and bed availability. We felt like moving to PCR was clinically and operationally the right thing to do."

The MGH administration, reflecting on the results of the trial, and the potential impact on patient care and capacity, approved the budget request to invest in a top-of-the-line PCR screening machine

[i] Shenoy et al. 2013. "Discontinuation of Contact Precautions for Methicillin-Resistant *Staphylococcus aureus*: A Randomized Controlled Trial Comparing Passive and Active Screening with Culture and Polymerase Chain Reaction." Clin Infect Dis. 57 (2): 176-184.

as well as enough cartridges for a pilot program. Hooper and Shenoy also received an innovation grant through the Center for Integration of Medicine and Innovative Technology, a non-profit consortium of teaching hospitals and universities in Boston, to support the implementation and analysis of the pilot.

Implementing Change

Despite the promise of PCR, Shenoy knew that anything less than real-time identification of eligible patients would fail to leverage the full potential of the new screening method. To this end, Shenoy worked with programmers in the hospital's Information Systems group to create an automated electronic system to alert providers at the point of care about a patient's screening eligibility at any point in time, dubbed the Rapid Infection Control Alert System (RICAS). During this process, Hooper and Shenoy worked to raise awareness across MGH about the IC Unit's efforts. They knew that any change to CP protocols would require buy-in from multiple stakeholders.

In 2011, with enhancements to RICAS almost complete and the PCR machine fully operational, Shenoy and Hooper began redesigning MGH's screening protocols for the pilot program. Given the short turnaround time (TAT) for PCR test results—processing only took 2 hours, but with transport and accessioning of samples, the group estimated a TAT of 5 hours—the team identified and proposed the ED as an ideal location to perform the screening.

The Emergency Department

The ED was among the busiest and most intense environments at MGH. As the entry point to the hospital system for patients seeking emergency medical services, the ED was equipped to provide a wide range of services. The ED had 49 beds, most of which were situated in single rooms, with others being in curtained spaces. At any given time, an average of 40 patients were in ED beds. During a busy afternoon, however, there could be 100 or more patients in the ED requiring a variety of treatments and procedures. Naturally, attending physicians and nurses navigated this often-chaotic environment by prioritizing tasks based on medical urgency. In 2011, the ED logged an average of approximately 240 patient visits per day, 27% of which eventually led to inpatient admissions. The remaining 73% of patients would spend approximately 3 hours in the ED before being discharged.

Knowing that admitted patients under CP were taking longer to leave the ED, Biddinger hoped the IC Unit's proposal would improve the operational metric he considered most important to the ED: median length of ED stay. As such, Biddinger was supportive of the IC Unit's proposal to perform the rapid PCR screening in the ED. The venture also had the full backing of Dr. Alasdair Conn, who had been at the helm of the ED since it became a standalone entity at MGH in 1988.

Biddinger, in consultation with ED staff, decided to incorporate screening into the ED's workflow as follows. As soon as a patient with MRSA history in his record was registered at the ED, RICAS would query the record and if the patient was eligible, a text page would be automatically sent to an ED Access Nurse.[j] The Access Nurse would then find the patient in the ED's computerized patient tracking system and make an electronic note that the patient was eligible for MRSA screening. After seeing the electronic note, the physician or physician's assistant caring for the patient would then ask the patient if s/he had been on any of a list of antibiotics recently and, if not, write an order for a PCR swab. The physician or the assistant would then use the swab to collect a specimen from the patient

[j] Access nurses in the ED were responsible for taking referral phone calls.

and send it for analysis. From that point on, the IC Unit was responsible for monitoring results and discontinuing CP (and "de-flagging") the patients in real-time.

Nine months after the introduction of PCR-based MRSA screening into the ED's workflow, the results were disappointing: only a small fraction of flagged MRSA patients were actually being screened. Biddinger remarked: "We had our access nurses try to write it in part of the patient chart, 'Please screen them for MRSA. Ask the questions, document it, and write an order.' We tried lots of emails, lots of communication, lots of campaigns, and we even changed the programming of our electronic chart to make it easier for the clinicians to document the relevant antibiotic use with just one click, but we just never got more than about 10% success."

It was soon apparent to Hooper, Shenoy and Biddinger that they underestimated the difficulty in changing work habits in an environment like the ED, even if the change entailed just an additional burden of one to two minutes per MRSA patient.

Hooper remarked: "Nobody questioned the logic of it. It was just implementing something in an environment like that. Despite buy in, telling people it's important to get something done is not enough sometimes. You've got to have the infrastructure or workflow so that people have time to 'check the last box.' And yes, Paul tried all sorts of things, but it never took off. It was very frustrating for Paul, I know, and probably their staff, when they were told what level of performance they achieved."

Shenoy added: "Their workflow did not work. They basically had it so separated in terms of who was responsible for what that ED clinicians could never prioritize the screening. It fell to the bottom of the pile, despite the fact that most of the clinicians actually liked the idea and understood the upside for patients, and for ED operations. But liking the idea did not translate into screening patients. It was one missed opportunity after another and very frustrating. Here we had everything set up—the page alerts, the new test, the micro lab all ready to go, and the ability to discontinue contact precautions in real-time as the results came in—and we were screening a handful of patients a month. I remember one month, halfway into our pilot year, the ED was only able to get a single patient off of CP—and they had 174 eligible encounters that month."

Biddinger reflected on the situation in the ED:

"Our providers were so overtaxed that to add one more responsibility without adding any resources, without adding anything—despite all the efforts we did to simplify the process—failed. We tried several iterations, but the challenge was exactly the opportunity. Everyone would come to the ED and say, 'I want to do X with your patients.' Smoking, drug, domestic violence counseling, testing for cholesterol, screening for high-blood pressure. It was a great opportunity because it was one of the rare times that people would touch the healthcare system, but there was a bandwidth issue. Every part of the ED was oversubscribed. We were not nearly big enough in terms of either space of staff for the volume of patients we saw, and we couldn't stop growing: 8% last year, 6% so far this year. We were the only business I knew of that was actually trying for a zero percent growth rate, and was failing miserably. The average number of patients seen individually by a physician just went up every year, and you know, the hours in the day were the same."

Alternatives

Despite their experience, Hooper and Shenoy had lost none of their faith in the value of adopting PCR screening in the ED. At the same time, it was clear they had to think of alternative plans for implementation.

The first option they considered was to ask the administration for a new full-time ED physician assistant (PA), who would then be made responsible for coordinating the MRSA screening in the ED. The team thought that the PA would be able to operate independently since he or she would have the necessary credentials to write orders for patients, and thus would completely eliminate the additional step of having the attending physician write the order for the PCR. Because the daily expected burden for screening in the ED did not constitute a full day's work, the team thought that the PA could also assist with other tasks in the ED, particularly during busy afternoons. Biddinger was always supportive of increasing the available resources in his department but informed Shenoy and Hooper that the ED had already asked for five new FTEs to fill other existing gaps in the ED and expected to receive approval for only two or three of them.

Biddinger offered a second alternative, which he thought was cheaper and more straightforward to launch. His idea was to assign the task of coordinating the screening to one of the clinical research coordinators (CRCs) in the ED. The CRCs were employed by the clinical research team that was exclusively conducting research in the ED. At that time, the team had approximately 20 ongoing studies, all of which were funded via grants through the MGH Clinical Research Program.[k] CRCs were compensated on an hourly basis and provided supplemental support to researchers with respect to day-to-day study management. CRC tasks included study initiation, subject screening, managing study visits, specimen collection and processing, data entry, and maintaining regulatory documents. Biddinger suggested employing the CRCs to implement the entire sequence of screening MRSA patients, including receiving the text page, asking the patient about recent antibiotic exposure, documenting their response, swabbing them and sending the specimen for analysis. The CRC would also be responsible for finding the attending physician required to authorize the order for a swab, because CRC's were not licensed to write patient orders. The CRC work structure meant that while an individual CRC would be assigned to the screening program each day, if a priority study required their involvement—for example a stroke imaging study in which time to scan was paramount—they would be diverted from the lower-priority, MRSA-screening protocol. The CRCs were only available to work weekdays from 7am to 10pm, implying that there was no such coverage during overnights, weekends, and holidays.

Shenoy and Hooper knew that a second failed attempt to launch the PCR screening method would not send the right signal to the hospital and the ED administrations. As such, they had to think critically about the prospects they were facing.

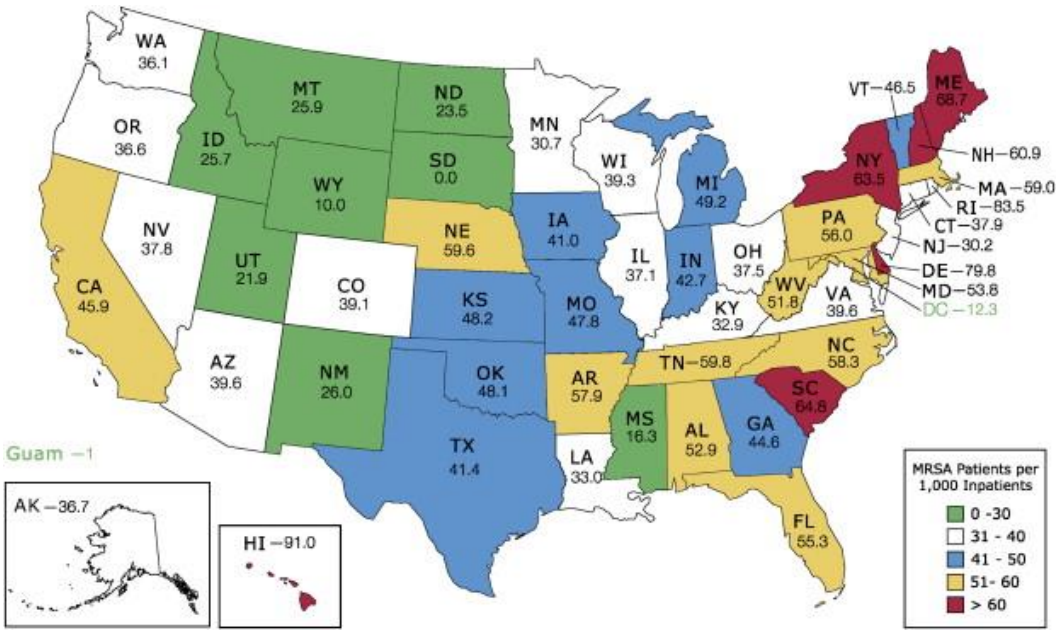
[k] CRC fees were negotiated based on a rate of $30/hour.

Exhibit 1 MGH Income Statements

	10/1/2011-9/30/2012	10/1/2010-9/30/2011	10/1/2009-9/30/2010
Revenue (in thousands of dollars)			
Net patient service revenue	2,281,337	2,071,361	1,976,538
Other operating revenue			
Direct research revenue	560,700	554,699	501,278
Indirect research revenue	192,175	184,864	171,808
Other	168,294	168,326	159,941
Total operating revenue	**3,202,506**	**2,979,520**	**2,809,565**
Expenses (in thousands of dollars)			
Operating expenses			
Employee compensation and benefits	1,214,317	1,152,704	1,085,544
Supplies and other expenses	911,172	838,951	850,010
Direct research and academic expenses	618,951	617,616	565,105
Depreciation and amortization	166,431	148,832	123,470
Interest	23,739	10,448	9,770
Total operating expenses	**2,934,610**	**2,768,551**	**2,663,992**
Income from operations	267,896	210,969	175,666
Nonoperating gains, net	5,663	12,945	5,634
Excess of revenue over expenses	**273,559**	**223,914**	**181,300**

Source: Massachusetts General Hospital.

Exhibit 2 MRSA Prevalence Rates by State in the U.S. in 2006



Source: Jarvis et al. 2007. "National Prevalence of Methicillin-Resistant *Staphylococcus aureus* in Inpatients at US Health care Facilities, 2006." Am J Infect Control. 35 (10): 631-637.

Exhibit 3 Signs Used at MGH to Educate and Remind Providers Regarding Contact Precautions Practices

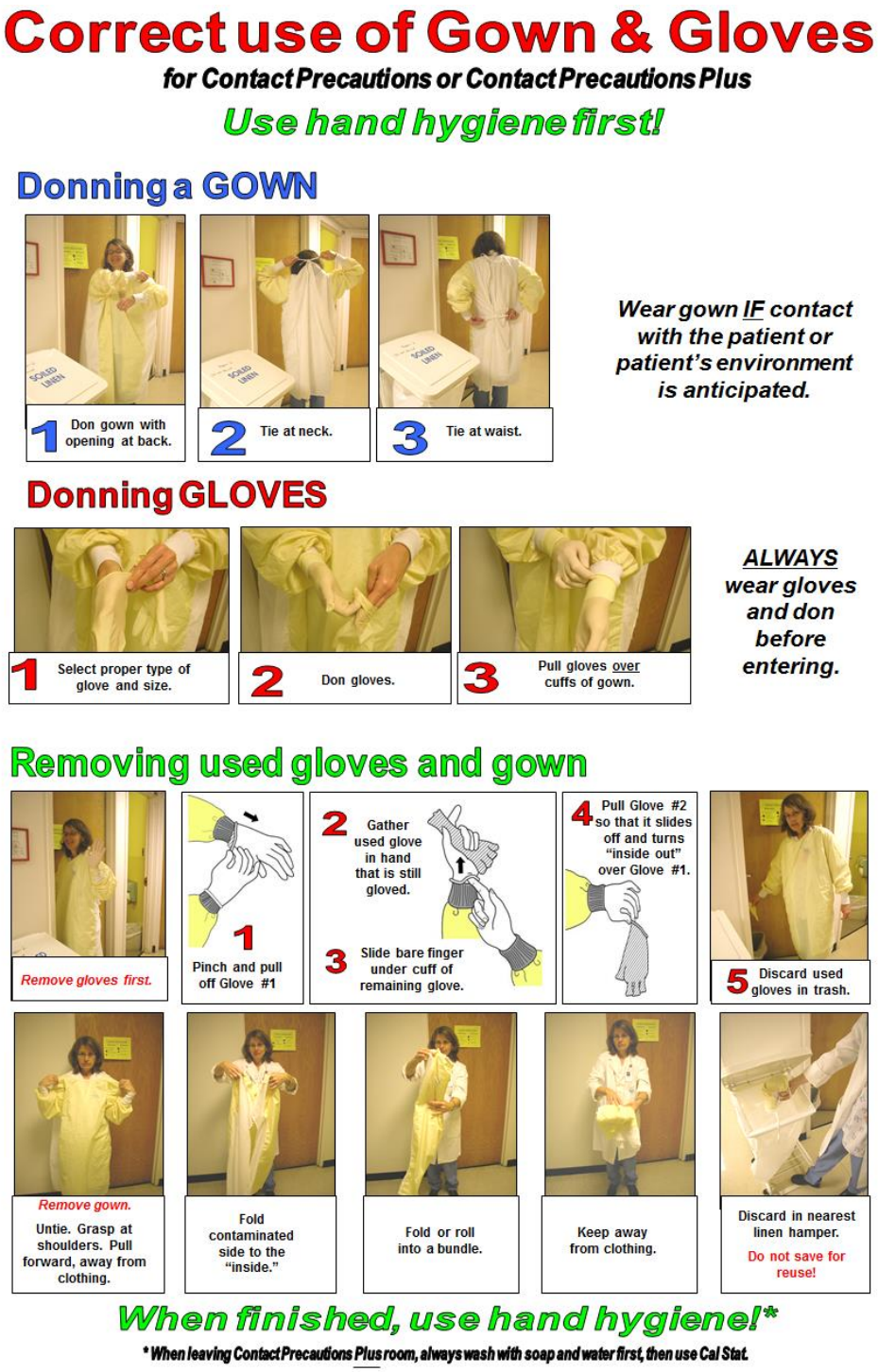
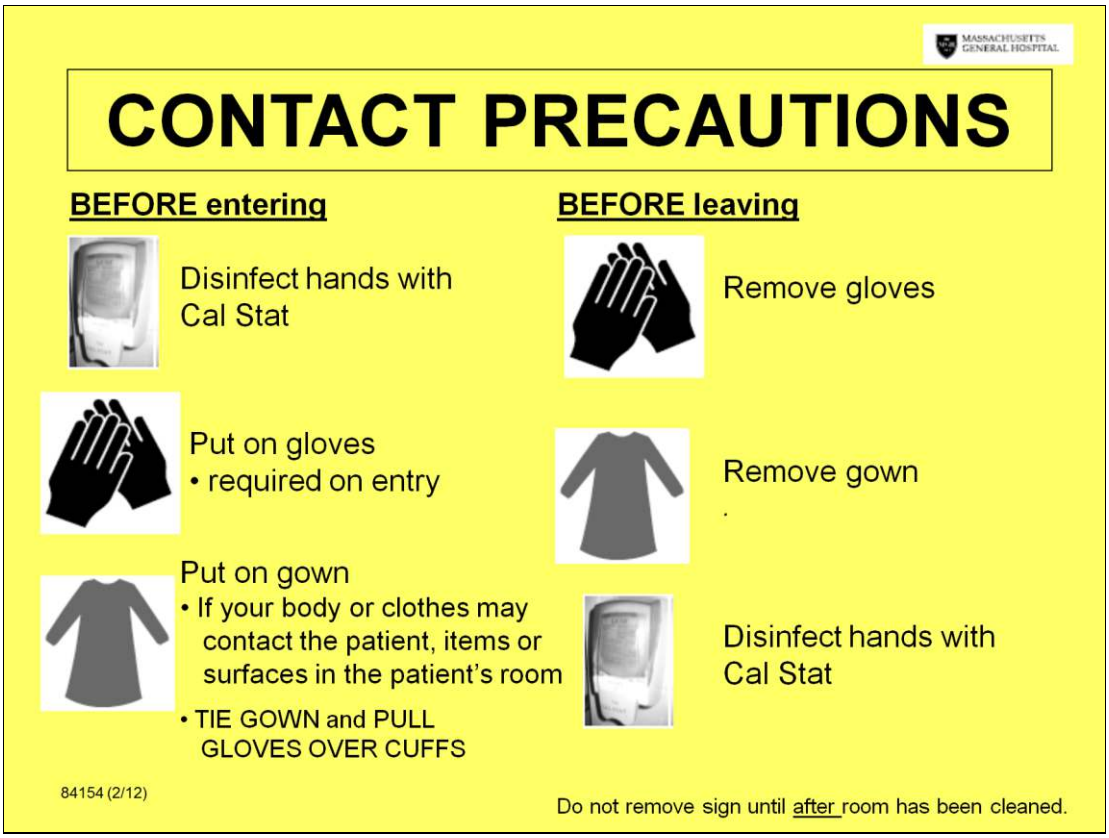


Exhibit 3 (continued)



Source: MGH Infection Control Unit.

Exhibit 4 Perceptions of Care among Patients under Contact Precautions versus Not under Contact Precautions

Perceived Issues with Care	Under Contact Precautions (N=238)	Not under Contact Precautions (N=290)
Overall (all issues with care)	33.6%	19.7%
Waits and delays	3.8%	4.5%
Poor communication	7.1%	5.5%
Environmental issues	1.3%	1.7%
Poor coordination of care	6.7%	2.4%
Poor interpersonal skill and unprofessional care	3.8%	2.4%
Lack of respect for patient needs and preferences	10.9%	3.1%

Source: Mehrotra et al. 2013. "Effects of Contact Precautions on Patient Perception of Care and Satisfaction: A Prospective Cohort Study." Infect Control and Hosp Epidem. 34 (10): 1087–1093.

Exhibit 5 2011 National Survey on Institutional Contact Precautions Practice: Respondent Institutional Characteristics and Infection Control Policies

	%
Institution characteristics (N = 2,580)	
Location	
Rural/small town, population <20,000	26.3
Town, population 20,000–49,999	14.6
Urban, population ≥50,000	58.4
Licensed beds	
<400	77.2
≥400	22.6
Bed organization	
All single occupancy	28.4
All double occupancy	2.3
Mix of single and double occupancy	68.6
MRSA infection control policies	
Is there a policy that allows for discontinuation of CP for MRSA? (N = 2,580)	
Yes	72.6
No	24.8
Do you actively screen for the purposes of discontinuation of MRSA CP? (N = 2,580)	
Never	31.4
Sometimes	42.4
Always	24.4
Details of MRSA CP policies incorporating use of microbiological assays (N = 1,465)	
Time since last positive culture before screening eligibility, months (N = 460)	
<6	25.7
≥6	72.8
Body site(s) of screening (N = 1,465)	
Nares	28.7
Nares plus original site of infection	45.6
Other	25.1
No. of negative specimens required to confirm clearance (N = 1,465)	
1	31.8
2	30.3
3	34.3
>3	1.8
Time interval between specimen collection (N = 974)	
24 hours	34.2
28 hours	22.1
1 week	35.7
>1 week	5.7

Source: Shenoy et al. 2012. "National Survey of Infection Preventionists: Policies for Discontinuation of Contact Precautions for Methicillin-Resistant *Staphylococcus aureus* and Vancomycin-Resistant Enterococcus." Infect Control and Hosp Epidem. 33 (12): 1272–1275.

Exhibit 6 Results of the 2010 Randomized Controlled Trial

Protocol Implementation	Nonintervention (N=198)	Intervention (N=259)
Screen initiated	31.3%	100.0%
Three swabs obtained	9.6%	73.7%
All negative, given 3 swabs obtained	78.9%	65.4%
Removed from CPs	6.6%	26.6%

Source: Shenoy et al. 2013. "Discontinuation of Contact Precautions for Methicillin-Resistant *Staphylococcus* aureus: A Randomized Controlled Trial Comparing Passive and Active Screening with Culture and Polymerase Chain Reaction." Clin Infect Dis. 57 (2): 176–184.