Patient Safety: It’s in our Hands

Controlling Hospital-Acquired Infections Through Proper Hand Hygiene

Preventing Central Venous Line–Associated Bloodstream Infections

Managing Clostridium difficile Infections

Safely Administering Anticoagulants
Primum non nocere

“Medicine has become the art of managing extreme complexity—and a test of whether such complexity can, in fact, be humanly mastered.”
—Atul Gawande, M.D., MPH, The Checklist Manifesto

Every medical student learns early that the fundamental underlying ethical principle of medicine is *primum non nocere*—first, do no harm. However, as medicine becomes ever more complex, as the number and sophistication of disease-fighting agents and gene therapies grow, the potential for error inevitably increases as well. The power to do greater good is accompanied by the possibility of doing greater harm.

Medical knowledge is estimated to double every seven to ten years. One recent study estimated that more than 20% of core information guiding clinical practice is changed within one year. How can a busy clinician who sees many patients each day be expected to flawlessly manage such complexity? To not only master the latest findings on a disease or treatment but to effectively change clinical practice based upon those findings? Are we reaching the limits of what even the most experienced and expert specialist can do? If so, how do we as a profession honor our fundamental ethical principle of doing no harm and ensuring patient safety?

The Medical University of South Carolina (MUSC) has achieved an impressive safety record by realizing that a fundamental cultural shift is needed to ensure the safe practice of medicine in an age of such complexity. It recognized that the paradigm of the physician-expert as the sole arbiter of patient care, his or her opinions not to be questioned by subordinates, had to give way to that of the health care team following best practices with the help of checklists and care bundles, each member willing to voice a concern or point out an error. The culture of defensiveness engendered by fear of malpractice had to give way to one of transparency, where errors, near misses, and failures to comply with guidelines are acknowledged, tracked, and then rectified. It realized that taming complexity and ensuring patient safety requires a systemic, institution-wide effort, which includes the formulation of consistent policies, education of all staff about those policies, monitoring (eg, secret shoppers and hotlines) to ensure that the policies are followed, and consistent enforcement.

For its efforts to ensure patient safety, MUSC was recognized in 2012 with a grade of A by the Leapfrog Group, which provides safety and quality data on hospitals to patients so that they can make informed decisions, and with a top ten ranking (#8) for safety by the United HealthSystem Consortium, an alliance of the nation’s leading nonprofit academic medical centers.

Nothing matters more to us than the safety of our patients. Although we are proud of our achievements profiled in this issue of *Progressnotes*, we know that the process of quality improvement is a never-ending one and that continued improvement in patient safety will require unwavering vigilance and tireless efforts. We stand ready to meet that challenge.

Sincerely,

Patrick J. Cawley, M.D., MBA
Chief Medical Officer/Executive Director Designate
Medical University Hospital

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On the cover: Inadequate hand washing. Child’s hand holding a man’s fingers photographed in ultraviolet light after application of a special revealing fluid and subsequent hand washing. Light areas reveal the areas that have not been washed effectively. Image by James King-Holmes; licensed from Science Source.
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Welcome
David G. Bundy, M.D., MPH
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The Timeout: A Sixty-Second Fix to Surgical Error?

Of the 50 million Americans who have surgery each year, one million develop complications and 150,000 die within 30 days of complications, more than three times the number who die in automobile crashes. It is estimated that half of those deaths and other serious complications could be avoided.

In contrast, there have been only 153 fatalities due to aviation crashes in the past decade in the United States, or about two deaths per 100 million passengers on commercial flights.

How has the aviation industry achieved this remarkable safety record when pilots, just like surgeons, remain subject to human error, whatever their level of experience and expertise?

The simple answer—checklists, which outline all the necessary steps for each takeoff and each landing and ensure that no step is missed due to human error brought on by fatigue or distraction.

In The Checklist Manifesto: How to Get Things Right, Atul Gawande, MD, MPH, a professor of surgery at Harvard Medical School and a professor in the Department of Health Policy and Management at the Harvard School of Public Health, argues that such checklists, which can typically be completed in less than 60 seconds, could also do much to drive error out of surgical care.

A 2009 New England Journal of Medicine article authored by the Safe Surgery Saves Lives Study Group, a group of international experts brought together by the World Health Organization (WHO) to improve surgical safety around the globe, backed up that claim, reporting that surgical mortality decreased from 1.5% to 0.8% and inpatient complications from 11.0% to 7.0% in eight hospitals in eight cities, representing both developed and developing countries, after the introduction of a 19-item surgical checklist.

A large study by the US Veterans Administration showed an 18% decrease in surgical mortality after introduction of a training program that included heavy reliance on checklists as well as a focus on team building and communication.

Dr. Gawande also helped spearhead the Safe Surgery Initiative 2015, which aims to ensure that checklists are used routinely in most US operating rooms by 2015. South Carolina was the first state to pilot the project and, through the efforts of the South Carolina Hospital Association, aims to reach the goal of surgical checklists in every operating room by the end of 2013, a full two years ahead of the national goal.

Even before South Carolina was asked to join the pilot project, the Medical University of South Carolina, under the leadership of Karen Weaver, RN, MA, BSN, Director of Surgical Services, had already been using such surgical checklists for several years. It has continued to hone and improve its checklist as part of the pilot project, and the checklist it has developed has been used by the Joint Commission as a model for other institutions.

The checklist being used at MUSC is a modification of the one developed by WHO and includes steps to be taken at three time points: before anesthesia is given (sign-in), before the incision is made (timeout), and before the patient leaves the operating room (sign-out). The checklist serves a number of purposes. It ensures that the right patient receives the right procedure at the right site. It encourages best practices, for example ensuring that the airway is assessed prior to surgery and that antibiotics are given
as prophylaxis with 60 minutes of the start of surgery (known to dramatically reduce surgical site infections). It also requires a postoperative count of surgical instruments and supplies to ensure that none has been left in the patient.

Last and perhaps most importantly, it improves communication. According to Susan Harvey, M.D., an anesthesiologist who serves as the Medical Director for the University Hospital Operating Rooms at MUSC, “The checklist fosters patient-specific communication among team members during every surgical encounter.” All members of the surgical team are asked to introduce themselves and briefly state their role. Requiring all team members to speak encourages open communication and honest feedback from nurses and other staff members who might not have felt comfortable speaking otherwise. Also as part of the timeout, surgeons are asked to point out any of their concerns about the case. This information may prompt nurses to bring additional equipment into the room, ensuring rapid response to any eventuality. Sign-out steps help ensure proper postoperative care for the patient and improve the transition from the operating room to the recovery area.

According to Danielle Scheurer, M.D., MSCR, Chief Quality Officer at MUSC, “Surgical checklists/ timeouts can reduce surgical mortality by as much as 40%. Few measures can make that big a difference. When something so simple that takes only 60 seconds can save a life, how can we not do it?”

References

For patients with end-stage renal disease, kidney transplants are quite literally a matter of life and death. A kidney transplant can add ten or more good-quality years to the life of a patient with end-stage renal disease, and yet as many as 25% of patients on dialysis die each year while awaiting a transplant.

Of the 100,000 US patients who are placed on the waiting list for kidney transplants each year, only slightly over 20,000 actually receive kidneys (16,000 from deceased donors; 6,500 from living donors). The situation is particularly dire among the African-American community: in South Carolina, blacks constitute 65% of patients on dialysis but represent 14% or less of living donors. If supply is ever to meet demand, the number of living donors, who can include not only family members but extended family, colleagues, friends, and church members, must dramatically increase.

According to Prabhakar Baliga, M.D., Chief of the Division of Transplant Surgery at MUSC, “the two main barriers to living donation are the recipient not being willing to ask for a donation and donors not following through on their commitment.” More than 50% of initially enthusiastic potential donors back out, many because they harbor misconceptions about the consequences of kidney donation (eg, many mistakenly believe that they will likely become diabetic or will not be able to have children).

In an age in which smart phones and tablet technology have penetrated deeply into the American way of life, with high adoption rates by minority populations (51% of African Americans have smart phones), technology likely offers the best way to dispel such misconceptions. Dr. Baliga and Frank A. Treiber, PhD, SmartState™ Endowed Chair in Technology at MUSC, were recently awarded an R01 grant in the amount of $1,290,625 by the National Institutes of Health/National Institute of Diabetes and Kidney Diseases to use technology, specifically iPads, to do just that.

Drs. Baliga and Treiber will develop two separate educational programs, one for potential donors and one for patients in need of a transplant. These video clip modules, which will be watched on iPads loaned to participants, will address many of these individuals’ common concerns and misconceptions and will feature not only past donors and recipients commenting on their own experience but also musical (eg, Darius Rucker) and athletic celebrities (eg, Carlos Dunlap) from South Carolina whose friends have been affected by chronic kidney disease. Before making these videos, Drs. Baliga and Treiber will run focus groups with various groups of African-American kidney donors and living donor recipients to identify all barriers to living kidney donation. Once the educational iPad programs are developed, potential living donors and recipients will be able to participate in live video chat sessions via iPad to discuss the videos with other potential donors or recipients, as well as with an African-American facilitator, who will be either a kidney donor or a living kidney transplant recipient.

Through this program, Drs. Baliga and Treiber are hoping to double the number of yearly living donations at MUSC (from 35–40 to 60–70 per year) and to provide a model to other hospitals seeking to enhance living donation. Ultimately, this creative use of technology could mean that many more lives are saved each year through kidney transplant.
**PATIENT SAFETY: INFECTION CONTROL**

**It’s All in the Hands**
Controlling Hospital-Acquired Infections

[FIGURE 1. Bacterial colonies growing in the print of a human hand on agar gel. Image by Scimat; licensed from Science Source.]

Improved hand hygiene is the single most effective (and cost-effective) measure that medical institutions can take to reduce the number of hospital-acquired infections (HAIs), according to Linda Formby, RN, CIC, Manager of Infection Prevention and Control at MUSC.

That something as simple as proper hand hygiene could help prevent an estimated 1.7 million HAIs and save up to 99,000 lives per year is truly remarkable.¹

Health care workers who do not scrupulously clean their hands between patients could transmit an organism acquired from one patient to many more in the course of a day (Figure 1). Strong evidence suggests that good hand hygiene contributes to a reduced rate of such nosocomial infections in hospitals.²,³ For instance, more frequent disinfection of hands using alcohol rub led to decreased rates of transmission of methicillin-resistant *Staphylococcus aureus* (MRSA) in a Swiss hospital (increase in adherence to proper hand hygiene: 48% in 1994 to 66% in 1997; decrease in overall nosocomial infections: 16.9% to 9.9%; decrease in MRSA: 2.16 to 0.93 episodes per 10,000 patient-days).² Lower rates of infection with vancomycin-resistant enterococci (VRE) were observed in another hospital after an institution-wide initiative improved hand hygiene.³

**What constitutes proper hand hygiene?**

In most instances, an antiseptic hand rub, which can be properly applied in 20 to 30 seconds, is preferred, as studies show better control of some infections with such an antiseptic hand rub than with soap and water. However, if hands are visibly soiled, or if a patient has symptoms of diarrhea or vomiting, which could signal infection by an organism like *Clostridium difficile* (see “Gut Decisions” in this issue) that cannot be killed by alcohol, hands should be washed for 40 to 60 seconds with soap and water. Regardless of whether hand rub or soap and water is used, enough product must be applied, the product must be distributed to all surfaces of the hands (Figure 2), and the hands must be allowed to dry thoroughly.

**When should hands be cleaned?**

Of course, hands should be washed before and after touching food or using the restroom. Hands should also be cleaned before and after caring for a patient or performing an invasive procedure and after touching a potentially contaminated surface, device, or bodily fluid, even if contact occurs while wearing gloves.

Not all health care workers realize they should wash their hands after they remove their gloves. Evidence shows that even when health care workers wear gloves and touch only intact areas of skin or the patient’s bed or clothing, their hands often become contaminated; such contamination occurred after 17% of health care encounters with patients infected with MRSA and 70% of those with patients infected with VRE.⁴

**Why is adherence to proper hand hygiene often low?**

In today’s high-tech world of medicine, an act as humble as cleaning one’s hands does not always receive the respect it deserves. Ironically, health care workers may be least likely to wash their hands when performing the very procedures associated with the highest risk for cross-contamination. A 2007 Italian study showed that adherence to proper hand hygiene was only 11.7% when risk of transmission was highest vs 29.6% when risk was moderate and 18% when risk was low.³ On a busy ward or in a hectic intensive care unit, health care workers may view the directive to wash their hands frequently as trivial, taking away valuable time from other patient care duties. In truth, however, as the Italian study shows,
that time could not be better spent as few measures do more to protect patients’ health than proper hand hygiene.

Health care workers may resist frequent hand washing because it causes a breakdown of their skin. Any initiative to improve hand hygiene should emphasize the importance of regular moisturizing to keep skin healthy. Healthy skin is also much less likely to have cracks that can be colonized by pathogenic organisms.

**MUSC’s Success in Improving Hand Hygiene**

Behavior and beliefs can be difficult to change. Doing so requires a concerted effort, encompassing education, mentoring, monitoring, disciplinary action, and reward. With such a concerted effort, MUSC improved adherence rates from less than 50% in July of 2010 to around 90% by the spring of 2012, meeting its stretch goal of attaining an adherence rate of 90% or better.

Using the IMPROVE model, MUSC identified opportunities for improvement in hand hygiene, which included education, medication administration, accountability, and reward and recognition. Adherence was found to suffer when employees were not aware of the policy, when the policy was inconsistent, and when employees were not disciplined for failure to follow policy or not rewarded for improved compliance.

To ensure that all employees received the same message and were held to the same standard, a single policy was developed for all staff, clinical (including physicians) and nonclinical alike. All new hires learned of this policy during orientation, and all employees were asked to complete a yearly training module highlighting the importance of hand hygiene. Care bundles, with proper hand hygiene as the centerpiece, were implemented for some of the more common HAIs (see “Lives on the Line” for more information on the intravenous line care and maintenance bundles). A champion in each unit served as an example and a mentor to his or her fellow employees. Secret shoppers were used to monitor adherence to hand hygiene guidelines, and an electronic tool was developed to allow employees to report instances of noncompliance anonymously.

Although these changes led to substantially improved hand hygiene and a decreased incidence of HAIs, true and sustainable change came only when these measures were embedded in the strategic plan and were made a basis for performance reviews of leadership and staff, prompting an institution-wide cultural shift. Rewards were also developed for employees or units with the best adherence, ranging from recognition (eg, banners, articles in campus newspaper) to monetary awards.

MUSC’s efforts provide a model for other institutions seeking to dramatically improve hand hygiene among their employees as a cost-effective way of controlling HAIs. As MUSC’s experience shows, rapid behavior modification and a cultural shift in attitudes toward hand hygiene require a multi-pronged approach, including a consistent education/communications strategy and enhanced accountability. Such an effort can succeed only with the strong support of the hospital’s leadership who understands that the key to preventing HAIs is “all in the hands.”

**References**


**FIGURE 2. Proper technique for cleaning hands. Reprinted with permission of the World Health Organization.**
For some patients, a central venous line (CVL; catheter inserted directly into a major vessel in the neck, chest, or leg) is quite literally a lifeline. Patients with cancer depend on CVLs for chemotherapy and patients with end-stage renal disease for hemodialysis. Although often life-saving, CVLs can provide a direct route for bacteria and other organisms into patients’ bloodstream, where they can circulate quickly to major organs. A third of bacterial endocarditis cases, in which a heart valve becomes infected, are associated with prior intravascular devices. Sepsis and shock are other potentially life-threatening complications of central venous line–associated bloodstream infections (CLABSI).

CLABSI are often deadly and always costly. It is estimated that a quarter of a million CLABSI occur each year, claiming the lives of 62,000 Americans annually and costing the United States from $296 million to $2.3 billion.¹ Medicare has announced that it will no longer reimburse for hospital-acquired infections like CLABSI, meaning that hospitals will need to absorb the cost of treating CLABSI and their complications.

And CLABSI are by and large preventable. That was demonstrated in 2003 by the STOP Bloodstream Infections (STOP BSI) initiative, which developed a model for controlling CLABSI known as the Comprehensive Unit-based Safety Program (CUSP) under the leadership of Peter J. Pronovost, M.D., PhD, Director of Patient Safety and Quality at Johns Hopkins University, and implemented that model in 127 intensive care units (ICUs) in Michigan. Within 18 months, these ICUs attained their goal of a median CLABSI rate of zero and have sustained it ever since.² In 2007, MUSC adopted an insertion bundle (ie, all of the recommended measures to be taken while inserting a CVL) developed by the Institute for Healthcare Improvement (Table 1). In response to a spike in CLABSI rates noted after introduction of a needleless valve system in 2008, MUSC further stepped up its efforts by adding a maintenance bundle (Table 2). After implementation of the maintenance care bundle at MUSC, a 69% decrease in CLABSI rates was observed in ICUs, translating to 125 CLABSI avoided, 23 deaths prevented, and $4.5 million saved.

According to Linda Formby, MUSC’s initiative succeeded because it had the support of senior administration and was incorporated into the strategic aims of the hospital, making it an institution-wide effort. Each service line was expected to have at least

### TABLE 1. The Central Venous Line Insertion Bundle

- Clean hands before and after touching the patient (and after taking off gloves)
- Select best insertion site (avoiding femoral artery when possible)
- Properly prepare the patient’s skin with chlorhexidine
- Use maximal barrier precautions (including cap, mask, gloves, gown, and full drape on patient)
- Remove catheter as soon as possible
one team focused on CLABSI reduction, and all clinical employees had a reduced CLABSI rate as a performance measure on their annual review.

Another measure taken by MUSC to reduce CLABSI rates is the establishment of a Vascular Access Insertion by Nurses (VAIN) team of specially trained nurses who are expert at bedside placement of peripherally inserted central venous catheters (PICCs) using ultrasound guidance. The team uses antibiotic-impregnated PICC catheters since evidence suggests they may help prevent CLABSI, particularly when combined with an insertion bundle. However, the best way to reduce CLABSI rates is to reduce the number of unnecessary CVL insertions, which is a major goal of the VAIN team. The VAIN team is responsible for triaging all PICC requests at MUSC. They first assess whether a PICC is warranted and, if so, whether it should be placed at bedside by the VAIN team or with fluoroscopic (x-ray) guidance by interventional radiology (IR) or the Infectious Diseases (ID) PICC placement team. If a PICC is not indicated and the patient’s health care team cannot provide access, the VAIN team accesses alternative deep brachial and cephalic insertion sites with ultrasound guidance. These measures have reduced the average monthly number of PICC insertions by the VAIN team from between 40 and 50 to 14 and by the IR and ID teams from more than 120 to less than 80. In the meantime, the VAIN team has provided peripheral venous access for as many as 100 patients with difficult access per month.

In patients with chronic diseases who may have a number of CVLs placed (eg, kidney failure patients receiving dialysis), venous access can be permanently lost due to clotting or obliteration of the vein in which the CVL is placed. Thus, it is important to be conservative when deciding whether to place a CVL. According to Sally Potts, MS, RN, PNP, Director of Professional and Therapeutic Services at MUSC, “If patients are at the beginning of chronic illness, we don’t want to start them down that path of exhausting all veins.”

The VAIN team also helps to monitor PICC lines, ensuring that dressings are properly placed and changed. They also see that the lines are removed when they are no longer necessary. Reducing the amount of time the patient is exposed to a CVL also reduces CLABSI risk. VAIN team members also serve as mentors for other nurses in proper line insertion and maintenance.

Ultrasound is increasingly being used to help guide and monitor CVL placement, helping minimize inadvertent physician error and improve outcome. According to Joseph R. Cantey, M.D., Professor in the Division of Infectious Diseases at MUSC, ultrasound-guided CVL placement will be standard of care in the near future because it helps ensure patient safety, virtually eliminating the 1% to 6% chance of lung collapse or the occasional cannulation of the artery rather than the vein that can occur with a standard CVL insertion. To ensure that residents at MUSC are proficient in ultrasound-guided CVL insertion, Dr. Cantey is working with the Simulation Center to develop training modules incorporating ultrasound since commercially available CVL insertion training modules do not. Residents must successfully perform a specified number of CVL insertions on medical mannequins fitted with special neck and shoulder pieces as part of their training.

From ultrasound-guided placement to special teams of nurses to rigorous anti-CLABSI measures for both insertion and maintenance, MUSC has spared no effort to ensure the safety of patients who depend on central venous access as a lifeline.

References
In 2010, *Clostridium difficile*, a spore-forming anaerobic bacterium (Figure 1), replaced methicillin-resistant *Staphylococcus aureus* as the most common hospital-acquired infection (HAI). While rates of other HAIs are decreasing, those of *C. difficile* infections (CDI) are at historic highs, in large part due to the emergence of a more virulent strain (PCR ribotype 027, PFGE type NAP1 [NAP1]).

*C. difficile* causes symptoms that range from diarrhea that resolves in a few days to potentially lethal pseudomembranous colitis, toxic megacolon (often requiring colectomy), and sepsis. Traditional at-risk populations include the elderly and those with a recent history of antibiotic use or a lengthy hospitalization, especially in the intensive care unit.

Of patients colonized or infected with *C. difficile*, 36% and 63% have the more lethal NAP1 strain, respectively. The NAP1 strain results in more severe symptoms, more aggressive and rapid disease progression, the need for more surgeries, and higher mortality. It is also likely to cause infection in younger patients and those with few or none of the traditional risk factors.

One of the most troublesome aspects of CDI is its tendency to recur and to become more difficult to treat effectively with each recurrence. As many as 12% to 24% of patients experience a recurrence within two months of diagnosis, and patients experiencing a recurrence are 50% to 65% more likely to experience additional recurrences. Relapse or recurrence are more likely in patients infected with the highly virulent NAP1 strain.

Because its spores persist for long periods on hospital surfaces, *C. difficile* can colonize patients and health care workers months after the person who was the source of the infection has left the hospital. Patients colonized with *C. difficile* may not develop infection until much later, usually after undergoing a course of antibiotics that wipes the gut clean of its normal bacterial flora, allowing the rampant growth of *C. difficile*.

### The Pathogenicity of *C. difficile*

Three events are required for CDI to develop: colonization with a toxigenic strain of *C. difficile*; a gut environment disrupted by antibiotic use, a procedure, or chemotherapy; and the production of toxins by the organism. Colonization occurs when *C. difficile* spores, after having been ingested and having survived the acidic environment of the stomach, reach the small intestine, germinate into the vegetative form and multiply (Figure 2). Only when the gut environment is disrupted (most commonly by antibiotics) does colonization progress to infection (occurring in 5% to 25% of antibiotic treatment courses). Only those strains of *C. difficile* bearing a pathogenic locus produce toxins (toxins A and B).

Both toxins induce production of tumor necrosis factor α (TNF-α) and proinflammatory interleukins that trigger an..
Inflammatory response resulting in the pseudomembranous formation characteristic of CDI (ie, inflamed mucosa with yellow and white plaques). Toxin A is thought to be primarily responsible for attacking the intestinal wall, sometimes leading to the complete erosion of the mucosa, and the loosening of tight epithelial junctions, thereby increasing vascular permeability. In contrast, toxin B typically attacks epithelial cells directly once the gut wall is damaged.

NAP1, the highly virulent strain of *C. difficile* that emerged recently and has been implicated in a number of outbreaks, has a genetic mutation in the *tcd G* gene that allows it to produce more toxin (16-fold more for toxin A and 13-fold more for toxin B) and to cause more severe toxin-triggered symptoms. It also produces a binary toxin, the role of which is not well understood.

The Importance of Good Antibiotic Stewardship

Risk for developing CDI is increased seven to ten fold in patients taking an antibiotic or who have taken an antibiotic in the past month; a three-fold risk persists at two months. Historically, third-generation cephalosporins, ampicillin, and agents with broad spectrum anti-an aerobic coverage (eg, clindamycin) have been thought to increase the risk of CDI; more recently, overuse of fluoroquinolones has been implicated in the increased incidence of infections with the highly virulent NAP1 strain.

Discouraging overuse of antibiotics, particularly high-risk antibiotics, is seminal to controlling CDI. Studies have shown that efforts aimed at improving antibiotic stewardship by discouraging the overuse of high-risk antibiotics (ie, fluoroquinolones), especially when combined with enhanced infection control precautions, have significantly reduced the use of these high-risk antibiotics as well as the incidence of even the highly virulent NAP1 strain.

Rapid and sustainable control can be achieved with a comprehensive bundle that comprises targeted antimicrobial management, education, early case finding methodologies, expanded infection control measures, and a *C. difficile* management team.

Infection Control Precautions

According to Cassandra D. Salgado, M.D., MUSC Hospital Epidemiologist, "*C. difficile* has emerged as a significant problem for infection prevention and control departments. The organism, which can survive for months on materials used to fabricate environmental surfaces in hospitals, may transiently contaminate the hands, clothing, and equipment of health care workers. The health care worker may subsequently transfer the organism to patients as they provide routine care. For this reason, it is important for all providers to be aware of the importance of CDI as well as comply with hospital procedures designed to mitigate risk.

Alcohol hand rubs do not kill *C. difficile* spores; hands must be washed thoroughly with soap and water. The most commonly used hospital disinfectants are also not effective against *C. difficile*; a bleach-based or other sporicidal formulation is required. Because it is caustic to hospital surfaces and equipment, bleach cannot be used routinely. However, it should be used for cleaning the rooms of patients with CDI.

When a patient develops diarrhea 72 hours or so after hospitalization or if the patient has other risk factors for CDI (recent antibiotic use or hospitalization), testing for *C. difficile* should be performed. Infection control precautions (namely contact precautions), including the use of gloves and gowns, the use of bleach-based disinfectants, and handwashing with soap and water (30 seconds to 2 minutes with thorough drying) vs alcohol rub, should be instituted while awaiting test results to limit any potential spread. These precautions must be continued for patients diagnosed with CDI. The duration of contact precautions depends on patient symptoms, treatment, and hospital protocols. Minimizing the deposition of spores on hospital surfaces can go a long way toward preventing or curbing an outbreak. The use of dedicated patient care equipment such as disposable thermometers has also been shown to decrease the incidence of CDI.

Disinfection with ultraviolet light is also effective in killing spores on environmental surfaces but can be cost prohibitive for some institutions.

A New, More Sensitive Diagnostic Test

Diagnosing CDI earlier in patients with diarrhea will allow the prompt institution of infection control precautions. Toxigenic culture, in which fecal samples are cultured for several days and toxin production tested, is the gold standard for detecting *C. difficile*.
Pathogenesis of *C. difficile*-associated disease

*Clostridium difficile* is spread via the fecal-oral route. The organism is ingested either as the vegetative form or as hardy spores, which can survive for long periods in the environment and can traverse the acidic stomach.

In the small intestine, spores germinate into the vegetative form.

In the large intestine, *C. difficile*-associated disease can arise if the normal flora has been disrupted by antibiotic therapy.

*Clostridium difficile* reproduces in the intestinal crypts, releasing toxins A and B, causing severe inflammation. Mucous and cellular debris are expelled, leading to the formation of pseudomembranes.

Toxin A attracts neutrophils and monocytes, and toxin B degrades the colonic epithelial cells, both leading to colitis, pseudomembrane formation, and watery diarrhea.

FIGURE 2. Pathogenesis of *Clostridium difficile*-associated disease. Reprinted from Sunenshine and McDonald. Copyright © 2006 Cleveland Clinic Foundation. All rights reserved.
(with extremely high sensitivity) but is not used widely because of its time requirements. By comparison, enzyme immunoassays, the most commonly used tests for diagnosing CDI because they provide rapid results, have an estimated sensitivity of only 58.8% (using toxigenic culture as the standard) and have been associated with both false-positives and false-negatives.⁴

Real-time polymerase chain reaction (PCR) offers a diagnostic tool that combines excellent sensitivity (100%) with rapid availability of results (about 2 hours from the start of the assay). PCR assays have been developed to detect genes of the toxins produced by the disease-causing strains of *C. difficile*, allowing for prompt and reliable identification. However, false-positive PCR results occur in patients who carry toxigenic *C. difficile* strains in their gut but who are not infected. For this reason, stool specimens submitted to the laboratory for testing must be diarrheal (loose, watery) stool. Earlier identification of CDI, perhaps through the use of PCR diagnostics, allows for more rapid implementation of contact precautions, treatment, and other infection control measures that could be key in preventing the contamination of hospital surfaces and in helping control the spread of CDI.

### Changing Treatment Recommendations

Historically, the two “workhorse” drugs for treating CDI have been metronidazole (Flagyl) and oral vancomycin, with the latter reserved for patients with more severe disease who had received but not benefitted from metronidazole. However, the new more virulent NAP1 strain is better controlled when oral vancomycin is the first line of treatment, and there have been reports of higher metronidazole failure in these patients (26% failure rate during an 2005-2006 outbreak in Quebec vs a more historic rate of about 10%).⁶,¹⁶

Some evidence suggests that a newer drug, fidaxomicin, a narrow-spectrum macrocyclic antibiotic targeting gram-positive aerobic and anaerobic bacteria including *C. difficile*, is as effective as oral vancomycin in treating the more virulent strains of the organisms and may also be associated with lower recurrence rates.¹⁶ If it could be determined in which patients recurrence is likely, then fidaxomicin might be considered first-line therapy in these patients; unfortunately, there is currently no validated way to do so.

Colectomies may be necessary in patients with severe disease who do not respond to pharmacological therapy. For more information on current treatment recommendations, refer to the Table. The Infectious Diseases Society of America is expected to outline when use of newer antibiotics, such as fidaxomicin, is indicated in its new guidelines for diagnosing and treating CDI.

### New Directions in Treatment and Prevention

Newer nonpharmacological approaches, including fecal transplants and adjunctive probiotics, focus on restoring the natural flora of the intestine so that it presents a less conducive environment for the development of CDI.

#### Fecal Transplants

Fecal transplants, in which a liquid suspension of stool from a healthy donor is infused into a patient to help restore a normal intestinal flora, has been shown to be effective in treating both recurrent CDI and pseudomembranous colitis. A systematic review of the literature showed a disease resolution of 92% across 27 case series and reports and 317 patients.¹⁷ Some evidence also suggests that fecal transplants, by restoring a healthy intestinal flora, can be effective in treating inflammatory bowel disease and irritable bowel syndrome, both associated with disruptions of healthy gut flora.¹⁷

### Probiotics

Probiotics are potentially beneficial bacteria or yeast that may help restore the balance of bacteria in the gut. High doses (5 to 40 billion CFU/day) of *Saccharomyces boulardii* and *Lactobacillus rhamnosus* show the most promise for preventing hospital-acquired diarrhea¹⁸,¹⁹; however, these initial findings await confirmation by a randomized controlled trial. Some institutions, including MUSC, are considering whether to prescribe probiotics with any course of antibiotics in order to minimize disturbances to the intestinal environment that would make it conducive to the development of CDI.

### Conclusion

*C. difficile* is now the most common organism associated with HAIs in acute care hospitals. Increased disease severity and poorer response to traditional therapies have been associated with emergence of the NAP1 strain. It is important to know a patient’s risk for CDI as well as to perform appropriate diagnostic testing. New pharmacological and adjunctive therapies are available for treatment of CDI, particularly for use among patients with severe or recurrent disease as well as for preservation or restoration of normal intestinal flora. Control of CDI in acute care hospitals depends on early recognition of symptoms and diagnosis with prompt institution of patient care precautions and environmental decontamination.

### References

TABLE: Treatment for *Clostridium difficile* Infection

<table>
<thead>
<tr>
<th>INITIAL EPISODE</th>
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<tbody>
<tr>
<td><strong>Mild to Moderate Disease</strong>&lt;br&gt;<strong>Definition:</strong> Leukocytosis with white blood cell count ≤15,000 cells/µL and serum creatinine &lt;1.5 times baseline</td>
<td><strong>Treatment:</strong> Oral metronidazole 500 mg three times a day for 10 to 14 days</td>
</tr>
<tr>
<td><strong>Severe Disease without Ileus</strong>&lt;br&gt;<strong>Definition:</strong> Leukocytosis with white blood cell count &gt;15,000 cells/µL and serum creatinine &gt;1.5 times baseline</td>
<td><strong>Treatment:</strong> Oral vancomycin 125 mg enterally four times a day for 10 to 14 days. Colectomy may be necessary if no response to medical management</td>
</tr>
<tr>
<td><strong>Complicated Severe Disease with or without Ileus</strong>&lt;br&gt;<strong>Definition:</strong> Hypotension or shock, megacolon</td>
<td><strong>Treatment:</strong> Intravenous metronidazole 500 mg every 8 hours for 10 to 14 days AND oral vancomycin 500 mg enterally four times a day for 10 to 14 days.* Colectomy may be necessary if there is no response to medical management</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>RECURRENT DISEASE</th>
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<tbody>
<tr>
<td><strong>First Recurrence</strong></td>
<td><strong>Subsequent (≥2) Recurrences</strong></td>
</tr>
<tr>
<td>Treat with the same drug used to treat the initial episode</td>
<td>Oral vancomycin 125 mg enterally four times a day for 10 to 14 days followed by vancomycin taper or pulse dose over 4-6 weeks**</td>
</tr>
<tr>
<td></td>
<td>Sequential oral vancomycin followed by rifaximin (resistance already described)</td>
</tr>
<tr>
<td></td>
<td>Concomitant oral vancomycin with rifampin (resistance already described)</td>
</tr>
<tr>
<td></td>
<td>Passive antibody</td>
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<td></td>
<td>Infusion of donor stool</td>
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</tbody>
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*In patients who are unable to tolerate oral medications, intracolonic vancomycin could be used.

**Vancomycin rather than with metronidazole, in part because of the adverse effects (eg, peripheral neuropathy) resulting from long-term exposure to metronidazole.

Waging War Against Thrombosis
The Anticoagulation and Bleeding Management Service at MUSC

In 2008, the Surgeon General declared war on deep vein thrombosis (DVT), a blood clot that occurs in a deep vein, usually in the lower leg or thigh (Figure 1). The clot can break free and travel to the lung, causing a pulmonary embolism, a potentially fatal blocking of an artery in the lung. DVT is the major cause of hospital-related mortality in the United States, contributing to more than 100,000 deaths per year.¹

Anticoagulants are the standard of care for DVT, and yet they pose their own risk if not administered properly, being among the top five drug classes associated with patient safety incidents.² Of the 446 medication-related sentinel events listed in the Joint Commission’s Sentinel Event database, 32 (7.2%) involved anticoagulants, two-thirds of which were incidents involving heparin.² However, anticoagulants remain crucial not only to the treatment of patients with DVT or pulmonary embolism but also to those with a high risk of thrombosis, such as those with atrial fibrillation or mechanical heart valves.

Given the importance of treating DVT and other thrombotic conditions and the risks associated with anticoagulants if not prescribed and administered correctly, the Joint Commission introduced a standard of care for anticoagulation into the Patient Safety Goals in 2008, and it is required today by all hospitals.

MUSC’s Anticoagulation and Bleeding Management Service, directed by Charles Greenberg, M.D., Professor in MUSC’s Division of Hematology/Oncology, was created in part to ensure that these anticoagulants are prescribed correctly and administered safely. More broadly, the Service diagnoses and treats patients with complex bleeding and clotting disorders.

A Successful Multidisciplinary Collaboration
The Anticoagulation and Bleeding Management Service is led by a multidisciplinary team, including Dr. Greenberg, a hematologist; Danielle Scheurer, M.D., MSCR, Chief Quality Officer at MUSC; and Joseph Mazur, PharmD. Physicians, nurses, and pharmacists work in a team environment to ensure safe anticoagulation at MUSC. Safety is hard-wired into the system, with daily patient reports being sent by the pharmacy to Caroline Vaughn, R.N., nurse coordinator for the program. If an order for an anticoagulant or blood clotting factor requires guidance, she will prompt the Service to follow up with the main physician team.

FIGURE 1. Artistic rendition of the major blood vessels of the lower male torso, and thigh, showing femoral vein thrombosis. Image by John Bavosi; licensed from Science Source.
Two recent initiatives—aimed at limiting the prescribing of anticoagulants to patients with epidurals and at limiting the dilutions of heparin stocked—illustrate why such close collaboration between quality initiatives and the pharmacy is important.

Anticoagulants should not be administered to a person with an epidural because even a small bleed in the epidural space can result in paralysis. To guard against this happening, Dr. Scheurer and Dr. Greenberg worked with a multidisciplinary team led by Sylvia Wilson, M.D., Assistant Professor in the Department of Anesthesia and Perioperative Medicine; Marilyn Winkel, MBA, RN, an improvement facilitator; and Dr. Mazur to build a number of “hard” and “soft” stops into the electronic medication ordering system. Hard stops prevent physicians from ordering anticoagulants and antiplatelets posing the greatest risk in patients with epidurals, while soft stops require a consult with the Regional Anesthesia Pain Service for anticoagulants and antiplatelets posing a less pervasive threat in these patients. According to Dr. Scheurer, this system has resulted in several “hard stops,” meaning that the system itself prevented potentially serious medication errors from occurring.

Care must also be taken in the dispensing of heparin, which is stored as a liquid in vials. It can be dangerous to stock too many dilutions of heparin, because doing so means vastly different dilutions of heparin are stored in identical vials side by side, potentially setting the stage for a “picking error.” Such an error occurred with the twins of celebrity Dennis Quaid, who were administered 1000 times the prescribed dosage of heparin at Cedars-Sinai hospital in Los Angeles because the wrong dilution of heparin was inadvertently taken from the shelf. Learning from this error, the Anticoagulation Service worked with quality control and the pharmacy at MUSC to reduce the number of dilutions of heparin stocked, thus minimizing the chances for such a picking error.

**Ensuring the Safe Administration of Anticoagulants**

Heparin and warfarin are the two most commonly prescribed anticoagulants for the treatment of DVT and other blood clots. For DVT, the two are often initially administered together, as intravenous heparin is faster-acting than oral warfarin (almost immediate vs. 2 days or longer) and can control the clot while the warfarin is taking effect.

**Heparin**

Although heparin is a very effective and widely used anticoagulant, it can lead to a life- or limb-threatening condition known as *heparin-induced thrombocytopenia* (HIT). HIT is caused by an immune reaction to heparin that paradoxically both increases the chance for clots and drastically reduces platelet levels (Figure 2).

Heparin, which is a naturally occurring anticoagulant that is released by mast cells and basophils during the normal clotting process, binds to a protein (platelet factor 4 [PF4]) on the platelet surface. The resulting heparin-PF4 complex is recognized as “foreign” by the body’s immune system, which creates antibodies against it. The antibodies bind to the complex, and the resulting immune complex binds to the surface of the platelet, thereby activating it. The activated platelets begin to clump together, increasing the risk for clots and decreasing the number of free-circulating platelets, resulting in a low platelet count. Patients with HIT are at high risk for DVT, stroke, and heart attack.

MUSC’s Anticoagulation and Bleeding Management Service is “state-of-the-art in preventing an adverse reaction to heparin,” according to Dr. Greenberg. It identifies patients at risk of developing HIT by tracking laboratory testing. It also recently implemented the 4T scoring system, which identifies patients at high risk for HIT based on clinical parameters (awarding 0, 1 or 2 points for four clinical categories [the four Ts]: thrombocytopenia, timing of the decrease in platelet count, thrombosis, other causes of thrombocytopenia) before actual HIT antibodies are identified. Heparin should be discontinued in patients with a high risk for HIT (4T score of 6-8), and MUSC has a number of alternative treatments in place for these patients.

**Warfarin and New Warfarin Alternatives**

Warfarin, a vitamin K antagonist approved for use in humans in 1957, is the most widely prescribed anticoagulant in the United States. Vitamin K is necessary for the proper functioning of several proteins associated with blood clotting, and so inhibiting it reduces the likelihood of clotting. Warfarin is economical and easy to reverse should complications (eg, excessive bleeding, tissue necrosis) occur.

Because warfarin acts against vitamin K, it is important that patients taking it maintain a consistent level of vitamin K in their diets, which some patients find burdensome. Also, patients’ international normalized ratio (INR), which reflects the blood’s ability to clot, must be monitored frequently to determine whether dosing needs to be adjusted. These drawbacks have led to interest in two new warfarin alternatives approved in the past two years by the US Food and Drug Association: rivaroxaban, an oral Factor Xa inhibitor, and dabigatran, a direct thrombin inhibitor.

Patients find these warfarin alternatives attractive because they require neither the frequent INR monitoring nor the dietary restrictions obligatory with warfarin. However, a major disadvantage is that these medications are not as easily reversed as warfarin if complications occur. To reduce the likelihood of complications, MUSC’s Anticoagulation Service has developed educational materials for both physicians and patients about the new medications. These materials will ensure that physicians know how to safely prescribe and administer the new medications and that patients...
know how to monitor themselves for possible complications. The Joint Commission has noted that empowering patients with such knowledge has been one of the most effective means of ensuring anticoagulation safety. Protocols are also in place should reversal of these medications be required.

Rare Bleeding and Clotting Disorders
In addition to ensuring that both established and newer anticoagulants are prescribed safely and in accordance with evidence-based guidelines, MUSC’s Anticoagulation Service also diagnoses and treats rare bleeding and clotting abnormalities, such as catastrophic antiphospholipid syndrome, hereditary spherocytosis, and immune thrombocytopenic purpura (ITP), among many others. The diagnosis and treatment of such rare blood disorders will be greatly facilitated by rotational thromboelastometry (ROTEM), recently instituted at MUSC under Dr. Greenberg’s leadership. These whole-blood analyzers are able to graph the entire clotting cycle within fifteen minutes of sampling and can be used, among other purposes, to identify which blood products are best suited for the treatment of these complex blood disorders (Figure 3).

It can be challenging to identify the proper blood products for patients with these rare blood disorders or for patients who have developed antibodies to antigens on the surface of red blood cells due to repeated transfusions (ie, some sickle cell, dialysis, and transplant patients). Jenny Petkova, M.D., a benign hematologist who is also Board certified in transfusion medicine, was recently recruited to MUSC to work closely with the Blood Bank. She has expertise in reducing the number of transfusions needed in such patients by stimulating the bone marrow or by prescribing medications to prevent excessive bleeding. She is also Director of the Adult Hematology Clinic, which cares for patients with these complex disorders on an outpatient basis.

MUSC’s Anticoagulation and Bleeding Management Service is a dedicated team of clinicians, pharmacists, nurses, and administrators who work collectively to manage anticoagulation therapy safely and effectively and provide patients throughout the MUSC Health Care System with state-of-the-art therapy to prevent DVT. They fight every day on the frontlines of the war against DVT, and together they are Changing What’s Possible for our patients with bleeding and clotting disorders.

To learn more about MUSC’s Anticoagulation and Bleeding Management Service, call MEDULINE at 1-800-922-5250 or 843-792-9200 and ask to speak to Caroline Vaughn, R.N.

References

FIGURE 3. ROTEM whole-blood analyzers recently acquired by MUSC.
“Become a blood donor. Give the gift of life.” When volunteers heed this call and donate blood, they trust that their gift will be respected and that good stewardship will be shown in the use of this valuable resource.

How valuable? Without red blood cell transfusions, some patients would undoubtedly die. These include some trauma, sickle cell, and leukemia patients, as well as patients undergoing chemotherapy for cancer. Having a plentiful, reliable blood supply is especially critical for a Level I Trauma Center like MUSC.

However, the thinking that blood transfusions are completely benign and benefit virtually any patient has changed. “Transfusion, like anything else, has its downsides,” according to Jerry Squires, M.D., PhD, Associate Professor of Pathology and Laboratory Medicine and Medical Director of the Transfusion Service at MUSC, and so it is important to properly manage blood resources so that transfusions are given only to those patients who truly need them. The inappropriate administration of blood unnecessarily exposes patients to certain risks associated with blood transfusion, particularly repeated blood transfusion.

Perhaps the most high-profile risk is that of infection. Bad blood captures headlines, as it did in the 1980s when it became clear that the human immunodeficiency virus (HIV) could be transmitted through blood donations. Since then, tests have been developed to screen out most viruses, such that the risk of acquiring either HIV or hepatitis C through blood transfusion is no higher than one in 2 million and the risk of acquiring hepatitis B is one in 400,000. However, new infection risks continue to be identified, including Chagas Disease, babesiosis, and hepatitis A.

Although the most well-known risk, infection is not the most common. Patients receiving multiple transfusions can develop allergies to antigens on the surface of red blood cells, making it much more difficult to find suitable blood products for them in the future. Acute transfusion reactions (within the first 24 hours after blood transfusion) are occasional complications of blood transfusions. Among the more serious of them is transfusion-related acute lung injury (TRALI), which is characterized by acute respiratory distress that develops within hours of the transfusion and is potentially lethal.

Historically, physicians turned to blood transfusions when patients’ hematocrits were low. Although a hematocrit of 14 is “normal,” the knee-jerk tendency to give any patient with a below-normal hematocrit a blood transfusion has been questioned. It is generally agreed that patients with a hematocrit of 10 g/dL or higher do not require a transfusion and that those with a hematocrit of 7 g/dL or below often do. In a landmark 1999 study, Hébert et al reported the results of a multicenter controlled trial randomizing 838 critically ill patients to either a restrictive (transfused if hematocrit <7 g/dL; maintenance hematocrit, 7-9 g/dL) or a liberal transfusion strategy (transfused if hematocrit <10 g/dL; maintenance hematocrit, 10-12 g/dL), finding that outcomes in patients treated using the restrictive transfusion strategy were as good as or, in some cases (in patients <55 years and those with less severe disease), better than in those treated using the liberal strategy.

Although physicians can rely on hematocrit triggers in some cases (transfuse if <7 g/dL or do not transfuse if >10 g/dL), many patients have a hematocrit that ranges from 7 to 10 g/dL. Often, patients with a hematocrit of 8 or 9 g/dL can “acclimate” to that range, remain asymptomatic, and not require a transfusion. In making the decision whether to transfuse in patients with a hematocrit in this range, physicians must rely on their own best clinical judgment.
Dr. Squires advises physicians as follows: “You’ve got to assess the patient. The laboratory value can corroborate and help you make the decision; however, if you start with the laboratory value, you will often make the wrong decision. Look at the patient to see if there are obvious indications that he or she needs red blood cells (eg, shortness of breath, tachypnea, tachycardia) or platelets or plasma….You have to leave laboratory results with clinical expertise.”

With proper blood management, the number of unnecessary transfusions can be drastically reduced, as MUSC’s recent successes show. Under Dr. Squires’ leadership, and with the strong support of the hospital administration, MUSC has significantly decreased the number of transfusions per 1000 patient-days from well over 200 in 2009 to under 150 in 2012. These successes were achieved by collecting data on the number of blood transfusions administered to patients with a hematocrit higher vs lower than 8 g/dL and sharing that information with physicians, along with educational materials about good blood management.

Transfusions can be reduced even in surgical patients, who, it is widely agreed, should not undergo an operation while anemic. Patients planning to undergo elective surgery can be evaluated early for anemia and, if anemic, can be administered iron or erythropoietin well in advance of surgery to raise hemoglobin levels without resorting to a blood transfusion. Hospitals often establish “anemia clinics” for this purpose. Another means of reducing the need for perioperative blood transfusion is cell salvaging, which is used for some operations at MUSC. Blood that would have otherwise been lost during surgery is collected and filtered and then reinfused into the patient, reducing the need for allogeneic blood transfusion and its associated risks.

Dr. Squires is also excited about the institution of whole-blood point-of-care testing at MUSC using ROTEM (Tem Innovations GmbH, Munich, Germany). This system provides surgeons and anesthesiologists a graph of the clotting cycle that they can use during the operation to guide decisions about which type of blood product to use (eg, plasma, platelets, cryoprecipitate) and when to administer it. This allows patients to receive the precise type of blood product they need and prevents wastage due to inappropriate administration. According to Alan C. Finley, M.D., Assistant Professor of Anesthesia & Perioperative Medicine at MUSC, “Bleeding management is a critical component of managing patients undergoing complex surgical procedures….Using ROTEM will allow us to minimize empiric blood transfusions by treating bleeding patients with an algorithm-driven protocol.”

Dr. Squires sums up the responsibilities of each party in the blood covenant as follows: “It’s critical that volunteers continue to donate. It’s our job as physicians to get that donated blood to the person who really needs it.”

References
The Joint Commission, Medicare, and other agencies have identified bundles of evidence-based clinical measures for certain diseases, such as stroke, myocardial infarction, and congestive heart failure, that, when successfully implemented, constitute "perfect care" for that disease. Hospitals are required to submit data to the Joint Commission and/or Medicare regarding their performance on each of these clinical measures. Like other hospitals, MUSC has worked hard to ensure that these care bundles for identified diseases have been embedded in practice and that the quality of their implementation is under continuous improvement.

Unlike many other hospitals, MUSC, under the leadership of Patrick Cawley, M.D., MBA, Chief Medical Officer/Executive Director Designate of the Medical University Hospital, has gone one step further, identifying ideal care bundles, or what it calls "MUSCare," for diseases or conditions, such as adult sickle cell disease or pancreatitis, not yet prioritized by the Joint Commission or any other regulatory body. According to Danielle Scheurer, M.D., MSCR, Chief Quality Officer at MUSC, there was a danger that patients with diseases for which "perfect care" reporting was not required would slip through the cracks: "Why should we let these other patients get squeezed out? Why don't we take the lead and go one step beyond what is required?"

Care bundles include evidence-based measures that improve outcomes; when good-quality evidence is not available on how to best treat a disease, MUSCare guidelines reflect a consensus of MUSC physicians as to what constitutes ideal care.

A number of physicians were tasked with piloting MUSCare by developing care bundles for conditions within their clinical specialty: Barton Sachs, M.D., for the anterior spine; Cathryn Caton, M.D., for pancreatitis; Keri Holmes-Maybank, M.D., for skin and soft tissue infection; and Dr. Scheurer for adult sickle cell disease, to name a few. The MUSCare bundle for adult sickle cell acute pain crisis is summarized here as a case in point.

With these pilot projects complete, MUSC has now rolled out the MUSCare initiative to all service lines. Each service line has a quality and performance improvement (QAPI) committee, and each of these QAPIs has been charged with developing and instituting an MUSCare bundle for a disease relevant to its specialty. Each QAPI must also collect data on how well these care measures are implemented so that areas for improvement can be identified and progress tracked.

Case in Point: MUSCare for the Adult Sickle Cell Acute Pain Crisis

The good news is that, due to improved pediatric care, more patients with sickle cell disease survive into adulthood, many into their fifth or sixth generation of life. The bad news is that the adult health care system may not be fully ready to meet their needs. Few physicians specialize in or have broad experience in treating adult sickle cell disease. Patients often are treated by primary care physicians, who can feel underequipped to treat these complex patients.

Sickle cell disease is a genetic disorder that causes red blood cells, usually round and flexible, to become sickled and sticky and thus less efficient at carrying oxygen and more likely to clump together to block blood vessels. Sickled red blood cells are much shorter-lived than healthy ones, making it difficult for the body to produce enough new blood cells to replace dying ones. Sickle cell acute pain crisis occurs when capillaries become blocked, cutting off the oxygen supply to the tissues and resulting in intense and often unremitting pain. Acute chest syndrome, in which the capillaries of the lungs become blocked, is the most serious manifestation and can be lethal. Almost all sickle cell patients require opioid therapy to control their pain.

Protocols are widely available for the management of sickle cell disease in the pediatric population. However, care can become...
fragmented as children reach their teenage years and begin to transition to adult care. Increased rates of mortality and morbidity have been reported for sickle cell patients within two years of this transition.¹ In adulthood, episodes of sickle cell acute pain crisis typically increase, often sending the patient to the emergency room multiple times a year.

Sickle cell patients in acute pain crisis will often request morphine or other opioids in the emergency room to control their pain, often raising suspicions that their pain is exaggerated or an excuse used by an addict for seeking drugs. For these reasons, the pain of many adult patients with sickle cell disease is not adequately controlled, severely affecting their quality of life and overall health.

What then is MUSCare for an adult sickle cell patient who presents in acute pain crisis?

The highest priority at admission is to control the patient’s pain by the appropriate administration of opioids (Table). It is also critical to obtain an oxygen saturation rate on room air and to provide oxygen as sickled cells are less efficient at carrying oxygen. Intravenous fluids should be administered as dehydration can further increase the viscosity of the blood. Because opioids can cause constipation, a bowel regimen should be instituted. As the body struggles to create new erythrocytes to replace the short-lived sickled ones, its supply of folic acid is depleted. Thus, a sickle cell patient who presents in acute pain crisis should receive folate.

For patients who are severely anemic or in whom blocked vessels lead to conditions that could endanger life or cause organ failure, blood transfusions may be necessary to increase the proportion of circulating healthy red blood cells. In other patients, anemia may be adequately addressed with medications or by stimulating the bone marrow. Transfusions should be utilized sparingly because repeated transfusions can lead to patients developing an antibody to an antigen on red blood cells, making it much more difficult to find blood products in the future. Because patients with sickle cell disease are at increased risk for infection, they should be vaccinated for influenza and pneumococcus. Some evidence suggests that incentive spirometry, in which a patient inhales from a device that allows a visual measure of the depth of the breath, may help protect against lung collapse or against the development of acute chest syndrome, the most lethal complication of sickle cell disease.

Discharge planning is especially important in these patients as it can help prevent the stress of emergency room visits. Obtaining a follow-up appointment for patients and providing them with a prescription for enough opioids to get them through to that appointment makes it far more likely that an acute pain crisis can be avoided or treated successfully at home (see the Table for the complete discharge bundle).

With proper management, including careful discharge planning, adult sickle cell patients and their providers may be able to minimize the number, or reduce the intensity, of acute pain crises.

Reference

Dr. David G. Bundy, M.D., MPH, joined MUSC in August 2012 as the new Medical Director for Quality and Safety at MUSC Children's Hospital and as Vice Chair of Quality and Safety in the Department of Pediatrics. He came to MUSC from Johns Hopkins University, where he served as Associate Director in the Division of Quality and Safety of the Department of Pediatrics. He was attracted to MUSC because of the demonstrated commitment of its physicians and administrators to a culture of safety.

Dr. Bundy believes his job is to “think about the how.”

How to best implement proven clinical strategies sometimes takes a back seat to the quest for the latest breakthrough. But Dr. Bundy points out that patients will not fully reap the benefits of such breakthroughs, or even of long-proven strategies, if they are not translated effectively and reliably into practice.

How then, according to Dr. Bundy, can we improve our track record at implementing proven strategies?

First, when it comes to instituting a new guideline or a new technology, we must recognize that the devil is in the details. As an example, Dr. Bundy cites the work of the MUSC team to customize EPIC, MUSC’s new electronic medical record, to pediatric care. In adults, medication is typically given at standard dosages, whereas in children dosages are often weight-based. Properly tailoring medication dosages in EPIC for children reduces the potential for dosage errors and thereby safeguards patients.

Second, we must acknowledge and mitigate human error. No human ever gets it right 100% of the time, even if he or she has been educated about the latest guidelines and intends to implement them. According to Dr. Bundy, “if you rely on human best intentions, you get it right 95% of the time, but that’s not good enough in a high-risk business like medicine or surgery.”

How then does another high-risk industry, commercial aviation, maintain its impressive overall safety record? It does so in part by developing checklists that must be completed before every takeoff and by every pilot, regardless of age and experience. These checklists reduce the risk that an essential step will be missed due to human error, whether from fatigue or distraction. Systematizing safety in this way has made commercial aviation the standard bearer for the patient safety and quality improvement movement in medicine. Similar checklists have proven very effective in reducing medical errors (see “The Timeout: A Sixty-Second Fix to Surgical Error?” in this issue).

Third, we must be willing to learn from mistakes or “near misses” when they occur. According to Dr. Bundy, “Anyone can swoop in when something terrible happens and say it shouldn’t happen again, but it’s a more advanced organization that learns from more subtle inputs—near misses, safety reports, safety rounds. We need to learn from the mistakes that we almost made.”

This may require a cultural change in health care, leading toward increased transparency and the opening of new lines of communication between the administration and employees on the front lines, who are aware of day-to-day challenges and obstacles to best care. Since his arrival, Dr. Bundy has instituted “Safety Rounds,” whereby he and other key leadership visit a few of the units each week, with the goal of visiting each at least once a month. Bringing leaders who are capable of effecting change together with frontline employees who know of opportunities for change can rapidly resolve issues and improve both efficiency and safety.

Finally, we need to communicate best practices or lessons learned from near misses to other departments and indeed to other institutions. Too often, health care professionals work in silos, with the result that successful strategies or important lessons learned are not shared and so do not have maximal effect. Dr. Bundy is developing a multidisciplinary quality and safety research group to collect and share quality data to break down such silos. MUSC also participates in a number of national consortia dedicated to quality improvement (eg, the PR-COIN network for juvenile idiopathic arthritis).

The appointment of Dr. Bundy highlights MUSC’s commitment to continually enhancing patient safety and its willingness to collaborate with other institutions in the service of that goal.
The Medical University of South Carolina Welcomes the Following New Physicians:

**C. Martin Bunke, M.D.** // Board Certifications: Internal Medicine, Internal Medicine: Nephrology // Specialty: Nephrology // Special Interests: Transplant nephrology, Transplant medicine // Medical School: Yale University // Residency: Clarion Health Partners // Fellowships: University of Washington Medical Center, Indiana University School of Medicine, New York Medical College

**Andrew S. Eisenman, M.D.** // Board Certification: Ophthalmology // Specialty: Ophthalmology // Special Interests: Cosmetic rejuvenation, Eye socket trauma, Eyelid reconstruction, Lacrimal drainage disorders, Orbital tumors // Medical School: Uniformed Services University of the Health Sciences // Residency: Walter Reed Army Medical Center // Fellowship: Wills Eye Hospital

**Puja S. Elias, M.D.** // Board Certification: Internal Medicine // Specialty: Gastroenterology & Hepatology // Special Interests: Barrett’s esophagus, Gastrointestinal cancers, Colorectal cancer screening // Medical School: Tulane University School of Medicine // Residency: Temple University Hospital // Fellowship: Medical University of South Carolina

**Barry T. Malin, M.D., MPP** // Specialties: ENT - Head & Neck, Oncology // Special Interests: Head and neck cancers, Microvascular reconstruction of the head and neck, Advanced head and neck skin cancers // Medical School: University of California at San Francisco // Residency: State University of New York at Buffalo // Fellowship: Medical University of South Carolina

**Michaella M. Prasad, M.D.** // Specialties: Urology, Pediatric Urology // Special Interests: Disorders of sexual development, Hypospadias, Robotic surgery, Hydronephrosis, Ureteropelvic junction obstruction // Medical School: Duke University School of Medicine // Residency: Harvard Medical School // Fellowship: Children’s Memorial Hospital at Northwestern University

**Nicoleta D. Sora, M.D.** // Specialty: Endocrinology // Medical School: University of Medicine and Pharmacy Romania // Residency: Yale University // Fellowship: Medical University of South Carolina

**Alejandro M. Spiotta, M.D.** // Specialties: Neurointerventional radiology, Neurosurgery // Special Interests: Brain tumors, Spinal tumors, Microdiscectomy, Fusions, Lumbar stenosis // Medical School: University of Pennsylvania // Residency: The Cleveland Clinic Foundation // Fellowship: The Cleveland Clinic Foundation


**Beje Sam Thomas, M.D.** // Board Certifications: Internal Medicine, Internal Medicine: Nephrology // Specialty: Nephrology // Special Interest: Transplant nephrology // Medical School: University of Debrecen Medical and Science Centre // Residency: University of Connecticut // Fellowships: University of Connecticut Health Center, Medical University of South Carolina

**Christina L. Vaughan, M.D.** // Board Certification: Neurology // Specialty: Neurology // Special Interests: Parkinson’s disease, Parkinsonism including problems of advanced disease such as dyskinesia and neuropsychiatric symptoms, Tremors, Chorea, Huntington’s disease, Dyssomnia, Spasmodic torticollis, Ataxia, Tics and Tourette’s syndrome, Clinical trials in movement disorders, Botulinum toxin injections, Fragile X-associated tremor/ataxia syndrome // Medical School: State University of New York at Buffalo School of Medicine and Biomedical Sciences // Residency: University of Pittsburgh Medical Center // Fellowship: Rush University Medical Center

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Statewide Broadcast...Gut Decisions: Controlling Clostridium Difficile Infections
April 26, 2013 • 11:00am-12:00pm
Cassandra Salgado, MD, MS

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