Centers for Disease Control and Prevention (CDC) Hospital-Acquired Infections

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Hospital-acquired infections (HAIs) are unintended infections that result from patients being exposed to medical care. HAIs put patients at risk for further complications, increase lengths of hospital stays, add to health-care costs, and cause significant patient mortality. HAIs are largely preventable, and reducing HAIs is a goal of every health-care organization as well as the Centers for Disease Control and Prevention (CDC). The CDC National Healthcare Safety Network (NHSN) is a secure web-based surveillance system that sets standards for defining and reporting HAIs. Hospitals must enroll and complete NHSN training to comply with the Centers for Medicare & Medicaid Services (CMS) Hospital Inpatient Quality Reporting (IQR) Program HAI requirements.

Acute-care hospitals are required to report six types of HAIs to CMS. Brief descriptions are given below. Complete surveillance definitions are available at cdc.gov/nhsn. The hospital infection preventionist is responsible for HAI surveillance and NHSN reporting. Surveillance is completed via a review of laboratory results

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and patient medical records. Data reported to NHSN are used to establish national performance benchmarks, to compare patient outcomes among health-care facilities, and to determine when to assess financial penalties and incentives based on the quality of care received. NHSN reports national- and state-level data using standardized infection ratios (SIRs) that are calculated by dividing the reported number of infections by the expected number of infections. The number of expected infections is calculated based on baseline national HAI aggregate data and is adjusted for each facility using variables found to be significant predictors of HAI incidence, such as bed size and teaching facility affiliation.

Key Concept
Hospital-acquired infections (HAIs) reported according to NHSN definitions are based on the review of cultures and medical records. Therefore, metrics based on NHSN HAIs are not derived from administrative data. NHSN HAI SIRs are risk-adjusted and therefore allow benchmarking among health-care organizations.

10.1 Definitions

10.1.1 Definition of Device-Associated HAIs

These are infections with a date of event (DOE) on or after hospital day 3 (where the day of admission is day 1) and an indwelling device was present for more than two consecutive calendar days on the date of event. The devices must still be in place on the DOE or must have been removed the day before or on the DOE. The two device-associated HAIs are

1. Central line-associated bloodstream infection (CLABSI): NHSN defines a CLABSI as a laboratory-confirmed bloodstream infection that is not secondary to an infection at another body site and a central line was in place for more than two consecutive calendar days on the DOE.
2. Catheter-associated urinary tract infection (CAUTI): NHSN defines a CAUTI as a urine culture with no more than two species of organisms identified, at least one of which is a bacterium of ≥100,000 colony-forming units (CFUs)/milliliter and an indwelling urinary catheter was in place for more than two consecutive calendar days on the DOE.

10.1.2 Definition of Procedure-Associated HAIs

These are infections that occur within 30 or 90 days after an NHSN-defined operative procedure (where day 1 is the procedure date) involving deep soft tissues of the incision or any part of the body deeper than the fascial/muscle layer that is opened or manipulated during the operative procedure. The two procedure-associated HAIs included in the CMS IQR Program are

1. Inpatient colon surgical-site infection (COLO SSI)
2. Inpatient total abdominal hysterectomy surgical-site infection (HYST SSI)

10.1.3 Definition of Hospital Onset Laboratory-Identified Events (LabID)

LabID event reporting is designed to be a less labor-intensive method of surveillance to track multidrug-resistant organisms (MDRO) and *Clostridioides difficile* (*C. diff*) infections. It uses laboratory testing data (without clinical evaluation) to provide proxy infection measures for the hospital's MDRO and *C. diff* exposure burden. Infection burden caused by these organisms is based exclusively on laboratory data in relation to admission date. Hospital onset (HO) events are those LabID specimens collected on or after hospital day 4 when the patient does not have a documented community onset (CO) event. Facilities report both HO and CO events to NHSN. The two LabID HAIs included in the CMS IQR Program are

1. Methicillin-resistant *Staphylococcus aureus* bloodstream infection (MRSA BSI): *Staphylococcus aureus* cultured from blood that tests oxacillin-resistant, cefoxitin-resistant, or methicillin-resistant by standard susceptibility testing methods, or any laboratory finding of MRSA in blood [includes but is not limited to polymerase chain reaction (PCR) or other molecular-based detection methods].
2. *Clostridioides difficile* infection (CDI): A positive laboratory test result for *C. diff* toxin A and/or B [includes molecular assays (PCR) and/or toxin assays], tested on an unformed stool specimen (must conform to the container) or a toxin-producing *C. diff* organism detected by culture or other laboratory means performed on an unformed stool sample.

10.2 Central Line-Associated Bloodstream Infections (CLABSI)

It is estimated that patients are exposed to an aggregate of approximately 15 million days of central venous catheter (CVC) use in the United States. Annually, hospitals report 250,000 cases of central line-associated bloodstream infections, of which 80,000 occur in intensive care units (ICUs) [1]. Most ICU patients and many noncritical care patients require the use of CVCs or peripherally inserted central catheters, collectively referred to as central lines (CLs). Having these lines puts patients at risk of CLABSIs. These infections lead to prolonged length of stay, exposure to antibiotics, and medical complications, and they are costly to the facility.

Prevention Standardization is essential for minimizing risk to patients: insertion, maintenance, and removal protocols should be established and implemented across all teams. A standardized supply cart and kits that contain all necessary components for the insertion of nontunneled CVCs will minimize variability in insertion

practice. CLABSI prevention activities can be summarized in an insertion bundle and a maintenance bundle.

The first element of the CLABSI insertion bundle is optimal site selection. The axillary/subclavian site is the preferred site for CL insertions [2, 3]. However, this site might pose a subclavian stenosis risk in patients needing arteriovenous grafting. For those patients, an alternative site needs to be considered. The internal jugular site is preferred to the femoral site; the latter has been associated with higher rates of infection [2]. If a CL is inserted at the femoral site, it should be reassessed daily and removed as soon as possible. Emergently placed femoral CLs should be removed within 24 h, as should any emergently placed CL where sterility cannot be guaranteed. Use a CL with the minimum number of lumens necessary for optimal patient management. More lumens are additional portals to the patient's bloodstream and increase the risk of infection [1, 3]. Per the CDC, providers should not use guidewire exchanges routinely for nontunneled catheters to prevent infection or for suspected infection [1, 3].

The remaining elements of the insertion bundle can be documented on a checklist and in the electronic medical record (EMR):

1. Perform hand hygiene before insertion.
2. Clip all hair around the site of insertion.
3. Adhere to aseptic technique.
4. Use maximal sterile barrier precautions (i.e., mask, cap, gown, sterile gloves, and sterile full-body drape).
5. Perform skin antisepsis with >0.5% chlorhexidine with alcohol and follow the manufacturer's instructions for use.
6. Staff present during insertion should stop a nonemergent CL procedure if proper protocol is not followed or sterility is breached [4].

The CLABSI maintenance bundle revolves around maintaining a clean, dry, intact CL dressing. Some insertion practices can help prevent future maintenance issues. Do not hub the line as this prevents proper placement of the antimicrobial disc during CL dressing changes. Optimally, all lumens should be secured downward or laterally. Downward securement will favor dressing adherence by minimizing the weight of lumens pulling apart dressing components; minimize exposure of dressing and lumens to hair, oral secretions, and other sources of infection; and provide a flatter surface free of skin folds and curvature, thereby promoting dressing adherence. Tubing anchors minimize movement of the CL that may loosen the dressing and can be used on heavier lines or multiple lines at a single anatomic site.

Appropriateness of the CL must be assessed during each shift [1, 3]. All CL dressings must remain clean, dry, and intact. If the CL is suspected to be infected, it should be removed immediately. Dressings should be changed every 7 days at minimum. Infection preventionists and unit-based nurse champions should perform regular bundle audits to ensure compliance. Blood culture draws from CLs should be avoided due to the risk of colonization and false-positive results [4, 5]. Routine catheter tip cultures are not part of the NHSN CLABSI definition, are not clinically useful, and should not be obtained [6].

Concurrent Review and CLABSI Surveillance *Ruling Out Other Sources of Infection:* If NHSN site-specific criteria for other infections are met, the BSI may be considered secondary to that source rather than the CL. When an infection preventionist first identifies a possible CLABSI, the first step is to rule out other possible primary sources of infection. If another source of infection is suspected, there must be diagnostic evidence (culture, imaging evidence, etc.) in order for the BSI to be considered secondary to that infectious source, and therefore not to be considered a CLABSI.

Learning from the Event When a CLABSI is identified at our institution, a number of well-established processes begin. The infection preventionist notifies the nursing unit director, unit-based medical director, and other facility leaders. The event also is mentioned at the health system-wide safety huddle. Unit leaders ensure that the patient's care team are aware that the patient developed a CLABSI, familiar with the CLABSI prevention bundle, and identify missed opportunities to prevent CLABSIs. A deep-dive tool (referred to as a "mini-RCA," see below) is completed by care team members and the infection preventionist to identify opportunities for CLABSI prevention. Unit-specific CLABSI data and risk assessment outcome measures are also provided weekly to key stakeholders, including unit and hospital leaders, licensed independent practitioners, nursing staff, and other clinicians. These data are also routinely reported to the Hospital Infection Control Committee and other internal stakeholders. CLABSI nurse champions meet regularly throughout the year, disseminate evidence-based best practice education to their respective units, and conduct a minimum of 10 CLABSI bundle audits on CLs per month with the bundle audit tool pictured in Fig. 10.1.

10.3 Catheter-Associated Urinary Tract Infections

According to the CDC, 15–25% of hospitalized patients will have an indwelling urinary catheter (IUC) at some time during their hospitalization. Each day the IUC remains, a patient has a 3–7% increased risk of CAUTI. It is estimated that more than 13,000 hospital deaths are associated with UTIs each year, of whom as many as 69% are preventable [1].

Prevention CAUTI prevention requires training on proper insertion technique, maintenance, limiting use of IUCs for only appropriate indications, and appropriate use of urine cultures. A bundle audit tool is used to monitor adherence to evidence-based practices (see Fig. 10.2).

Our facility has adopted a Nurse-Driven Foley Removal Protocol that outlines specific indications for an IUC and gives nurses the authority to remove the IUC without a provider order if one of the below indications is not met:

- *Acute urinary retention*: the patient is unable to pass urine because of an enlarged prostate, blood clots, or an edematous scrotum/penis or is unable to empty the bladder because of neurologic disease/medication effect or neurogenic bladder

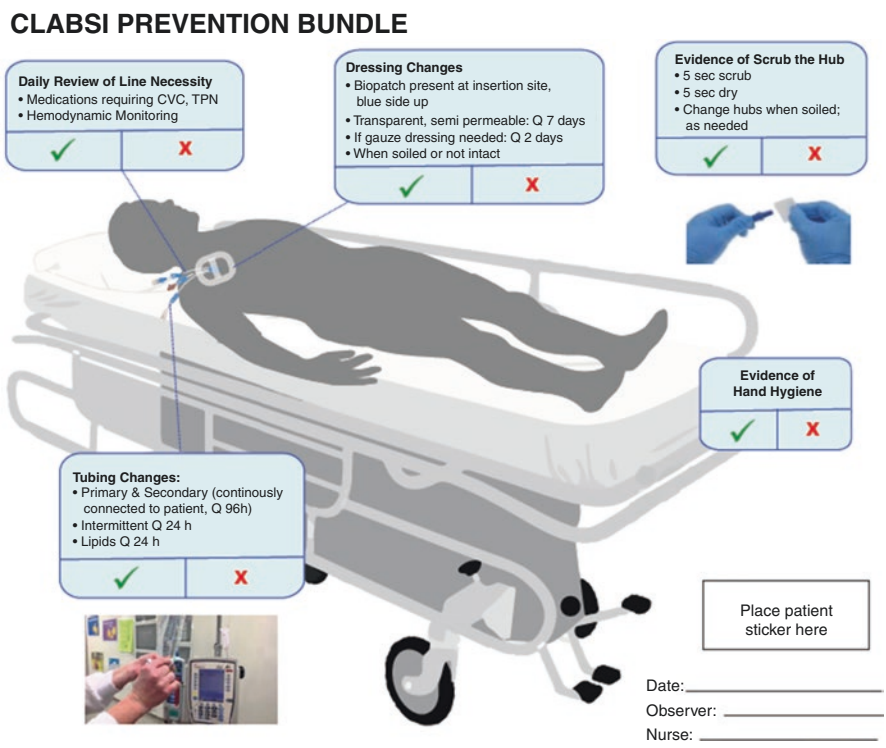

Fig. 10.1 CLABSI prevention bundle audit tool. CVC, central venous catheter; TPN, total parenteral nutrition; sec, seconds; Q, every; h, hours. (© Ochsner Health)

- *Ordered or placed by urology service*
- *Critically ill in ICU and requiring hourly monitoring of urine output*
- *Nonhealing perineal or sacral wounds* related to urinary incontinence to avoid further deterioration of wound and skin
- *Prolonged required immobilization* for trauma or surgery, that is, potentially unstable thoracic or lumbar spine, multiple traumatic injuries such as pelvic fractures
- *Hospice/comfort care or palliative care*
- *Chronic IUC on admission*
- *Selected postoperative cases* such as pelvic surgery and transplants

Patients meeting one of the above criteria should be assessed to determine if an alternative can be used. Our facility has acquired special supplies and equipment to give care teams alternatives to IUC. They include condom catheters, external female catheters, in and out catheterization, and ready availability of bladder scanners. Monitoring IUC usage, often calculated as IUC days, is

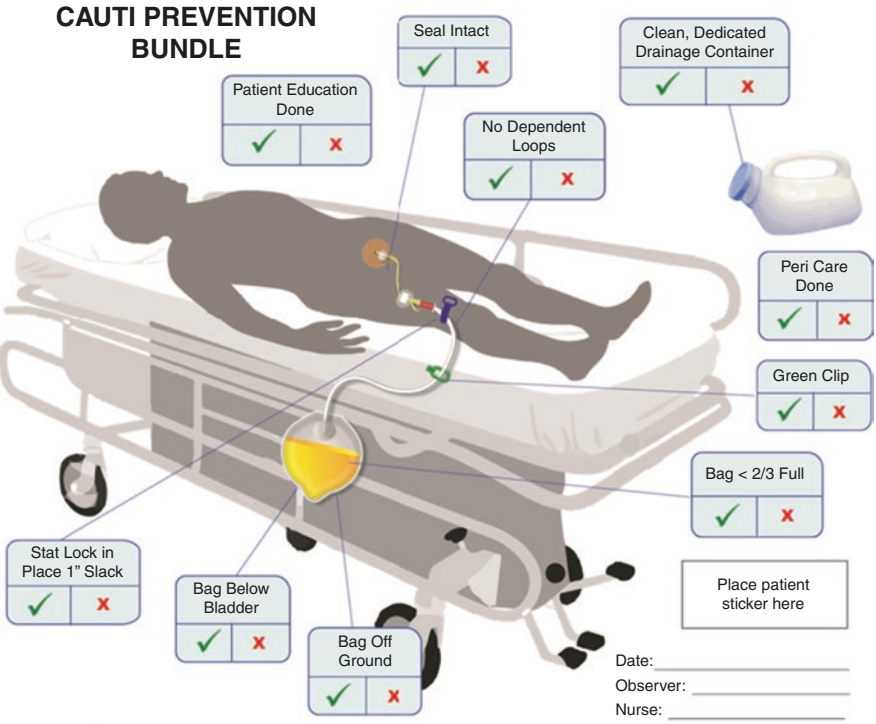

Fig. 10.2 CAUTI prevention bundle audit tool. (© Ochsner Health)

essential for reducing CAUTIs. Utilization should be calculated separately for critical care and noncritical care units. NHSN offers a standardized utilization ratio that shows how a facility's IUC or CL usage compares to other facilities across the country.

Testing Stewardship While reducing IUC utilization can be a nurse-driven task, providers can help in CAUTI prevention through testing stewardship. A positive urine culture is rarely the cause of fever and typically represents asymptomatic bacteriuria rather than a clinical infection [7]. Therefore, urine cultures should be reserved for patients with other site-specific signs or symptoms of UTI, such as suprapubic or costovertebral angle tenderness or >10 white blood cells on urinalysis. This facility addressed urine culture stewardship by creating an order panel in the electronic medical record that guides providers through the decision to order a urinalysis "reflex to culture" (Fig. 10.3). At our hospital, such an order results in the laboratory performing a urine culture only if the white blood cell count in the urinalysis equals or exceeds 10 per high-power field. In addition, medical staff-approved guidelines for fever workup in patients with urinary catheters were created and distributed (Fig. 10.4).

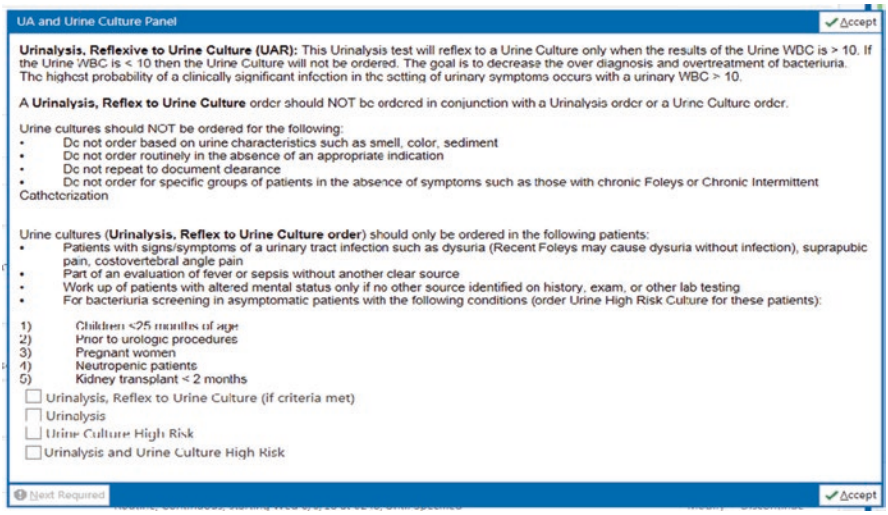

Fig. 10.3 Order panel for urinalysis and urine culture. WBC white blood cell count. (© Ochsner Health)

10.4 Surgical Site Infections (SSI)

Both colon (COLO) and abdominal hysterectomy (HYST) surgeries involve body sites that are colonized with microorganisms that increase the risk of infection after surgery. Various interventions can be utilized to provide an accurate evaluation of COLO SSI and HYST SSI outcomes and reduce SSI risk related to these procedures.

Prevention Some of the most common interventions are preoperative oral mechanical bowel preparation and antibiotics, perioperative skin antisepsis, intraoperative antimicrobial prophylaxis, wound edge protectors, and time out to change instrumentation for wound closure.

One additional element to consider in reducing SSI events is ensuring that the infection preventionist clearly understands how to accurately interpret and apply the NHSN surveillance definitions. At times, clinical documentation makes it difficult to accurately evaluate a patient's medical record when compared with the surveillance definitions.

Case Illustration: SSI Avoided in Patient with Abdominal Pain and Fluid Collection After Colon Surgery

A patient has a COLO procedure and, 17 days later, is readmitted with abdominal pain localized to the operative site that is described as throbbing. She also reports nausea and vomiting. Imaging studies of the abdominopelvic area reveal a fluid collection abutting the anterior abdominal wall incision within the peritoneum, with findings consistent with seroma or hematoma; however, a developing abscess is not excluded. Bowel loops are closely tethered to this

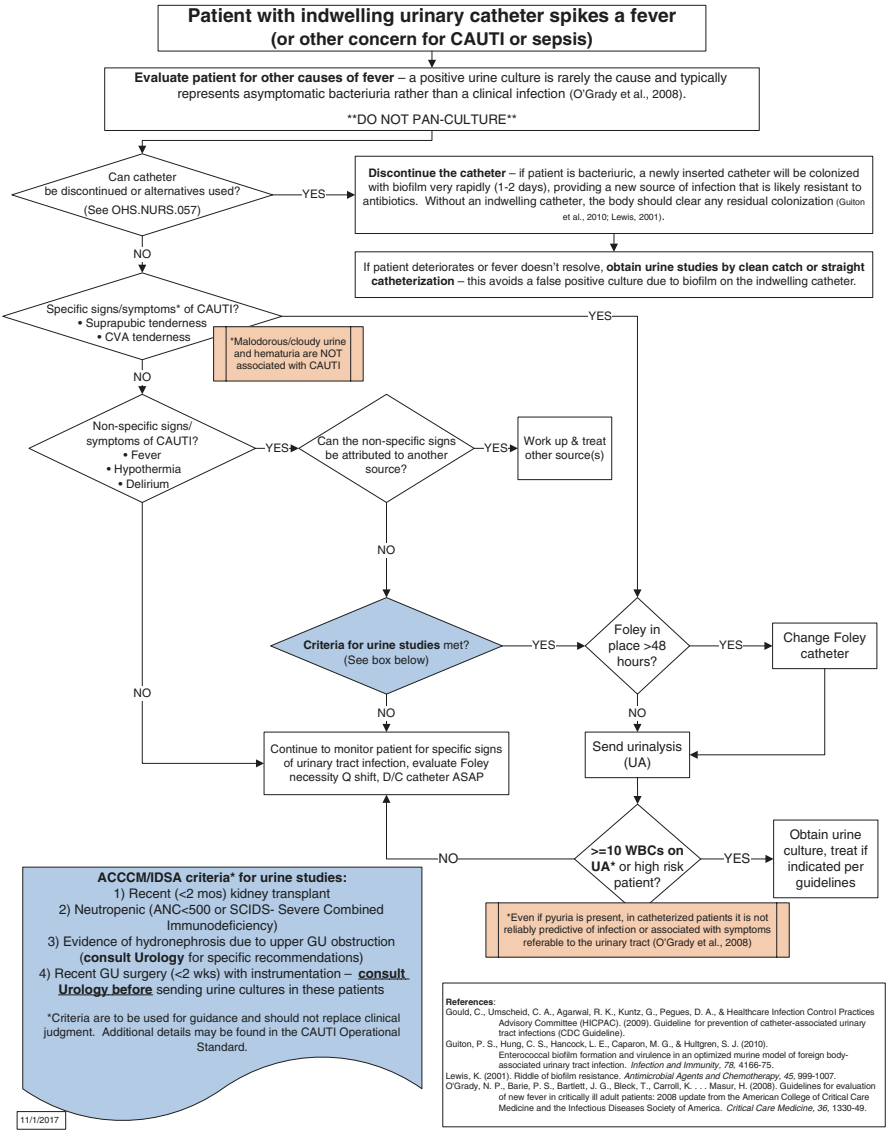

Fig. 10.4 Algorithmic approach to fever workup in patients with indwelling urinary catheters. (© Ochsner Health)

collection. Piperacillin–tazobactam is administered for intra-abdominal (IAB) infection. At first glance, an infection preventionist might easily interpret this as an IAB SSI event. There is clear evidence of infection that involves the organ space (peritoneum) with supportive evidence from imaging studies; however, without a positive fluid culture or purulent drainage from the IAB space or a positive blood culture, this postoperative infection does not meet NHSN criteria and should not be reported as an SSI.

Importance of Medical Record Documentation Clinical documentation of an infection noted during a surgical procedure may not equate to the NHSN present-at-the-time-of-surgery (PATOS) determination. PATOS events are still reported to NHSN but are excluded from reporting to CMS and other quality organizations. To apply PATOS to an SSI event, infection must be visualized during the surgery and documented in the operative report [8]. Providers should be aware of this documentation requirement and appropriately document in operative notes whenever there is evidence of infection during procedures. While wound class alone cannot be used to meet PATOS, correct documentation of wound class will allow NHSN to give an accurate risk stratification when calculating a facility's expected number of infections. Our mini-RCA process (see below) has been beneficial to identify opportunities for greater documentation accuracy. An example from our practice is our ability to use NSHN exclusion criteria to avoid reporting a colectomy SSI for situations where colectomy was part of a complex surgical approach for another condition. A case where a culture specimen is taken from a fluid collection that was not manipulated during the surgical procedure is another example. Of course, only appropriately documented cases may offer such opportunities.

10.5 MRSA BSI

MRSA BSIs are dangerous to patients and costly to health-care facilities. A single hospital-acquired MRSA infection can increase the cost of patient care by $24,015 [9]. The LabID criteria used by NHSN only require a positive MRSA blood culture. Even MRSA BSIs that are secondary to an MRSA infection of another site must still be reported to NHSN. Therefore, reducing MRSA BSIs requires preventing all sources of MRSA. To prevent these infections and protect patients, Ochsner has approved an evidence-based Decolonization Protocol for Patients at High Risk of MRSA Infection. Decolonization is completed via daily chlorhexidine gluconate (CHG) bathing and a 5-day course of twice-daily nasal mupirocin. High-risk groups for MRSA infection have been defined as

1. Patients with a *current or past MRSA infection* (in the past 6 months): Studies showed a 52% reduction in hospital-acquired MRSA BSIs in ICU patients with a previous MRSA infection after implementing a decolonization protocol [8, 10]. Decolonization led to a 30% reduction in HA MRSA infections for all patients [11].
2. *Dialysis* patients [10].
3. Patients with *CLs* and *IUCs***:** In patients with indwelling devices such as CLs, decolonization decreased all BSIs by 32% and MRSA or vancomycin-resistant enterococcus infection by 37% [12].
4. *Patients admitted from other hospitals, postacute care, or congregate living facilities* (nursing homes, rehab, correctional facilities, etc.): MRSA infection rate decreased by 65% in long-term care residents after implementation of a decolonization protocol [13].
5. Patients who are or previously were *intravenous drug users.*

6. Patients admitted to *critical care* units: A cluster-randomized clinical trial in 74 adult ICUs found that decolonization reduced all hospital-acquired MRSA by 37% and hospital-acquired MRSA BSI by 44% [14].

10.6 *Clostridioides difficile* Infections (CDIs)

Clostridioides difficile (*C. diff*) is a Gram-positive, spore-forming anaerobic bacillus that produces two large toxins, A and B, that cause diarrhea and colitis in susceptible patients. According to CDC, more than 200,000 cases and nearly 13,000 deaths occur from this disease annually [15].

Risk Factors and Prevention Antimicrobial therapy is widely accepted as the single greatest risk factor for the development of CDI. Other risk factors are gastric acid-reducing medications, recent exposure to a health-care facility, and previous *C. diff* infection. *C. diff* spores spread easily and can live on surfaces for months if not properly cleaned. Alcohol-based hand sanitizers and disinfectants are not sufficient to kill *C. diff* spores. Handwashing must be performed with soap and water and surface disinfection with bleach or other sporicidal disinfectants. Primary drivers of HO CDI are inappropriate antibiotic use, overuse of gastric acid-reducing medications, inadequate environmental cleaning and hand hygiene, inappropriate testing, and exposure. Acid-suppression therapy has been strongly associated with CDI. We encourage clinical teams to continually reevaluate the need for proton pump inhibitors (pantoprazole, omeprazole) and H2 receptor antagonists (famotidine, ranitidine) daily and discontinue them at the earliest possible time. Some organizations have pharmacist-driven medical staff-preapproved order guidelines that allow conversion of proton pump inhibitor therapy in the absence of a specific medical order. Daily assessment of antimicrobial therapy for opportunities to discontinue and/or de-escalate is paramount to preventing CDI. Avoiding the use of high-risk antibiotics (fluoroquinolones, cephalosporins, carbapenems), unless clinically necessary, is a best practice for reducing CDI risk.

Addressing these drivers requires collaborative efforts with infection prevention, nursing, physicians, pharmacy, laboratory, informatics, environmental services, and administrative leadership. After implementation of several collaborative interventions, our hospital reduced HO CDI by 50% from 104 events in 2017 to 52 events in 2020.

Testing Stewardship It has been our experience that success in testing stewardship is enhanced through a collaborative approach. Communication regarding assessment and testing for *C. diff* among care team members is facilitated with the use of visual aids that are distributed widely among all floors in our hospital. The "Diarrhea Decision Tree" (Fig. 10.5) is now used routinely in our hospital. Testing for CDI should be reserved for patients with clinically significant diarrhea, defined as three or more liquid or unformed stools occurring within a 24-h period. If a patient is known to have CDI, treatment can be started without testing (there is no need to

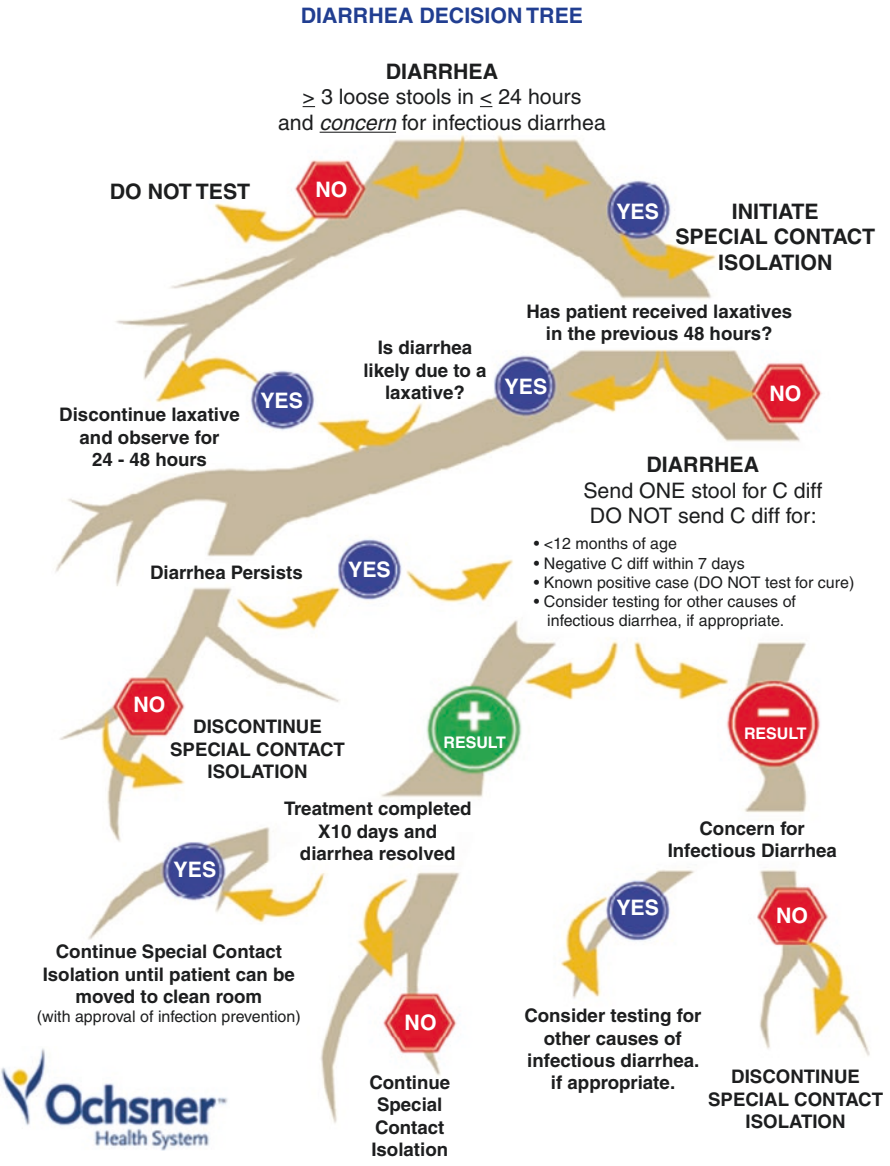

Fig. 10.5 Visual aid for unit nursing personnel to promote a collaborative approach to testing stewardship. (© Ochsner Health)

retest for CDI). Prior to testing, providers should consider other reasons for diarrhea, such as laxative or enema use, lactulose, tube feeds, or intravenous contrast. Laxatives or other causes of diarrhea should be discontinued before testing for CDI. Our organization has developed a suite of decision support tools to assist providers with testing stewardship. They include soft stops when laxatives have been

administered within the past 72 h of an intended *C. diff* stool test, auto-cancellation of *C. diff* testing orders past 24 h, hard stops for retesting, etc. We have adopted a team-based collaborative approach to testing stewardship that includes double checking for adherence to our testing protocol and escalation to unit medical leadership (see Fig. 10.5).

Documentation and Workup on Admission Appropriately documenting CDI when present on admission is key to avoiding the appearance and reporting of an unwarranted HO CDI. When patients are admitted with active diarrhea and other signs and symptoms such as fever, abdominal pain, and leukocytosis, our teams are consistently advised to order the test within 48 h of the admission.

10.7 The Mini Root-Cause Analysis ("Mini-RCA") Process for Infection Events

NHSN surveillance processes offer a standardized tool and uniform method to identify HAIs. Going beyond identification, our teams have sought to use information from our own patients to improve performance in avoiding hospital-acquired infections. We believe it vital to identify and investigate the root cause of HAI events. Our teams have developed the so-called mini-RCA process where patient-facing staff are provided the opportunity to retrospectively review HAI events to better determine the cause of these infections. This process is similar to Dr. Peter Pronovost's Comprehensive Unit-Based Safety Project methodology wherein patient-facing staff are empowered to identify defects in patient care that increase infection risks [16]. At Ochsner Medical Center, unit-based medical directors and nursing directors take the lead in completing mini-RCAs for CAUTI, CLABSI, *C. diff*, and MRSA bacteremia events. Physician and nursing leaders collaborate with staff involved in the patient's care to dive into the medical record. This process also includes interviewing staff across multiple disciplines to understand what can be done differently to prevent the next HAI event. Learnings from our mini-RCA process have contributed to insights regarding documentation opportunities. One example relates to the fact that NSHN definitions allow certain conditions to exclude a bacteremia to be ascribed to the central venous catheter. In the case of central venous catheters, such exclusions include documentation of invasive tampering or manipulation of the line by patients or visitors. Another exclusion applies for cases where a source of the infection is clearly documented and treatment initiated within the appropriate time period.

Outcomes Related to the Mini-RCA Process MRSA bacteremia HAIs were identified at a higher number than in prior years. During the mini-RCA process, many patient care units noted that several MRSA bacteremia events were secondary to other non-blood-related MRSA infections, such as pneumonia, wound, and peripheral IV catheter-site infections. They were often observed in patients with a history of MRSA infections. Clinical pharmacists also evaluated these events and

determined there were no additional antimicrobial interventions to reduce the risk of these patients progressing to MRSA bacteremia infections. Utilizing this feedback, the organization developed a business case to implement proactive interventions related to nasal and skin decolonization for high-risk patients. At present, all high-risk patients receive a 5-day course of nasal mupirocin and daily skin antiseptic bathing using CHG-impregnated cloths [10, 17].

Another example involved an increase in *C. diff* infections in an inpatient internal medicine telemetry unit. After the staff completed a series of mini-RCAs related to these infection events, we learned that many staff were not aware of specimen requirements and clinical practice guidelines for appropriate *C. diff* testing. Education was provided to staff related to specimen collection requirements, including visual cues to determine acceptable stool characteristics prior to submitting for testing (e.g., the "stick" test to assure no solid specimens are sent for testing). Posters were placed throughout the unit to guide staff through the process of assuring that requirements for submission of stool specimens were met. Nursing and laboratory staff were also empowered to cancel orders when patients did not meet specimen collection requirements. The electronic medical record was utilized to add clinical decision support tools during the ordering process.

The knowledge gained from mini-RCAs is imperative to identify opportunities to reduce further infection risk. Unit-level leaders and staff can offer recommendations for providing high-quality patient care. Infection preventionists can assist units and the entire organization with identifying and obtaining resources to reduce infection risks. Input from frontline staff is vital to better understand how infections occur and how best to implement interventions to reduce the likelihood of another patient being harmed by a preventable infection.

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