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Eliminating Nosocomial Infections at Ascension Health

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The article is the fourth of a series, which charts the journey of one health care system, Ascension Health, toward the clinical transformation of inpatient care—and no preventable injuries or deaths.

As described elsewhere,[1,2] Ascension Health, the largest Catholic and largest nonprofit health care system in the United States, has articulated a call to action that promises to provide "Healthcare That Works, Healthcare That Is Safe, and Healthcare That Leaves No One Behind, for Life," and to the goal of excellent clinical care with no preventable injuries or deaths by July 2008. This article reports on two alpha sites' experience in addressing one of Ascension Health's priorities for action—nosocomial infections.

Nosocomial infections comprise one of the leading causes of preventable injuries and deaths in hospitals, affecting 5% to 10% of hospitalized patients and contributing to increased morbidity, mortality, length of stay and cost.[3–5] Catheter-related bloodstream infections (CR-BSIs) and ventilator-associated pneumonia (VAP) account for the most significant morbidity, mortality and cost.[3] Although nosocomial infections historically have been accepted as adverse events related to hospitalization, they are considered preventable; therefore, a lower rate of nosocomial infections is a reflection of a higher quality of care. Compliance with evidence-based guidelines for preventing CR-BSIs and VAPs[6,7] is not universal, and variation of practice is still common.

Risk Factors and Prevention Measures

The risk for CR-BSI starts with the insertion of the catheter. Both phlebitis and septicemia can occur with a peripheral intravenous (IV) catheter, as well as with a

Article-at-a-Glance

Background: Eliminating nosocomial infections was identified as one of eight priorities for action for Ascension Health. St. John Hospital and Medical Center (SJHMC), and St. Vincent's Hospital (STV), designated alpha sites, developed best practices for the prevention of catheter-related blood stream infections (CR-BSIs) and ventilator-associated pneumonia (VAP), respectively.

Methods: Both hospitals used the Institute for Healthcare Improvement model of "bundles" to achieve the goal of reducing nosocomial infections and also implemented multidisciplinary rounds and the use of daily goal sheets in the intensive care unit (ICU).

Results: Through the use of ventilator bundle, central line (CL) bundle, MDRs, and daily goal sheets, both facilities reduced CR-BSIs and VAPs by more than 50%.

Discussion: SJHMC saw the benefit of having the physical presence of the ICPs in the ICUs, providing the staff with on-the-spot reinforcement of the initiative. STV found by starting the change process through the use of a flexible MDR team, the hospital was able to successfully implement positive changes in its ICU culture. On the basis of the success in the ICU, the concept of MDR teams eventually was adapted and spread to all units. Open communication among all patient caregivers was extended and served to provide improved patient care throughout the hospital.

central venous catheter, also known as a central line (CL). Although these complications can occur with both peripheral and CLs, the prevalence is higher with CLs.[8] The subclavian site is recommended as the preferred site because it is associated with a lower risk of infection.[6] The femoral site has been discouraged because of a higher incidence of infectious and thrombotic complications.[3,9] Most of the early-onset infections occur because of poor compliance with hand hygiene and/or aseptic technique that calls for maximum sterile barriers and chlorhexidine disinfection.[3,10] A process that incorporates hand hygiene, antiseptic techniques, and use of maximum barrier precautions should lead to a reduction in CR-BSIs.

VAP is defined as a pneumonia that develops more than 48 hours after endotracheal intubation, affects 8% to 28% of those on mechanical ventilation, and is associated with high mortality (25%–50%).[11–13] It also is associated with increased morbidity, length of stay (LOS), and cost, which may reach $40,000 per case.[11–13] Risk factors for VAP include nonmodifiable and modifiable factors.[12] Host factors, which are difficult to alter, include older patients, high severity of illness, altered mental status, and chronic pulmonary disease. However, attention to intervention and treatment factors will help reduce the rate of VAP.

Multiple interventions have shown benefit in reducing the risk of VAP, including avoiding tracheal intubation and using noninvasive positive pressure ventilation, shorter duration of mechanical ventilation, subglottic suctioning, avoiding nasal intubation, and avoiding manipulation of ventilatory circuit.[11] Placing intubated patients in the semirecumbent position, avoiding stomach distention or gastric residuals, and maintaining oral hygiene have contributed to a lower VAP rate.[11–13]

Reducing CR-BSI: The SJHMC Experience

SJHMC, a 607-bed tertiary-care teaching facility in Detroit, has 60 adult critical care beds across four units: surgical (SICU), medical (MICU), cardiac (CICU), and cardiovascular ICU (CVICU). Intensivists and resident physicians manage patients in the ICUs. In 2003, CL use (CL days/patient days) ranged from 42% to 98%. Although most of these CLs were inserted in one of the four ICUs, some were placed in the operating room (OR), emergency department (ED), or on the general nursing unit. Intensivists and attending and resident physicians insert CLs.

Nurses assist the physicians with line insertion by gathering supplies and preparing IV setups. Nosocomial surveillance for CR-BSI is conducted by infection control practitioners (ICPs) using the National Nosocomial Infections Surveillance System (NNIS) definitions.[14] In 2003, SJHMC's CR-BSI rate averaged 7.0 (range, 4.3–9.0) per 1,000 CL days. An opportunity existed to improve patient safety by decreasing the risk of CR-BSI.

Developing the Team

The initiative began in February 2004, when Ascension Health accepted SJHMC's proposal to become an alpha site for reducing nosocomial infections. Alpha sites were selected on the basis of local leadership's commitment to the initiative and willingness to allocate human and other resources to complete small tests of change in the designated focus area, evaluate the effect, track improvements, and lead the spread of successful strategies throughout the system. Each alpha site was allowed to choose its priority for action.

The rate of CR-BSIs in the ICUs was higher than NNIS rates, and efforts were initiated to reduce infection. A more structured approach to improve the process was needed. The infection control department met with the senior vice president of quality and the hospital chief executive officer (CEO) to describe the process to improve patient care and reduce costs. Senior leadership's support was key to ensuring availability of resources and enhancing the visibility of the initiative.

Developing the CL Bundle

The infection control department put together the educational component for physicians and nurses, with its medical director [M.G.F.] providing the education to physicians, and the ICPs providing it to nursing. In addition, ICPs educated rotating resident physicians in the ICU monthly. The educational program addressed the following:

- The significance of the problem with CR-BSI, the associated morbidity and mortality, and its financial impact on hospitals
- Types of CLs, indications for their use, and associated risk (infectious and noninfectious), included

alternate-access catheters with lower risk (peripherally inserted central catheters or peripheral intravenous catheters if no central access was required).

- Appropriate site of placement with a focus on avoiding femoral lines, a technique supported by our hospital policy, which discourages the use of femoral lines except for cases with high risk for pneumothorax and risk of noncompressible hematoma. Routine change or exchange over a guide wire of CL was discouraged.
- NNIS definitions of CR-BSI
- Detailed description of the tools for the procedure, including the CL cart, CL kit, CL checklist, and CL bundle components; this included a detailed description of the appropriate procedure for applying chlorhexidine and dressing changes.
- Tools to assess compliance (reviewing the checklist for documentation of compliance with the required bundle components)
- Measurement of outcomes (CR-BSI)
- Addressing potential barriers with implementation
- Promoting the role of the IV team in CL care

A protocol for line insertion was identified through the use of Centers for Disease Control and Prevention Healthcare Infection Control Practices Advisory Committee guidelines[6] and the IHI Central Line Bundle Mode.[15] Best practices were identified as skin preparation with a chlorhexidine product and use of a full sterile drape to cover the patient. In addition, physicians placing CL were required to practice hand hygiene before insertion and wear a sterile gown, gloves, and cap/mask. A checklist was developed for CL insertions that would be utilized to assess compliance with this protocol. The checklist included the following items:

- Before the procedure: hand hygiene by physician, the use of chlorhexidine, and use of a full drape
- During the procedure: use of hat, mask, and gown, maintenance of a sterile field, and the use of the assistant in the procedure of the same precautions
- After the procedure: application of a sterile dressing

The checklist forced compliance with the components of the procedure by not allowing the operator to proceed without following the best practices. The checklist did not allow "no" as one of the answers. The two options were either "yes" or "yes after correction."

Nursing and physician champions were designated. The nursing champion was defined as a nurse well known in the ICU who was involved in training nurses on his or her unit on using the checklist to document the correct placement of central catheters and was responsible for compliance with the checklist on all lines placed. The unit nurse manager acted as the nurse champion and supported the nurses' stopping of the procedure at any time if the physician was not complying with the established protocol. The physician champion was chosen based on being well known in the ICU, being involved in training residents for catheter placement, directing in-services for resident physicians (medical and surgical) on appropriate line placement and the use of the tool, and serving as a contact person if problems occur between operator (physician) and nursing. The ICU's medical director was asked to be the physician champion and was directly contacted if there were any issues with the procedure.

A CL insertion cart containing necessary supplies was assembled, including the chlorhexidine skin preparation product, which was new to the ICUs. Before starting the intervention, a gap analysis was conducted to identify deficiencies between current practice and the new protocol (Table 1, page 615). The CL kit was customized to include a large drape and chlorhexidine gluconate for skin antisepsis.

A team consisting of an ICP, medical director of infection control, and the IV nursing manager developed a plan for line tracking, dressing changes, and facilitating removal of the CL.[15] The team met with information technology to develop an electronic database for tracking CLs. The goal was to follow all CLs placed in ICU and promote their discontinuation when they were no longer necessary, even after the patient's transfer from ICU.

Implementation and Measurement

The new protocol was started with one nurse, one physician, and one patient. This process was then spread to involve all patients and nurses in the pilot ICU, and eventually all the ICUs were involved. Throughout the initiative, the ICPs rounded in the ICUs daily to collect the checklist and provide feedback if the form was missing information or not completed correctly. All components of the bundle needed to be present or the operator was considered noncompliant. The information from the

Table 1. St. John Hospital and Medical Center's Gap Analysis of Central Line Bundle Components

Central Line Bundle	Yes*	No†
Product for hand hygiene	X	
Chlorhexidine gluconate for skin antisepsis		X
Full sterile drape		X
Physician wears sterile gloves/gown, cap, and mask		X Gown and cap not always worn
Avoid femoral lines	X Policy addresses issue	
Sterile dressing applied	X	

* Already in place.

† Needs to be implemented.

checklist was then entered into the database. The checklist was revised three times to make it user friendly and still capture key information. MDR was incorporated into the ICU practice before the initiative; however, use of the daily goal sheet was new to the process. The sheet served as a communication tool regarding the plan of care for each ICU patient.

Monthly CR-BSI rates were reported back to the individual ICUs. Unit rates were compared with historical and NNIS rates[14]; feedback was important to maintain momentum.[6] Each report included high-level detail regarding the use of the protocol for line insertion. CR-BSI rates were also included on the hospital scorecard. Several months into the initiative, the CEO sponsored a celebration for the ICU nursing staff to recognize its efforts.

Data on daily CL utilization was collected through our ICU surveillance of all CLs (including Swan-Ganz, short-term triple-lumen catheters, and peripherally inserted CLs). The involved units submitted daily reports to infection control indicating the number of patients with a CL. All patients in ICU with positive blood cultures were evaluated by the ICPs for potential CR-BSIs.

Results

CR-BSI rates were compared pre- and postintervention. The CR-BSI rate gradually decreased in the ICUs. The initial goal was to reduce CR-BSIs in the ICUs by 30%. Before the intervention (July 2003–January 2004), the mean CR-BSI rate was 9.6 per 1,000 catheter days. The mean CR-BSI rate since the start of the intervention (February 2004–January 2006) was 3.0 per 1,000 catheter days—significantly lower than preintervention rates (independent 2-tailed *t*-test, assuming different variances, $p = .003$). In the first year of the intervention (February 2004–January 2005), CR-BSIs were reduced by 55%, exceeding the goal. Figure 1 (page 616) shows the decrease in the CR-BSI rate in the SICU, our pilot unit. In the first year of implementation in the pilot ICU, 92% (438/474) of the CL were placed using the bundle.

Detailed analysis of each CR-BSI allowed the team to determine if it was a potentially avoidable infection. When we reviewed CR-BSIs, we determined if the CL bundle was used for line insertion. Eleven (73%) of the 15 cases with CR-BSIs did not have documentation of the use of the CL bundle. The ICPs found that for some of the CR-BSIs, the CL was placed outside the ICU, in an area of the hospital not using the bundle, including the operating room (OR), emergency department (ED), and medical-surgical general units. These data provided the opportunity to spread the learning experience from the ICUs to other areas of the hospital to standardize the safest practice throughout the facility.

Implementation of the CL bundle was associated with a longer period of infection-free catheter days in ICU patients placed on the bundle. For patients with CR-BSI, the average time to acquire infection increased from 5.8 days in 2004 to 13.2 days in 2005. Catheter manipulation or site care may be the contributing factors to these infections.[16] A program is being developed to reinforce ongoing CL care. In addition, we promoted the use of

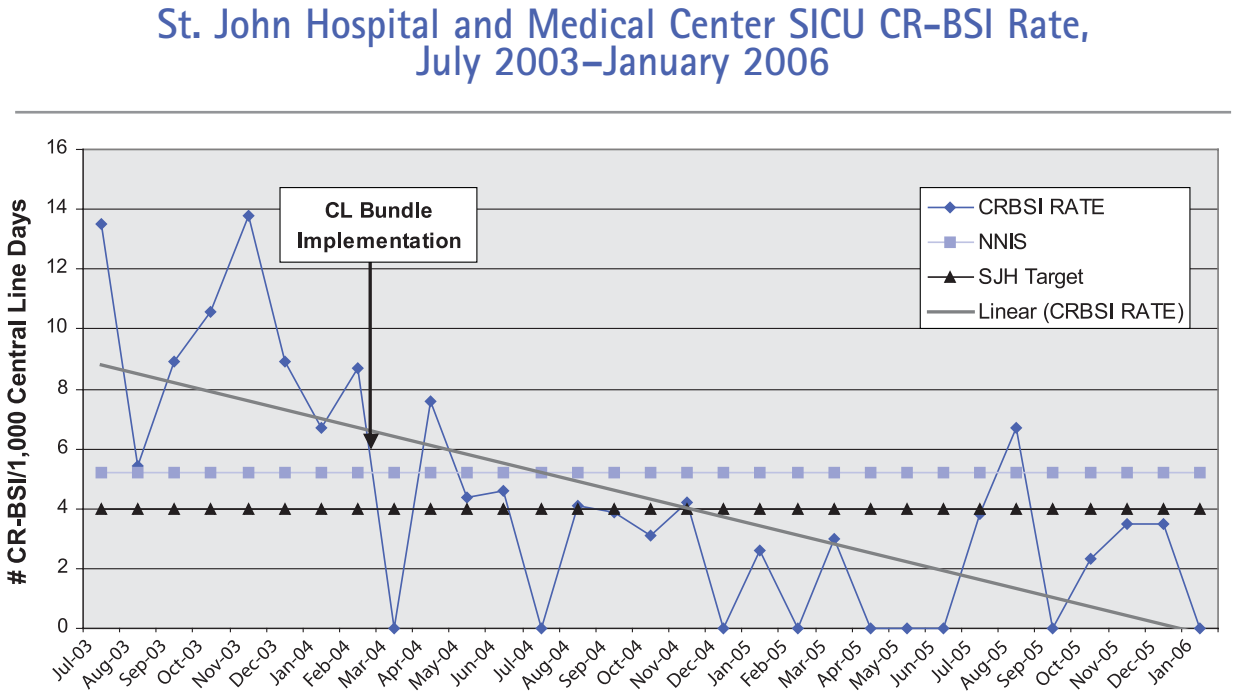

Figure 1. *Surgical (SICU) catheter-related bloodstream infection (CR-BSI) rates at St. John Hospital and Medical Center (SJH) are shown in comparison with historical mean (diagonal line) and National Nosocomial Infections Surveillance System (NNIS) rates. CL, central line.*

lower-risk devices such as peripherally inserted central catheters for those who need long-term IV access or peripheral IV catheters if appropriate.

We encountered barriers in developing and maintaining an electronic database to track CL. The IV team nurses were asked to input the data and follow up on all patients transferred from ICU with a CL. The IV team manager was supportive, but initial resistance was noted by many IV team nurses. The system was seen as complicated and not user friendly. Although the IV team nurses rounded on all medical-surgical units, they never intervened to discontinue unnecessary CLs on the general wards. With the encountered resistance by the IV team nurses, this effort was later halted.

Reducing VAP: The STV Experience

STV, a 338-bed acute-care hospital in Birmingham, Alabama, that serves a five-county area, has two 14-bed ICUs (medical-surgical ICU and CVICU). The medical-surgical ICU, which served as the pilot for the initiative to eliminate VAP, is the focus for this article.

STV does not have an intensivist program, and most patients on mechanical ventilation at STV are managed by pulmonary physicians. Respiratory therapy and nursing assist in managing these patients, and the infection control manager performs surveillance for VAP, using the NNIS definitions.[14] For the 13 months before the intervention, the average rate of VAPs in ICU was 8.2 per 1,000 ventilator days—higher than the NNIS pooled mean of 5.4.

Developing the Team

In February 2004 STV started its project to reduce nosocomial infections, working with Ascension Health and the IHI Critical Care Collaborative.[17] The administration committed its financial support of the project. A team of ICU nurses, representatives from administration, and quality managers was formed. Concepts introduced included use of bundles, MDR, daily goal sheets, small tests of change, and measurement of results. An implementation team was established to develop the process changes and further define goals included nursing staff, pharmacy, infection control, case management, social workers, dietary, respiratory, chaplain, transporters, quality managers, and a representative from CVICU, who would eventually spread the process changes to that unit.

The team was designated the MDR team and served as the catalyst to the changes. Although the long-term goal was to reduce the number of VAPs to zero, the immediate goals established by the MDR team associated with VAP were as follows:

- Reduce the VAP rate by 50%
- Reduce the number of ventilator days by 50%
- Reduce the average number of days a patient was mechanically ventilated by 50%
- Reduce ICU LOS by two days

Staff education was a necessary component at each step in the process change. The MDR team ensured staff's understanding of all aspects of the changes to come. Impediments to educating all staff included the use of traveling nurses and temporary staff and the normal turnover rate among staff nurses. A train-the-trainer approach was taken to accomplish the necessary staff education. Charge nurses, who were educated first, then educated the staff on their various shifts. ICU managers attended the nurse orientation program to explain the MDR, bundles, and other changes occurring in the critical care environment. The same approach was used with all new employees and with continuing education for staff.

Physicians were educated on the changes underway and were encouraged to participate. Although there was a lot of interest among the physicians, there was limited direct participation by them initially.

Developing the Ventilator Bundle

The MDR team designed a daily goal sheet, developed a VAP bundle, defined methodology for data collection and reporting, and determined an implementation date. The MDR team's role was critical to the overall success in implementing the changes.

The daily goal sheet became the MDR team's standardized tool (although one that can be revised as needed) for communication about the ICU patient. It included the elements of the VAP bundle, as well as other supportive evaluations, and provided a good overview of the patient's condition on that day. It was used to document recommended changes that needed to be communicated to the physician and other MDR team members, and finally, what was needed to transfer patients out to the medical-surgical units to improve flow.

The MDR team developed the bundle for ventilator patients on the basis of IHI guidelines.[17] The initial bundle consisted of head of the bed (HOB) at 30 degrees, deep vein thrombosis (DVT) prophylaxis, peptic ulcer disease (PUD) prophylaxis, oral care every two hours, and hand washing[7] (Table 2, page 618). Two other suggested bundle elements—sedation vacation and weaning protocol—were not implemented initially. However, protocols were developed later for each, and STV is moving toward implementation.

HOB. HOB at 30 degrees was the first bundle element implemented. An observation survey by the MDR team revealed that the ICU beds were elevated around 10–15 degrees. Measurement by the staff nurse was made easy with incorporation of a bubble protractor that indicated HOB elevation in the ICU beds. In addition, ICU beds supporting mechanically ventilated patients had pressure relief surfaces, therefore minimizing the risk for pressure ulcers.

DVT. Patients with respiratory failure have an increased risk of developing a DVT. Studies show that 22%–80% of ICU patients develop a DVT because of prolonged immobility, sepsis, and vascular injury from indwelling catheters, or other invasive devices.[18] All ICU patients were placed on DVT prophylaxis, unless contraindicated.

PUD. Patients with respiratory failure who are mechanically ventilated have an increased risk for developing stress ulcers and associated gastrointestinal bleeding. Factors that affect this include decreased gastric pH, increased gastric mucosal permeability, and ischemia.[19] Patients with a nasogastric tube show a significantly higher risk of developing gastrointestinal bleeding independent of body position.[20] Patients requiring ventilator support were placed on PUD prophylaxis on intubation.

Implementation and Measurement

The ICU staff nurse measured DVT and PUD prophylaxis compliance and reported findings in the daily MDR meeting. If no order was obtained for the appropriate prophylaxis, the staff nurse followed up with the physician to determine why prophylaxis was omitted.

Kits containing the material for every-two-hour oral care were placed in the patient room each morning and

Table 2. St. Vincent's Hospital's Ventilator Bundle and Oral Care Bundle*

Ventilator Bundle

- Head of bed at 30 degrees
- DVT prophylaxis
- Peptic ulcer disease prophylaxis
- Sedation vacation
- Daily weaning trial
- Oral care bundle

Oral Care Bundle

- Oral care every 2 hours
- Use suction toothbrush 0800 and 2000
- Suction secretions from the back of throat before performing
- Use suction swabs with peroximint except at 0800 and 2000 when suction toothbrush is used
- After each 2-hour oral suctioning, apply moisturizer to all mucous membranes, gums and patient's lips
- Document in nursing notes

* DVT, deep vein thrombosis.

inventoried the next day by the staff nurse to determine use. Compliance was reported in the daily MDR meeting.

Hand washing was the most difficult part of the bundle to measure. Different methods were used in an attempt to obtain data, including peer observation, charge nurse observation, and sign-in sheets. However, in practice, hand washing fell to the "honor system," with auditing by the unit charge nurse.

Results

As shown in Figure 2 (page 619), STV's ICU VAP rate per 1,000 ventilator days decreased from the average of 8.2 per 1,000 for 13 months (January 2003–January 2004) to 3.3 per 1,000 for 24 months (February 2004–January 2006; independent 2-tailed t-test, assuming different variances, $p = .02$). The average LOS in the ICU also decreased by more than three days, from a 2003 average of 8.0 days to a January 2006 average of 4.9 days. The average number of days on a ventilator and total ventilator days also decreased.

The absence of VAPs in the ICU from the time of implementation until August 2004—a period of more than 200 days—was encouraging. Beginning in August 2004, as new VAPs were identified, each was investigated thoroughly to determine if it was due to lack of compliance with the bundle.

We celebrate each month that passes without a VAP. The MDR team is convinced the key to success in eliminating VAP is continuous staff education, keeping the concepts in front of the staff that affect the outcome, and timely reporting of the data to support the changes made.

Discussion

Data from both SJHMC and STV showed a positive impact on patient care through the implementation of the CL and VAP bundles, respectively. Both hospitals attended the IHI collaborative together and networked via conference calls as they implemented their initiatives. Each facility had a focused effort, although each facility implemented both bundles and MDR.

The implementation of the CL bundle led to a reduction of CR-BSI of more than 50% at SJHMC. The results may be an underestimate of the effect of the intervention because we included all patients in the ICU with CLS—both those for whom the bundle was implemented and those for whom it was not. The intervention is similar to that described by Render et al., who reported that adhering to maximum sterile barrier and the use of chlorhexidine antisepsis resulted in a 50% reduction in CR-BSI.[21] Whereas Render et al. found adherence to chlorhexidine in about 50% of the cases, we enforced the use of chlorhexidine by having it as the only antisepsis available in the CL kit, making it extremely difficult for the physician to use other antisepsis agents such as betadine. We were also able to prolong the mean time to developing a CR-BSI to up to 2 weeks by 2005. The compliance with CL bundle prevents early infection of CLs. Late infections are usually related to either hub contamination or progressive catheter colonization post-placement leading to CR-BSI. We are preparing educational materials that address appropriate line care.

STV, whose efforts were associated with marked reduction in VAPs, used a care bundle that included the IHI components in addition to oral care.[16,22] Unlike SJHMC, physician support at STV was minimal. In addition, the

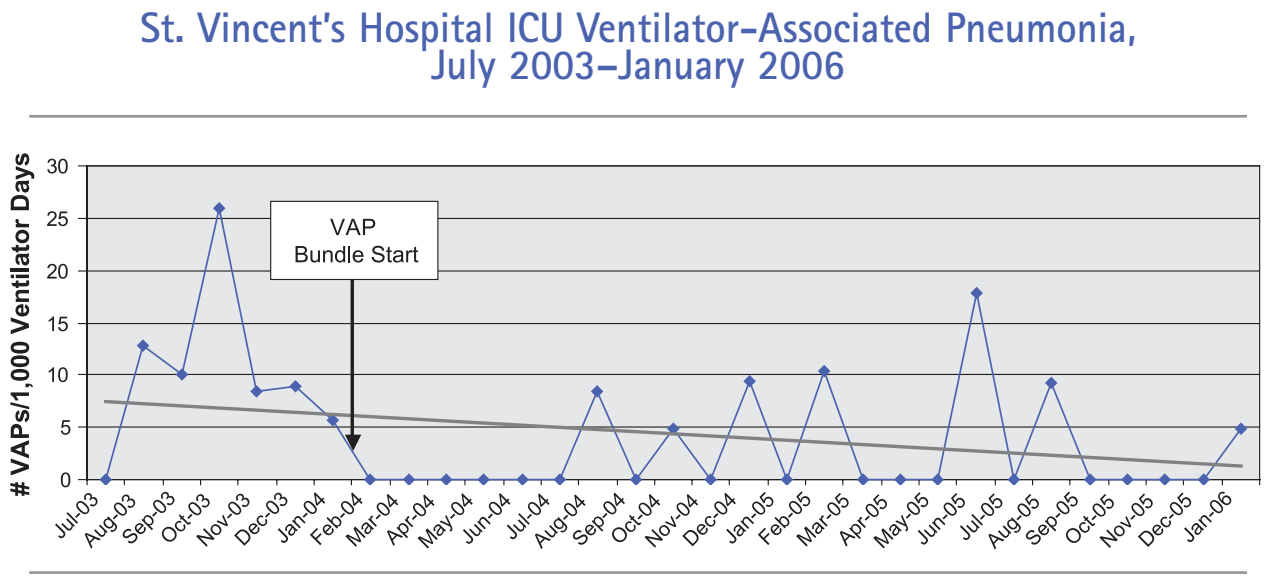

Figure 2. *St. Vincent's Hospital intensive care unit (ICU) ventilator-associated pneumonia (VAP) rates are shown.*

lack of presence of intensivists made it more difficult to implement the sedation vacation component of the bundle. However, the VAP rates improved significantly, and the effect of the intervention mirrored the results reported by Resar et al.[22] We believe that HOB elevation and oral care had a major impact on reducing the VAP rates.

STV found initial resistance from nursing regarding elevating the HOB, which was based on concern for the increased risk of pressure ulcers and increased risk of complications with blood pressure. Through education of the staff and physicians about the reduced risk for VAP in patients in semi-recumbent positioning, especially in patients receiving enteral nutrition,[23] it was able to improve compliance.

Introducing a new process in any facility can be difficult. An important part of the success was support from administration to eliminate the barriers usually encountered with a new project.[21] The physician champion was key to getting buy-in from skeptical physicians who were not convinced that the new practice would work.

The success of the quality improvement changes were tied directly to regular use of an interdisciplinary team supported by administration with good data collection, thorough analysis, and regular reporting to reinforce the changes.[24] Monthly feedback was important because it made everyone accountable and kept these initiatives a priority. (Information was not publicly posted for families to review.)

We did not achieve all our goals. At SJHMC, the electronic database for tracking CLs did not work as intended; the system was difficult to use, and limited staffing on the IV team prevented successful implementation. In addition, checklists for some CLs that were inserted in the ICU were often missing because of the difficulty in tracking CLs. Future implementation of electronic medical records should facilitate tracking.

Successful change comes slowly and requires persistence by members of the MDR team and solid support from administration to impact culture. Flexibility on the part of unit managers, charge nurses, and staff is a primary characteristic required to affect the change process. SJHMC saw the benefit of having the physical presence of the ICPs in the ICUs, providing the staff with on-the-spot reinforcement of the initiative. STV found by starting the change process through use of a flexible MDR team, the hospital was able to successfully implement positive changes in its ICU culture. On the basis of the success in the ICU, the concept of MDR teams eventually was adapted and spread to all units in STV. Open communication among all patient caregivers was extended and served to provide improved patient care throughout the hospital.

SJHMC and STV have used a systemwide Web site to share their experiences, including educational material and tools that they developed, with other Ascension

Health hospitals. In addition, prevention of nosocomial infections has been a frequent topic of monthly educational conference calls held among all the hospitals. We continue to improve our processes and share successes and barriers, thus contributing to "Healthcare That Is Safe" and to our goal of zero preventable injuries and deaths by July 2008. J

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