Infection Control
Executive Summary

Infection Control Tool Kit

The Centers for Disease Control and Prevention (CDC) estimates hospital-acquired infections (HAIs) affect more than 1.7 million U.S. patients annually and cause about 99,000 deaths. The total cost to the healthcare system is estimated at $4.5 – $7.5 billion annually. This results in an increase in ICU stays by eight days and an increase in average hospital stays by 7.4 – 9.4 days. With the overwhelming statistics and the latest ruling from the Centers for Medicare and Medicaid Services (CMS) stating they will no longer reimburse for certain hospital-acquired infections, the implication for hospitals is they will have to absorb these additional treatment costs. With escalating expenses and decreasing reimbursement, our healthcare system is looking to medical device manufacturers to bring them technology that will help prevent infections and reduce costs.

Welch Allyn has a solid reputation for providing innovative solutions to the healthcare industry for nearly 100 years. With safety and reliability at the forefront, Welch Allyn is prepared with products and services that will assist you in meeting the infection control crisis. As healthcare costs escalate, there is no better time to join forces with Welch Allyn for key products that will serve in this effort. The following tool kit will provide you with information in this fight against infection and the associated escalating costs.

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We at Welch Allyn hope this kit provides you with some of the tools you need to assist in your fight against infections.
Summary

of the Centers for Medicare and Medicaid Services (CMS) new payment and coverage policies to improve safety for hospitalized patients.
New Regulation to Deny Payment for Certain HAIs and Medical Errors

On July 31, 2008, the Centers for Medicare and Medicaid Services (CMS) announced new Medicare and Medicaid payment and coverage policies to improve safety for hospitalized patients. Beginning October 1, 2008, the CMS announced that it will no longer reimburse hospitals for certain preventable hospital-acquired infections (HAIs) and medical errors that occur in their facilities (see Table 1). The Inpatient Prospective Payment System (IPPS) FY 2009 final rule expands the list of selected hospital-acquired conditions (HACs) that have Medicare payment implications after October 1, 2008. The agency has issued a State Medicaid Director (SMD) letter outlining the authority of State Medicaid Agencies to deny payment for selected hospital-acquired conditions.

In the IPPS FY 2009 final rule, CMS also announced enhancements, including the addition of 13 new measures, to another hospital Value Based Purchasing (VBP) initiative, the Reporting Hospital Quality Data for the Annual Payment Update program (hospital pay for reporting). More information about the additional quality measures is available at: www.cms.hhs.gov/apps/media/fact_sheets.asp.

The agency required hospitals to begin reporting for discharges on or after October 1, 2007, whether the diagnoses for selected conditions listed on claims were present on admission (POA). In the IPPS FY 2008 final rule, CMS selected eight categories of conditions for the HAC provision, and in the IPPS FY 2009 proposed rule, CMS identified nine additional categories of candidate conditions.

All of the conditions have payment implications when acquired during an inpatient stay beginning with discharges October 1, 2008. The additional conditions are: 1) surgical site infections following certain orthopedic procedures and bariatric surgery for obesity; 2) manifestations of poor blood sugar control, such as diabetic ketoacidosis and hypoglycemic coma; and 3) deep vein thrombosis or pulmonary embolism associated with total knee and hip replacement procedures.

The new Medicare regulations include protections to prevent hospitals from billing patients when payments are withheld and to minimize avoidance of patients perceived to be at risk for infections.

How leading institutions are managing the clinical and economic impact of the new HAI regulations will vary but will be a focus of these organizations in order to comply with the new regulation.

For further information see: www.cms.hhs.gov/AcuteInpatientPPS/IPPS/list.asp

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Table 1

<table>
<thead>
<tr>
<th>Selected Hospital Acquired Condition</th>
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</thead>
<tbody>
<tr>
<td>Foreign Object Retained After Surgery</td>
</tr>
<tr>
<td>Air Embolism</td>
</tr>
<tr>
<td>Blood Incompatibility</td>
</tr>
<tr>
<td>Pressure Ulcer Stages III &amp; IV</td>
</tr>
<tr>
<td>Falls and Trauma</td>
</tr>
<tr>
<td>Catheter-Associated Urinary Tract Infection (UTI)</td>
</tr>
<tr>
<td>Vascular Catheter-Associated Infection</td>
</tr>
<tr>
<td>Manifestations of Poor Glycemic Control</td>
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</tbody>
</table>

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Clinical studies and articles
Blood Pressure Cuff as a Potential Vector of Pathogenic Microorganisms: A Prospective Study in a Teaching Hospital

C. de Gialluly, MD; V. Morange, MD; E. de Gialluly, MD; J. Loulergue, MD; N. van der Mee, PhD; R. Quentin, MD, PhD

Objective
To investigate the potential role of blood pressure (BP) cuffs in the spread of bacterial infections in hospitals.

Design
A comprehensive, prospective study quantitatively and qualitatively evaluating the bacterial contamination on BP cuffs of 203 sphygmomanometers in use in 18 hospital units from January through March 2003.

Setting
A university hospital with surgical, medical, and pediatric units.

Results
A level of contamination reaching 100 or more colony-forming units per 25 cm$^2$ was observed on 92 (45%) of inner sides and 46 (23%) of outer sides of 203 cuffs. The highest rates of contamination occurred on the inner side of BP cuffs kept in intensive care units (ICUs) (20 [83%] of 24) or on nurses’ trolleys (27 [77%] of 35). None of the 18 BP cuffs presumed to be clean (i.e., those that had not been used since the last decontamination procedure) had a high level of contamination. Potentially pathogenic microorganisms were isolated from 27 (13%) of the 203 BP cuffs: 20 of these microorganisms were Staphylococcus aureus, including 9 methicillin-resistant strains. The highest rates of contamination with potentially pathogenic microorganisms were observed on cuffs used in ICUs and those kept on nurses’ trolleys. For 4 patients with a personal sphygmomanometer, a genetic link was found between the strains isolated from the BP cuffs and the strains isolated from the patients.

Conclusions
The results of this survey highlight the importance of recognizing BP cuffs as potential vectors of pathogenic bacteria among patients and as a source of reinfection when dedicated to a single patient, emphasizing the urgent need for validated procedures for their use and maintenance.

Methods
This prospective study, spanning 3 months (January through March 2003), was performed in 5 surgical units, 7 medical units (including 1 short-term stay unit), 2 intensive care units (ICUs), 2 pediatric units (1 medical and 1 surgical), 1 emergency unit, and 1 unit that included operating rooms only. The BP cuffs used in these units were classified as wall-model BP cuffs if used for patients in operating rooms or in emergency or short-term stay units, as stored BP cuffs if kept in drawers or cupboards of nurses’ offices, as individual BP cuffs if used for a single patient either in an ICU or isolated unit because of colonization or infection that involved multidrug-resistant...
bacteria, and as BP cuffs on nurses’ trolleys if stored on nurses’ trolleys and used for several patients in the same unit. A defined cleaning procedure for the BP cuffs was available only in 2 units: BP cuffs were cleaned and disinfected by wiping with disinfecting detergent (Surfanios; Anios) after the last scheduled operation of the day in the operating rooms and by dipping into the same detergent on discharge of the patients in the ICU. The BP cuffs that were cleaned and disinfected just before samples were taken for microbiological analysis were classified in a separate group designated as clean BP cuffs. Two samples were taken from each BP cuff, one from the inner side (the surface in contact with the patients’ skin) and the other from the outer side (the surface in contact with the healthcare staff’s hands), using Count-Tact agar plates and a Count-Tact applicator (bioMérieux). The plates were incubated at 30˚C for 4 days in ambient air. The BP cuffs were considered to be abnormally contaminated when the number of colony-forming units (cfu) per plate was 100 or more (i.e., 4 cfu/cm² or more) and highly contaminated when the number was more than 300 cfu/25 cm² (i.e., more than 12 cfu/cm²).

Microorganisms that represent a high risk of nosocomial infection (Staphylococcus aureus, enterobacteria, Pseudomonas species, Acinetobacte species, and yeast) were specifically checked and tested for their susceptibility to antimicrobial agents by the disk-diffusion method. Pathogens isolated from a personally dedicated BP cuff of a patient with a nosocomial infection were compared; pulsed-field gel electrophoresis (PFGE) or random amplification of polymorphic DNA was used for Gram-negative bacteria isolates, and PFGE and phage typing were used for S. aureus isolates.

Results

Overall, 2 samples (1 from the inner side and 1 from the outer side) from each of 203 BP cuffs were obtained (Table 1). Analysis of the inner side of the BP cuffs revealed that the highest rates of contamination (defined as a contamination level of 100 cfu/25 cm² or more) were observed among BP cuffs from the ICU (20 [83%] of 24; 14 [58%] of cuffs had a contamination level of more than 300 cfu/25 cm²) and the adult surgical units (38 [58%] of 65). Analysis by type of use showed the highest rates of inner-side BP cuff contamination among those used by a single patient (26 [63%] of 41) and those kept on nurses’ trolleys (27 [77%] of 35). The level of contamination was generally less on the outer side of the BP cuff, the highest rates again being observed in the ICU (18 [75%] of 24). None of the 18 clean BP cuffs (15 from the operating rooms and 3 from medical units) had a level of contamination of 100 cfu/25 cm² or higher.

Most bacterial colonization of BP cuffs corresponded to saphro-
Table 2. Potentially Pathogenic Organisma that Contaminated the Inner (In) and Outer (Out) Sides of Blood Pressure (BP) Cuffs, According to Unit Type and Sphygmomanometer Category

<table>
<thead>
<tr>
<th>Organism</th>
<th>Total no. of isolates</th>
<th>Wall Model (n = 57)</th>
<th>Stored (n = 52)</th>
<th>Individual (n = 41)</th>
<th>Nurse’s Trolley (n = 35)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Both/In/Out/Total</td>
<td>Both/In/Out/Total</td>
<td>Both/In/Out/Total</td>
<td>Both/In/Out/Total</td>
<td>Both/In/Out/Total</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>20</td>
<td>1/2/0/3</td>
<td>2/1/1/4</td>
<td>0/3/3/6</td>
<td>0/4/3/7</td>
</tr>
<tr>
<td>MSSA</td>
<td>11</td>
<td>1/2/0/...</td>
<td>1/1/1/...</td>
<td>0/0/1/...</td>
<td>0/1/3/...</td>
</tr>
<tr>
<td>MRSA</td>
<td>9</td>
<td>0/0/0/...</td>
<td>1/0/0/...</td>
<td>0/3/2/...</td>
<td>0/3/0/...</td>
</tr>
<tr>
<td><em>Acinetobacter baumannii</em></td>
<td>4</td>
<td>0/0/0/0</td>
<td>1/0/1</td>
<td>0/0/0/0</td>
<td>3/0/0/3</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>2</td>
<td>0/0/0/0</td>
<td>0/0/0/0</td>
<td>2/0/2/0</td>
<td>0/0/0/0</td>
</tr>
<tr>
<td><em>Serratia marcescens</em></td>
<td>2</td>
<td>0/0/0/0</td>
<td>0/0/0/0</td>
<td>1/1/0/2</td>
<td>0/0/0/0</td>
</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>1</td>
<td>0/0/0/0</td>
<td>0/0/0/0</td>
<td>0/0/1/1</td>
<td>0/0/0/0</td>
</tr>
<tr>
<td>Yeast</td>
<td>1</td>
<td>0/0/0/0</td>
<td>0/0/0/0</td>
<td>1/0/1/0</td>
<td>0/0/0/0</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>3/5/10/15</td>
<td>3/10/2/9</td>
<td>3/10/2/9</td>
<td>3/10/2/9</td>
</tr>
</tbody>
</table>

Note: Three blood pressure cuffs were contaminated with 2 strains of potentially pathogenic microorganisms, as follows: methicillin-susceptible *S. aureus* (MSSA) and *E. coli*, methicillin-resistant *S. aureus* (MRSA) and *A. baumannii*, and *P. aeruginosa* and *S. marcescens*.

Defined methods.

Phytophore of the skin flora (coagulase-negative staphylococci and coryneform bacteria). Nevertheless, 30 types of pathogenic bacteria were isolated from 27 (13%) of the 203 BP cuffs, with 3 cuffs being simultaneously contaminated with 2 strains (Table 2). Strains of *S. aureus* were found on 20 (74%) of the 27 BP cuffs, with strains from 9 (45%) of the 20 BP cuffs resistant to methicillin. During the study period, a nosocomial infection due to bacterial species concomitantly isolated from the BP cuff occurred in 5 patients (4 in the ICU and 1 in a surgical unit). The strains isolated in the 4 cases of bronchopneumonia, which were diagnosed on the basis of analysis of protected brush pulmonary or bronchial aspirates, were *S. aureus* (in 3 cases) and *Pseudomonas aeruginosa* and *Serratia marcescens* (in 1 case, both of which were also isolated from a urine and a wound specimen). The fifth case of nosocomial infection concerned a surgical wound infected by *S. aureus*. For 3 of the 4 patients infected with *S. aureus*, typing of the *S. aureus* strains (via antibiotyping, PFGE, and phage typing) demonstrated a link between the strains identified in samples taken from the patient’s BP cuff and those isolated from the patient. For the *S. marcescens* and *P. aeruginosa* strains, typing by PFGE and random amplification of polymorphic DNA, respectively, showed that strains from the patient had the same pattern as strains from the patient’s BP cuff.

Discussion

Our data indicate extensive contamination of BP cuffs, irrespective of the type of hospital unit, with the exception of those kept in operating rooms or pediatric units, where the use of the cuffs is often restricted. The most highly contaminated BP cuffs (contamination level, more than 300 cfu/25 cm²) were observed in the ICU (Table 1), possibly because these cuffs were kept on the arms of the patients for a prolonged period to continuously monitor BP. Furthermore, the practice of keeping BP cuffs on nurses’ trolleys and used for several patients, potentially favoring dissemination of pathogens. Most importantly, in 5 cases of nosocomial infection, molecular typing showed a genetic relationship between the bacteria isolated from the infection and from the BP cuff used by the patient. Four of these cases occurred in the ICU. All these findings encourage the development of stringent disinfection procedures for BP cuffs. For patients in the ICU, cleaning of BP cuffs only after the patient has been discharged is insufficient, because persistence of the pathogen on the BP cuffs may possibly lead to reinfection. Procedures should include cleaning the cuffs with a disinfecting detergent several times per day (e.g., at each staff changeover). This should be effective, because our study showed no contamination of the 18 BP cuffs cleaned just before the samples were taken (Table 1). Furthermore, the practice of keeping BP cuffs on nurses’ trolleys should be reviewed, or at least these cuffs should be regularly cleaned between each patient’s visit according to a standardized procedure.

The results of this study indicate an urgent need to alert and educate hospital staff about the potential health risks associated with use of BP cuffs, because many healthcare personnel appear to be unaware of these risks. The findings reported
herein, in particular the link between contaminated BP cuffs and nosocomial infections, also strengthen the case for developing and implementing validated standard operating procedures for the use and maintenance of BP cuffs in all hospital units.

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Acknowledgment
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References
Introduction
Hospital-acquired infection outbreaks may be prevented by providing single-patient-use disposable blood pressure cuffs that will remain with that patient from admission until discharge from the hospital before being discarded. Single-patient-use disposables may prevent hospital-acquired infections that result from use of devices by multiple patients.

Background
Hospital-acquired infections (HAIs) are becoming increasingly common worldwide and occur during more than two million hospitalizations in the United States each year. Due to an increase in invasive procedures and a growing resistance to antibiotics, HAIs have increased by 36% in the last 20 years and are consuming more health care dollars each year. The burden these infections place on our health care system can be divided into three categories: the cost of quality, the cost of human lives and the financial impact. The human cost is over 99,000 deaths per year in the United States, which represents a 5% death rate for HAIs. Quality costs include increased ICU stays by 8 days, and increased average hospital stay between 7.4 and 9.4 days. Total dollar costs added to the health care system are between $4.5 and $5.7 billion annually, with the average cost per infection of $13,973 and an increased cost to patients (who survived) of approximately $40,000. Specifically, methicillin-resistant Staphylococcus aureus (MRSA) has become endemic, even epidemic in many U.S. hospitals and added 2.7 million extra days in the hospital with an average cost of $35,367.

Where do the funds come from to pay for HAIs? Do they come from third-party payers, Medicare/Medicaid, hospitals, or patients? Haley et al analyzed 9423 nosocomial infections and found that only 5-18% of nosocomial infections would have caused the admission to be reclassified to a higher diagnosis related group (DRG). Of those hospitalizations able to be reclassified to a higher DRG, the extra payment only funded 5% of the total cost to treat the infection. That leaves 95% of the financial burden of HAIs to hospitals and patients.

Problem
Common HAIs include pneumonia, catheter-associated urinary tract infections, intravascular device-related infections, and surgical site infections from various bacteria, viruses and fungi. The sources of infection, modes of transmission, and rates of transmission vary based on setting, immune status of patients, and adherence of staff to infection control procedures. Because of the multifactorial nature of HAIs, tendency to affect immuno-suppressed patients, and often multi-drug resistant organisms, the primary method to avoid morbidity/mortality and costs associated with these infections is through prevention. Harbath et al found that at least 20% and as much as 70% of HAIs are preventable, depending on the setting and type of infection. To prevent HAIs it is necessary to identify sources and modes of transmission of the infection and to implement prevention guidelines and practices. The modes of transmission of HAIs include direct-contact transmission (direct contact between two people) and indirect-contact transmission (transfer of an infectious agent through a contaminated intermediate object).

HAIs are the result of a high prevalence of pathogens with susceptible hosts and efficient transmission mechanisms from patient to patient. Unfortunately, these pathogens tend to become incorporated into the normal flora of hospital workers and are
readily transmitted through direct-contact transmission. Although less common, medical devices such as sphygmomanometers, thermometers, and stethoscopes have been implicated in the spread of HAI through indirect-contact transmission. In a study by Base-Smith, sphygmomanometer cuffs from various inpatient settings were found to have bacterial colonization rates of 81-100%. Also, 45.7% of the “clean” cuffs were contaminated with organic and/or inorganic substances. The patient contact sides of cuffs were contaminated twice as often as the nonpatient sides. Stemlich et al. found similar colonization rates of re-used disposable blood pressure cuffs. Myers et al. identified a single blood pressure cuff as the common source of a nosocomial infection outbreak in a neonatal intensive care unit.

Similarly, Livornese et al. found an electronic thermometer as the vehicle which caused an outbreak of vancomycin-resistant Enterococcus faecium in a med-surg intensive care unit and ward of a university hospital. Marinella et al. found that 100% of stethoscopes were contaminated with coagulase negative staphylococcus and 38% were contaminated with Staphylococcus aureus. In general, physicians tended to have a higher bacterial load on their stethoscopes than nurses.

Solution

Numerous organizations worldwide including the World Health Organization (WHO) and the Infection Control Practices Advisory Committee at the Centers for Disease Control and Prevention (CDC) have developed recommendations on protecting patients and health care workers from HAI. The foundation of HAI prevention is proper hand-hygiene technique, and the CDC 2002 guidelines explicitly cover indications for handwashing and hand antisepsis, hand-hygiene technique, surgical hand antisepsis, and selection of hand-hygiene agents. If health care workers achieved 100% compliance with proper hand-hygiene techniques it would significantly reduce the spread of HAI. Unfortunately, studies have found hand-hygiene compliance rates to be consistently less than 50%. Perceived barriers to hand hygiene include skin irritation, inaccessible supplies, interference with worker-patient relation, patient needs perceived as priority, wearing gloves, forgetfulness, ignorance of guidelines, insufficient time, high workload and understaffing, and lack of scientific information demonstrating impact of improved hand hygiene on hospital infection rates. Eliminating perceived barriers to hand hygiene is an important first step in improving hand-hygiene compliance rates and reducing HAI. The CDC has also published clear guidelines for isolation precautions, prevention of hospital-acquired pneumonias, intravascular device-related infections, surgical site infections, and catheter-related urinary tract infections, and these guidelines must also be closely followed to achieve maximum patient safety.

CDC recommendations regarding indirect transmission through patient care devices and environmental reservoirs are less specific than the recommendations listed and require some interpretation. The recommendations include:

1. Establish policies and procedures for containing, transporting, and handling patient-care equipment and instruments/devices that may be contaminated with blood or body fluids.
2. Remove organic material from critical and semi-critical instruments/devices, using recommended cleaning agents before high-level disinfection and sterilization to enable effective disinfection and sterilization processes.
3. Wear personal protective equipment (PPE), such as, gloves and gowns, according to the level of anticipated contamination when handling patient-care equipment and instruments/devices that are visibly soiled or may have been in contact with blood or body fluids.

Because it has been shown that patient care devices such as blood pressure cuffs and thermometers are frequently colonized with bacteria and have been implicated in various outbreaks of HAI, it is necessary to reduce the possibility of cross contamination with these devices. A simple solution would be to provide each patient with a new disposable blood pressure cuff that remains with the patient during his/her hospital stay and is disposed of when the patient is discharged from the hospital. By providing a single-patient-use disposable blood pressure cuff, the possibility of an outbreak from cross contamination would be greatly reduced. This solution does not eliminate the possibility of a HAI from the cuff, because the cuff will become colonized with the patient’s flora and be a potential source of a future HAI. It is necessary to maintain hospital recommendations for disinfection and sterilization procedures for these devices. However, this solution does eliminate the possibility of cross contamination from a blood pressure cuff from multiple patient contact and will possibly prevent HAI outbreaks from a colonized blood pressure cuff.
Conclusion
Hospital-acquired infections represent an increasing financial burden and declining quality of health care in the United States. Approximately 95% of the estimated $5 billion total health care cost from hospital-acquired infections falls on the shoulders of the hospitals and patients. The need for strict prevention guidelines is essential. One possible strategy for the prevention of hospital-acquired infection outbreaks can be achieved by providing each patient with a disposable blood pressure cuff that will remain with them during their hospital stay and be disposed of when the patient is discharged. Likewise, providing medical devices (thermometers) in each patient room that are appropriately sanitized between patients can prevent outbreaks of HAIs. Strict adherence to CDC guidelines regarding handwashing, hand-hygiene, and use of standard precautions also remains critical to preventing future HAIs.

References
While last month’s cover story focused on keeping patients safe, we can’t ignore the everyday risks to healthcare workers (HCWs). You’ll find recounts of a number of hair-raising medical errors and near-misses reported to the Agency for Healthcare Research and Quality (AHRQ) on its Morbidity & Mortality Rounds on the Web (www.webmm.ahrq.gov). In what seems to be a page taken from a bad medical thriller, one case study illustrates the ghastly things that can happen when complacency creeps in. A patient who had been in a car crash presented to an ER with massive injuries and profuse bleeding. A fabric-and-nylon blood pressure (BP) cuff used on this patient was saturated with so much blood, it could be wrung out. The patient later died from his injuries. A second patient, also in a collision and who had cuts all over her body, was placed in the same trauma bay vacated by the first patient. The same bloody cuff was used on her, with no regard for standard precautions. A nurse noted that the cuff was used from patient to patient, an observation that was received by other staff members with a shoulder shrug. Several weeks later, the medical examiner revealed that the first patient was HIV and hepatitis B virus positive and that the collision was a suicide.

In an analysis of this case, Atul K. Madan, MD, of the department of surgery at the University of Tennessee, says, “The early days of the AIDS epidemic saw first responders trying to literally guess which patients might be harboring a potentially lethal blood borne agent. In addition to the obvious problems of profiling and stigma, these ‘eyeball tests’ proved highly inaccurate, sometimes with serious consequences. Ultimately, the healthcare system embraced a strategy of universal precautions—in essence, assuming that any patient might be harboring a blood-borne infectious agent and acting accordingly. Unfortunately, as with many sensible infection control practices, universal precautions are sometimes neglected.”

Madan says the prevalence of HIV infection in ER patient populations ranges from 0.15 percent to 7.8 percent. He adds that the presence of HIV is smaller than that of most other blood-borne pathogens, with the risk of hepatitis and other bacteria much greater. He points to several studies of ER and trauma patients that found almost 25 percent of patients exhibited seropositivity for at least one transmissible, infectious agent.

Madan says that while rates of nosocomial transmission from equipment to patients remain unknown, cases of such transmission have been documented. He says hospitals should establish—and enforce—policies and processes for the proper cleaning or disposal of contaminated equipment in the ER, and adds that at least one study has shown implementation of policies like these can improve compliance with universal precautions.

“This case raises the specific issue of whether disposable BP cuffs (or disposable covers) should be added to universal precautions, at least in settings such as trauma care. One study from the OR revealed blood contamination of approximately 30 percent of surfaces tested. Cuffs are already known to be reservoirs of bacterial pathogens such as Clostridium difficile.

“Contamination with blood and bloodborne viruses is likely a significant—albeit under-recognized-patient-safety problem. Until the cost-effectiveness of disposable BP cuffs has been established, we can at least recommend explicit attention to the cleaning and disinfection of cuffs between patients, even in hectic settings such as trauma resuscitations.”
Introduction
This study investigated the possibility that significant bacterial contamination of re-usable, non-disposable blood pressure cuffs might occur in the operating room, P.A.C.U., and I.C.U. settings. Such contamination might be of clinical significance were the BP cuff to be located in the region of the operative site during a surgical procedure, or near a wound in the post-operative period. Colonization might be of greater significance in the case of immunosuppressed, obstetric and orthopedic patients undergoing total joint replacement because of the increased need for sterility. Previous studies had pointed out that blood pressure cuffs could indeed be a vector for the transmission of bacterial infections in ward and I.C.U. settings. A comparison of the relative colonization of re-used cuffs of both permanent and disposable types used with manometers and non-invasive automatic blood pressure monitors was made with clean, disposable cuffs.

Methods
Blood pressure cuffs for study were obtained from the operating rooms and I.C.U. settings at three institutions: a university hospital, an orthopedic hospital and a cancer-center hospital. Cuffs were cultured within their utilization site and were all ‘clean’ and ready for patient use. Cultures were taken at different times of the day, so as to avoid a possible bias of cuffs being cleaned at the end of the day. Cuff cultures were coded so those microbiologic technicians were unaware of their source. Actual cultures were obtained using Rodak trypticase soy agar plates, which were directly applied to the surface of the cuffs on inner and outer surfaces, since both are potentially contaminable and thereby potentially communicable.

Results
In a data collection group of 80 separate patient-related cultures, the colonization rate was 98.7% (p<0.001). In order to assess the significance of the degree of colonization, six anesthesiologists’ medial upper arms were cultured directly, and significance was thus defined as a colony count greater than the mean colonization rate of the samples thus obtained, i.e., >20 colonies/16 cm². 85% of all patient-related cultures had “significant” bacterial colonization.

30% of all patient-related cultures (N=80) had an organism other than a coagulase negative staph. growing. All organisms were susceptible to antibiotics and none were methicillin resistant. Of assays obtained from an orthopedic hospital (N=17), 100% of cuffs were colonized, with significant colonization of 71%. Samples obtained at the end of an operative day, after the O.R.’s were cleaned and closed, including a wiping of cuffs, produced lower colony counts in the orthopedic hospital, with a significant colonization of 50% (N=6). Of assays obtained from a cancer-center hospital (N=3) with a large percentage of immunosuppressed patients, 100% of the cuffs were colonized, with significant colonization of 80%. The most common organism cultured overall was coagulase negative staphylococci growing on 79 of 80 cuffs. Thirteen cultures obtained at the cancer hospital came from disposable cuffs which were being re-used until they appeared to be dirty, and twelve of these (92%) produced significant colonization.

Highest rates of colonization were generally obtained from cuffs used in P.A.C.U. – I.C.U. settings. The only negative significant colonizations that were consistently observed were derived from cultures of new, non-used, disposable blood pressure cuffs (N=4).
Discussions

The study showed that “significant” bacterial colonization of blood pressure cuffs utilized in the O.R., I.C.U. and P.A.C.U. settings does occur. Cuff types surveyed included automatic and manometric types of the permanent and disposable types. Cuff materials were either nylon or plastic. Previous studies have shown that blood pressure cuffs can actually be a clinically important vector in the transmission of infection on an in-patient floor\(^1\), and in a neonatal I.C.U.\(^3\)

Attitudes of staff employing the cuffs, including anesthesiologists and nursing professionals were also informally surveyed and revealed that almost none routinely cleaned cuffs between patients and few regarded the cuff as a possible source for infection.

It is thus recommended that efforts be made to reduce bacterial contamination of blood pressure cuffs. Cuffs should be located on the contralateral limb to the operative site when at all possible. Spraying cuffs with a topical disinfectant such as entornexidine can reduce their bacterial load by 75%\(^2,4\). Repeated use of a disposable cuff on different patients produces significant colonization on the cuffs and defeats their major advantage. Only clean, non-used disposable cuffs had insignificant colonization rates in this study. Ideally, it is recommended that where applicable, a cleansed cuff or an unused disposable cuff be dedicated to a patient upon arrival at the hospital, and that it follow the patient to the O.R., to the P.A.C.U. and to the floor. This can also be adopted in I.C.U. settings. Such a procedure has been associated with a threshold reduction in nosocomial infection rate in I.C.U. setting\(^3\). Further studies are underway to quantify colonization rates on patient’s skin directly, pre- and post-operatively following application of a re-usable blood pressure cuff in the O.R. It is hoped that these results and safeguards might further reduce the risks and improve the care of patients in the operating room, P.A.C.U. and I.C.U. settings.

References

Objective
The purpose of this study as documented by the author and a pediatric resident was to determine the cause of nosocomial infection in a special care nursery. Guidelines for determining the presence and classification of infection were adopted from those suggested by the CDC. In this study an infection was considered to be nosocomial if the onset occurred at least 48 hours after admission.

Setting
A special-care nursery, which consisted of two intermediate-care nurseries, seven Isolette intensive care rooms and three isolation rooms.

Results
During 21 weeks of surveillance, 46 of 248 infants who were at risk (18.5%) acquired 52 infections in the special-care nursery area with a nosocomial infection rate of 21.0%. Of these 248 infants, 54 died while in the special-care nursery. Eight of the deaths were related to nosocomial infection. One in seven causes of death for these infants was attributed to nosocomial infection. It was observed during the 16th week of surveillance that the Doppler blood pressure monitor was used on all infants in the special-care nursery. A portion of the blood pressure cuff was excised and cultured. It was found to contain *Klebsiella pneumoniae*, *E. cloacae*, *Staphylococcus aureus* and several other Gram-negative bacilli.

Finding
With the introduction of single-patient blood pressure cuffs there was an associated decrease in nosocomial infection rates. *Klebsiella pneumoniae* and *E. cloacae* disappeared.

Conclusions
Therefore, blood pressure cuffs can be attributed to nosocomial (hospital)-acquired infection. This study has caused increased awareness by the physician of the magnitude of nosocomial infection in the hospital setting.
Objective
Presumed “clean” blood pressure cuffs in critical care areas were evaluated to determine if they were contaminated with bacterial colonization of organic and inorganic materials.

Settings used to obtain the data: 707-bed, tertiary-care, level-one trauma centers. Blood pressure cuff samples were selected from OR, MICU (Medical Intensive Care Unit), SICU (Surgical Intensive Care Unit), CICU (Cardiac Intensive Care Unit), NSICU (Neurosurgical Intensive Care Unit), BSICU (Burn Special Intensive Care Unit), ER, and PACU (Post-anesthesia Care Unit).

Results
Bacterial colonization, in 70 separate cultures obtained over six weeks, occurred on 57 (81%) of the cuffs. Bacterial colonization was found on 100% of the cuffs obtained from the OR, PACU, BSICU, and the ER. Ninety percent of cuffs obtained from the SICU and 80% of cuffs from the MICU were colonized. Cuffs from the NSICU and CICU demonstrated no growth.

Conclusions
Frequent bacterial colonization and significant contamination of organic and inorganic materials do occur on presumed “clean” blood pressure cuffs.

Flora found on these cuffs may have the potential to produce opportunistic infection when introduced to critically ill patients who are susceptible to disease.

Education and infection control practices amongst healthcare providers may decrease morbidity, mortality and unnecessary healthcare costs.
Objective

This study was conducted to determine the extent of microbial contamination on blood pressure cuffs used in the operating and recovery rooms of a teaching hospital. The authors suggest that the blood pressure cuff is as yet an unrecognized source of bacterial contamination, which may play a part in the hospital’s nosocomial infection rate.

Settings & Patients

As part of this study, new blood pressure cuffs were placed in six operating rooms, and one recovery room. A defined area of the cuff in contact with the patient was sampled before issue and at the end of the operating day for a period of five days. Swabs were plated, incubated and evaluated after 48 hours.

Results

Results indicated that 68 different microorganisms were isolated from the forty-two samples. Seventy-one percent (n=61) were Staphylococci. One of the Staphylococcus aureus was found to be resistant to methicillin, gentamycin and erythromycin. The remaining 25 organisms were thought to be skin and environmental representatives, although they may pose a risk to certain groups of patients.

Summary

It was concluded that the majority of microorganism isolates in this study posed little risk to healthy patients undergoing surgery. The one case where the gentamycin-methicillin resistant pathogen was identified caused concern, since no patient known to have that pathogen had been in the operating room during the corresponding day of data collection. Therefore, the bacteria would have had to survive for some time on the cuff, implying that the cuff acts as a vehicle of infection. The authors noted that enforcing policies that prohibit the transfer of cuffs outside a room where isolation precautions are in effect is very difficult. In addition, general-use blood pressure cuffs are handled by many health care workers and patients. Because there are often no visible signs of contamination, no disinfecting procedures are employed on the cuff. The potential for cross contamination magnifies, as often patients, who are sources of antibiotic-resistant pathogens, are unknown to the hospital staff. Blood pressure cuffs attached to resuscitation equipment were identified as another source of contamination.

Conclusions

This study emphasizes the need for increased awareness of the potential for cross contamination of patients and health care workers from seemingly innocuous items of general-use hospital equipment, specifically blood pressure cuffs.
Cost/Benefit Model
for facility conversion to disposable blood pressure cuffs
Cost/Benefit Overview

The calculation of annual costs for reusable cuffs was derived using the following methodology.

The admissions/year figure is based on data obtained from the American Hospital Association (AHA). We looked at the total number of hospital admissions per year and the total number of hospital beds in the U.S. We then took the information on admissions/bed/year and the total patients/bed/day along with the average patient stay.

The cuff cost of $25/cuff with a three-year cuff life is based on the Welch Allyn warranty. From that figure we calculated the cost/patient for each respective bed size based on admissions/year.

The number of HAIs/year is based on data from the CDC. We calculated the number of infections/year due to cuff as 1%, based on data from the de Gialluly reference. The number of infections/year due to cuffs is a calculation of percentage of HAIs/year due to cuffs times the number of patients who acquire HAI/year.

The cost per infection is based on data from the PW Stone reference.

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**AHA Data**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Admissions/Year</td>
<td>37,188,775 Admissions</td>
</tr>
<tr>
<td>Beds</td>
<td>947,412 Beds</td>
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<tr>
<td>Admissions/Bed/Year</td>
<td>39.25 Admissions</td>
</tr>
<tr>
<td>Patients/Bed/Day</td>
<td>0.11 Patients</td>
</tr>
<tr>
<td>Average Patient Stay</td>
<td>9.30 Days</td>
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</tbody>
</table>

**CDC Data**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>HAIs/Year</td>
<td>2,000,000 Patients</td>
</tr>
<tr>
<td>HAI %</td>
<td>5.38% Patients</td>
</tr>
</tbody>
</table>

*Estimated from data in the article noted in footnote 1

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1 de Gialluly, C, MD; Morange, V, MD; de Gialluly E., MD; Loulergue, J. MD; van der Mee, N., PhD; Quentin, R. MD, PhD. Blood Pressure Cuff as a Potential Vector of Pathogenic Microorganisms: A Prospective Study in a Teaching Hospital, September 2006; Vol. 27, No. 9.

Calculation of annual costs: Reusable BP cuffs

> 150-bed hospital – costs of reusable cuffs for a 150-bed hospital – assumptions:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admissions/year:</td>
<td>5,888 admissions</td>
<td>(based on AHA data(^2))</td>
</tr>
<tr>
<td>Cuff cost/year:</td>
<td>$8.33/cuff</td>
<td>(based on a $25.00 cuff with 3-year cuff life)</td>
</tr>
<tr>
<td>Cuff cost/patient:</td>
<td>$0.21</td>
<td>(cuff cost/# patients cuff used on/year)</td>
</tr>
<tr>
<td># patients who acquire HAI/year:</td>
<td>317</td>
<td>(based on CDC data 5.38(^%-1))</td>
</tr>
<tr>
<td>% HAIs/year due to cuff:</td>
<td>1(^%)*</td>
<td></td>
</tr>
<tr>
<td># infections/year due to cuff (rounded estimate):</td>
<td>3</td>
<td>(# patients who acquire HAI/year X % HAIs/year due to cuff)</td>
</tr>
<tr>
<td>Cost/infection:</td>
<td>$40,000(^3)</td>
<td></td>
</tr>
<tr>
<td>Fully burdened cost of reusable cuffs:</td>
<td><strong>$127,911</strong></td>
<td>(Annual cost of HAIs + cost of reusable cuffs)</td>
</tr>
</tbody>
</table>

300-bed hospital – costs of reusable cuffs for a 300-bed hospital

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Admissions/year:</td>
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<tr>
<td>Cuff cost/year:</td>
<td>$8.33/cuff</td>
<td>(based on a $25.00 cuff with 3-year cuff life)</td>
</tr>
<tr>
<td>Cuff cost/patient:</td>
<td>$0.21</td>
<td>(cuff cost/# patients cuff used on/year)</td>
</tr>
<tr>
<td># patients who acquire HAI/year:</td>
<td>633</td>
<td>(based on CDC data 5.38(^%-1))</td>
</tr>
<tr>
<td>% HAIs/year due to cuff:</td>
<td>1(^%)*</td>
<td></td>
</tr>
<tr>
<td># infections/year due to cuff (rounded estimate):</td>
<td>6</td>
<td>(# patients who acquire HAI/year X % HAIs/year due to cuff)</td>
</tr>
<tr>
<td>Cost/infection:</td>
<td>$40,000(^3)</td>
<td></td>
</tr>
<tr>
<td>Fully burdened cost of reusable cuffs:</td>
<td><strong>$255,822</strong></td>
<td>(Annual cost of HAIs + cost of reusable cuffs)</td>
</tr>
</tbody>
</table>

500-bed hospital – costs of reusable cuffs for a 500-bed hospital

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Admissions/year:</td>
<td>19,627 admissions</td>
<td>(based on AHA data(^2))</td>
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<tr>
<td>Cuff cost/year:</td>
<td>$8.33/cuff</td>
<td>(based on a $25.00 cuff with 3-year cuff life)</td>
</tr>
<tr>
<td>Cuff cost/patient:</td>
<td>$0.21</td>
<td>(cuff cost/# patients cuff used on/year)</td>
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<tr>
<td># patients who acquire HAI/year:</td>
<td>1056</td>
<td>(based on CDC data 5.38(^%-1))</td>
</tr>
<tr>
<td>% HAIs/year due to cuff:</td>
<td>1(^%)*</td>
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</tr>
<tr>
<td># infections/year due to cuff (rounded estimate):</td>
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<td>Cost/infection:</td>
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<tr>
<td>Fully burdened cost of reusable cuffs:</td>
<td><strong>$426,369</strong></td>
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\(^1\)Estimated from data in the article noted in footnote 1
Calculation of annual costs: Disposable BP cuffs

> 150-bed hospital – cost of disposable cuffs for a 150-bed hospital

| Admissions/year: | 5,888 admissions  | (based on AHA data)
| Cuff cost:       | $3.50/cuff        |
| Total cost of disposable cuffs: | $20,608 (# admissions * cuff cost) |

300-bed hospital – cost of disposable cuffs for a 300-bed hospital

| Admissions/year: | 11,776 admissions  | (based on AHA data)
| Cuff cost:       | $3.50/cuff        |
| Total cost of disposable cuffs: | $41,216 (# admissions * cuff cost) |

500-bed hospital — cost of disposable cuffs for a 500-bed hospital

| Admissions/year: | 19,627 admissions  | (based on AHA data)
| Cuff cost:       | $3.50/cuff        |
| Total cost of disposable cuffs: | $68,692 (# admissions * cuff cost) |

Total cost savings Disposable BP cuffs vs. Reusable BP cuffs

> 150-bed hospital – cost savings for disposable cuffs vs. reusable cuffs

(Cost of reusable cuff + HAIs) $127,911 - (Disposable Cuff Cost) $20,608 =

$107,303

300-bed hospital – cost savings for disposable cuffs vs. reusable cuffs

(Cost of reusable cuff + HAIs) $255,822 - (Disposable Cuff Cost) $41,216 =

$214,606

500-bed hospital – cost savings for disposable cuffs vs. reusable cuffs

(Cost of reusable cuff + HAIs) $426,369 - (Disposable Cuff Cost) $68,692 =

$357,677

*Estimated from data in the article noted in footnote 1
AHA Data

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