

Nondisposable sphygmomanometer cuffs harbor frequent bacterial colonization and significant contamination by organic and inorganic matter

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In the hurried milieu of operating rooms, emergency departments, and intensive care units, contaminated sphygmomanometers (blood pressure cuffs) may not be routinely sanitized or replaced with clean cuffs between patient use. Previous investigations, though few in number, have identified blood pressure cuffs as potential sources of nosocomial infection or vehicles for transmission of contagion in selected patient populations. In this study, presumed "clean" blood pressure cuffs were cultured and evaluated for organismal proliferation and contamination by organic and inorganic debris. Results indicated that frequent bacterial colonization and soiling with organic and inorganic substances did occur on "clean" blood pressure cuffs. Although risk of disease transmission was not measured, the need for better sanitation and disinfection of the cuffs between patient use became evident.

Key words: Blood pressure cuff, contamination, fomite, sphygmomanometers.

Introduction

During the early 1960s, research supported the belief that hospital fabrics could be disseminators of microorganisms and reservoirs of infectious patho-

gens.¹⁻³ In subsequent studies investigating the epidemiology of hospital acquired infections, resultant data implicated the sphygmomanometer cuff as a potential source or vehicle for the transmission of bacterial contamination between hospital staff and patients.³⁻⁶

Despite this knowledge, the ubiquitous blood pressure cuff is regarded as a pathogenically innocuous instrument. It is not perceived to require the vigorous between patient sanitizing that other reusable items receive. The belief among health-care providers and departments of infection control is that blood pressure cuffs are not fomites and do not impose a significant risk of pathogen transmission to patients with intact skin. However, increasing numbers of patients may be at risk for hospital-acquired infections transmitted by improperly sanitized blood pressure cuffs. In particular, immunosuppressed patients (e.g., those with acquired immunodeficiency syndrome, burns, or undergoing transplant) as well as obstetrical and pediatric patients may be at risk. Those with indwelling vascular access catheters, electronic devices, or artificial joints may also be more susceptible. Cases of bacterial transmission and cross contamination of patients and hospital personnel with *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Klebsiella pneumoniae*, *Enterobacter cloacae*, and other gram-negative bacilli residing on blood pressure cuffs have been confirmed.³⁻⁵ Direct causation of nosocomial infection by contaminated blood pressure cuffs was not substantiated. However, the

evidence of increased morbidity and mortality of patients infected with organisms identical to those cultured on communally used cuffs is incontrovertible.⁴

Interestingly, most items that directly contact the previous patient are exchanged for new disposable or clean reusables prior to subsequent patient use, i.e., except for blood pressure cuffs. Therefore, it is likely that the accumulation of cellular debris, perspiration, blood, and other potentially pathogenic or allergenic substances (e.g., povidone-iodine or latex) on blood pressure cuffs is enhanced after use by multiple patients between cleanings.

To survey the attitudes of infection control nurses, a questionnaire was distributed at the 1992 San Francisco convention for the Association of Practitioners of Infection Control.⁷ Of 120 respondents, 5 (4.2%) strongly agreed that the blood pressure cuff could be a significant source of infection while 64 (53.3%) agreed that it was somewhat possible; 41 (34.2%) disagreed, and 10 (8.3%) strongly disagreed (Figure 1).

Results of the author's informal survey distributed to same day surgery (SDS), operating room (OR), and postanesthesia care unit (PACU) staff of a large Midwest level-one trauma center revealed different opinions concerning the blood pressure cuff as a fomite. Personnel were asked if a blood pressure cuff-skin barrier device was necessary, useful, not useful, or not necessary to prevent possible between patient contamination by hospital blood pressure cuffs. Six participants (100%) in the SDS unit stated that it was necessary, 9 (100%) in the PACU said it was useful, 19 (100%) in the OR said that it was useful, and 13 (68.4%) in the OR also remarked that it was necessary.

Informal inquiries made of other urban hos-

pital healthcare providers revealed that they were not consistently aware of cuff disinfection practices. If equipment sanitation protocols existed, blood pressure cuffs were either excluded from the list of items or not clearly addressed. In some institutions, the whereabouts of cuff cleaning protocols were unknown or were presumed to be filed in the housekeeping or infection control departments. Knowledge of cuff disinfection techniques elicited informally from the respondents in various intensive care units, OR, and emergency room (ER) settings included the following: wiping with a damp cloth, sending the cuff to central processing, spraying with a disinfectant, using cuff covers, obtaining new disposable cuffs from material resources, using a cuff that was visually less soiled, or replacing a cuff sanitized by housekeeping between each patient use. Overall, the predominant practice was to replace the cuff only when gross contamination or moisture was evident.

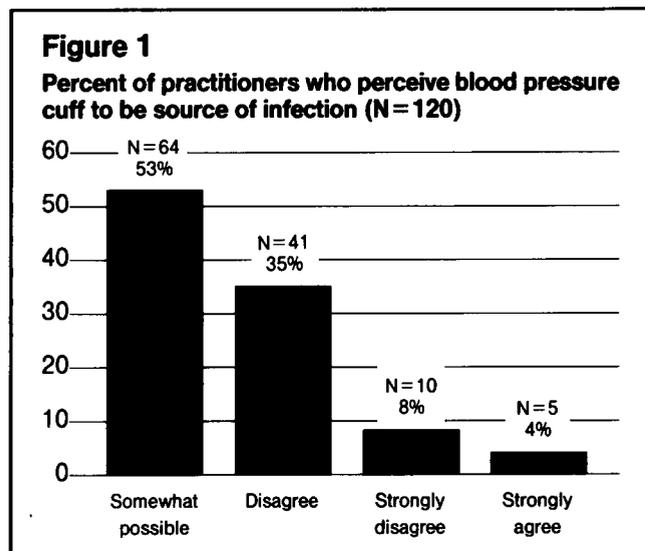
Possibilities for lack of between patient cuff sanitation may be attributed to many causes. Lack of substitution cuffs, time constraints, beliefs of healthcare providers, and knowledge deficits identifying the cuff as a potential fomite are a few. Regardless of the rationale, each patient, particularly those in critical care milieus, should have a sanitized cuff, free of potentially pathogenic organisms and debris.

The purpose of this study was to determine if significant bacterial colonization and organic or inorganic contamination occurred on presumed "clean" blood pressure cuffs in critical care arenas. Data obtained from this study will hopefully provoke practitioners and institutions to define, promulgate, and enforce cuff disinfection protocols. In susceptible patient populations, the potential risk of cross infection from soiled cuffs may be averted.

Methodology and materials

The study was conducted in a Midwestern 707-bed, tertiary care, level-one trauma center. Following acceptance by the hospital, institutional review board (IRB), directors, and head nurses of special care units, the following eight areas were selected for blood pressure cuff sampling: OR, medical intensive care unit (MICU), surgical intensive care unit (SICU), burn special intensive care unit (BSICU), cardiac intensive care unit (CICU), ER, PACU, and neurosurgical intensive care unit (NSICU).

■ *Sampling.* Out of the possible 124 available bedside blood pressure cuffs in the study units, 70 were chosen. Ten cuffs each were sampled in the OR, PACU, BSICU, SICU, MICU, and ER. Five



cuffs each were sampled in the CICU and NSICU. Blood pressure cuffs included in the study met the following criteria:

- "Clean," i.e., ready for subsequent patient use as deemed by the usual unit practice or standard.

- No specific sampling time was assigned. Cuffs could be sampled as soon as the bedside was vacated for the next patient. This criterion allowed for more random sampling, since bedside cuffs became available continually throughout the day due to patient transfer or death.

- No exclusion was made for the type of cuff material (nylon or plastic). Manual and automatic cuffs were both included.

As bedside blood pressure cuffs became available in the study units, they were removed, placed in a sterile cellophane package, and labeled 1AB through 70AB. The numeric and alphabetic labeling identified the origin of the cuff as well as the two types of testing to be performed on each one. Test "A" sampled for bacteria, while test "B" identified the presence of organic or inorganic soiling. Date, time of sampling, and drop time at the microbiological laboratory were recorded. A cuff disinfected by central processing or the anesthesia research assistant was replaced at the study site bedside to prevent disruption of nursing care.

- *Method for bacterial culturing.* On arrival to the testing site, sterile packages containing the sample cuffs were opened and placed flat on a sterile towel on the counter. The patient side of the cuff was always cultured first with the pneumatic tubes toward the investigator. The Culturette II® collection and transport system (Becton-Dickinson and Company, Cockeysville, Maryland) was used. The Culturette II contains two rayon-tipped swabs and one ampule of 0.5 mL modified Stuart bacterial transport medium with sodium glycerophosphate, 1%, sodium thioglycolate, 0.1%; calcium chloride dihydrate, 0.01%; and water. After aseptically opening and saturating the Culturette II with growth medium, the swab was swept over patient side surface and at pneumatic cuff juncture in a consistent pattern for all samples. Swab 1 was replaced into the Culturette II tube after swab 2 was removed. The cuff was then turned over, and swab 2 swept over the nonpatient surface in like fashion. Swab 2 was returned to the Culturette II medium, and the samples were sealed and sent to the laboratory with appropriate laboratory forms. Upon arrival, the swabs were swept over blood-agar plates and cultured at 37°C for 48-72 hours. Licensed microbiological technicians blinded to test units performed colony identifications and recorded the results.

- *Method for detecting organic or inorganic contamination.* Since specific testing for the presence of human blood was beyond the capability of the laboratory and the scope of this study, a regimen suggested by the chief microbiologist that used 3% hydrogen peroxide solution was selected. Three percent hydrogen peroxide, in the presence of blood, povidone-iodine, peroxidase, ammonia (sometimes found in sweat and blood), staphylococci, and other inorganic or organic substances (e.g., pus or tissue) will foam on contact.

Initially, Hemocult® screening tests for occult fecal blood (SmithKline Diagnostics, San Jose, California) were used with three random nonstudy cuff samples. Following water extraction of residue from these cuffs, all three cuffs sampled tested grossly positive for blood. SmithKline Diagnostics' senior product manager was notified of the positive test results. Aside from a positive reaction to the presumed blood, false positive results could also manifest in the presence of ammonia, formalin, peroxidase, staphylococci, iodine, and other organic or inorganic substances reacting with the reagent.

Therefore, specificity for the presence of blood *only* could not be guaranteed with either the hemocult test or the 3% hydrogen peroxide solution. However, since cuffs in any of the units could be contaminated with the above substances, it was decided to use the less costly hydrogen peroxide method.

Each cuff, after culturing for bacteria (1A-70A) was tested for the presence of organic or inorganic contamination (1B-70B). The cuff was lifted from the sterile towel and spread on a white paper towel with the pneumatic tubes facing the researcher. Patient side first, the cuff was then tested by saturating it with 60 mL of USP (United States Pharmacopeia) 3% hydrogen peroxide aspirated into a 60 mL sterile syringe. Any foaming or bubbling detected was measured in millimeters and its location (patient and/or nonpatient side) recorded on the cuff's data sheet. The process was repeated on the nonpatient side. Any runoff of peroxide with subsequent discoloration on the paper towel was described as "pink" or "rusty." This observation was intended to primitively distinguish between possible blood (pink) or povidone-iodine (rusty) contamination on cuffs, since both substances can cause peroxide to foam. As an aside, positive results, i.e., foaming, did not occur on new cuffs removed from their shipping wrappers or on cuffs sanitized in central processing or disinfected by the anesthesia research assistant.

After testing, the study cuffs were disinfected by the anesthesia technician. The technique in-

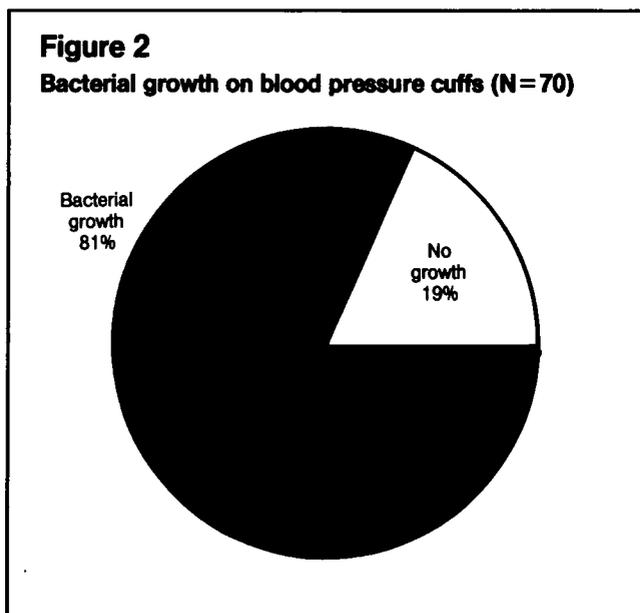
involved clamping of the pneumatic tubes followed by a brush scrubbing with hydrogen peroxide to remove debris. Next the cuff was wiped with a solution of Vesphene® 0.8% and then soaked for 10 minutes in Cidex®. After rinsing with water, the cuffs were dried in central processing's air dryer.

Results

■ **Bacterial colonization.** In 70 separate cultures collected over 6 weeks, bacterial colonization occurred on 57 (81%) of the cuffs (Figure 2). One cuff (1.4%) was colonized with *S. aureus* while 100% of those colonized grew flora identified as coagulase negative staphylococci, corynebacterium (diphtheroids), *Neisseria* species, *Propionibacterium*, *Bacillus* species, and nonhemolytic streptococci.

In the units from which cuffs were sampled, bacterial colonization was discovered on 100% of the cuffs from the OR, PACU, BSICU, and ER. Of the cuffs from the SICU and MICU, 90% and 80% were colonized respectively, while the NSICU and the CICU demonstrated no growth (Figure 3).

■ **Organic or inorganic contamination.** Overall 32 (45.7%) of the "clean" cuffs were contaminated with organic and/or inorganic substances e.g., blood, povidone-iodine, pus, staphylococci, ammonia, or peroxidase that should not have been present (Figure 4). Although most of the contaminated cuffs had debris on both sides, the patient and nonpatient sides were not equally contaminated. The patient sides exhibited greater surface area foaming (in mm²) on 22 (65.7%) of the cuffs. Ten of the cuffs (34.3%) revealed greater evidence of contamination on the nonpatient side. Rust-colored solution was more frequently extracted than was pink-colored solution.



Cuffs from the following units displayed the highest percentages of organic or inorganic contamination: OR, 90%; BSICU, 80%; and MICU, 60%. The PACU, SICU, and ER manifested 50%, 20%, and 20% contamination, respectively, while the CICU and the NSICU exhibited no evidence of organic or inorganic contamination (see Figure 3).

Discussion

The study revealed that frequent bacterial colonization and significant contamination by organic or inorganic substances does occur on clean, nondisposable blood pressure cuffs used in critical care settings. The OR, SICU, PACU, and BSICU exhibited the highest percentages of colonization, consistent with earlier studies. Although most flora identified on the cuffs were weakly virulent, their potential to produce opportunistic infection may be magnified when introduced to susceptible patients, such as those hospitalized in critical care units. One cuff, however, (1.4%) was colonized with *S. aureus*. Since species and colony counts were not performed, significance of the colonization (i.e., minimal, moderate, or heavy) could not be assessed. It is, nonetheless, irrefutable that virulent forms of staphylococcal organisms should not be present on instruments used between patients.

It is curious that neither colonization nor organic or inorganic soiling occurred on the cuffs sampled from the NSICU and the CICU. This may be attributable to several causes. In those units, arterial lines are used in preference to automatic or manual cuffs. It is not known if calibration of the arterial line with the blood pressure cuff is performed (although this should be a standard of care). Second, the atypical findings may have resulted from substitution of new or scrupulously cleaned cuffs by the units' housekeeper (who may have been aware of the study purpose). Third, the culture medium may have been dry with those particular samples. Last, these units may have used appropriate disinfection techniques, which deserve further inquiry.

The nearly 50% contamination of "clean" cuffs with substances such as povidone-iodine, pus, blood, ammonia, peroxidase, staphylococci, or other residue is unacceptable. Additionally, the patient sides of the cuffs were contaminated twice as often as the nonpatient sides. This finding further supports the likelihood that inoculation of an open wound or an intravenous or arterial access site with undesirable flora or debris from unsanitized cuffs will occur. Another negative finding was the aesthetic appearance of the cuffs. Although staining and soiling do not necessarily indicate pathoge-

Figure 3

Percent of bacterial growth and organic or inorganic contamination (N = 120)

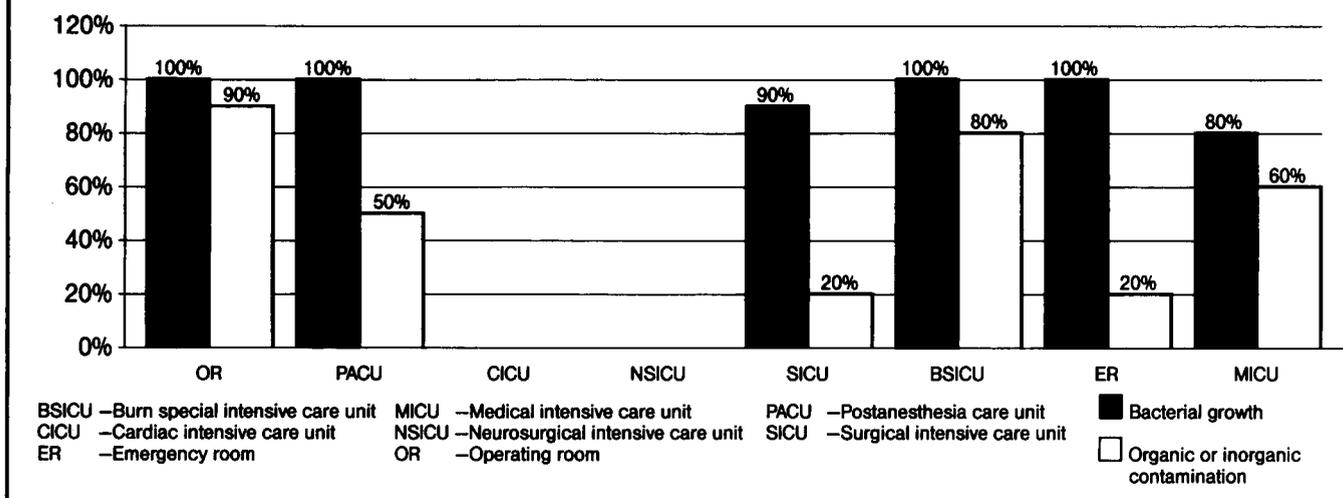
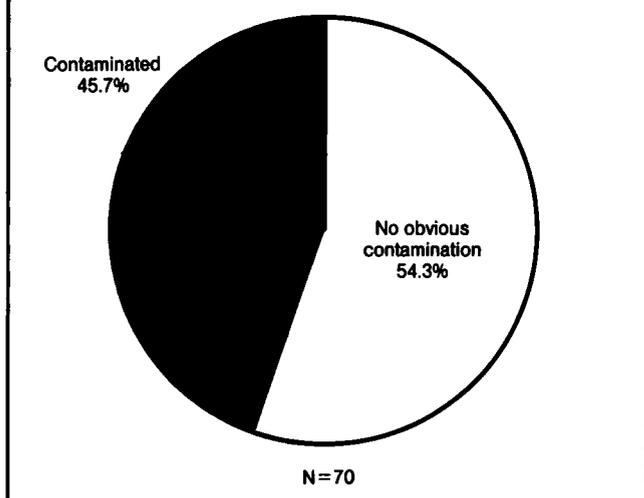


Figure 4

Organic or inorganic contamination on blood pressure cuffs (blood, iodine, ammonia, staphylococci, peroxidase, or formalin)



nicity, their presence manifests a breach of patient trust. Each patient assumes that items used for his or her personal care should at least be "hotel clean," i.e., without foreign excretions, tissues, or allergenic chemicals.

The general opinion of medical, nursing, and ancillary personnel indicates that the sphygmomanometer is not perceived as a fomite. This belief is supported by the fact that consistent disinfection protocols and practices are not routinely used or enforced by some healthcare providers. However, personnel polled about the use of a patient-cuff barrier device would use them for protection, even though their units' cuffs are allegedly clean.

Recommendations derived from this survey

include further investigation into transmission potential, infection control practices, and education of healthcare providers regarding the blood pressure cuff as a possible source of infection. In so doing, potential causation of increased patient morbidity and mortality, as well as unnecessary hospital costs, may be avoided.

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