



Supporting Documentation
On Bacteria and Blood Pressure Cuffs

Blood Pressure Cuff as a Potential Vector of Pathogenic Microorganisms

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ORIGINAL ARTICLE

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

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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 cm² 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 (ie, 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.

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Nosocomial infections occur frequently among hospitalized patients,^{1,4} and blood pressure (BP) cuffs, as with other non-invasive items,⁵⁻⁸ have been shown to be involved in their transmission.⁹⁻¹⁶ However, most publications concern observational case reports^{11,12} or small studies often restricted to specific contexts.^{10,13-16} In practice, the role of BP cuffs in the dissemination of nosocomial infections is frequently overlooked.^{14,16} Before the present study, we questioned 56 health-care staff members (nurses and physicians) in 44 French hospitals (50 different units) and found that only 23% were aware that BP cuffs could be involved in the propagation of nosocomial infections and that many units had no specific written procedure for cleaning the devices (C. de Gialluly et al., unpublished data). To raise awareness of this risk among the staff of our university hospital, we performed a prospective, hospital-wide study to quantitatively and qualitatively measure the bacterial contamination of BP cuffs, as a function of the type of hospital unit and the type of cuff, defined in terms of their mode of use or storage.

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

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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 (ie, 4 cfu/cm² or more) and highly contaminated when the number was more than 300 cfu/25 cm² (ie, more than 12 cfu/cm²).

Microorganisms that represent a high risk of nosocomial infection (*Staphylococcus aureus*, enterobacteria, *Pseudomonas* species, *Acinetobacter* 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)^{17,18} or random amplification of polymorphic DNA¹⁹ 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 contami-

nation 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 saprophytes 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.*

TABLE 1. Rate of High Bacterial Contamination on the Inner (In) and Outer (Out) Sides of Blood Pressure (BP) Cuffs, According to Unit Type and Sphygmomanometer Category

Variable	Total no. of BP cuffs (n = 203)	No. (%) of BP cuffs, by contamination level and cuff side					
		100-300 cfu/25 cm ²			>300 cfu/25 cm ^{2a}		
		In (n = 62)	Out (n = 34)	Both ^c (n = 16)	In (n = 30)	Out (n = 12)	Both ^c (n = 9)
Unit type							
Medical	50	14 (28)	30 (46)	2 (4)	5 (10)	1 (2)	0
Surgical	65	30 (46)	14 (22)	9 (14)	8 (12)	4 (6)	3 (5)
Operating room	27	4 (15)	1 (4)	1 (4)	0	0	0
Intensive care	24	6 (25)	11 (46)	3 (12)	14 (58)	7 (29)	6 (25)
Pediatric	20	1 (5)	1 (5)	0	2 (10)	0	0
Emergency and short stay	17	7 (41)	1 (6)	1 (6)	1 (6)	0	0
Sphygmomanometer category^b							
Wall model	57	20 (35)	8 (14)	5 (9)	10 (18)	4 (7)	3 (5)
Stored	52	7 (13)	4 (8)	2 (4)	2 (4)	1 (2)	1 (2)
Individual	41	12 (29)	13 (32)	2 (5)	14 (34)	7 (17)	5 (12)
On nurse's trolley	35	23 (66)	9 (26)	7 (20)	4 (11)	0	0
Clean	18	0	0	0	0	0	0

NOTE. CFU, colony-forming units.

^a Defined as levels in which the precise number was uncountable.

^b Defined in Methods.

^c The number of contaminated BP cuffs in this column is also included in the In and Out columns.

TABLE 2. Potentially Pathogenic Organisms That Contaminated the Inner (In) and Outer (Out) Sides of Blood Pressure (BP) Cuffs, According to Sphygmomanometer Category

Organism	Total no. of isolates	No. (%) of isolates, by sphygmomanometer category ^a and BP cuff side															
		Wall model (n = 57)				Stored (n = 52)				Individual (n = 41)				Nurse's trolley (n = 35)			
		Both	In	Out	Total	Both	In	Out	Total	Both	In	Out	Total	Both	In	Out	Total
<i>Staphylococcus aureus</i>	20	1	2	0	3	2	1	1	4	0	3	3	6	0	4	3	7
MSSA	11	1	2	0	...	1	1	1	...	0	0	1	...	0	1	3	...
MRSA	9	0	0	0	...	1	0	0	...	0	3	2	...	0	3	0	...
<i>Acinetobacter baumannii</i>	4	0	0	0	0	0	1	0	1	0	0	0	0	3	0	0	3
<i>Pseudomonas aeruginosa</i>	2	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0
<i>Serratia marcescens</i>	2	0	0	0	0	0	0	0	0	1	1	0	2	0	0	0	0
<i>Escherichia coli</i>	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Yeast	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Total	30	...	...	...	3 (5)	...	...	...	5 (10)	...	...	...	12 (29)	...	...	...	10 (28)

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*.

^a Defined in Methods.

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 arm of the patients for a prolonged period to continuously monitor BP. A strikingly high rate of contamination and colonization by potentially pathogenic bacteria (Table 2) was also observed on BP cuffs kept 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 (eg, 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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