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Adhesive Tape: Potential Source of Nosocomial Bacteria

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During a 7-day period, a variety of bacteria, including opportunistic ones, were recovered from 23 rolls of adhesive tape being used in a 16-bed intensive care unit. All rolls of tape were sterile when received from the manufacturer. Mixed flora was recovered from a total of 15 rolls, whereas eight rolls yielded pure cultures. Organisms recovered included *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and various species of *Enterobacteriaceae*. Although no illness or infection arising directly from contaminated adhesive tape has been documented, we feel that a potential source of infection has been identified. Most important is the fact that such tape may contaminate the hands of personnel who handle it. Also, the adhesive tape may directly contaminate a patient since it is widely used to secure artificial airways and various drainage tubes which results in the tape coming into close contact with the mucous membranes lining the patient's respiratory and urogenital tracts.

Various authors who have attempted to trace the source of contamination for specific outbreaks of nosocomial (i.e., hospital acquired) infections have reported the recovery of bacterial organisms from intravenous infusion products (1), inhalation therapy equipment (3, 6), stethoscopes (4), medicinals and lotions (7, 9), and catheters (8). Contaminated shaving brushes used for preoperative shaving preparations have been incriminated in the cross-infection of patients in an intensive care unit (12).

A bacteriologic survey of the 16-bed intensive care unit of our 560-bed teaching hospital revealed that rolls of adhesive tape at the bedside of patients were contaminated with opportunistic bacteria, including *Pseudomonas*, *Escherichia coli*, *Klebsiella*, *Enterobacter*, and coagulase-positive staphylococci. These organisms had also been isolated from the hands of personnel and clinical specimens of patients in the unit. Since it appeared that contaminated rolls of tape might be a potential vehicle for the transmission of these bacteria, we conducted a study to verify these preliminary results. Evidence is presented in this paper that indicates rolls of adhesive tape become contaminated with opportunistic bacteria during usage in the intensive care unit. This finding reveals another potential source of nosocomial infections since adhesive tape is widely used to secure artificial airways and nasogastric and drainage tubes. As a result, both the adhesive and nonadhesive surfaces of the tape may come into close contact with the mucous membranes lining the patient's nose, throat, and urinary tract. Adhesive tape is also used to secure various vascular catheters in place, often by placing the tape very near the puncture site. In addition, the tape, once it becomes contaminated, can further serve to contaminate the hands of personnel who handle it.

MATERIALS AND METHODS

A new, unopened can containing 24.5- by 360-inch rolls of adhesive tape (Parke, Davis and Co. no. 30-1176-1) was opened and each of the rolls was cultured by making impressions on petri dishes (100 by 15 mm) containing Trypticase soy agar (TSA, BBL). Each of the two flat surfaces was pressed directly to the agar surface of separate plates. Using a third plate, the area corresponding to the outer circumference of the roll was cultured by rolling the tape back and forth over the agar surface, producing a series of linear impressions. The tape was handled with sterile gloves and gloves were changed between culturing different surfaces of the tape. Each roll of tape was then numbered on the paper lining along the inner circumference and placed in the supply storage cabinet where adhesive tape was routinely stored until needed in the patient care area. All other ½-inch adhesive tape was removed from both storage cabinet and the patient care area, leaving only the previously cultured rolls of ½-inch tape for use by personnel. At intervals of 1, 5, and 7 days after initial culturing, each roll was recultured and its location in the unit recorded.

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Differential media was prepared from commercially available dehydrated media (Difco, BBL) as directed by the manufacturer. In addition to Gram stain and reactions on triple sugar iron agar, the tests used routinely on all isolates of gram-negative bacilli included indole, methyl red, Voges-Proskauer, citrate utilization, and motility. Supplementary tests which were performed when necessary were lysine decarboxylase, ornithine decarboxylase, urease, phenylalanine deaminase, deoxyribonuclease, and acid from arabinose, raffinose, and rhamnose. The media used for the tests were those recommended by Edwards and Ewing (2).

All nonfermentative gram-negative bacteria isolated were additionally tested for oxidase, oxidation of glucose, oxidation of 10% lactose, growth on cetrimide agar (0.03% cetrimide in TSA) at 42 C, fluorescence and pigment production. Tetramethyl paraphenylenediamine dihydrochloride (Kodak) in a final concentration of 1% (wt/vol) was used to perform the oxidase test.

Staphylococci were identified on the basis of Gram stain and coagulase production. Lyophilized rabbit plasma (BBL) was used to test for staphylococcal coagulase production. The 3-h tube coagulase test was performed. *Bacillus* sp. were identified on the basis of colonial morphology and Gram stain.

Cultures were incubated at 37 C for 18 to 24 h. In the case of *Pseudomonas aeruginosa*, cultures were incubated at 42 C and examined for fluorescence with a Wood's lamp after 24- and 48-h periods. All plates were held for 72 h before being reported as no growth.

RESULTS AND DISCUSSION

Each of 24 rolls of adhesive tape from the freshly opened can, as received from the manufacturer, was found to be sterile by our culturing procedure. When a roll of tape was removed to the patient care area, however, bacterial contamination occurred (Table 1). Rolls 1 to 13 were placed in use in the patient care area sometime between day 0 (i.e., the day of initial culturing from newly opened can) and day 1. By day 1, rolls 1 to 13 each showed bacterial contamination. The 11 rolls (14 to 24) which were still in the storage cabinet remained sterile. Rolls 14 to 23 were put into use sometime after the collection of day 1 cultures and day 5, and were each found to be positive on day 5 cultures. Roll 23 was found to be heavily contaminated after being in use for 1 h in the patient area, yielding a pure culture of >300 colonies of *Klebsiella*. However, this finding only suggests gross contamination in a short time since we did not culture the roll immediately prior to usage. Also high bacterial counts must be viewed with some reservation because of our culturing procedure. When the rolls were initially cultured, both moisture and nutrients from the agar most likely adhered to the tape and may have provided a nutrient surface for the growth of the contaminating organisms. Roll 24 was the only roll that was not removed from the storage cabinet during the 7-day study period and was also the only roll from which organisms could not be recovered.

Table 1 also shows the location of the various rolls at the time each set of cultures was obtained. Although most rolls appeared to remain at a single location, some rolls were found to have been moved to different areas of the unit and thus were used on more than one patient. Roll 11, for example, was found at a different location on each of the 3 days that cultures were collected.

Of the 23 rolls of tape which were used and subsequently became contaminated, mixed flora were obtained from 11 rolls, whereas pure cultures were observed with eight. The remaining four, although initially yielding only a single bacterial organism, subsequently developed mixed flora. At no time during the survey did an initially mixed culture convert to one containing a single organism.

TABLE 1. *Bacterial counts and location of rolls of adhesive tape*[a]

Roll no.	Day 1		Day 5		Day 7	
	Count	Location	Count	Location	Count	Location
1	29	Bed 11	59	Bed 11	59	Bed 11
2	137	Bed 12	>300	Bed 9	ND	
3	28	Bed 13	65	Bed 13	155	Bed 13
4	34	Bed 14	111	Bed 14	ND	
5	30	Bed 15	76	Bed 15	>300	Bed 16
6	78	Bed 1	ND[b]		ND	
7	14	Bed 2	19	Bed 2	15	Bed 2
8	17	Bed 4	76	Bed 4	93	Bed 4
9	27	Bed 4	52	Bed 4	86	Bed 1
10	25	Bed 2	29	Bed 2	35	Bed 2
11	51	EC[c]	107	Bed 5	120	Bed 3
12	112	Bed 6	>300	Bed 6	ND	
13	42	Bed 7	100	Bed 7	ND	
14	0	Cabinet[d]	25	Bed 8	77	Bed 8
15	0	Cabinet	96	Bed 9	>300	Bed 9
16	0	Cabinet	54	EC	70	EC
17	0	Cabinet	115	Bed 12	180	Bed 12
18	0	Cabinet	27	Bed 1	ND	
19	0	Cabinet	137	Bed 3	>300	Bed 5
20	0	Cabinet	15	Bed 10	45	Bed 10
21	0	Cabinet	39	Bed 9	100	Bed 9
22	0	Cabinet	150	Bed 14	ND	
23	0	Cabinet	>300[e]	Bed 16	ND	
24	0	Cabinet	0	Cabinet	0	Cabinet

[a] Colony counts represent organisms recovered from all surfaces of each roll of tape; all cultures of unused rolls on day 0 were sterile.
[b] Not done, roll could not be located.
[c] Emergency cart.
[d] Storage cabinet.
[e] Cultured after 1 h of use.

In general, the flat surfaces of the rolls yielded higher numbers of bacteria than did the outer edge. This was probably due to: (i) flat surfaces offering a greater surface area; (ii) rolls were usually placed on their sides when not in actual use, exposing these areas to various environmental surfaces; and (iii) flat surfaces were coated with a slightly sticky residue from the adhesive substance used on the tape.

The specific organisms recovered (Table 2) appeared to fall into two main groups. The first group included *Staphylococcus epidermidis*, *Bacillus* sp., *Mima polymorpha*, and fungus, organisms commonly found on environmental areas and normal skin. *S. epidermidis* and *Bacillus* sp. were the organisms most frequently isolated from the rolls of tape. The second group consisted of gram-negative bacilli which are often isolated from the hospital environment and are frequently found to produce disease in hospitalized individuals. This group included *Klebsiella*, *Serratia marcescens*, *E. coli*, *P. aeruginosa*, *Proteus vulgaris*, and *Proteus mirabilis*. These organisms have also been found to colonize the hands of patients during hospitalization (10), and, with the exception of *S. marcescens* and *P. aeruginosa*, are commonly associated with the gastrointestinal tract of man. The gram-negative bacilli giving the highest growth intensities were *Klebsiella* and *S. marcescens*. These two organisms were also the most frequently isolated gram-negative bacilli.

The rolls of tape may also have been contaminated with anaerobes, such as clostridia, or more fastidious bacteria. These organisms would not have been detected by our culturing procedure.

TABLE 2. *Organisms recovered from rolls of adhesive tape*

Organism	Colonies per roll of tape					
	<10	11–50	51–100	101–200	>200	Total
S. epidermidis	8[a]	9	2	1	0	20
Bacillus sp.	3	5	1	1	0	10
Klebsiella	3	2	1	2	1	9
S. marcescens	1	2	1	0	2	6
E. coli	4	1	0	0	0	5
P. aeruginosa	2	2	0	0	0	4
S. aureus	2	2	0	0	0	4
M. polymorpha	2	1	0	0	0	3
Fungus	3	0	0	0	0	3
P. vulgaris	1	1	0	0	0	2
P. mirabilis	0	1	0	0	0	1

[a] Number of rolls giving the corresponding number of colonies of organisms indicated.

While we have not documented an illness or an infection directly arising from contaminated adhesive tape, we believe a potential source of hospital-acquired infections has been clearly identified. Rolls of adhesive tape may become contaminated from the environmental surfaces with which they come in contact, the hands of personnel who handle them, or the patients directly or indirectly via contamination of the hands of personnel using it. Most important is the fact that such tape may subsequently contaminate the hands of personnel who handle it. The role of hands in the transmission of hospital infections and the need for strict maintenance of handwashing procedures preceding direct contact with critically ill patients has already been clearly demonstrated (5, 11). Unfortunately, many individuals may not take the precaution of washing their hands after handling an apparently harmless roll of adhesive tape. Since we have shown that rolls of adhesive tape cannot be expected to remain sterile after initial use, handwashing after use of tape is imperative for hospital personnel.

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