

# The role of surgical gowns, drapes, and masks in the generation of airborne particulates

In reporting the results of their comprehensive study on airborne particulates, the researchers and authors of "Airborne particulates in the OR environment" (*AORN Journal*, June 1999) focused on two sources—one inanimate, the other human.<sup>1</sup> First was a qualitative comparison between two surgical gowns and drapes made of nonwoven materials—one was a combination of wood pulp and polyester, the other was 100% polypropylene. The second source focused primarily on the filtering capabilities of the surgical mask and its inability to effectively retain contamination expelled from the nose and mouth.

## THE RESISTANCE OF NONWOVEN MATERIALS TO ABRASION

In commenting on the presence of wood pulp fibers that had been liberated from one material during its use, the researchers said "that the use of disposable gowns, scrubs, and surgical draping constructed of wood pulp/polyester was associated with significant linting compared to items made from polypropylene."<sup>2</sup> They further observed that even after 100% polypropylene fabrics had been used, they found lint in the air sampling devices composed of wood pulp fibers rather than polypropylene.

These results confirm a study performed in 1983 in which researchers reported that the construction of some nonwoven materials renders them conducive

to abrading quite easily.<sup>3</sup> For example, a nonwoven cellulose laminate product was subjected to an abrasion test normally used for woven textiles and was found to produce approximately 632 times as much lint by weight as the woven material to which it was compared.

## WOOD PULP FIBERS AND POSTSURGICAL COMPLICATIONS

As controversial as the role that airborne contamination may have on the outcome of a surgical procedure, the pathogenicity of wood pulp fibers has been identified in the literature on numerous occasions. Complications after surgery attributable to wood pulp fibers from nonwoven materials first was reported in the literature on several occasions more than 25 years ago.<sup>4</sup>

In 1979, wood pulp fibers again were cited as having caused complications in 22 out of 1,000 surgical procedures.<sup>5</sup> These complications included keloids, wound dehiscence, incisional hernias, and chronic abscesses at the wound site. Two patients suffered recurrent bouts of intestinal obstructions due to peritoneal adhesions. The hospital's pathologist detected the presence of wood pulp fibers with polarized light and believed the failure to use this technique more than likely accounted for the lack of widespread recognition of wood pulp fibers' presence. Another less

known report published in 1984 revealed that patients' reactions to wood pulp fibers were secondary to those attributable to cellulose lint fibers.<sup>6</sup>

## MODE OF TRANSMISSION

These disclosures drew a response challenging the allegation that disposable gowns and drapes were the direct source of wood pulp fibers. The authors of a 1979 article titled "Wood fiber contamination of reusable cotton laparotomy pads" maintained that the fibers were released by reusable laparotomy pads that had not been properly cleaned or were mishandled.<sup>7</sup> When released, the fibers were said to have adhered to internal surfaces (eg, the intestine) and were thereby accountable for the complications. Interestingly enough, the authors did not dispute that the fibers were responsible for granulomas. As evidenced in this article, the wood pulp fibers' mode of transmission into the patients' viscera might have occurred via the airborne route. This, however, does not preclude the possibility of fibers being transmitted by direct contact via a number of other routes (eg, the surgeon's gloved hands, exposed [uncovered] instruments).

## IDENTIFYING FIBER CONTENT

The federal government's Textile Fiber Products Identification Act of 1958 was enacted to ensure that consumers be provided with information regarding the fiber content of

NATHAN L. BELKIN, PhD, is retired and resides in Clearwater, Fla.

items identified as household textile articles. These articles were defined as "wearing apparel, costumes and accessories, draperies, floor coverings, furnishings, bedding, and other textile goods of a type customarily used in a household."<sup>8</sup> The government subsequently modified the law and currently requires manufacturers to include information as to how the items can be cleaned (eg, laundered and dried, dry cleaned).

There are several reasons why there is no reference to any product made out of a nonwoven material. First, at the time the law was enacted, nonwoven fabrics were not found in any of the items to which the law applied. In addition, the law was not intended to be applicable to items that were to be used once then thrown away.

It should be noted that in 1991, the nonwoven industry filed a petition requesting a reduction of tariffs on its surgical products. The document indicated that, with the exception of one particular brand, the range of wood pulp fiber content of the materials used for those products was an integral part of their construction, varying from 50% to 100%.<sup>9</sup>

→ Under the circumstances, and in light of what is recorded in the clinical literature, it appears to be reasonable that it is incumbent on the perioperative nurse to understand the products used in the OR. This would include requesting information about the fiber content of nonwoven surgical gowns and draping materials directly from the manufacturer.

#### **OTHER SOURCES OF AIRBORNE CONTAMINATION**

Other than wood pulp fibers, the researchers and authors of "Airborne particulates in the OR

environment" also found a widespread presence of organisms (eg, staphylococci) in the OR, and they looked forward to reducing the level of potentially nosocomial aerosol contamination by developing more efficient masks.

## **The surgical mask may not protect the patient from the wearer or the wearer from the patient.**

Currently, it has been reported that steps have been taken in developing new standards affecting the mask selection process.<sup>10</sup> In light of recently published literature regarding the effectiveness of the surgical mask, the question that logically arises is what purpose would new standards serve?

Historically, improvements in surgical masks have focused on their filtering efficiency, with tests being performed in specifically designed chambers under stringently controlled environmental conditions and monitored with quantitative sampling techniques. Test methods may differ, however, so efficiency claims are not always comparable.<sup>11</sup> Even so, depending on how a mask fits and/or is put on, some exhaled air will escape unfiltered around its edges. Thus, whatever its filtering efficiency, the mask's fit has a direct bearing on its effectiveness. Actually, it has been demonstrated that improving the filtering effi-

ciency can increase the amount of leakage.<sup>12</sup>

This says nothing about the extent to which the mask may be abused during its use (ie, worn dangling around the neck or for prolonged periods of time).<sup>13</sup> In addition, prevailing *in vivo* studies have not considered the effect that prolonged use has on edge leakage or other possible escape routes for bacteria. It is known that when the filtering media becomes wet from moist air exhaled by the wearer, its resistance to air flow increases, thus increasing air leakage around its edges.<sup>14</sup>

A review of the literature on the mask's effectiveness indicates that use of a mask may not protect the patient from the wearer or the wearer from the patient.<sup>15</sup> For example, the bacterial skin population of certain areas of the face, (ie, under the eyes, nose, angle of the jaw, under the chin) has been identified as being "too numerous to count (TNTC)."<sup>16</sup> The effect of the mask's movement over these facial areas while talking has been examined.<sup>17</sup> Just as it has been demonstrated with other apparel type items, dissemination of these skin bacteria could be attributed to the friction between the mask and those areas of heavy skin contamination while talking.<sup>18</sup>

Not to be overlooked are the findings of a comprehensive *in vivo* study performed in the 1960s.<sup>19</sup> Researchers found that during quiet breathing, few, if any, nasal bacteria are expelled in the air, despite heavy colonization of the nose. They further reported that

- quiet talking reduced oral bacterial contamination 2% to 7% compared to ordinary talking,
- from a distance of 1 m (ie, 39.37 inches), bacteria expelled while talking in the

ventilated OR did not contaminate settling plates on the surgical table or on the instrument tray.

- opposing air flows carried airborne contamination away from the center toward the room's periphery, and
- oral bacteria conveyed in droplets into the air during ordinary talking by non-scrubbed personnel not within the immediate vicinity of the surgical site do not pose an infection hazard, and that wearing of masks by those personnel is unnecessary.

#### THE MASK'S ADDITIONAL ROLE

With the emergence of the era of hazards associated with the transmission of bloodborne pathogens, the Occupational Safety and Health Administration categorized the mask as an item of personal protective equipment and assigned it the additional function of protecting the wearer from the patient.<sup>20</sup>

The first collaborative research initiative of the AORN Foundation was a 15-month study (ie, 481 cases) of occupational blood exposures in the ORs of six hospitals.<sup>21</sup> The research group reported that the eyes were the most vulnerable because they accounted for 45.3% of all blood exposures. They found that 83.7% of those exposed had worn masks and that some masks had eye shields attached; 74.4% were not wearing eye protection, including those wearing glasses. In the remainder

of the cases, some form of eye protection was worn (ie, goggles, face shields, eye shields attached to masks). Even in some of those instances, however, the research group found that the protective eyewear was inadequate to prevent eye exposures.

The late William C. Beck, MD, once suggested that the surgical mask could be replaced by a splash-shield.<sup>22</sup> As demonstrated in the literature, a device of this nature would protect the patient by deflecting the wearer's exhaled breath behind his or her head, which would then, in turn, be moved to the periphery of the room by the air circulation system.<sup>23</sup> Thus, the wearer would be protected from the patient's blood while being relieved of the breathing and general discomfort he or she may experience from using a surgical mask.

#### CONCLUSION

To this day, there has been little agreement about the influence of airborne contamination on the outcome of surgical procedures. Nevertheless, a number of methods (ie, ultraviolet irradiation, laminar flow systems) have been implemented through the years in attempts to minimize its presence. With few exceptions, these methods have all but been abandoned in favor of today's high-efficiency particle air filtered circulation systems that generate 15 to 20 air changes per hour.

Whatever their mode of transmission, and whether they be vec-

tors for other infectious microorganisms, wood pulp fibers have been identified as causing complications after surgery. For that reason, if no other, it is incumbent on the perioperative nurse to

- inquire of the manufacturer as to the fiber content of the material of which their disposable surgical gowns and drapes are made, and
- protect exposed instruments from airborne contamination using aseptic routine.

As for the role of the surgical mask, the principle supporting its use was adopted more than a century ago. The practice has simply been passed along because it seemed a reasonable thing to do at the time. Its effectiveness has managed to escape criticism, and the mask has simply survived the ages being perpetuated by the "that is the way we have always done it" syndrome. With the emergence of the era of hazards associated with the transmission of bloodborne pathogens, what has been forgotten is that the surgical mask originally was, and still is, designed to cover only the nose and mouth—it was never intended to be a complete facial covering. As confirmed in the literature, masks do not provide complete protection for either the wearer or the patient. The question that remains is whether the perioperative nursing community and society in general are prepared to abandon its theoretical, but still unproven, use in favor of a protective splash-shield type of device. ▲

#### NOTES

1. C Edmiston et al, "Airborne particulates in the OR environment," *AORN Journal* 69 (June 1999) 1169-1183.

2. *Ibid.*

3. E M Buras, R H Harris, "Generation of lint from fabrics," *Textile Chemist and Colorist* 15 (January 1983)

17-19.

4. M A Tinker et al, "Granulomatous peritonitis due to cellulose fibers from disposable surgical fabrics: Laboratory investigation and clinical implications," *Annals of Surgery* 180 (December 1974) 831-835. M Tinker, I Teicher, D Burdman, "Cellulose granulomas and

their relationship to intestinal obstruction," *Annals of Surgery* 133 (January 1977) 134-139.

5. M J Dragan, "Wood fibers from disposable surgical gowns and drapes," *JAMA* 241 (May 25, 1979) 2297-2298.

6. K Janoff et al, "Foreign body reactions secondary to cellulose lint fibers," *American Journal of Surgery* 147 (May 1984) 598-600.

7. G D Huebner and G M Olderman, "Wood fiber contamination of reusable cotton laparotomy pads," *Surgery, Gynecology and Obstetrics* 148 (June 1979) 887-889.

8. Legislative History of the Textile Fiber Products Identification Act: P.L. 85-897: 72 Stat. 1717: Sept 2, 1958 (Washington, DC: Covington & Burling, 1959.)

9. Written Comments on Certain Tariff and Trade Bills (Washington, DC: US Government Printing Office, 1991) 364-369.

10. J O Stull, "New developments in standards affecting the selection of surgical masks," *Surgical Services Management* 4 (July 1998) 24-35.

11. W T Davis, "Filtration efficiency of surgical face masks: The need for more meaningful standards," *American Journal of Infection Control* 19 (February 1991) 16-18. C R Ford, D E Peterson, C R Mitchell, "An appraisal of the role of surgical face masks," *American Journal of Surgery* 113 (June 1967) 787-790.

12. R A Shooter, M A Smith, C J W Hunter, "A study of surgical masks," *British Journal of Surgery* 203 (1959) 246-249.

13. F Koch, "Perspectives on surgical attire," *Infection Control and Sterilization Technology* 2 (January 1996) 15-17.

14. A Weber et al, "Aerosol penetration and leakage characteristics of masks used in the health care industry," *American Journal of Infection Control* 21 (August 1993)

167-173.

15. N L Belkin, "A century after their introduction, are surgical masks necessary?" *AORN Journal* 64 (October 1996) 602-607; N L Belkin, "The evolution of the surgical mask: Filtering efficiency versus effectiveness," *Infection Control and Hospital Epidemiology* 18 (January 1997) 49-57; N L Belkin, "Surgical masks: Another sacred cow?" *The Guthrie Journal* 66 (Winter 1997) 32-34; N L Belkin, "The surgical mask: Is it still necessary?" *Surgery* 122 (September 1997) 641-642.

16. H I Maibach, G Hildick-Smith, "Methods of preventing infection and cross-infection," in *Skin Bacteria and Their Role in Infection*, part 4 (New York: McGraw-Hill Book Co, 1965) 222-223.

17. R T Schweizer, "Mask wiggling as a potential cause of wound contamination," *Lancet* 2 (Nov 20, 1976) 1129-1130.

18. N L Belkin, "Reduction of airborne contamination through operating room apparel," *AORN Journal* 4 (November/December 1966) 75-79. H R Bernard, W R Cole, D L Gravens, "Reduction of iatrogenic bacterial contamination in operating rooms," *Annals of Surgery* 165 (April 1967) 609-613.

19. N J Mitchell, S Hunt, "Surgical face masks in modern operating rooms—a costly and unnecessary ritual?" *Journal of Hospital Infection* 18 (July 1991) 238-242.

20. "Occupational exposure to bloodborne pathogens; Final rule," *Federal Register*, 56 (Dec 6, 1991) 64177.

21. J Jagger, M Bentley, P Tereskerz, "A study of patterns and prevention of blood exposures in OR personnel," *AORN Journal* 67 (May 1998) 979-996.

22. W C Beck, "The surgical mask: Another 'sacred cow'?" *AORN Journal* 55 (April 1992) 955-957.

23. Belkin, "A century after their introduction, are surgical masks necessary?" 602-607.

## Time Study Participants Needed for Home Study Program

The *AORN Journal* is asking members with less than seven years of perioperative nursing experience to volunteer to complete time studies for the Home Study Program. The Home Study Program is awarded contact hours based on time study feedback using the American Nurses Credentialing Center's Committee on Accreditation criteria. Time study participants are responsible on a rotating basis for reading the content, evaluating content for accuracy, and documenting the length of time

required to complete the home study. Participants must be willing to provide a quick turnaround of the completed home study. Participants will receive a coupon redeemable for one free Home Study of their choice for each time study completed. Members who are interested in participating in this program should send their name, address, and phone number to Liz Leaver, *AORN Journal*, 2170 S Parker Rd, Suite 300, Denver, CO 80231-5711 or via e-mail at lleaver@aorn.org.