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USE OF PERSONAL PROTECTIVE EQUIPMENT AND OPERATING ROOM BEHAVIORS IN FOUR SURGICAL SUBSPECIALTIES: PERSONAL PROTECTIVE EQUIPMENT AND BEHAVIORS IN SURGERY

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ABSTRACT

OBJECTIVE: To evaluate Universal Precautions (UP) compliance in the operating room (OR).

DESIGN: Prospective observational cohort. Trained observers recorded information about (1) personal protective equipment used by OR staff; (2) eyewear, glove, or gown breaks; (3) the nature of sharps transfers; (4) risk-taking behaviors of the OR staff; and (5) needlestick injuries and other blood and body-fluid exposures.

SETTING: Barnes-Jewish Hospital, a 1,000-bed, tertiary-care hospital affiliated with Washington University School of Medicine, St Louis, Missouri.

PARTICIPANTS: OR personnel in four surgical specialties (gynecologic, orthopedic, cardiothoracic, and general). Procedures eligible for the study were selected randomly. Hand surgery and procedures requiring no or a very small incision (eg, arthroscopy, laparoscopy) were excluded.

RESULTS: A total of 597 healthcare workers' procedures were observed in 76 surgical cases (200 hours). Of the 597 healthcare workers, 32% wore regular glasses, and 24% used no eye protection. Scrub nurses and medical students were more likely than other healthcare workers to wear goggles. Only 28% of healthcare workers double gloved, with orthopedic surgery personnel being the most compliant. Sharps passages were not announced in 91% of the surgical procedures. In 65 cases (86%), sharps were adjusted manually. Three percutaneous and 14 cutaneous exposures occurred, for a total exposure rate of 22%.

CONCLUSION: OR personnel had poor compliance with UP. Although there was significant variation in use of personal protective equipment between groups, the total exposure rate was high (22%), indicating the need for further training and reinforcement of UP to reduce occupational exposures (*Infect Control Hosp Epidemiol* 1999;20:110-114).

Exposure to bloodborne pathogens poses a serious occupational threat to healthcare workers. Surgical personnel, in particular, are at high risk of infection from bloodborne pathogens, especially from percutaneous injuries caused by needles and sharp instruments.[1,2]

To develop preventive interventions, we need to understand the epidemiological characteristics of blood contact among surgical personnel. To evaluate Universal Precautions compliance, we observed orthopedic, gynecologic, general, and cardiothoracic operating room procedures and documented the personal protective equipment (PPE) worn by operating room staff, behaviors of the operating room personnel during the procedures, and body-substance exposures.

METHODS

Setting

The operating room observations were conducted from June through October 1996 at Barnes-Jewish Hospital, a 1,000-bed, tertiary-care hospital affiliated with Washington University School of Medicine, St Louis, Missouri. Hospital policy during the study period required that Universal Precautions (use of appropriate protective equipment for anticipated contact with blood or body fluids) be followed for all patients, regardless of diagnosis.

Selection of Procedures for Observation

Procedures eligible for the study included those performed on adult patients in four surgical specialties: orthopedic, general, gynecologic, and cardiothoracic surgery. Cases were selected randomly to ensure a representative sample of surgeons and operating room staff. Hand surgery, insertions of arterial and venous access devices, and procedures requiring no or a very small incision (eg, arthroscopy, laparoscopy) were excluded. A different surgical service was designated for observation on each study day. If a procedure from that service was not available for observation, a procedure from any eligible service was observed. If two or more eligible procedures were available

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for observation, a procedure was selected using the following method: the operating room with the lowest number was chosen; subsequently, operating rooms with successively higher numbers were chosen; when the operating room with the highest number had been chosen, the process was started again with the operating room with the lowest number.

Descriptive Data and Data Collection

There were three trained observers. Observers generally watched cases from 7:30 AM to 3:30 PM. For each procedure, information about patient age, gender, estimated blood loss during the procedure, and procedure length was recorded. Attending surgeons, house staff, surgical assistants, scrub nurses, circulating nurses, and medical students were observed. Each observation period covered one procedure; healthcare workers were documented once during the surgical case. If at any time during a procedure a healthcare worker failed to adhere to Universal Precautions, a "break in technique" was recorded. Healthcare workers could receive more than one documented break for each surgical case. A given healthcare worker might be observed in more than one observation period.

Personal protective equipment used by operating room staff was documented. Appropriate eyewear was defined as face shields, goggles, or regular glasses with side shields. Eyewear, glove, or gown breaks were defined as lack of appropriate PPE when there was a reasonable risk for exposure to blood and body fluids. The number of pairs of gloves put on by the operating room personnel at the beginning of the case and the number of times operating room personnel changed the inner and outer gloves or removed a layer of gloves and did not replace them were documented. The number of times that operating room personnel performed the act of examining their gloves or gowns to determine if there was a hole or if blood had soaked through were counted and defined as a glove or garment check.

Sharps passage was ascertained by watching 10 passages: 2 during the incision, 4 during the surgery, and 4 during closure. The method of the sharps passage (eg, to a neutral zone, basin, hand-to-hand, announcement of the sharps transfer, point towards the recipient) was documented. Breaks were recorded if the pass was not announced or the point was directed toward the recipient. Manual manipulation of needles (fingers used to pull needles through tissue, holding suture needles when tying knots, and digital palpation of a needle tip in a body cavity) also was recorded.

Researchers also documented risky behaviors (defined as any behavior that would put others in the operating room at risk for exposures) and body-substance exposures (needlestick injuries; mucous membrane and percutaneous exposures). At the end of the case, after they removed their gloves and gowns, all surgical team members were examined for the presence of blood on their hands, face, or body.

Data Analysis

Data analysis was performed using SPSS (version 6.1; SPSS Inc, Chicago, IL). Chi-square and Fishers' Exact tests were used to compare categorical variables. The *t* test was used to compare continuous variables. Two-tailed probability values <.05 were considered statistically significant. This study was approved by the Institutional Review Board of Washington University School of Medicine.

RESULTS

During the study period, 76 cases (compiling 200 hours) were observed, of which 32% were orthopedic, 26% gynecologic, 28% general, and 14% cardiothoracic. The mean patient age was 57 (range, 18-87) years, mean procedure length was 130 (range, 13-374) minutes, and the mean estimated blood loss was 291 (range, 0-1,500) mL. A total of 597 healthcare workers' episodes were observed: 12% were attending surgeons; 20%, house staff; 25%, anesthesia personnel; 1%, surgical assistants; 20%, scrub nurses; 15%, circulating nurses; and 7%, medical students (Table 1). The four surgical specialties had over 300 staff members.

Of the 597 healthcare workers observed, 39% wore goggles, 5% wore face shields, 32% wore regular glasses, and 24% had no eye protection at all. As shown in Table 2, the use of eye protection varied significantly by specialty ($P<.001$) and by job description ($P<.001$). Personnel performing cardiothoracic surgery wore goggles or face shields only 31% of the time, as compared to 55% for general surgery and over 40% for gynecologic and orthopedic surgery. Use of goggles or face shields was lowest for attending physicians (27%) and anesthesia personnel (22%), whereas medical students, house staff, and scrub nurses all used such protection at least 60% of the time.

Double gloves were worn by only 28% of the 344 relevant healthcare workers observed (anesthesia personnel and circulators were not expected to double glove). As shown in Table 3, double gloving varied significantly by specialty ($P<.001$) and by job description ($P<.001$). Personnel performing orthopedic surgery wore double gloves 64% of the time, as compared to 20% for gynecologic and less than 10% for cardiothoracic and general surgery staff. Use of double gloves was highest for house staff (43%), followed by attending physicians (26%), medical students (26%), and scrub nurses (15%).

Sharps passages were not announced in 91% of the 575 surgical procedures (Table 4) Of announced passages, 64% were in gynecologic surgery cases. In 86% of cases, sharps were adjusted manually by surgical personnel. There were 3 percutaneous injuries (2 scalpel injuries and 1 needlestick injury) and 14 cutaneous blood and body-fluid exposures observed, for a total exposure rate of 22%. Of the 17 exposures, 8 occurred in orthopedic cases, and 6 were observed during gynecologic operations.

DISCUSSION

Blood and body-fluid exposures are daily events that often are ignored or assumed to be unavoidable among those who work in the operating room. Because blood-

TABLE 1
CHARACTERISTICS OF OPERATING ROOM CASES OBSERVED

Characteristic	No.	(%)
Total surgical cases observed	76	(100)
Orthopedic	24	(32)
Gynecologic	20	(26)
General or vascular	21	(28)
Cardiothoracic	11	(14)
Hours of observation	200	(100)
Mean patient age, y±SD (range)	57±18	(18-87)
Mean estimated blood loss, mL (range)	291	(0-1,500)
Mean procedure length, min (range)	130	(13-374)
Healthcare workers by job type		
Attending	74	(12)
House staff	120	(20)
Anesthesia (MD or CRNA)	151	(25)
Surgical assistant	6	(1)
Scrub nurse	116	(20)
Circulator	88	(15)
Medical student	42	(7)

Abbreviations: CRNA, certified registered nurse anesthetist; MD, medical doctor; SD, standard deviation.

borne pathogens such as hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) can cause lethal disease when inoculated parenterally or via mucous membrane or nonintact skin contact, there are compelling reasons to decrease blood and body-fluid exposures to the lowest possible level. To improve safety and to reduce the risk of occupational transmission of HIV, the Centers for Disease Control and Prevention (CDC) recommended Universal Precautions in 1987.[3,4] Universal Precautions include the routine use of barrier precautions and techniques to reduce the likelihood of exposure. Barrier precautions also provide important protection against other potentially harmful pathogens, including HBV and HCV.

Several studies have shown the prevalence of HBV infection to be higher among healthcare workers than among the general US population.[5-8] Although antibody testing for HCV has been available in the United States since 1992, prevalence data on HCV still are limited. Serological surveys conducted by Shapiro[9] and Panlilio[10] found anti-HCV seroprevalence among surgeons to be 0.8% and 0.9%, respectively. As of June 1997, the CDC reported 52 US healthcare workers with documented cases of occupationally acquired HIV infection and 114 healthcare workers with possible occupational HIV transmission.[11] Documentation of cases can be difficult, particularly if exposures are not reported at the time of occurrence. It has been estimated that only 10% to 60% of percutaneous injuries to healthcare workers are reported.[12,13]

In our study, 3 percutaneous and 14 cutaneous exposures occurred, for a total exposure rate of 22%. In Tokars' study,[14] the percutaneous injury rate among surgical personnel was 7%. In two studies from San Francisco[15] and Albuquerque,[16] the observed rates of exposure to blood were 6% and 28% for any blood contact and 1% and 3% for percutaneous exposures, respectively. Reported injury rates may vary due to study methods, surgical procedures observed, surgical techniques, and safety precautions employed by the surgical team.

There were significant differences in compliance among the four surgical services observed during this study. Double gloving was more common in orthopedic surgery. Healthcare workers in the gynecologic surgery department were more likely to announce the passage of sharps. Although these two specialties seemed to be more compliant with some aspects of Universal Precautions,

TABLE 2
EYE PROTECTION BY SPECIALTY AND OCCUPATION, BASED ON 597 HEALTHCARE-WORKER OBSERVATIONS

	Goggles	Face Shields	Regular Glasses	No Eye Protection	
	No. (%)	No. (%)	No. (%)	No. (%)	*P*
Worker observations	234 (39)	26 (5)	193 (32)	144 (24)	
Specialty					<.001
Cardiothoracic surgery	8 (8)	23 (23)	23 (23)	45 (46)	
General or vascular surgery	93 (55)	0 (0)	55 (32)	22 (13)	
Gynecologic surgery	58 (40)	1 (1)	51 (35)	35 (24)	
Orthopedic surgery	75 (41)	2 (1)	64 (35)	42 (23)	
Job description					<.001
Attending surgeon	19 (26)	1 (1)	46 (62)	8 (11)	
House staff	50 (42)	2 (2)	53 (44)	15 (12)	
Anesthesia (MD or CRNA)	31 (20)	3 (2)	48 (32)	69 (46)	
Scrub nurse or surgical assistant	69 (57)	15 (12)	20 (16)	18 (15)	
Circulator	36 (41)	4 (5)	18 (20)	30 (34)	
Medical student	29 (69)	1 (2)	8 (19)	4 (10)	

Abbreviations: CRNA, certified registered nurse anesthetist; MD, medical doctor.

TABLE 3
GLOVE USE BY SPECIALTY AND OCCUPATION, BASED ON 344 HEALTHCARE-WORKERS' OBSERVATIONS*

	Double Glove	Single Glove	
	No. (%)	No. (%)	*P*
Worker observations	97 (28)	247 (72)	
Specialty			<.001
Cardiothoracic surgery	4 (7)	49 (93)	
General or vascular surgery	9 (9)	88 (91)	
Gynecologic surgery	18 (20)	73 (80)	
Orthopedic surgery	66 (64)	37 (36)	
Job description			<.001
Attending surgeon	19 (26)	55 (74)	
House staff	51 (43)	67 (57)	
Scrub nurse or surgical assistant	17 (15)	97 (85)	
Medical student	10 (26)	28 (74)	

* Anesthesia personnel and circulators were not expected to double glove. Data regarding glove use was not available for two house staff, eight scrub nurses, and four medical students.

TABLE 4
RISK BEHAVIORS DURING SHARPS PASSAGES

Specialty	Total No. of Passages	Passage Not Announced No. (%)	Point at Recipient No. (%)
Cardiothoracic surgery	89	88 (99)	2 (2)
General or vascular surgery	139	131 (94)	5 (4)
Gynecologic surgery	148	114 (77)	6 (4)
Orthopedic surgery	183	174 (95)	1 (1)

their exposure rates still were higher than the other specialties.

Young healthcare workers were more likely to use certain components of Universal Precautions: double gloving was more common with house staff, and medical students were more likely to wear goggles. In Michaelsen's study of compliance with Universal Precautions among physicians, noncompliant physicians were approximately twice as likely as compliant physicians to be age 37 years or older.[17] A population survey among 375 hospital-based physicians in Los Angeles County found that glove wearing was significantly and positively associated with a younger age, greater concern about infection, and more frequent exposure to blood and body fluid.[18] Older physicians are likely to have been trained with different views and guidelines on infection precautions. The adoption of the new behaviors and the discontinuation of past behaviors may be more difficult for them. Several studies concerning healthcare workers working in surgical and nonsurgical fields, including ours, show that gloves are the most frequently used precaution, possibly reflecting a long tradition with this protective barrier.[17,19-21]

There are a few limitations to this study. Our findings may not be generalized to other healthcare-worker populations, because only high-risk surgical specialties were used. That surgical personnel were aware they were being observed and emphasis was placed on following Occupational Safety and Health Administration-mandated guidelines may have affected their decision to use additional PPE.

Our results demonstrate suboptimal compliance with Universal Precautions among operating room personnel. The majority of the healthcare workers did not wear sufficient PPE. Double gloving for surgical procedures was uncommon. Sharps passages generally went unannounced, and inappropriate behaviors unnecessarily increased the risk of bloodborne pathogen exposure in the operating room. The 22% total exposure rate was high, indicating the need for further training and enforcement of Universal Precautions to reduce occupational hazards.

After more than a decade of the HIV epidemic, studies show that healthcare workers' compliance with the Universal Precautions still is poor. Healthcare workers need to be instructed about how to protect themselves in the workplace. To improve safety, emphasis should be placed on continuing education and training, behavior modification, engineering controls, and active administrative commitment to safety in the workplace. Data acquired from epidemiological studies such as this must be used to design educational interventions for healthcare workers in order to improve compliance with Universal Precautions and decrease the risk of occupational exposure. This study obtained baseline information that will be used to tailor an educational program to increase compliance with Universal Precautions.

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