The National Study to Prevent Blood Exposure in Paramedics: Exposure Reporting

Winifred L. Boal, MPH,[1]* Jack K. Leiss, PhD,[2] Sara Sousa, MPH,[2] Jennifer T. Lyden, BA,[2] Jia Li, MS,[3] and Janine Jagger, PhD[4]

Background *This survey was conducted to provide national incidence rates and risk factors for exposure to blood among paramedics. The present analysis assesses reporting of exposures to employers.*

Methods *A questionnaire was mailed in 2002–2003 to a national sample of paramedics selected using a two-stage design. Information on exposure reporting was obtained on the two most recent exposures for each of five routes of exposure.*

Results *Forty-nine percent of all exposures to blood and 72% of needlesticks were reported to employers. The main reason for under-reporting was not considering the exposure a "significant risk." Females reported significantly more total exposures than males. Reporting of needlesticks was significantly less common among respondents who believed most needlesticks were due to circumstances under the worker's control. Reporting was non-significantly more common among workers who believed reporting exposures helps management prevent future exposures. Reporting may have been positively associated with workplace safety culture.*

Conclusions *This survey indicates there is need to improve the reporting of blood exposures by paramedics to their employers, and more work is needed to understand the reasons for under-reporting. Gender, safety culture, perception of risk, and other personal attitudes may all affect reporting behavior.* Am. J. Ind. Med. 51:213–222, 2008.

KEY WORDS: paramedics; prehospital; needlestick; blood exposure; under-reporting; occupational health; survey

INTRODUCTION

Substantial attention has been paid to the hazard of occupational exposure to blood and other potentially infectious body fluids. It has been estimated that hospital-based healthcare workers in the United States experience approximately 385,000 percutaneous injuries every year [Panlilio et al., 2004]. These exposures put workers at risk for serious infections such as human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV) [Henderson, 2004]. The average risk of HIV transmission after a needlestick injury (NSI) with HIV-infected blood is estimated to be approximately 0.3% [Centers for Disease Control and Prevention, 2005]; for HCV, it is 1.8% [Centers for Disease Control and Prevention, 2001]. HBV is transmitted to

[1]Division of Surveillance, Hazard Evaluations, and Field Studies, National Institute for Occupational Safety and Health, Cincinnati, Ohio
[2]Statistics and Epidemiology, Health Sciences, Constella Group, LLC, Durham, North Carolina
[3]Statistics and Epidemiology, Health Sciences, Constella Group, LLC, Cincinnati, Ohio
[4]Department of Internal Medicine, University of Virginia, Charlottesville, Virginia
The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention.
Contract grant sponsor: National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention; Contract grant number: U01 OH04266-01.
*Correspondence to: Winifred L. Boal, Research Epidemiologist, Surveillance Branch, Division of Surveillance, Hazard Evaluations, and Field Studies, National Institute for Occupational Safety and Health (NIOSH), 4676 Columbia Parkway, R-17 Cincinnati, OH 45226.
E-mail: wboal@cdc.gov

Accepted 28 November 2007
DOI 10.1002/ajim.20558. Published online in Wiley InterScience (www.interscience.wiley.com)

6–30% of susceptible health care workers who experience an NSI from an HBV-infected patient [National Institute for Occupational Safety and Health, 1999].

The National Study to Prevent Blood Exposure in Paramedics was initiated to provide incidence rates for occupational exposures to blood and to identify risk factors for these exposures among paramedics. Paramedics were selected as the occupational group to focus on because they perform invasive medical procedures in uncontrolled, out-of-hospital locations, which may affect their risk of exposure to blood [Boal et al., 2005].

Under-reporting of needlestick exposures to blood among paramedics and other emergency medical technicians (EMTs) has been documented to range from 20% to 52% [Klontz et al., 1991; Tandberg et al., 1991; Carrillo et al., 1996; Gaffney et al., 2000]. Under-reporting of exposures to blood among other healthcare workers in the United States ranges up to 96% [Hamory, 1983; Mangione et al., 1991; O'Neill et al., 1992; Rattner et al., 1994; Diekema et al., 1996; Ramsey and Glenn, 1996; Centers for Disease Control and Prevention, 1997; Pettit et al., 1997; Greene et al., 1998; Haiduven et al., 1999; Lee et al., 1999; Alvarado et al., 2000; Doebbeling et al., 2003; Mendelson et al., 2003; Patterson et al., 2003; Sohn et al., 2004], and similar rates have also been reported from a number of other countries [McGeer et al., 1990; Hettiaratchy et al., 1998; Shiao et al., 1999; Rabaud et al., 2000]. Reasons for not reporting exposures have included believing the risk of infection was low, being too busy, not knowing the reporting procedure, and not wanting to appear careless [Hamory, 1983; Mangione et al., 1991; Tandberg et al., 1991; Haiduven et al., 1999; Shiao et al., 1999; Debnath, 2000; Rabaud et al., 2000; Sohn et al., 2004].

The purpose of this article from the National Study to Prevent Blood Exposure in Paramedics is to describe blood exposure reporting behavior by route of exposure and other factors among paramedics in the United States.

MATERIALS AND METHODS

Details on the methods for this investigation have been provided previously [Leiss et al., 2006]. A survey was mailed during the fall and winter of 2002–2003 to a nationally representative sample of paramedics in the United States. A two-stage design was used to select the sample by, first, selecting states using probabilities proportional to the number of paramedics within each state, and second, selecting samples from state lists of certified paramedics. Eleven states were selected in the first sampling stage; 5,000 paramedics were randomly selected from these states' lists in the second sampling stage. Because California's state needlestick prevention law had been in effect for several years before comparable national regulations, there was an interest in estimating incidence rates separately for California, so a simple random sample of 1,500 paramedics was selected from California. The total sample size was 6,500. The Human Investigation Committee of the University of Virginia approved this study.

Respondents were eligible to participate if they were currently certified as a paramedic, currently worked a paid or volunteer job as a paramedic where they had direct patient contact, and responded to four or more calls in the 4 weeks previous to the survey. Because many paramedics hold more than one job, subjects could enter information on as many as two paid and one volunteer jobs where they made at least four calls in the previous 4 weeks.

For each of five routes of exposure, respondents were asked how many times they had contact with blood during the previous 12 months. These routes were: (1) needle or lancet stick after use on a patient; (2) cut by scalpel, razor, scissors, or sharp object like glass or metal that had blood or body fluid containing visible blood on it; (3) blood or body fluid containing visible blood in the eyes, nose, or mouth (hereafter referred to as mucous membrane exposures); (4) blood or body fluid containing visible blood on non-intact skin; and (5) human bite. The twelve-month period was selected to reduce recall bias while being long enough to allow for a substantial number of exposures.

For each route of exposure, additional questions were asked about the two most recent exposures within the previous 12 months. These included questions on reporting behavior. Respondents were asked whether the exposure had been reported to the appropriate authority, and if not, the survey provided four possible reasons for non-reporting, with the instruction to check all that applied: (1) It wasn't a significant exposure, (2) I didn't want to be reprimanded, (3) Confidentiality, and (4) Other (specify). (Our interpretation of ''Confidentiality'' is that the respondent did not want others to know of the exposure.) They were also asked whether a written report had been made about the incident.

Information was also collected on demographic variables. In addition, a number of questions used a 5-point Likert scale to address whether the respondent would report exposures under specified conditions and solicited the respondent's attitude towards exposure and prevention.

Two questions using a yes/no/don't know format were included as indicators of management emphasis on workplace safety culture. These were: ''If you did not follow Universal/Standard Precautions, would your supervisor speak to you about it?'' and ''Is following safety procedures part of your job evaluation?''

In order to produce population estimates from the survey data, a weight for each paramedic in the sample was constructed from his/her selection probability with adjustment for non-response. Analyses were conducted with SAS version 9 (SAS Institute, Cary, NC, 2002) and SUDAAN version 9.0 (Research Triangle Institute, Research Triangle Park, NC, 2004). The survey instrument may be viewed at http://www.constellagroup.com/paramedicquestionnaire/.

RESULTS

California, Connecticut, Florida, Illinois, Kentucky, Minnesota, North Carolina, Ohio, Pennsylvania, Tennessee, and Texas were selected in the first stage. Illinois refused to participate. Three hundred fifty-eight (358) surveys were undeliverable due to incorrect addresses; of the 6,142 paramedics presumed to have been contacted, 3,378 questionnaires (55%) were returned. Of these, 2,664 (78.9%) met the eligibility criteria and comprise the study group. More than 85% of the study group were non-Hispanic whites. The response rate was 55% assuming that 79% of non-respondents met the eligibility criteria, as was true among respondents. Of the 2,664 paramedics, 538 individuals experienced 895 exposures within the previous 12 months (Table I).

Respondents experienced a total of 660 exposures when asked to consider the two most recent exposures by each of the five routes of exposure. Only 49% (n = 327) of the total exposures were reported to the employer; of these, a written report was made for 82%. The most common reason paramedics gave for not reporting an exposure to their employer was that the worker did not consider it a "significant exposure" (Table II).

Reporting rates for needlestick/lancet exposures were significantly greater than cuts ($P < 0.01$) or non-intact skin ($P < 0.01$), as were rates for mucous membrane exposures compared to cuts ($P < 0.01$) or non-intact skin ($P < 0.01$).

TABLE I. Number of Paramedics who Reported on the Survey at Least One Exposure and Total Number of Exposures by Route of Exposure

Route of exposure	Number of paramedics who reported on the survey at least one exposure	Total number of exposures reported on the survey by all paramedics
Needlestick/lancet	118	132
Cut from sharp object	62	83
Mucous membrane	131	147
Non-intact skin	204	508
Bite	23	25
Total	538	895

Paramedics were most likely to report needlestick/lancet injuries if the puncture was deep: 100% of 6 severe injuries (deep stick or profuse bleeding) and 95% of 50 moderate sticks (skin puncture, some bleeding), but 63% of 63 superficial sticks (little or no bleeding), were reported. Of the 22 needlestick/lancet injuries not reported because respondents did not consider them a significant exposure, 19 were superficial sticks, 2 were moderate injuries, none were severe, and 1 was not classified as to severity.

For needlestick/lancet injuries, mucous membrane exposures, and for all routes combined, females reported a

TABLE II. Reporting Behavior by Route of Exposure

	Route of exposure					
Exposure reporting[a]	Needlestick/ lancet, n%[b] (95% CI)	Cut from sharp object, n%[b] (95% CI)	Mucous membrane, n%[b] (95% CI)	Non-intact skin, n%[b] (95% CI)	Bite, n%[b] (95% CI)	Total, n%[b] (95% CI)
Number of exposures	125	73	144	293	25	660
Number of exposures reported to employer	91, 72% (66–77)	32, 37% (17–56)	100, 66% (60–71)	87, 29% (24–35)	17, 53% (20–86)	327, 49% (45–53)
Number of exposures not reported to employer	30, 26% (20–32)	38, 61% (40–83)	40, 32% (26–38)	197, 69% (63–74)	8, 47% (14–80)	313, 49% (45–53)
Reason for not reporting exposure to employer[c]						
Not a significant exposure	22	31	31	182	6	272
Did not want to be reprimanded	6	3	3	9	1	22
Confidentiality	0	0	1	3	0	4
Other	4	5	4	10	2	25
No reason given	2	0	3	6	0	11
Number of exposures with missing information on whether exposure was reported to employer	4, 2% (0–5)	3, 2% (0–5)	4, 2% (0–4)	9, 2% (1–3)	0	20, 2% (1–3)

CI, confidence interval.

[a]Only the two most recent exposures per route of exposure that occurred within the previous 12 months are included.

[b]Percentages are weighted.

[c]Respondents could check all that apply.

significantly higher percentage of exposures than males ($P < 0.001$ for all three routes of exposure). No pattern of reporting was apparent by age. Those with eleven or more years since certification as a paramedic reported significantly fewer sharps injuries ($P = 0.012$) and total exposures ($P = 0.001$) than those with ten or fewer years of certification (Table III).

Of the 2,664 respondents, 2,593 held at least one paid job; Table IV presents reporting behavior by route of exposure and characteristics of the job identified on the survey as paid job #1. There was no significant difference in reporting rates by workplace union status. There was no difference in general by type of employer (city/county, private company, or hospital). By the number of runs in the previous seven days where the paramedic personally attended to patients (which could be a marker for workload), there was a suggestion that reporting was higher for those who went on more runs, although this was statistically significant only for non-intact skin ($P = 0.001$) and total exposures ($P = 0.003$).

Reporting rates for total exposures were highest among paramedics who indicated their supervisor would speak to them about following Universal/Standard Precautions and that following safety procedures was part of their job evaluation. Conversely, the rates for total exposures were lowest for those who answered ''no'' to both questions (Table IV).

All respondents were asked how likely (on a 5-point Likert scale where 1 = never and 5 = always) they were to fill out an incident report if they came in contact with patients' blood or visibly bloody body fluids under various conditions. Their responses to these hypothetical questions were compared to the reporting behavior of paramedics who experienced exposures within the previous 12 months (Table V). The results for the hypothetical exposures were similar for all three jobs. As with actual exposures, reporting percentages for hypothetical exposures were substantially lower for contact with non-intact skin than for needlesticks or mucous membrane exposures. The percentage of the study group who answered they would always report the hypothetically posed exposures was substantially greater than the percentage of respondents who actually reported similar exposures to their employers in the previous 12 months.

Respondents were also asked for their agreement (on a 5-point Likert scale where 1 = disagree and 5 = agree) with the statement, ''Reporting blood exposures helps management protect paramedics from future exposures to patients' blood.'' A higher percentage of paramedics who had not experienced an exposure within the previous 12 months agreed with the statement than paramedics who had experienced at least one exposure (Table VI). Combining Likert scores 4 and 5, 74% (95% confidence interval [CI], 68–79) of those who did not experience an exposure agreed with the statement compared to 59% (95% CI, 54–64) of those who experienced one or more exposures ($P < 0.0001$). Results for needlestick/lancet and mucous membrane exposures were similar (data not shown). Fifty-one (51) percent (95% CI, 44–59) of paramedics who did not report any of their exposures in the previous 12 months agreed with the statement compared to 60% (95% CI, 47–73) of paramedics who reported some and 65% (95% CI, 54–74) who reported all of their exposures; a test for linear trend was not significant.

Approximately half of all respondents disagreed (Likert scores 1 and 2) with the statement, ''Most needlestick injuries are caused by circumstances beyond the control of the paramedic.'' Among those who experienced one or more needlestick/lancet injuries in the previous 12 months, 70% (95% CI, 48–86) of those who did not report their most recent needlestick/lancet injury disagreed with this statement compared with 41% (95% CI, 30–54) of those who reported their most recent needlestick/lancet injury ($P < 0.0001$).

Approximately half of all respondents agreed (Likert scores 4 and 5) with the statement, ''Most needlestick injuries are caused by personal carelessness.'' There was no difference in agreement with this statement between those who reported their most recent needlestick/lancet injury and those who did not.

DISCUSSION

For a variety of reasons, it is important that workers report exposures to blood and other potentially infectious body fluids. Employees who do not report their exposures run the risk of seroconversion and morbidity if timely post-exposure medical evaluation and treatment is not sought. Furthermore, if an exposure is not formally documented, an infected worker may not be eligible for workers' compensation if a claim is filed. In other cases, undiagnosed, infected workers could lose their chance for timely treatment and put others, especially sexual partners, at risk of infection. In addition, employers need to accurately assess the frequency and circumstances of workers' blood exposures in order to implement effective strategies to prevent exposures and potential infections. Underestimation of exposure incidence and poor information on risk factors may decrease the employer's incentive to implement safer equipment or work practices or to seek product engineering upgrades from device manufacturers.

This survey suggests that reporting behavior is related to the paramedic's personal assessment of the risk of transmission. They were more likely to report deep or moderate than superficial needlesticks. They were more likely to report needlestick injuries or mucous membrane exposures than cuts from sharp objects containing visible blood or exposures to blood on non-intact skin. It appears they considered the latter exposures to carry a low risk of infection from bloodborne pathogens. While these exposures do have a

TABLE III. Reporting Behavior by Personal Characteristics and Route of Exposure

Characteristic (%)[a,c]	Number of total exposures[b,d]	Exposures reported to employer[a,b]											
		Needlestick/lancet		Cut from sharp object		Mucous membrane		Non-intact skin		Bite		Total	
		n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
Gender													
Male (80%)	504	63	68% (62–74)	26	35% (14–55)	72	60% (55–65)	78	31% (27–36)	13	50% (19–81)	252	47% (41–52)
Female (20%)	128	28	89% (78–100)	5	55% (19–90)	28	89% (79–100)	9	25% (10–41)	[f]		74	69% (57–82)
Age (years)[e]													
20–29 (19%)	136	26	80% (53–100)	9	70% (45–95)	24	60% (33–86)	18	31% (9–53)	[f]		78	54% (38–69)
30–39 (45%)	281	36	61% (40–82)	15	51% (9–93)	47	67% (57–77)	43	29% (20–39)	9	47% (17–76)	150	48% (39–58)
40+ (35%)	206	28	83% (69–98)	7	25% (16–34)	27	72% (39–100)	21	31% (8–53)	[f]		89	50% (36–65)
Years since paramedic certification													
≤2 (15%)	111	17	56% (39–72)	4	52% (15–89)	20	69% (46–93)	18	40% (7–73)	[f]		60	51% (42–60)
3–5 (21%)	130	18	89% (70–100)	9	62% (45–80)	26	64% (26–100)	16	22% (9–35)	[f]		71	58% (42–74)
6–10 (30%)	180	31	81% (71–91)	12	84% (69–100)	23	66% (51–82)	20	33% (6–61)	7	47% (15–78)	93	60% (40–80)
11+ (34%)	203	25	64% (40–89)	6	7% (0–19)	29	68% (46–91)	31	27% (16–38)	[f]		98	39% (33–45)

CI, confidence interval.

[a]Percentages are weighted and may not total 100 due to rounding.

[b]Only the two most recent exposures per route of exposure that occurred within the previous 12 months are included.

[c]Percentage of respondents with characteristic.

[d]Because of missing data, totals within characteristic categories are less than the 660 total exposures.

[e]One paramedic was less than 20 years old and reported neither of two non-intact skin exposures.

[f]Fewer than 10 exposures were experienced.

TABLE IV. Reporting Behavior Among Paramedics Who Held at Least One Paid Job by Characteristics of Paid Job #1 and Route of Exposure

Characteristic (%) of paid job #1[a,b,c]	Number of total exposures[d]	Exposures reported to employer[c,d]											
		Needlestick/lancet		Cut from sharp object		Mucous membrane		Non-intact skin		Bite		Total	
		n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
Unionized workplace													
Yes (49%)	275	39	68% (50–86)	16	47% (23–72)	52	81% (64–98)	44	34% (22–45)	[e]		157	55% (44–65)
No (51%)	327	50	79% (65–94)	14	29% (0–59)	45	63% (50–76)	39	27% (15–39)	10	43% (5–81)	158	49% (44–54)
Employer													
City or county (63%)	362	52	76% (62–89)	21	38% (0–76)	67	76% (65–87)	55	29% (19–38)	[e]		202	54% (50–59)
Private company (24%)	153	23	68% (40–97)	6	74% (44–100)	23	62% (43–81)	26	42% (30–53)	5	44% (12–77)	83	54% (42–67)
Hospital (13%)	84	15	76% (50–100)	3	13% (0–37)	8	70% (35–100)	1	2% (0–6)	[e]		30	41% (27–55)
Number of runs in last 7 days where attended to a patient													
0–11 (47%)	229	32	61% (49–72)	11	24% (0–55)	31	49% (16–81)	25	18% (12–25)	[e]		102	36% (24–48)
12+ (53%)	374	55	78% (63–94)	19	46% (30–62)	67	82% (67–97)	56	36% (30–42)	13	48% (18–78)	210	59% (53–64)
If you did not follow Universal/Standard Precautions, would your supervisor speak to you about it?													
Yes (72%)	410	53	80% (64–97)	21	45% (29–60)	84	70% (63–76)	57	37% (28–47)	11	50% (17–84)	226	58% (51–64)
No (12%)	105	15	70% (46–93)	4	37% (0–79)	5	16% (0–35)	12	24% (0–49)	[e]		39	38% (17–59)
Don't know (16%)	95	21	64% (25–100)	[e]		9	83% (53–100)	14	22% (9–35)	[e]		49	41% (18–64)
Is following safety procedures part of your job evaluation?													
Yes (74%)	399	54	85% (73–97)	17	18% (0–40)	74	68% (60–76)	62	39% (31–46)	10	63% (17–100)	217	53% (47–60)
No (17%)	153	22	57% (32–82)	8	72% (47–97)	15	66% (46–85)	16	20% (13–27)	[e]		66	45% (40–50)
Don't know (10%)	53	11	72% (49–95)	[e]		9	71% (28–100)	5	12% (0–27)	[e]		28	49% (32–66)

CI, confidence interval.

[a]Characteristics pertain to the job identified on the survey as paid job #1.

[b]Percentage of respondents with the characteristic.

[c]Percentages are weighted and may not total 100 due to rounding.

[d]Only the two most recent exposures per route of exposure that occurred within the previous 12 months are included.

[e]Fewer than 10 exposures were experienced.

TABLE V. Comparison of Hypothetical Exposure Reporting Behavior to Actual Reporting Behavior

Characteristic of exposure	Percentage[a] of respondents who answered hypothetically that they would always[b] report exposures[c] (%)	Percentage[a] of respondents actually experiencing comparable exposures who reported the exposure[d] (%)
Needlestick after use on a patient	93	72
Blood contact with mucous membranes	92	66[e]
Body fluid containing visible blood contact with mucous membranes	92	
Blood contact with non-intact skin	73	29[e]
Body fluid containing visible blood contact with non-intact skin	72	

[a]Percentages are weighted.
[b]Percentage who answered '5' on a Likert scale where '1' = never and '5' = always.
[c]Pertains to paid job #1.
[d]Data from the two most recent exposures per route of exposure that occurred within the previous 12 months.
[e]Survey questions on actual exposures combined exposures to blood with exposures to body fluid containing visible blood.

lower risk, it is possible that paramedics are underestimating that risk. Occupational transmissions of both HIV and HCV from patient to healthcare worker have been documented through contact with non-intact skin [Centers for Disease Control and Prevention, 2001; Beltrami et al., 2003] and mucous membranes [Centers for Disease Control and Prevention, 2001]. In addition, in several investigations of HBV outbreaks among healthcare workers, most infected workers could not recall an overt percutaneous injury, raising the likelihood that the infections might have resulted from blood or body fluid exposures that inoculated HBV into scratches, abrasions, burns, other skin lesions, or on mucosal surfaces [Centers for Disease Control and Prevention, 2001]. In one case, a nursing home aide with skin abrasions from a side job as a landscaper and a history of psoriasis developed co-infections of HIV and HCV from non-intact skin contact with a patient's vomitus, feces, or urine, although none were visibly bloody [Beltrami et al., 2003].

Because female paramedics reported significantly more exposures than males, there may be a culture among male paramedics that discourages reporting. This was supported anecdotally by paramedics not in the sample who were interviewed during survey instrument development where many male paramedics considered emergency calls a battle and getting covered in blood a badge of honor (JTL, personal communication). In our study, factors other than culture were not an explanation—neither the number of runs in the last 7 days where the paramedic attended to a patient nor the years since paramedic certification explained the gender difference. A study of behavioral risk factors among EMTs, the 2002 Longitudinal Emergency Medical Technician Demographic Study (LEADS), concluded that males drove faster, drank more, and wore their seatbelts less than females [Pirrallo et al., 2005], which could be supportive of a gender difference in risk behavior that affects bloodborne pathogen exposure reporting rates.

TABLE VI. Agreement of Respondents With Statement on Reporting Blood Exposures by Number of Exposures (All Routes) and Number of Exposures Reported to the Employer

	Number (%)[a] of respondents by agreement with the statement: "Reporting blood exposures helps management protect paramedics from future exposures to patients' blood"				
Number of exposures	Disagree 1	2	3	4	Agree 5
0	115 (6)	98 (5)	330 (15)	430 (21)	1,231 (53)
1+	39 (8)	36 (8)	85 (25)	78 (15)	202 (44)
Reported no exposures[b]	18 (9)	17 (8)	40 (31)	32 (17)	70 (34)
Reported some exposures[b]	[c]	[c]	[c]	[c]	11 (48)
Reported all exposures[b]	17 (7)	17 (6)	40 (23)	41 (15)	121 (50)

[a]Percentages are weighted and may not total 100 due to rounding.
[b]Only the two most recent exposures per route of exposure that occurred within the previous 12 months are included.
[c]Fewer than 10 respondents.

Paramedics who had not experienced any blood exposure within the 12 months previous to the study were significantly more likely than paramedics who had been exposed to agree that reporting exposures helps management prevent future exposures. It is not clear why this was. Perhaps those who experienced exposures thought their exposure was not preventable and therefore, reporting it would not prevent future exposures, or in their experience, reporting did not result in effective managerial changes. Among those who had experienced exposures in the previous 12 months, agreement with the statement increased with reporting rates, although non-significantly, suggesting that those who think reporting helps management prevent future exposures are more likely to report an event.

Half of all respondents and 70% of those who did not report their most recent needlestick/lancet injury disagreed with the statement, ''Most needlestick injuries are caused by circumstances beyond the control of the paramedic.'' The survey did not probe how respondents interpreted this statement, but the results suggest they think most needlestick injuries are caused by circumstances under the paramedic's control. Possible examples of circumstances beyond the paramedic's control are the unexpected movement of the emergency vehicle or the patient and the types of medical devices purchased by management, whereas circumstances under the paramedic's control could include activation of safety devices, proper disposal of used sharps, and glove usage. Since there was a significant difference in agreement with this statement between those who reported their most recent needlestick/lancet injury and those who did not, this suggests that paramedics may be under-reporting because they feel the injury was due to circumstances under their control and thus their own fault. On the other hand, there was no difference in agreement between those who reported needlesticks and those who did not with the statement, ''Most needlestick injuries are caused by personal carelessness.'' The survey did not probe how ''personal carelessness'' was interpreted, but this suggests paramedics view ''the control of the paramedic'' and ''personal carelessness'' differently.

Safety culture appears to influence reporting of exposures by paramedics. Although not statistically significant, reporting was greater among paramedics employed where safety culture was emphasized, as indicated by whether supervisors would speak to them about following Universal/Standard Precautions and whether safety procedures were part of job evaluations.

Respondents reported far fewer actual exposures to blood than when asked hypothetically about reporting behavior. Possible explanations could be that: (1) their hypothetical answers reflected accepted work practice, (2) when imagining a hypothetical exposure, they pictured what they considered a high risk exposure, or (3) in the hypothetical situation they did not have to confront real life barriers to reporting, such as the time required to report or the desire to avoid being seen as having had ''too many'' exposures.

Respondents in the present study reported 72% of needlestick injuries and 62% of all percutaneous injuries in 2002–2003. These data show little improvement over earlier surveys of paramedics and EMTs: while there was an improvement over the Dade County paramedics and EMTs who reported 48% of needlesticks and 9% of cuts and abrasions in 1994 [Carrillo et al., 1996], our results are not better than those from the 1980s for Florida paramedics who reported 77% of needlesticks [Klontz et al., 1991] or for Albuquerque EMTs who reported approximately 67% of percutaneous injuries [Tandberg et al., 1991]. Also, given that the prevalence of infection among patients seen in inner-city emergency departments has been reported as high as 12.9% for HIV [Alpert et al., 1996] and 18% for HCV [Kelen et al., 1992], paramedics may be underestimating their risk.

This is the only national sample of paramedics that provides under-reporting data, the first paper since 1991 to address possible associations with gender, age, tenure, and selected attitudes, and the only paper to address multiple routes of exposure, depth of needlestick, unionization, type of employer, number of calls, safety culture, and hypothetical reporting. It is also the only paper focusing on U.S. paramedics since enhanced regulations on bloodborne pathogens went into effect in the late 1990s and early 2000s, and thus, reflects more recent trends.

Training and education projects or other intervention efforts targeting both management and workers to improve exposure reporting rates would be beneficial. Topics for managers include the importance of exposure surveillance in order to identify exposure prevention strategies, acting on those strategies, and the impact of an authentic culture of safety for injury prevention. Topics for workers include the importance of reporting even exposures perceived as low risk because of the risk of disease transmission and so the information can be used in prevention strategies, countering any workplace or gender cultural disincentives to reporting, and countering any inclination to blame oneself for exposures or view injuries as not preventable.

CONCLUSIONS

This survey indicates there is need to improve the reporting of blood exposures by paramedics to their employers. More work is needed to understand the reasons for under-reporting. The most frequent reason given for non-reporting, for all routes of exposure, was that the exposure was not perceived as significant. Paramedics may, in particular, be underestimating their infection risk for routes other than needlesticks. Under-reporting appears to be greater among paramedics who are male and those who believe most needlestick/lancet injuries are due to circumstances under the

paramedic's control (possibly due to a disinclination to report injuries perceived to be the worker's fault). The survey also suggests that under-reporting is greater among paramedics whose employers do not emphasize safety culture and among those who do not believe that reporting blood exposures helps management protect workers from future exposures.

REFERENCES

Alpert PL, Shuter J, DeShaw MG, Webber MP, Klein RS. 1996. Factors associated with unrecognized HIV-1 infection in an inner-city emergency department. Ann Emerg Med 28:159–164.

Alvarado F, Panlilio A, Cardo D, NaSH Surveillance Group. 2000. Percutaneous injury reporting in U.S. hospitals, 1998. In: Program and Abstracts of the 4th Decennial International Conference on Nosocomial and Healthcare-Associated Infections. Atlanta, GA: Centers for Disease Control and Prevention. Abstract P-S2-38.

Beltrami EM, Kozak A, Williams IT, Saekhou AM, Kalish ML, Nainan OV, Stramer SL, Fucci MH, Frederickson D, Cardo DM. 2003. Transmission of HIV and hepatitis C virus from a nursing home patient to a health care worker. Am J Infect Control 31:168–175.

Boal WL, Hales T, Ross CS. 2005. Blood-borne pathogens among firefighters and emergency medical technicians. Prehosp Emerg Care 9:236–247.

Carrillo L, Fleming LE, Lee DJ. 1996. Bloodborne pathogens risk and precautions among urban fire-rescue workers. J Occup Environ Med 38:920–924.

Centers for Disease Control and Prevention. 1997. Evaluation of safety devices for preventing percutaneous injuries among health-care workers during phlebotomy procedures–Minneapolis-St. Paul, New York City, and San Francisco, 1993–1995. MMWR Morb Mortal Wkly Rep 46:21–25.

Centers for Disease Control and Prevention. 2001. Updated U.S. Public Health Service guidelines for the management of occupational exposures to HBV, HCV, and HIV and recommendations for post-exposure prophylaxis. MMWR Morb Mortal Wkly Rep 50(RR-11): 1–52.

Centers for Disease Control and Prevention. 2005. Updated U.S. Public Health Service guidelines for the management of occupational exposures to HIV and recommendations for postexposure prophylaxis. MMWR Morb Mortal Wkly Rep 54(RR-9):1–17.

Debnath D. 2000. Improving reporting of sharp injuries. Hosp Med 61:852–854.

Diekema DJ, Albanese MA, Schuldt SS, Doebbeling BN. 1996. Blood and body fluid exposures during clinical training: Relation to knowledge of universal precautions. J Gen Intern Med 11:109–111.

Doebbeling BN, Vaughn TE, McCoy KD, Beekmann SE, Woolson RF, Ferguson KJ, Torner JC. 2003. Percutaneous injury, blood exposure, and adherence to standard precautions: Are hospital-based health care providers still at risk? Clin Infect Dis 37:1006–1013.

Gaffney P, Carrigan T, Johnson G. 2000. Survey of needlestick injuries in paramedics and technicians in the West Yorkshire Metropolitan Ambulance Service. Pre-hosp Immed Care 4:30–33.

Greene ES, Berry AJ, Jagger J, Hanley E, Arnold WP III, Bailey MK, Brown M, Gramling-Babb P, Passannante AN, Seltzer JL, Southorn P, Van Clief MA, Venezia RA. 1998. Multicenter study of contaminated percutaneous injuries in anesthesia personnel. Anesthesiology 89: 1362–1372.

Haiduven DJ, Simpkins SM, Phillips ES, Stevens DA. 1999. A survey of percutaneous/mucocutaneous injury reporting in a public teaching hospital. J Hosp Infect 41:151–154.

Hamory BH. 1983. Underreporting of needlestick injuries in a university hospital. Am J Infect Control 11:174–177.

Henderson DK. 2004. How're we doin'? Preventing occupational infections with blood-borne pathogens in healthcare. Infect Control Hosp Epidemiol 25:532–535.

Hettiaratchy S, Hassall O, Watson C, Wallis D, Williams D. 1998. Glove usage and reporting of needlestick injuries by junior hospital medical staff. Ann R Coll Surg Engl 80:439–441.

Kelen GD, Green GB, Purcell RH, Chan DW, Qaqish BF, Sivertson KT, Quinn TC. 1992. Hepatitis B and hepatitis C in emergency department patients. N Engl J Med 326:1399–1404.

Klontz KC, Gunn RA, Caldwell JS. 1991. Needlestick injuries and hepatitis B immunization in Florida paramedics: A statewide survey. Ann Emerg Med 20:1310–1313.

Lee CH, Carter WA, Chiang WK, Williams CM, Asimos AW, Goldfrank LR. 1999. Occupational exposures to blood among emergency medicine residents. Acad Emerg Med 6:1036–1043.

Leiss JK, Ratcliffe JM, Lyden JT, Sousa S, Orelien JG, Boal WL, Jagger J. 2006. Blood exposure among paramedics: Incidence rates from the national study to prevent blood exposure in paramedics. Ann Epidemiol 16:720–725.

Mangione CM, Gerberding JL, Cummings SR. 1991. Occupational exposure to HIV: Frequency and rates of underreporting of percutaneous and mucocutaneous exposures by medical housestaff. Am J Med 90:85–90.

McGeer A, Simor AE, Low DE. 1990. Epidemiology of needlestick injuries in house officers. J Infect Dis 162:961–964.

Mendelson MH, Lin-Chen BY, Solomon R, Bailey E, Kogan G, Goldbold J. 2003. Evaluation of a safety resheathable winged steel needle for prevention of percutaneous injuries associated with intravascular-access procedures among healthcare workers. Infect Control Hosp Epidemiol 24:105–112.

National Institute for Occupational Safety and Health. 1999. NIOSH alert: Preventing needlestick injuries in health care settings. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2000-108.

O'Neill TM, Abbott AV, Radecki SE. 1992. Risk of needlesticks and occupational exposures among residents and medical students. Arch Intern Med 152:1451–1456.

Panlilio AL, Orelien JG, Srivastava PU, Jagger J, Cohn RD, Cardo DM, NaSH Surveillance Group, EPINet Data Sharing Network. 2004. Estimate of the annual number of percutaneous injuries among hospital-based healthcare workers in the United States, 1997–1998. Infect Control Hosp Epidemiol 25:556–562.

Patterson JMM, Novak CB, MacKinnon SE, Ellis RA. 2003. Needlestick injuries among medical students. Am J Infect Control 31:226–230.

Pettit LL, Gee SQ, Begue RE. 1997. Epidemiology of sharp object injuries in a children's hospital. Pediatr Infect Dis J 16:1019–1023.

Pirrallo RG, Levine R, Dickison PD. 2005. Behavioral health risk factors of United States emergency medical technicians: The LEADS project. Prehosp Disast Med 20:235–242.

Rabaud C, Zanea A, Mur JM, Blech MF, Dazy D, May T, Guillemin F. 2000. Occupational exposure to blood: Search for a relation between

personality and behavior. Infect Control Hosp Epidemiol 21: 564–574.

Ramsey PW, Glenn LL. 1996. Nurses' body fluid exposure reporting, HIV testing, and hepatitis B vaccination rates: Before and after implementing universal precautions regulations. AAOHN J 44:129–137.

Rattner SL, Norman SA, Berlin JA. 1994. Percutaneous injuries on the "Front Line": A survey of housestaff and nurses. Am J Prev Med 10:372–377.

Shiao JS, McLaws ML, Huang KY, Ko WC, Guo YL. 1999. Prevalence of nonreporting behavior of sharps injuries in Taiwanese health care workers. Am J Infect Control 27:254–257.

Sohn S, Eagan J, Sepkowitz KA. 2004. Safety-engineered device implementation: Does it introduce bias in percutaneous injury reporting? Infect Control Hosp Epidemiol 25:543–547.

Tandberg D, Stewart KK, Doezema D. 1991. Under-reporting of contaminated needlestick injuries in emergency health care workers. Ann Emerg Med 20:66–70.