Provision and use of personal protective equipment and safety devices in the National Study to Prevent Blood Exposure in Paramedics

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Background: Paramedics are at risk for human immunodeficiency virus, hepatitis B virus, and hepatitis C virus infection from occupational blood exposure. This study examined how often paramedics are provided with personal protective equipment (PPE), sharps containers, and selected safety devices by their employers; the frequency with which paramedics use sharps containers and these safety devices; and paramedics' attitudes regarding this equipment.
Methods: We conducted a mail survey among a nationally representative sample of certified paramedics. California was oversampled to allow for separate estimation of proportions for this population.
Results: The final sample included 2588 paramedics, 720 of whom were from California (adjusted response rate, 55%). Paramedics in California were provided safety devices more often than paramedics in the United States as a whole. For each type of device, there was at least a 40% increase in use when the device was always provided compared with when it was not always provided. Eighty-four percent of paramedics thought that safety needles significantly reduce blood exposure, but substantial percentages thought that safety needles, eye protection, and masks interfere with some medical procedures. Approximately one fifth said that they need more training in the use of safety devices and PPE.
Conclusion: Lack of access to safety devices is the major barrier to their use, and the higher rates of provision and use in California may be the result of the state's early safety needle legislation. Increased provision, training, and improvement of safety equipment are needed to better protect paramedics from blood exposure. (Am J Infect Control 2008;36:743-9.)

Paramedics are at risk of infection from human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV) through occupational blood exposure.[1-3] Like other health care workers, paramedics routinely use sharp instruments (eg, needles and lancets) to perform procedures such as starting and maintaining intravenous lines, administering medications, and blood glucose testing. Unlike most other health care workers, they often perform these procedures in moving ambulances or in restricted spaces with poor visibility, such as accident or crime scenes; with uncooperative or even combative patients; and under the pressure of emergency medical conditions. Paramedics routinely treat bleeding patients as well as extricate bleeding patients in rescue operations. They are often in the path of splashing blood from patient wounds or medical procedures and sometimes are bitten by patients. This work environment creates the potential for blood exposure from blood contact with nonintact skin and mucous membranes of the eyes, nose, and mouth; from percutaneous injury from a contaminated needle or sharp object; and from bites.

There are a number of strategies for reducing occupational exposure to blood, including engineering controls, such as medical devices with engineered sharps injury protections[4-8]; protective work practices, such as not recapping used needles; safe disposal of sharps in a puncture-resistant sharps container; and use of personal protective equipment (PPE), such as gloves and protective eyewear, which place a barrier between the worker and blood or other body fluid.[9] Paramedics are expected to comply with Universal Precautions,[9] the guidelines promulgated by the Centers for Disease Control and Prevention that outline specific measures

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that health care workers should take to prevent exposure to body fluids. Current blood exposure prevention guidelines advise that all patients be assumed to be infectious for bloodborne pathogens and that all contact with blood or potentially infectious body fluids be avoided.

Despite their risk for occupational blood exposure,[1] little is known about paramedics' use of PPE, puncture-resistant sharps containers, and safety-engineered devices. In the early 1990s, use of most types of PPE among paramedics was low.[3,10-12] It is not known whether use of PPE has improved in recent years. Similarly, it is not known how often safety-engineered devices, which became available after those earlier studies, are provided to paramedics and how often paramedics use them.

The purpose of this paper is to present results from the National Study to Prevent Blood Exposure in Paramedics on provision and use of PPE and safety-engineered devices among paramedics in the United States. This study examined how often paramedics are provided with PPE, sharps containers, and selected safety devices by their employers and the frequency with which paramedics use sharps containers and these safety devices. We also examined whether provision of safety devices by employers is associated with increased use by paramedics. In addition to national results, results for California are presented separately. (The national results include California.) California was the first state to enact legislation (A.B. 1208, California code of Regulations, Title 8, Section 5193) requiring the use of safety devices to prevent needlestick injuries. This law, enacted in 1998 and in full effect by August 1999, provided the model for the congressional legislation requiring the Occupational Safety and Health Administration to revise the Bloodborne Pathogens Standard in 2001. Because the California law had been in effect for several years before our survey was conducted and the large population affected, we selected a sufficient sample from California to allow separate estimation of proportions for California paramedics.

METHODS

A mail survey was conducted among a nationally representative sample of licensed paramedics in the United States in 2002–2003. Paramedics in California were oversampled to allow separate estimates for this population. Because many paramedics work more than one paid job, work as a volunteer paramedic, or both, the questionnaire items were job specific for up to 2 paid and 1 volunteer jobs in which the paramedic had made at least 4 calls in the previous 4 weeks. In this paper, we describe availability and use of PPE and safety devices for the first reported paid job only. Additional details of the study design are provided elsewhere.[1]

The provision of PPE and safety devices was measured on a 5-point Likert scale, with 1 labeled ''never'' and 5 labeled ''always.'' The PPE provision question stated, ''Please tell us how often your squad or unit provides you with the following equipment.'' The types of PPE individually listed were as follows: disposable gloves, leather gloves, safety goggles, face/surgical type masks, full-face shields, fluid-impermeable laboratory coats, and fluid-impermeable disposable coveralls. The provision of safety devices question asked, ''How often does your squad or unit provide you with retracting, self-blunting, shielded, or hinged cap devices?'' The specific types of safety devices individually listed were as follows: shielded winged steel (butterfly) needles; retracting or shielded lancets; prefilled or cartridge syringes with sliding shields, hinged caps, or retracting needles; syringes with sliding shields, hinged caps, or retracting needles (not prefilled or cartridge); and intravenous (IV) catheters with shielded or blunted stylets. We also asked, ''How often does your squad or unit provide a puncture-resistant sharps container?'' Use of safety devices was measured by a yes/no question that asked, regarding the last time the respondent used each of the types of devices listed above, whether or not it was a safety device, that is, whether it was retracting, self blunting, shielded, or hinged capped (as appropriate for the type of device). Use of the puncture-resistant sharps container was also measured by a yes/no question that asked, regarding the last time the respondent disposed of a sharp, was the sharp disposed of in a puncture-resistant container. We also asked whether there was a union for paramedics at their workplace.

To understand paramedics' attitudes toward use of safety equipment, a number of items used a 5-point Likert scale addressing whether the respondent agreed or disagreed that selected types of safety needles or PPE interfered with medical procedures; whether the respondent thought safety needles, eye protection, or masks significantly reduce the chance of blood exposure; whether the respondent needs more training on how to use safety needles or PPE; and whether the respondent needs better or more PPE for protection from patients' blood. The complete questionnaire can be accessed at www.constellagroup.com/paramedicquestionnaire.

Because of the skewed distributions of the Likert scale questions on provision of equipment and devices, we dichotomized the responses as ''always provided'' (5 on the scale) and ''sometimes or never provided'' (1-4 on the scale). We report frequencies and confidence intervals adjusted for unequal probabilities of

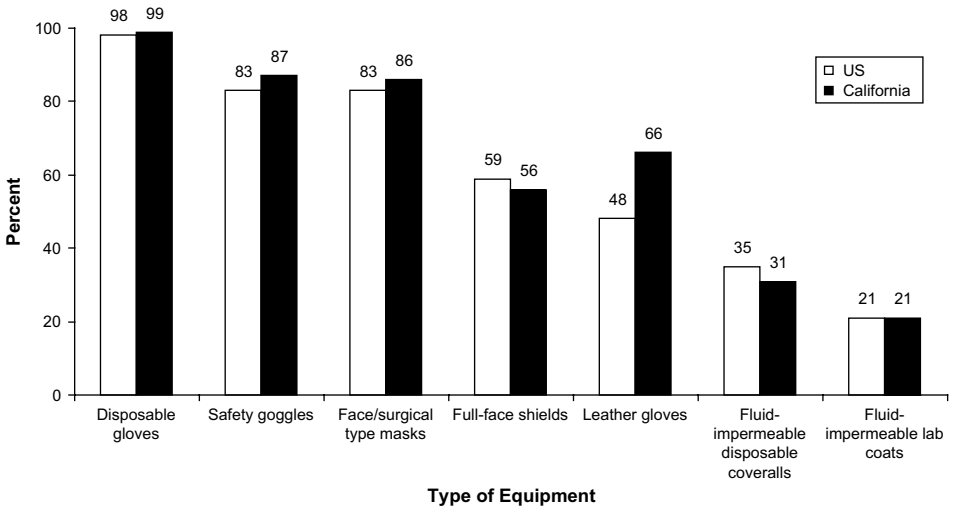

Fig 1. Percentage of paramedics reporting that their squad or unit always provided selected types of personal protective equipment, by type of equipment.

selection, clustering, and nonresponse. Data analysis was conducted with SAS version 9.1.3 (SAS Institute, Cary, NC). This study was approved by the Human Investigation Committee of the University of Virginia.

RESULTS

The adjusted response rate, assuming that the rate of ineligible individuals among nonrespondents was the same as among respondents, was 55% for the national sample and 55% for California. Over 80% of respondents were white non-Hispanic males, 73% were between the ages of 30 and 49 years, and over 60% had greater than 5 years of experience as a certified paramedic. Approximately half of the US sample reported that their workplace had a union for paramedics. This report is based on the 2588 respondents who worked at least 1 paid job, 720 of whom were from California.

The percentage of paramedics who reported that equipment was always provided is shown in Fig 1 for the 7 types of PPE. Over 80% of paramedics reported that disposable gloves, safety goggles, and face/surgical masks were always provided. However, less than 60% reported that full-face shields, leather gloves, and fluid-impermeable clothing were always provided. With the exception of leather gloves, these patterns were generally the same for the US and California samples. There was little difference by whether there was a union in the workplace (data not shown).

Ninety-eight percent of respondents reported that their unit or squad always provided a puncture-resistant sharps container, and 99% reported using this type of container the last time they disposed of a sharp (data not shown). This pattern was the same for US and California.

Figure 2 shows the percentage of paramedics for whom safety devices were provided by the employer. Provision of safety devices varied by type of device. For example, 93% of California paramedics were provided with engineered IV catheters, whereas only 57% were provided with safety syringes. Provision also varied between US and California samples. Except for winged steel needles, paramedics in California were provided safety devices more often than paramedics in the United States as a whole. For example, 85% of California paramedics reported that safety lancets were always provided, as compared with 64% of all US paramedics. Similarly, 57% of California paramedics reported that safety-engineered syringes were always provided, as compared with 34% of all US paramedics. There were no differences in provision of safety devices in workplaces with or without unions (data not shown).

Use of safety devices (Table 1) followed a pattern similar to the provision of safety devices. Use of safety devices was higher in California. However, even in California, 2 types of safety devices—nonprefilled syringes and winged steel needles—were used less than 65% of the time. There was no pattern for use of safety devices by age of paramedic, gender, or years of experience (data not shown).

Use of safety devices was substantially higher among paramedics who reported that the safety device was always provided (''5'' on the Likert scale; see Table 1) for both the US and California samples. For safety devices for which overall use was below 50%, it was generally double among paramedics to whom the device was always provided, as compared with paramedics to whom it was not always provided. However, even among paramedics to whom the device was always

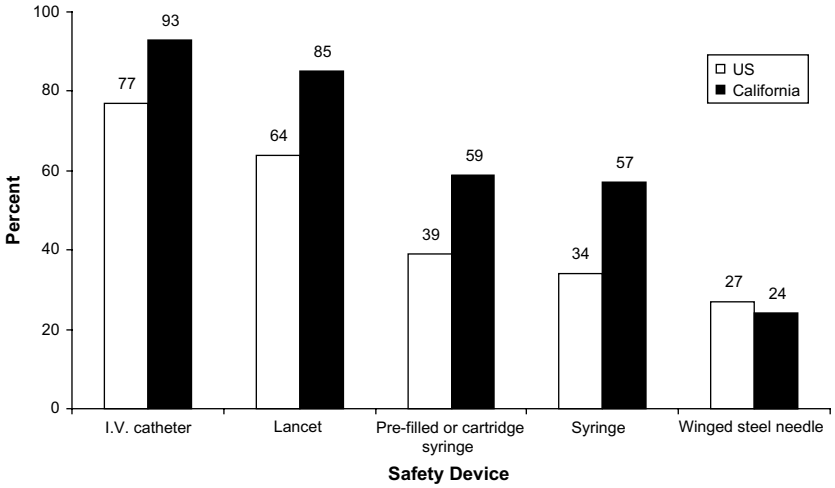

Fig 2. Percentage of paramedics reporting that their squad or unit always provided selected safety devices, by type of device.

Table 1. Percentage of paramedics who used a safety-engineered device the last time they used that general type of device

	United States, n = 2588 % (95% CI)			California only, n = 720 % (95% CI)*		
Device	Total	Safety device not always provided (a)	Safety device always provided (b)	Total	Safety device not always provided (c)	Safety device always provided (d)
Intravenous catheter	83 (82-84)	42 (26-58)	96 (95-97)	95 (93-97)	69 (55-83)	97 (96-98)
Lancet	66 (60-70)	14 (11-17)	92 (90-94)	87 (85-90)	28 (18-38)	96 (94-98)
Prefilled or cartridge syringe	45 (42-49)	24 (18-29)	77 (76-79)	66 (63-70)	35 (29-40)	88 (85-91)
Syringe	36 (31-42)	18 (12-24)	71 (67-74)	60 (57-64)	33 (27-38)	80 (76-84)
Winged steel needle	25 (22-28)	10 (9-12)	56 (52-60)	24 (21-27)	10 (7-14)	54 (46-62)

NOTE. National Study to Prevent Blood Exposure in Paramedics, 2002-2003, United States and California.
*The California sample is a subset of the US sample.

provided, use of some types of safety devices was 75% or less.

Figure 3 shows the increased use of safety devices among paramedics to whom the device was always provided compared with paramedics to whom it was not always provided. The height of the bars represents the difference between columns b and a in Table 1 for the United States as a whole and the difference between columns d and c for California. For most types of devices, there was 45% to 55% greater use among paramedics to whom the device was always provided. For lancets, it was 80% greater. The increases for each type of safety device were approximately the same for the United States and California.

Regarding attitudinal questions, 84% of the US sample agreed that safety needles significantly reduce exposure to blood. Ninety-four percent and 93%, respectively, thought that masks and eye protection significantly reduce blood exposure, and 94% thought that PPE in general protects against bloodborne pathogen exposures. However, one quarter to one third thought that masks, eye protection, and safety needles interfere with a paramedic's ability to do some procedures. Substantial percentages thought that they needed more training in the use of safety devices and PPE and needed better or more PPE to protect themselves from blood. Attitudes for California paramedics were similar to the United States as a whole.

DISCUSSION

Increasing the use of safety-engineered medical devices by paramedics would be expected to prevent blood exposure in this population, following evidence of the effectiveness of these devices in health care workers.[4-6] This study examined whether provision of safety devices by employers is in fact associated with increased use by paramedics.

To investigate the effect of provision of safety devices by the employer on paramedics' use of the

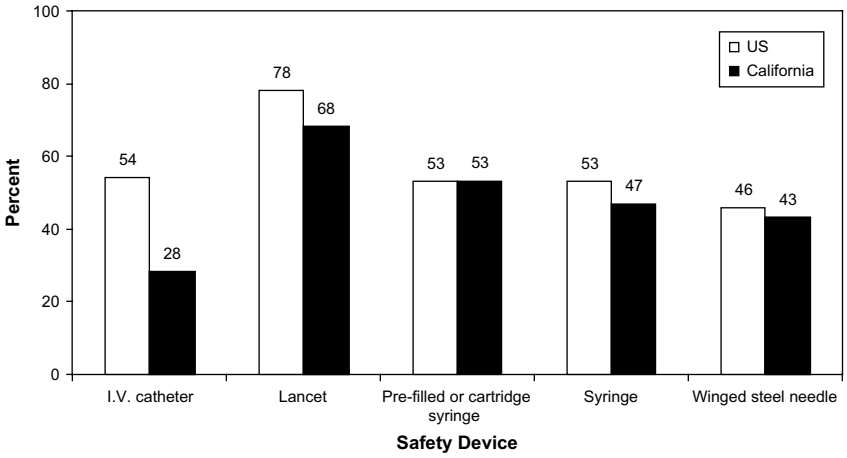

Fig 3. Difference in use of selected safety devices between paramedics who were always provided the device and those who were not—United States and California. The graph shows the amount of greater use among paramedics who were always provided the device. The height of the bars is the difference in percent use between paramedics who were always provided the device and those who were not always provided the device. The height of the bars for the United States is equal to column b minus column a from Table 1; for California, it is equal to column d minus column c from Table 1.

devices, we compared use among paramedics to whom the devices were always provided to use among paramedics to whom the devices were sometimes or never provided. There are 2 possible scenarios under which provision by employers would not result in increased use. In one, paramedics who are always provided with the devices use them, and paramedics who are not always provided with the devices obtain them by other means and also use them. In this case, the percentage of paramedics reporting use would be high in both groups. In the other scenario, both paramedics who are provided the devices and those who are not provided the devices do not use them. In this case, use would be low in both groups.

We found that use was much greater among paramedics to whom the devices were always provided (Table 1 and Figure 3). Furthermore, although level of provision and level of use were higher in California than in the United States as a whole (Table 1), the differences in use shown in Fig 3 were remarkably similar for the 2 samples. This indicates that paramedics who are provided safety devices by their employers do use them and that paramedics who are not provided safety devices are not accessing them in another manner.

Nevertheless, some paramedics who always had safety devices available were not always using them (Table 1). This indicates that, at least for some paramedics, conventional devices were available along with comparable safety devices. Paramedics may refrain from using safety devices because they are not adequately trained in how to use them, they find that the device interferes with their care of the patient, or they consider the devices ineffective in reducing blood exposures (Table 2). Paramedics told us informally that some safety devices were difficult to use, ie, the activation of the safety feature was not intuitive, and using them would actually put them at greater risk for blood exposure. Previous studies among hospital workers have shown that repeated comprehensive training on the use of safety devices can increase acceptability and use.[8] This suggests that appropriate training and improved design could increase paramedics' use of safety devices.

The greater provision and use of safety devices in California compared with the United States may reflect the impact of California's safety needle law. This legislation had been in effect for over 3 years when our survey was conducted. Although the revision to the national Bloodborne Pathogens Standard went into effect in 2001, it may not have reached its full impact throughout the country by the time of our survey. In addition, previously reported results from this survey showed that incidence rates of blood exposure for California paramedics were one third to half the rates for the United States as a whole.[1] This, combined with the difference in provision and use between California and the United States reported above, suggests that safety needle legislation may be an effective way to reduce blood exposure in paramedics. Future research should evaluate the impact of needlestick prevention laws on provision and use of safety devices among paramedics. Moreover, some paramedics may work for employers who are not covered by Occupational Safety and Health Administration regulations (federal or state). This may have implications for prevention;

Table 2. Percentage of paramedics who agreed with each statement

Statement	United States, n = 2588 % (95% CI)	California, n = 720 % (95% CI)*
Safety needles significantly reduce the chance of getting an injury from a contaminated needle.	84 (81-88)	83 (80-86)
Eye protection significantly reduces the chance of getting blood in a paramedic's eyes.	93 (91-95)	95 (93-96)
A mask significantly reduces the chance of getting blood in a paramedic's mouth.	94 (91-96)	95 (93-96)
PPE significantly reduces the chance of being exposed to bloodborne pathogens.	94 (92-95)	94 (92-96)
Safety needles interfere with a paramedic's ability to do some procedures.	33 (31-36)	27 (24-30)
Eye protection interferes with a paramedic's ability to do some procedures.	31 (25-37)	28 (24-31)
A mask interferes with a paramedic's ability to do some procedures.	23 (19-26)	26 (22-29)
Following universal/standard precautions interferes with a paramedic's ability to care for his/her patients.	5 (4-6)	4 (3-6)
I should be given more training in how to use safety devices.	23 (20-27)	19 (16-21)
I should be given more training in how to use PPE.	20 (17-23)	18 (15-20)
I need better PPE or more PPE to protect myself from patients' blood.	28 (23-32)	25 (22-28)

NOTE. National Study to Prevent Blood Exposure in Paramedics, 2002-2003, United States and California.
PPE, personal protective equipment.
*The California sample is a subset of the US sample.

therefore, future research should also assess how or if paramedics are protected from occupational blood exposure in these types of work environments.

In addition to safety devices, provision and use of PPE is also a basic strategy for preventing blood exposure in health care workers,[9] but we found that several types of PPE and safety devices were not provided to a substantial proportion of paramedics. We have no data on factors affecting employers' provision of PPE, but we found that substantial proportions of respondents thought that safety needles, eye protection, masks, and following universal/standard precautions interfere with the ability to do some procedures. Similarly, Kelen et al[12] found that substantial proportions of emergency department workers did not follow Universal Precautions because of insufficient time, interference with skill, and uncomfortable precautions. Paramedics told us informally that they do not use some PPE for those reasons, as well as because they simply did not like the available equipment, and that they found some PPE awkward to use. On the other hand, our data confirm that a substantial proportion of paramedics want more training in how to use PPE and that they want better or more PPE to protect themselves from blood exposure (Table 2). Future research should develop better designed PPE that is more acceptable to paramedics and investigate how to increase provision of PPE to paramedics.

The 55% response rate creates the potential for nonresponse bias. However, recent research has shown that the response rate in itself is not a good indicator of whether the results are biased. Studies with low response rates can be unbiased, and studies with high response rates can be severely biased.[13] In the present study, the primary concern is with the finding that paramedics who are always provided with safety devices have higher use of safety devices compared with other paramedics (Table 1). Nonresponse only causes bias when respondents and nonrespondents differ with respect to the factor being measured.[14] Accordingly, the above finding would be a spurious result produced by bias if either of 2 situations prevailed. In one scenario, in the group to whom the devices were always provided, some paramedics used the devices more frequently and also tended to be respondents; others used them less frequently and tended to be nonrespondents. In the other scenario, in the group to whom the devices were not always provided by the employer, some paramedics managed to get the devices from another source and also tended to be nonrespondents; others did not have the devices at all and tended to be respondents. These scenarios, although possible, seem unlikely.

Our findings suggest that there is a need for increased provision and use of safety devices and PPE among paramedics. Legislation may be an effective means of increasing paramedics' access to safety devices, although we have only indirect evidence of this. Improved training and continued design improvements in both PPE and safety devices are desired by paramedics. All of this points to the need for additional studies as well as ongoing surveillance of blood exposure to protect the occupational health and safety of paramedics.

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