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Practices and Factors Influencing Sharps Use and Safety in a Suburban FIre Department and Among Emergency Medical Services Personnel

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Practices and Factors Influencing Sharps Use and Safety in a Suburban Fire Department and Among Emergency Medical Services Personnel

by

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Dedication

This dissertation is dedicated to the firefighters and emergency medical services personnel who place themselves at multiple risks, including the potential for needlestick injury and transmission of bloodborne pathogens, during the course of each and every duty day. It is also dedicated to the emergency responders who have contracted Hepatitis B, Hepatitis C, and HIV as a result of their attempts to protect the lives and well-being of others.

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Abstract

Needlestick injuries (NSIs) are a recognized risk for occupationally-related transmission of bloodborne pathogens (BBP). The occurrence of NSIs and BBP exposures among firefighters (FFs) and emergency medical services (EMS) personnel has been documented.

The purposes of this study were: 1) to define the problem of NSI among FFs and EMS personnel in a suburban fire department (FD) and identify practices and factors that influence sharps use and safety; 2) design and implement and intervention to promote safer sharps device usage; and 3) to measure the effectiveness of the intervention among FFs and EMS personnel.

A multi-phase, mixed methods approach was used that included a diagnosis phase that utilized a mixed methods exploratory design, an intervention period, and a quantitative evaluation phase that used a before and after evaluation design. In the diagnosis phase, data regarding sharps device practices were obtained through a count of discarded sharps devices. Qualitative data regarding sharps practices and factors which influenced those practice were obtained via focus groups. The PRECEDE/PROCEED model (PPM) was used as the theoretical framework for assessment, planning, implementation, and evaluation of an intervention to increase the occurrence of safer sharps device behaviors and decrease the frequency of riskier sharps device behaviors. The evaluation phase included a post-intervention sharps count and a post-intervention survey to assess changes in sharps practices and the impact of the intervention.

During the baseline sharps count, 2743 sharps devices were counted and classified according to pre-established categories of safer or risky behaviors for NSI. Altered safety devices on IV stylets were the highest count for unsafe behaviors (n=105), followed by recapped traditional needles (n= 53). A statistically significant increase in risky behaviors was observed in discarded sharps from engines, as opposed to ambulances, among all sharps devices combined (p=0.000) and IV stylets (p=0.000). When comparing advanced life support (ALS) medications to all other medications, a statistically significant increase in unsafe behaviors occurred among all sharps devices combined (p=0.000) and prefilled syringes (p=0.000). Input from eight focus groups of firefighters allowed for identification of multiple themes which guided the development of an intervention.

The intervention included distribution of a hands-on training kit and booklet, expansion of an existing required BBP training, and posters to increase awareness regarding NSI prevention.

In the evaluation phase, a total of 2178 sharps devices were counted and classified in a post-intervention sharps count. Altered safety devices on IV stylets were the highest count of unsafe behaviors (n=50). Recapped traditional needles were the second highest count of unsafe behaviors (n=27), but experienced an 18.7% drop in frequency when compared to baseline. When comparing riskier behaviors to the pre-intervention baseline sharps count, statistically significant decreases in risky behaviors were observed in all sharps devices combined (χ^2=25.71, p=0.000), IV stylets (χ^2=16.87, p=0.000), and traditional needles (χ^2=5.07, p=0.024).

A post-intervention survey, consisting of 15 Likert scale questions, was returned by 165 out of 383 active field personnel (41.3%). Results indicated high frequencies of strongly agree and somewhat agree responses regarding risk perception; the importance of using safer needle devices; the impact of the intervention on safer needle practices and sharps safety awareness.

Critical predisposing, reinforcing, enabling, and environmental factors which influenced sharps device practices were identified. This study identified factors and practices which influenced unsafe sharps device behaviors. Due to the statistically significant decreases in risky behavior in the post-intervention sharps count and the positive responses in the post-intervention survey, it can be concluded that the intervention did positively impact sharps device behavior and reduced the risk of NSI. The implications of the study are numerous and include a need to explore these practices and factors at other fire departments and EMS agencies, address gaps in regulations; promote research targeting FFs and EMS personnel in regard to NSI, and promote a nationwide effort to prevent NSI among emergency responders.

Introduction

Needlestick injuries (NSIs) and occupationally-related transmission of bloodborne pathogens (BBP) are a recognized risks and have been extensively studied among healthcare workers (HCWs). Firefighters (FFs) and emergency medical services (EMS) personnel are not typically included in the traditional definition of HCWs. Rates of NSI and blood exposure in FFs and EMS personnel have been addressed in the published literature; however, the practices and factors that increase the risk of NSI within this group have not been the subject on in-depth examination. While hospital personnel are positively impacted by regulations enforced by The Joint Commission, Federal or State-specific Occupational Safety and Health Administrations, and various other regulatory agencies, firefighters and EMS personnel employed by county or city fire departments often lack the protection provided by state or federal oversight. This lack of regulation increases the likelihood that FFs and EMS personnel will experience a higher risk for NSI and occupationally-related NSI. The purposes of this study were as follows: to first define the risk of NSI among FFs and EMS personnel in a suburban fire department (FD) and identify practices and factors that influence sharps use and safety; then design and implement an intervention to promote safer sharps device usage; and finally to measure the effectiveness of the intervention among FFs and EMS personnel.

The following research questions were formulated for examination during this study:

1) What are the types of unsafe sharps techniques are present in this FD, as observed in discarded, used sharps?
2) What is the frequency of the unsafe sharps techniques identified in Question one?
3) What sharps practices occur in this FD that increase the likelihood of occupationally-acquired NSI, as identified in focus groups of FFs and EMS personnel?
4) What factors are present that affect unsafe sharps techniques and practices in this population?
5) What is the culture of safety as perceived by PCFR personnel and how does it impact the occurrence of unsafe sharps techniques and practices?
6) Can an intervention tailored to this population impact the frequency of unsafe sharps techniques?
7) Can an intervention tailored to this population improve the culture of safety regarding sharps use and NSI?

In order to accurately frame the issue of NSI and BBP exposure, it is necessary to first review the transmission of BBPs and NSI in traditional HCWs, occupational exposure to BBPs and risk of NSI in FFs and EMS personnel, regulations regarding BBP, how a culture of safety impacts an organization, the culture, environment, and safety

within EMS and the fire service, and the theory of the PRECEDE/PROCEED model. Each of these topics and their relevance to the proposed study questions will be discussed in subsequent chapters of this dissertation. Results and discussion, as they pertain to each research question, will follow.

Chapter 1. Bloodborne Pathogens and Needlestick Injuries: Transmission, Occurrence, and Risk among Traditional Healthcare Workers and Emergency Personnel

Bloodborne Pathogen Transmission

The Centers for Disease Control and Prevention estimates that 385,000 percutaneous, or needlestick, injuries are incurred by hospital-based healthcare workers (HCWs) each year in the United States (Centers for Disease Control, 2010). In addition, NSIs affect various HCWs not based in a hospital setting, such as home care staff, emergency medical services personnel, and pharmacy staff. Needlestick injuries (NSIs) among healthcare workers (HCWs) are a concern primarily due to the risk of transmission of bloodborne pathogens, specifically, Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), and Hepatitis C Virus (HCV). NSIs, also referred to as parenteral exposures, have been well-established as a higher risk exposure to infectious blood or body fluids, as compared to other routes of exposure (National Surveillance System for Healthcare Workers, 2011; Cardo, Culver, Cisiesielski, et al, 1997; Centers for Disease Control, 2007; Fisman, Harris, Sorock, et al., 2003; Hernandez, Bruguera, Puyelo, et al., 1992; Lanphear, Linnemann, Cannon, et al., 1994). In addition to the occurrence of NSI, prevalence of disease among the population, risk of transmission after NSI, and the frequency of exposures all contribute to the likelihood that a HCW will test positive for HBV, HCV, or HIV after a parenteral exposure (Bell, 1997). In order to define the risk to HCWs following NSI, it is important to estimate prevalence,

transmission in HCWs, and risk of transmission after NSI for the three bloodborne pathogens of greatest concern – HBV, HCV, and HIV.

Human Immunodeficiency Virus (HIV). While the rates of death from HIV infection are decreasing due to advances in treatment and increases in early detection, the prevalence of individuals with HIV infection in the general population remains high. While the documented number of HCWs with confirmed occupationally acquired HIV is only 56 cases between 1981 and 2006; there are likely to be additional HCWs who were exposed during the course of employment but have either not reported their infection or have other risk factors that limit the ability to evaluate the possibility of occupational transmission (Centers for Disease Control, 2007). Despite an estimated transmission rate following NSI, post-exposure prophylaxis does exist that can reduce the likelihood of seroconversion following exposure.

Prevalence of HIV. Estimates from the Centers for Disease Control and Prevention (CDC) through the end of 2009 indicate that 1,148,200 persons over the age of 13 years were living with HIV infection in the United States, including 207,600 persons who were infected but not yet diagnosed (Centers for Disease Control, 2012). In 2009 alone, there were an estimated 20,281 deaths or 8.3 deaths per 100,000 populations in the United States in persons diagnosed with HIV (Centers for Disease Control, 2012). During this time period, Florida was ranked as the state with the third highest frequency of deaths of persons within (16.9 deaths/100,000 population), surpassed only by New York (19.4 deaths/100,000 population) and Louisiana (17.0 deaths/100,000 population) (Centers for Disease Control, 2012). In the United States at the end of 2009, the highest prevalence rate for HIV was among persons 45-54 years of age (854.2/100,000

population) and the highest percentage of persons unaware of their HIV positive status was highest among persons aged 13 to 24 years (59.5%) (Centers for Disease Control, 2012). The prevalence rate of HIV among blacks/African Americans (1,685.3/100,000 population) was highest among all races/ethnicities and significantly higher than the second highest race/ethnicity group, Hispanics/Latinos (617.4/100,000 population) (Centers for Disease Control, 2012).

The majority of persons in the United States living with HIV by the end of 2009 were male (75.7%) and male-to-male sexual contact was the most frequently attributed cause of HIV infection in males (68.1%). (Centers for Disease Control, 2012). Males who were infected with HIV dueto heterosexual contact were most commonly undiagnosed (24.4%) (Centers for Disease Control, 2012). The overall transmission rate of HIV from 2006 to 2009 decreased 9% from 2006 (4.58 cases per 100 persons living with HIV) to 2009 (4.19 cases per 100 persons living with HIV) (Centers for Disease Control, 2012).

Transmission of HIV in healthcare workers. In a matched case-control-study, using data from the U.S. National Occupational Mortality Surveillance (NOMS) system, males linked to HIV were more likely to be healthcare workers; although the strength of association has decreased over time (Luckhaupt & Calvert, 2008).

In 1991, a standard protocol was released by the Centers for Disease Control and Prevention (CDC) for local and state health departments to investigate cases of HIV infection in healthcare workers who did not have other identified risk factors (Centers for Disease Control, 2007). 'Documented cases' of occupationally acquired HIV are defined as cases in which the HCW has no identified risk factors and HIV seroconversion is

temporally related to exposure from an HIV-positive source. 'Possible cases' are those in which the HCW has no identified risk factors, has opportunities for job-related exposure to blood, body, fluids or HIV-positive laboratory materials, is found to be HIV positive, but there is no documented seroconversion after exposure (Centers for Disease Control, 2007). Fifty-seven (57) documented cases of occupationally-acquired HIV were documented by the CDC from 1981 to 2006; of these cases, 85.7% involved transmission through percutaneous injury and none involved EMTs or paramedics (Centers for Disease Control, 2007). In the same data set, an additional 140 possible cases were identified, 12 of which were EMTs or paramedics (Centers for Disease Control, 2007; Do, Ciesielski, Metler, et al., 2003.) Clearly, employment as a HCW places an individual at increased risk for percutaneous injuries which is a significant concern for occupationally-transmitted HIV.

Risk for transmission of HIV after percutaneous injury. In a multi-national study involving data from the national surveillance systems of France, Italy, the United Kingdom, and the United States, researchers at the CDC identified the following risk factors for HIV seroconversion in HCWs after percutaneous injury: (1) deep injury; (2) injury with a device that was visibly contaminated with the patient's blood; (3) a procedure involving a needle placed in a source patient's artery or vein; (4) and exposure to a source patient who died of acquired immune deficiency syndrome (AIDS) within two months of the exposure (Cardo, Culver, & Ciesielski, 1997). The risk of transmission following NSI contaminated with blood from a patient infected with HIV is 0.3% (Bell, 1997; GAO, 2000).

Post-exposure management for HIV. Post-exposure prophylaxis (PEP) given within hours of exposure to potentially infectious blood can reduce the likelihood of transmission of HIV (Centers for Disease Control, 2005). The PEP drug regimen typically includes two or more drugs from five classes available to treat HIV infection: nucleoside reverse transcriptase inhibitors (NRTIs), nucleotide reverse transcriptase inhibitors (NtRTIs), nonnucleoside reverse transcriptase inhibitors (NNRTIs), protease inhibitors (PI) and a single fusion inhibitor (Centers for Disease Control, 2005). The recommended PEP regimen is based on the severity of the exposure type and the infection status of the source patient (Centers for Disease Control, 2005). These PEP regimens are not without risk due to the toxicity of the drugs and resultant negative side effects; therefore the decision to prophylactically treat the HCW must be based on the risk of transmission (Centers for Disease Control, 2012). Regardless of the use of PEP, exposed HCWs must be monitored for seroconversion for at least 6 months after exposure, typically at baseline, 6 weeks, 12 weeks, and 6 months (Centers for Disease Control, 2001). In cases where a HCW is exposed to contaminated blood from a patient co-infected with HCV and HIV and the HCW develops HCV as a result, the post-exposure monitoring period should be extended for at least 12 months (Centers for Disease Control, 2001).

Hepatitis B Virus (HBV). HBV can be transmitted by percutaneous or mucosal exposure to infected blood or body fluids (CDC, 2012). Transmission most typically involves injection-drug use, sexual contact with an infected person, or from an infected mother to her newborn during Childbirth (CDC, 2012).

Prevalence of HBV. The CDC (2012) estimates that there were 35,000 new HBV infections in the U.S. in 2010 and that 805,000 to 1.4 million persons are chronically infected. In 2010, the death rate in the U.S. due to HBV infection was 0.5 deaths/100,000 population (Centers for Disease Control, 2012). In one review of 21.8 million death certificates in the U.S., demonstrated a relatively constant age-adjusted mortality rate of HBV at 0.56 deaths per 100,000 persons per year (Ly, Xing, Klevens, et al., 2012).

Transmission of HBV in healthcare workers. The Centers for Disease Control and Prevention (CDC) estimated that 12,000 new HBV infections occurred in HCWs in 1985; however, this number steadily decreased to 500 in 1997, primarily due to the introduction of a safe and effective vaccine (Centers for Disease Control, 2010). In a previously mentioned matched case-control study using National Occupational Mortality Surveillance (NOMS) data, male HCWs were more likely than persons from other occupations to die from HBV in the time periods of 1984-1991 and 1992-1999 (Luckhaupt & Calvert, 2008).

Risk for transmission of HBV after percutaneous injury. Estimates of the risk of transmission for unvaccinated HCWs range from 6 to 30% (GAO, 2000). Ninety-six percent of persons vaccinated for HBV develop immunity (GAO, 2000; Centers for Disease Control, 2010).

Data from 2010 analyzed by the CDC, 3,350 reports of new HBV were reviewed, of those 47% (n=1,566) had information about exposure to risk factors (CDC, 2012). Among this group that reported risk factors for HBV, 0.7% (n=10) reported employment in the medical, dental, or other field involving contact with human blood and 4.2% (n=54) reported a NSI.

Post-exposure management for HBV. HCWs who are unvaccinated for Hepatitis B and exposed to blood or body fluids suspected to be infected with HBV should immediately receive the first injection of the HBV vaccination series and complete the series on the recommended schedule (Centers for Disease Control, 2006). HCWs who have previously received the vaccine, but lack documentation regarding immune response, should be immediately tested for antibodies to the Hepatitis B surface antigen to assess the efficacy of their prior vaccination (Centers for Disease Control, 2006). Depending on the vaccination status of the HCW and the source patient, Hepatitis B Immunoglobulin (HBIG) may be indicated. A summary of the post-exposure prophylaxis, as recommended by the Centers for Disease Control (2001) is presented in Table 1. Preferably, the recommended post-exposure prophylaxis regimen will commence within the first 24 hours following exposure (Centers for Disease Control, 2001).

Hepatitis C Virus (HCV). In the general population, the most common means of transmission of HCV is percutaneous exposure, such as NSI, injection-drug use, and receipt of blood or blood products before the availability of standard screening tests (Centers for Disease Control, 2012). HCV infection can manifest as acute or chronic, but there is no laboratory distinction between the two. Approximately 75-85% of newly infected persons develop chronic infection (Centers for Disease Control, 2012). The CDC (2012) estimates that there were 17,000 new HCV infections in 2010 and that 2.7-3.9 million persons in the U.S. were chronically infected. In 2010, the mortality rate due to HCV infection was 4.7 deaths/100,000 population, surpassing the mortality rate for HIV (Centers for Disease Control, 2012).

Prevalence of HCV. There are 3.2 million people in the United States who are chronically infected with HCV; among those individuals, 66% were born between 1645 and 1964 (Centers for Disease Control, 2012; Ly, Xing, Klevens, et al., 2012).

Table 1

Recommended Postexposure Prophylaxis for Exposure to Hepatitis B Virus

Recommended postexposure prophylaxis for exposure to hepatitis B virus

Vaccination and antibody response status of exposed workers*	Treatment		
	Source HBsAg† positive	Source HBsAg† negative	Source unknown or not available for testing
Unvaccinated	HBIG§ x 1 and initiate HB vaccine series¶	Initiate HB vaccine series	Initiate HB vaccine series
Previously vaccinated			
Known responder**	No treatment	No treatment	No treatment
Known nonresponder††	HBIG x 1 and initiate revaccination or HBIG x 2§§	No treatment	If known high risk source, treat as if source were HBsAg positive
Antibody response unknown	Test exposed person for anti-HBs¶¶ 1. If adequate,** no treatment is necessary 2. If inadequate,†† administer HBIG x 1 and vaccine booster	No treatment	Test exposed person for anti-HBs 1. If adequate,¶ no treatment is necessary 2. If inadequate,¶ administer vaccine booster and recheck titer in 1–2 months

* Persons who have previously been infected with HBV are immune to reinfection and do not require postexposure prophylaxis.

† Hepatitis B surface antigen.

§ Hepatitis B immune globulin; dose is 0.06 mL/kg intramuscularly.

¶ Hepatitis B vaccine.

** A responder is a person with adequate levels of serum antibody to HBsAg (i.e., anti-HBs ≥10 mIU/mL).

†† A nonresponder is a person with inadequate response to vaccination (i.e., serum anti-HBs < 10 mIU/mL).

§§ The option of giving one dose of HBIG and reinitiating the vaccine series is preferred for nonresponders who have not completed a second 3-dose vaccine series. For persons who previously completed a second vaccine series but failed to respond, two doses of HBIG are preferred.

¶¶ Antibody to HBsAg.

Centers for Disease Control(2001)

Through 2004, deaths from HCV have been trending upwards (Ly, Xing, Klevens, et al., 2012). In a review of 21.8 million death certificates in the U.S., Ly, Xing, Klevens, and colleagues (2012) found an age-adjusted mortality rate of 4.58 deaths per 100,000 persons per year, with an average annual increase of 0.18 deaths per 100,000 per year.

Transmission of HCV in healthcare workers. Currently there is no vaccine for HCV; therefore, all HCWs are at risk for acquiring HCV if exposed. Approximately 2 to 4% of new HCV infections occurring in the U.S. each year affect HCWs, but there is no definitive evidence that these are occupationally-related transmissions (Centers for Disease Control, 2010). Luckhaupt and Calvert (2008) analyzed data from NOMS and found a significant association between employment in the health-care industry for males and females, and concluded that HCWs are at increased risk of HCV due to occupationally-related exposures to HCV infected blood or body fluids. Prior to the identification of HCV in 1990, the virus was referred to as non-A, non-B hepatitis (CDC; 2010).

Risk for transmission of HCV after percutaneous injury. The average transmission rate for HCWs exposed to infected blood is 1.8% (Centers for Disease Control, 2010; Puro, Petrosillo, Ippolito, et al., 1995; Kiosawa, Sodeyama, Tanaka, et al., 1991; Mitsui, Iwano, Masuko, et al., 1992; Hernandez, Bruguera, Puyelo, et al., 1992; Sodeyama, Kiyosawa, Urushihara, et al., 1993; Lanphear, Linneman, Cannon, et al., 1994). Henderson (2003) reviewed 26 longitudinal studies conducted between 1991 and 2002 and found a transmission range of 0 to 22.2% following parenteral exposure to HCV.

There is evidence that transmission is related to NSI with hollow-bore needles; in fact, one study indicated that transmission of HCV occurred only with these types of needles (Puro, Petrosillo, Ippolito, et al., 1995). In one review of national data from 1980 to 1989, there were 176 reported exposures to source patients who were infected with HCV (Lanphear, Linnemann, Cannon, et al., 1994). Eleven of these HCWs (6.3%) were already HCV positive at the time of exposure (Lanphear, Linnemann, Cannon, et al., 1994). Fifty (50) HCWs who reported NSI as the route of exposure were available for follow-up at 5 months or later; 22 HCWs who were exposed via other routes were available in the same follow-up period (Lanphear, Linnemann, Cannon, et al., 1994). For this total of 72 patients available for follow-up, three (6.3%) sero-converted for HCV; all three of these HCWs had been exposed via NSI, for a conversion rate of 6% of all HCWs exposed via percutaneous route (Lanphear, Linnemann, Cannon, et al., 1994).
In the United Kingdom, a case series involving occupationally transmitted HCV to 15 HCW revealed that 100% involved a percutaneous injury. All but one of these NSI occurred with a hollow-bore needle. (Tomkins, Elford, Nichols, et al., 2012).

Post-exposure management for HCV. Following exposure to HCV, the Centers for Disease Control (2001) recommends anti-HCV testing for the source patient and baseline testing on the exposed HCW for anti-HCV and liver enzyme activity. The HCW should receivefollow-up testing at 4-6 months. Any positive anti-HCV results should be confirmed with enzyme immunoassay using supplemental anti-HCV testing, such as recombinant immunoblot assay (RIBA). PEP in the form of antiviral agents or immunoglobin is not currently recommended (Centers for Disease Control, 2001; Henderson, 2003).

Needlestick Injuries and Prevention

Circumstances of needlestick injuries in healthcare workers. The National Surveillance System for Healthcare Workers (NaSH) systematically collects data about occupational exposures and infections among HCWs through a voluntary surveillance system that includes 64 hospitals throughout the United States. Between 1995 and 2007, 30,945 blood and body fluid (BBF) exposures were reported, 82% of those exposures were percutaneous injuries (NaSH, 2011). Within the subset of percutaneous injuries (n=25,324), 55% (n=13,847) occurred with hollow-bore needles of which 30% occurred with a hypodermic needle attached to the syringe, 12% occurred with a winged steel needle, 6% involved an "other" hollow-bore needle, 4% occurred with a IV stylet, and 3% occurred with a vacuum needle (NaSH, 2011). Over one-fourth of the NSI described in the NaSH report (2011) were related to activities in which the needle was being inserted, moved, or removed from the patient. Recapping of used needles, a practice known to increase the risk of NSI and prohibited by OSHA regulations, accounted for 6% of NSI with a hollow-bore needle (NaSH, 2011).

Economic burden of needlestick injuries. Providing the appropriate response to NSI in HCWs carries an economic burden related to laboratory tests for the HCW and source patient, provision of post-exposure prophylaxis, counseling for the exposed employee, and lost productivity (Lee, Botteman, Xanthakos, et al., 2005). In a literature review of 12 studies, Lee and colleagues found that the estimated cost of NSI ranged from $51 to $3,766; however, these cost estimates did not factors in the costs of medical complications from HIV, HCV, or HBV if the HCW seroconverted after exposure (Lee, Botteman, Xanthakos, et al., 2005). The United States Government Accounting Office

(GAO) advised that the initial cost of post-exposure treatment varied due to the circumstances of the exposure and estimated a range from $500 to $2500 per exposure, resulting in a total cost of $37 to $173 million per year in the U.S. due to exposures in hospital-based HCWs (2000).

Hierarchy of controls. Prevention of NSIs is paramount in efforts to prevent transmission of bloodborne pathogens (BBPs) among healthcare workers. The 'hierarchy of controls' refers to a ranking of control measures for NSI, from most effective to least effective (Wilburn & Eijekmans, 2004). This hierarchy is summarized in Figure 1 and includes: 1) elimination of the hazard (which includes substitution), 2) engineering controls, 3) administrative controls, 4) work practice controls, and 5) personal protective equipment (American Nurses Association, 2002; Centers for Disease Control, 2010; Wilburn & Eijekmans, 2004). The first level of prevention for NSIs, elimination of the hazard, is accomplished through substitution, the use of alternate means of medication administration when possible, such as a tablet instead of injection, or the elimination of unnecessary injections or sharps devices that are also unnecessary, such as use of needleless IV systems (American Nurses Association, 2002; Centers for Disease Control, 2010; Wilburn & Eijekmans, 2004). Engineering controls, also known as ESIPs or safer needle devices, include needles that retract, sheathe, or blunt after use (American Nurses Association, 2002; Centers for Disease Control, 2010; Wilburn & Eijekmans, 2004). The third level in the hierarchy, administrative controls, entails the implementation of policies and training programs to limit exposure to and increase awareness of the hazard; these types of efforts may include a NSI prevention committee, facility-wide training on prevention of NSIs, or an exposure control plan (American Nurses Association, 2002;

Wilburn & Eijekmans, 2004). Work practice controls that are implemented to prevent NSIs might include placing sharps containers in easily accessible and highly visible areas, emptying sharps containers before they are full , verbally announcing a warning to nearby HCWs when using a sharp, and avoidance of passing sharps (American Nurses Association, 2002; Centers for Disease Control, 2010; Wilburn & Eijekmans, 2004). Lastly, personal protective equipment (PPE), such as gloves, gowns, masks, and eye protection should be provided to place a barrier or filter between the worker and the hazard (American Nurses Association, 2002; Wilburn & Eijekmans, 2004).

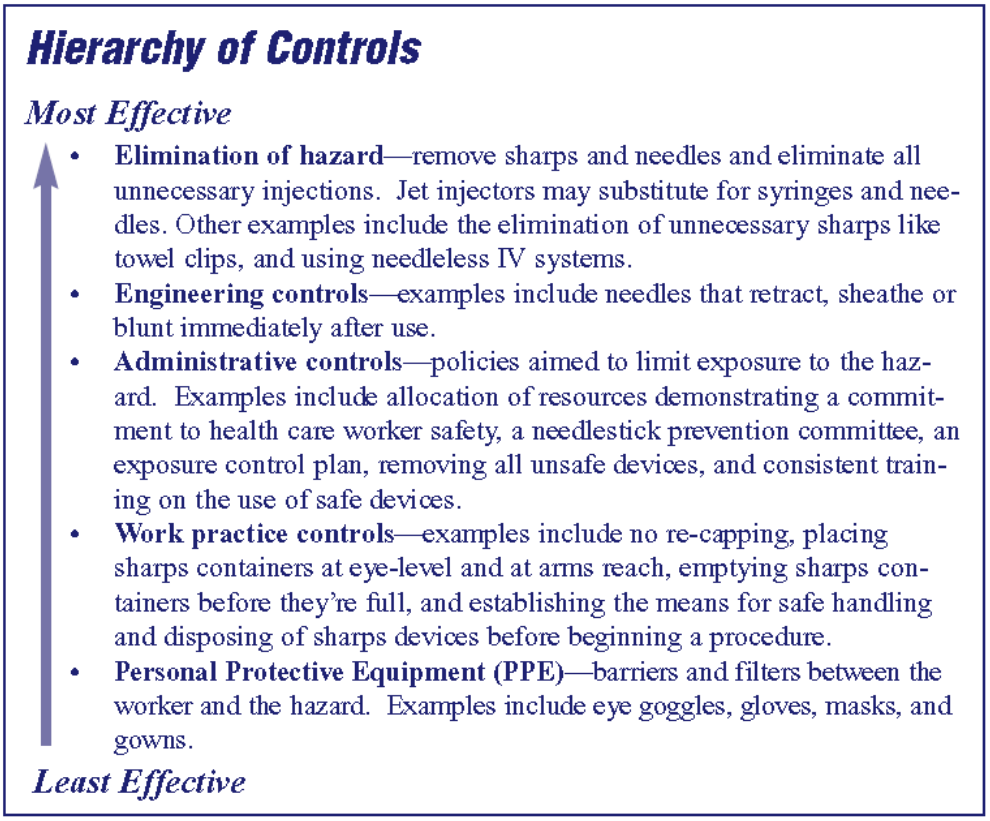

Figure 1. Hierarchy of controls for prevention of needlestick injury. American Nurses Association (2002).

Safer needle devices. The term 'engineering controls' refers to designs, devices, or practices that remove or isolate a practice in the workplace (Centers for Disease Control, 2010). In the context of NSI prevention, engineering controls refer to puncture

resistant sharps disposal containers and needles or other sharps devices with an integrated engineered sharps injury prevention features (ESIPs), also referred to as safer needle devices (Centers for Disease Control, 2010). Since the introduction of safer needle devices in 1989, the variety and availability of these devices has increased and the cost has decreased (Department of Health and Human Services, 2005). Safety needle devices typically include either some mechanism to cover the needle (i.e. hinged needle protectors attached to needle), a retractable feature that allows the needle to be withdrawn into an encasement, a self-blunting design, or a device design that removes the need for a needle altogether (GAO, 2000).

The Emergency Care Research Institute (ECRI) has proposed criteria for the development and selection of safer needle devices (1999, 2000). These criteria propose that the safety feature: 1) be an integral part of the device; 2) be simple and obvious in operation; 3) be reliable and automatic; 4) provide a rigid cover that allows the hands to remain behind the needle; 5) is in effect before disassembly and remains in effect after disposal; 6) ensures that the user technique is similar to that of conventional devices; 7) minimize the risk of infection to patients and not create infection control issues beyond those of conventional devices; 8) have minimal increase in biohazard waste volume; 9) be cost effective (ECRI, 1999; ECRI, 2000; Centers for Disease Control, 2010).

Effect of safer needle devices. There has been some criticism regarding the use of ESIPs without comparative data between device designs (Hyman, 2005), or data regarding the efficacy and reliability of these devices (Trim & Elliott, 2003). However there is evidence that the introduction of safer needle devices does reduce the frequency of NSIs, particularly when used as a component of a larger prevention program (Centers

for Disease Control, 2000; Orenstein, Reynold, Karabaic, et al., 1995). In fact, it has been argued that reductions in sharps injury rates since 1993 are primarily due to ESIPs emerging as the predominant technology (Jagger, Perry, Gomaa, et al., 2008). A GAO report from 2000 estimates that 69,000 of 236,000 NSI could be eliminated annually with the use of safer needle devices and an additional 109,000 could be prevented by eliminating the use of needle in unnecessary circumstances (e.g. using a needle when a needleless option as available). In total, 75% of NSI injuries could be avoided by implementation of these two prevention approaches.

While it is generally accepted that the number of HCWs who develop occupationally-acquired HIV infection would decrease if the number of NSI decreased, an estimate of the number of cases potentially avoided cannot be calculated (GAO, 2000). The GAO (2000) did estimate that 65 cases of occupationally-acquired HBV infection and 42 cases of occupationally-acquired HCV infection could be prevented among HCWs in the hospital setting each year by avoiding unnecessary use of needles, using needles with safety features, and following safer work practices.

Safer work practices. In addition to safer needle devices, safer work practices significantly impact the occurrence of NSI (GAO, 2000). Safer work practices are any method of using sharps devices that decreases the likelihood of NSI, such as not recapping used needles unless no alternative exists, properly disposing of used needles in puncture-resistant sharps containers; and consolidating specimen collection from patients (GAO).

Needlestick injury prevention programs. Since the effectiveness of safety devices or NSI prevention strategies varies with each facility and setting, no single device

or program will work for all facilities or settings (Centers for Disease Control, 2010). There is a large body of published studies describing successes of NSI prevention programs in the hospital setting. Besides the availability of safer needle devices and improved work practices, NSI prevention efforts must address other contributing factors such as training; a reduction in the use of invasive procedures, when possible; a secure work environment; and an adequate staff-to-patient ratio (Hanarahan & Reutter, 1997; Wugofski, 1992; Zafar, Butler, Podgorny, et al., 1997; Gershon, Pearse, Grimes, et al., 1999).

From 1993-1995, Alvarado-Ramy, Beltraim, Short and colleagues (2003) completed a study at ten hospitals in the United States to evaluate a comprehensive NSI prevention program. This program included enhanced surveillance for NSI, education and training of HCWs on the use of ESIPs, assessment of ESIP use and activation and the efficacy of the devices, and evaluation of HCW satisfaction with the ESIPs (Avarado-Ramy, Beltraim, Short, et al., 2003). Reports of percutaneous injury were reviewed and classified as 'preventable' if one of four criteria was met: (1) a needle was unnecessary for the procedure; (2) a "safer" needle device was available; (3) a safer work practice could have been used; or (4) there was improper needle disposal (Avarado-Ramy, Beltraim, Short, et al., 2003). HCWs reported a total of 361 NSI involving hollow-bore devices; investigators classified 78% as preventable (Avarado-Ramy, Beltraim, Short, et al., 2003). In this group of hospitals, a comprehensive NSI prevention program centered around the use of ESIPs did successfully lower NSI rates (Avarado-Ramy, Beltraim, Short, et al., 2003).

The effect of implementing ESIPs at Memorial Sloan-Kettering Cancer Center was analyzed by comparing a 12 month period before and after introduction of "safer-needle system" (Sohn, Eagan, Sepkowitz, et al., 2004). Exposures were classified as 'high' or 'low' in accordance with categories provided by the CDC for surveillance of HCWs exposure to blood/body fluids and bloodborne pathogens; insertion of an IV and blood sampling were among tasks rated as 'high' risk (Sohn, Eagan, Sepkowitz, et al., 2004). After ESIPs were widely available at the facility, the high-risk percutaneous injury rate dropped from 1.75 to 0.83 per month (P=0.056), the overall NSI incidence rate decreased from a monthly average of 10.8 to 4.9 (P<0.01), and the total NSI rate per 1,000 full-time employees per year dropped from 34 to 14 (P<0.01) (Sohn, Eagan, Sepkowitz, et al., 2004).

At the University of Connecticut Health Center, the NSI intervention program included increased education, changes in the types of sharps devices purchased, more administrative involvement, availability of ESIPs, and introduction of safe practice protocols (Trape-Cardoso & Schenck, 2004). Over a five year period, medical and dental students and nursing personnel experienced statistically significant changes in the rate of percutaneous exposure to bloodborne pathogens (from 7.9% to 2.6% and from 9.2% to 2.7%, respectively) (Sohn, Eagan, Sepkowitz, et al., 2004).

Occupational Exposure to Bloodborne Pathogens and Risk of Needlestick Injury for Emergency Personnel

The risk of needlestick injury (NSI) in firefighters (FFs) and Emergency Medical Services (EMS) personnel warrants further examination and intervention. When NSIs involve a patient with an infectious disease, the consequences of and the risk of NSI can

be life-changing and cause significant morbidity and mortality. Despite concerns about underreporting, there are local and national studies that document the existence of NSI in this unique population. In addition, there are increased risks of incurring NSI due to the EMS work environment, as well as the type of patients who receive emergency care.

Consequences of and risk from NSI for emergency personnel. Needlestick injuries in firefighters and EMS personnel are of concern due to the risk of transmission of bloodborne pathogens, such as Hepatitis B (HBV), Hepatitis C (HCV), and Human Immunodeficiency Virus (HIV). While the discussion regarding the risk of bloodborne pathogen exposure tends to focus on HIV, transmission of HCV is also of significant concern. HBV is no longer a significant concern for occupational exposure due to the availability of a safe and effective vaccine and the widespread implementation among healthcare workers in the U.S. (RisChitelli, Harris, McCauley, et al., 2001).

FFs and EMS personnel commonly treat patients with traumatic injuries or medical conditions resulting in a large amount of blood on the scene of the call or in the back of the ambulance. Thus, exposure to blood potentially contaminated with HIV, HBV, and/or HCV is an inherent risk in the EMS field. In a GAO report addressing needlestick injuries and prevention, it is noted, "[t]he total number of needlestick injuries sustained annually in the United States is unknown, and the lack of data from nonhospital settings appears to be greatest obstacle in deriving a national injury estimate" (2000, p.3). Understanding NSI in FFs and EMS personnel is one piece of addressing this gap in knowledge.

Occupational transmission of Human Immunodeficiency Virus (HIV). Numerous studies regarding bloodborne pathogen exposure in the more general

classification of healthcare workers have identified risk factors that increase the likelihood of transmission of HIV. These risk factors for seroconversion include percutaneous injury, as opposed to mucosal or cutaneous exposure, the concentration of virus in the blood involved in the exposure, and the depth, extent, and amount of tissue involved in the injury (Henderson, Fahey, Willy, et al., 1990).

Occupational transmission of Hepatitis C Virus (HCV). Similar studies regarding occupational transmission of HCV identify employment in the healthcare field as a risk factor for seroconversion (Alter, 1997). One review of occupational exposures with blood from patients known to be infected with HCV found that 16 out of 911 (1.8%) HCWs tested for follow-up seroconverted (Alter, 1997). Four of the 16 (25%) seroconversions occurred in employees who had experienced a needlestick with a hollowbore needle (Alter, 1997). However, several studies have documented evidence that occupationally transmitted Hepatitis C is not a significant concern within the EMS and fire service community and that the prevalence rate of Hepatitis C among emergency services and/or public safety workers is similar to that of the general population (Datta, Armstrong, Roome, et al., 2003; Upfal, Naylor, & Mutchnick, 2001; Werman & Gwinn, 1997; Roome, Hadler, Thomas, et al., 2000; Pardoe, 1994; Spitters, Zenilman, Yeargin, et al., 1995).

Occupational transmission of Hepatitis B Virus (HBV). Hepatitis B does pose a risk to unvaccinated HCWs. If a healthcare worker is unvaccinated and exposed to Hepatitis B via percutaneous injury, the risk of disease transmission is up to 100 times more likely than if exposed to HIV (Centers for Disease Control and Prevention, 2011).

However, prevention efforts for occupationally acquired Hepatitis B have focused on employer-based vaccination programs.

Over time, the frequency of occupational transmission of HBV has decreased significantly due to introduction of a safe and effective vaccine, a decrease in prevalence of disease in the general population, and implementation of prevention programs with HCWs (RisChitelli, Harris, McCauley, et al., 2001; Centers for Disease Control, 2010). In 1982, the CDC estimated that 10,000 HCWs from the medical and dental fields contracted HBV; by 2004, this number had dropped to 304 (Centers for Disease Control, 2011). A decrease was also seen in the incidence of acute Hepatitis B in the general population of the United States due to implementation of a national strategy to eliminate HBV, as shown in Figure 2 (Centers for Disease Control, 2011). Clearly, the risk of occupationally-acquired HBV has decreased due to the availability of a safe and effective vaccine; occupational risk of HIV transmission via percutaneous injury is of highest concern.

Exposure to bloodborne pathogens in firefighters and EMS personnel.

Despite a known limitation of underreporting, available data from local and national studies indicate that percutaneous injuries do occur in FFs and EMS at a rate that deserves targeted prevention efforts. In addition, FFs and EMS personnel function in a unique environment that pre-disposes them to needlestick injury. While there is little published data about the risk factors that lead to NSI in FFs and EMS personnel, the available data about NSI risk factors and traditional HCWs suggest an elevated risk level for FFs and EMS personnel.

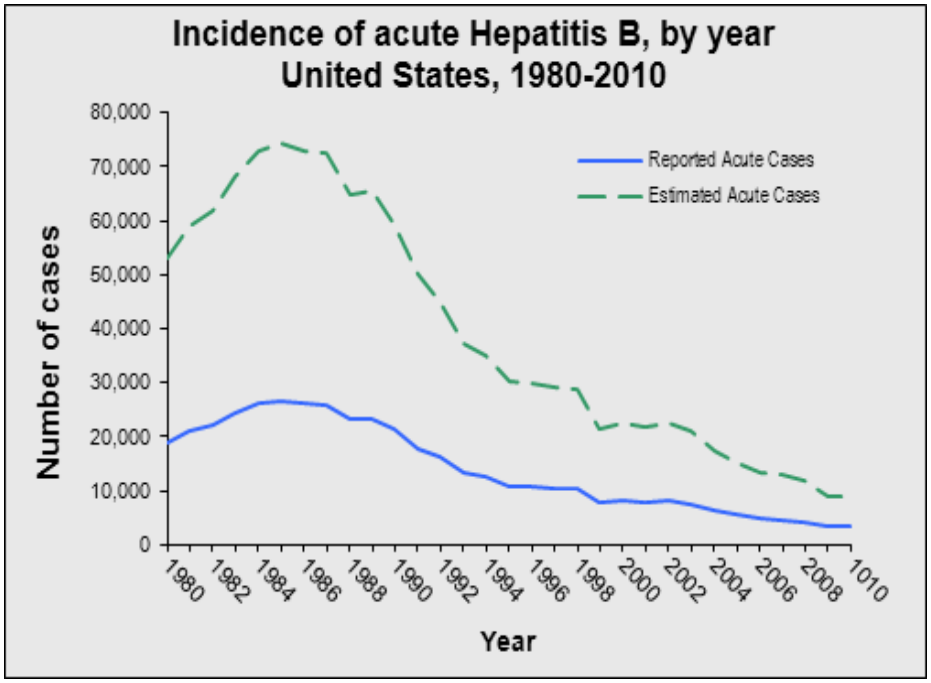

Figure 2. Decreasing incidence of acute Hepatitis B, by year, United States, 1980-2010. Centers for Disease Control (2011).

Underreporting of exposures to BBP in FFs and EMS personnel. Reports and discussions regarding bloodborne pathogen exposures in EMS personnel and FFs must be analyzed in the context of under-reporting; that is, one must consider that a large percentage of bloodborne pathogen exposures in this population are not reported. In fact, in a survey of 296 firefighters and EMS personnel in Miami, Florida, 52% of respondents who had incurred an NSI within the past 12 months had not reported the injury to their employer (Carillo, Fleming & Lee, 1996). In a survey of paramedics within 11 states, participants who indicated that they had experienced a bloodborne pathogen exposure within the previous 12 months (n=538) were asked about whether the incident was reported to the employer (Boal, Leiss, Sousa, et al., 2008). For NSI (n=125), only 72% of exposures were reported to the employer. A variety of reasons were given for not

reporting these injuries, including not thinking a significant exposure had occurred and not wanting to be reprimanded (Boal , Leiss, Ratcliffe et al, 2010).

These findings of under-reporting among EMS personnel and FFs are similar to the trend among general HCWs. A review of seven published surveys of HCWs who had incurred NSI indicated that at least 50% did not report their injury (Centers for Disease Control, 2010). The available data regarding NSI should be reviewed with assumption that the rates and frequencies provided are merely a 'basement' level.

Rates and frequencies of BBP Exposure in FFs and EMS personnel: Local populations. Several studies with local populations of EMS personnel and FFs have attempted to define the problem of bloodborne pathogen exposure among this unique population. However, these studies may not be representative of the national trend, given the limited populations studied.

A review of exposure reports from 1988 and 1989 involving FFs/EMTs at the Portland, Oregon Fire Bureau showed that of the 75 exposures involving needlesticks, contamination of non-intact skin, or mucous membranes with blood or body fluids, 18.7% were needlestick injuries (Reed, Daya, Jue, et al., 1993). Authors from the Portland study estimated an incidence rate of 0.24 needlesticks per 1,000 EMS calls (Reed, Daya, Jue, et al., 1993).

A retrospective study of first responders visiting Emergency Departments in Rhode Island from 1995-2001 identified 200 emergency department visits for blood or body fluids exposures (Merchant, Nettleton, Mayer, & Becker, 2009). Thirty-four percent of these injuries were percutaneous injuries; the incidence rate for this type of injury peaked in 1999 and then began to decrease (Merchant, Nettleton, Mayer, & Becker,

2009). In a similar retrospective study of the Boston EMS system, 419 occupational exposure health reports filed between 2007 and 2009 were reviewed (El Sayed, Kue, McNeil, & Dyer, 2011). Only 1.5% of these exposures were caused by needlestick injury (El Sayed, Kue, McNeil, & Dyer, 2011). This frequency of needlestick injury was quite a bit lower than previous studies. The authors attributed this low rate to the availability of self-capping needle devices and an annual review of all needlestick injuries (El Sayed, Kue, McNeil, & Dyer, 2011).

Firefighters from Atlanta and Fulton County, Georgia were surveyed regarding occupational exposures to blood as part of a larger study also involving law enforcement officers (Averhoff, Moyer, Woodruff, et al., 2002). Of the 189 firefighters who participated in the survey, only 0.6% reported ever having sustained a NSI and 1.7% reported being cut by a sharp object while performing job duties (Averhoff, Moyer, Woodruff, et al., 2002). Marcus, Srivastava, Bell and colleagues (1995) surveyed EMS workers as they were returning from calls in three U.S. cities with high acquired immune deficiency syndrome (AIDS) incidence. One needlestick injury was reported in the course of 165 shifts and 2,472 emergency calls, resulting in an estimated annual frequency rate for percutaneous injury of 0.2 (Marcus, Srivastava, Bell, et al., 1995). The same study revealed an average of 0.8 NSI per 100 worker-shifts (Marcus, Srivastava, Bell, et al., 1995).

While these local studies provide insight into the reality of NSI among FFs and EMS workers, they may not accurately reflect rates among fire departments and EMS agencies in other locations. National studies, while limited in number, may provide a more accurate definition of the scope of the problem.

Rates and frequencies of BBP in FFs and EMS personnel: National samples. A limited number of national studies were identified during this literature review**.** Rischetelli, Harris, McCauley and colleagues (2001) reviewed five published studies regarding the risk of NSI among FFs and EMS personnel and used data from those studies to calculate an annual risk for NSI among full-time EMS personnel and firefighter-paramedics compared to that of traditional HCWs: 870-1370 NSIs/1000 employees/year and 92-230 NSIs/1000 employees/year, respectively.

Chen and Jenkins (2007) surveyed 1067 workers who were treated in Emergency Departments for bloodborne pathogen exposures, identified through the National Electronic Injury Surveillance System (NEISS). Needlestick injuries were the primary source of exposures in non-hospital settings, including EMS personnel and FFs. There was a statistically significant difference ($P<0.001$) in the frequency of needlestick injuries with used needles or sharps between non-hospital and hospital personnel: 84% and 55%, respectively (Chen & Jenkins, 2007).

Reichard, Marsh, and Moore (2011) estimated that 15% of injuries among EMTs and paramedics requiring emergency department visits nationally from 2003 to 2007 were related to needlestick injury (n=99.400) (Reichard, Marsh, & Moore, 2011). However, a national cross-sectional survey of nationally registered EMTs (NREMT) found that 5.2% (n=659) of all injuries reported were puncture-type injuries (Heick, Young, & Peek-Asa, 2009).

In a mail survey of paramedics in ten states, Leiss and colleagues found an incidence rate for NSI of approximately 1.2 NSI per 10,0000calls (Leiss, Ratcliffe, Lyden, et al., 2006). In a related study, Boal and colleagues (2010) surveyed 2664

paramedics in 12 states in 2002-2003 and found that 132 participants reported an NSI within the previous 12 months, representing 24.5% of all reported bloodborne pathogen exposures within this group. The rate of needlesticks was estimated to be 100 per 1,000 employee-years (Boal , Leiss, Ratcliffe et al, 2010). A review of needlestick injury rates for emergency responders in eight published studies revealed a range of 3 NSIs per 1,000 employee years for firefighter-EMTs in Portland, Oregon to 367 NSIs per 1,000 employee years for paramedics in Florida (Boal , Leiss, Ratcliffe et al, 2010).

While the incidence rates of *reported* NSIs may not be high, NSIs account for a significant portion of bloodborne pathogen exposures among EMS personnel and FFs and pose a risk for transmission, particularly HIV. Job related risk factors, such as the EMS environment and the types of calls, increase the likelihood of NSI.

Risky needle practices in EMS personnel. Harris and Nicolai (2010) surveyed EMS personnel in Virginia to determine compliance with overall universal precautions. Of the 183 participants who reported regularly using needles while performing job duties, 14% said they always re-capped needles after use, 14% reported re-capping most of the time, 11% seldom re-capped needles, and 61% never re-capped (Harris & Nicolai, 2010).

Risk of needlestick injury related to the EMS work environment. EMS personnel and FFs routinely use hollow-bore needles when providing emergency care and these types of needles cannot be avoided when providing critical aspects to patient care, such as starting intravenous lines (IVs) or when giving intramuscular (IM) injections. While regular use of these devices is particularly concerning for transmission of bloodborne pathogens (Do, Ciesielski, Metler, Hammet, Jianmin, & Flemming, 2003;

Tomkins, Elford, Nichols, et al., 2012), there are additional elements of risk that exist in the FD and EMS workplace.

In a qualitative study of hospital-based personnel, participants cited overcrowded work areas and poor lighting as contributing factors to NSI (Knapp, Grytdal, Chiarello, et al., 2009). A case-crossover study among hospital-based personnel showed statistically significant increases in NSI when the employee was rushing, angry, distracted, or when the sharp was passed multiple times and increases in NSI when the employee was fatigued or working with an uncooperative patient (Fisman, Harris, Sorock, et al., 2003). In another case-crossover study examining injuries from sharps devices among medical trainees and HCWs, fatigue emerged as a statistically significant factor for NSI (Fisman, Harris, Rubin, et al., 2007). The very nature of EMS work introduces many of these risk factors on a regular basis. For example, the back of the ambulance is a confined space with limited areas for movement. Some scenes, such as motor vehicle accidents, may involve patient treatment outside during night time hours. FFs and EMS personnel often work 24 or 48 hour shifts, resulting in increased fatigue.

Therefore, there is a definitive risk of HIV transmission as a result of NSI in EMS personnel and firefighters. FFs and EMS personnel regularly use hollow-bore needles in a work environment that is inherently risky for NSI. Understanding the circumstances in which these NSI occur, as well as additional job related risk factors and practices, can help to identify areas to target in prevention efforts.

Risk of needlestick injury related to call type. The type of emergency medical situation or 'call' may also influence the likelihood of bloodborne pathogen exposure. While there is limited information about this risk factor in the published literature, there

is some suggestion that calls that are more critical in nature may be more likely to result in exposure. At the Portland, Oregon Fire Bureau, 20% of reported needlestick injuries in 1988-1989 were sustained during calls that involved cardiopulmonary resuscitation (CPR) (Reed, Daya, Jue, et al., 1993). In Chen and Jenkin's (2007) study of bloodborne pathogen exposures treated in emergency departments, greater than 70% of survey respondents from EMS and law enforcement reported the bloodborne pathogen exposure, including NSI, occurred while performing an emergency task.

In focus groups of hospital-based personnel and supervisors regarding NSI, participants indicated that uncooperative patients were the greatest risk for NSI (Knapp, Grytdal, Chiarello, et al., 2009). FFs and EMS personnel often provide care to uncooperative patients, including those suffering from head injury, post-ictal after seizures, intoxicated or under the influence of illicit substances, and aggressive behavior due to mental health issues.

EMS personnel and FFs regularly participate in critical medical calls and in calls involving uncooperative patients, thereby adding to the risk of NSI. Given the occurrence of NSI in EMS personnel and FFs, the risk of transmission of HIV and HCV with these NSIs, and the risk factors inherent in the provision of emergency medical care in the field, the issue of NSI in emergency medical responders warrants further exploration.

While FFs and EMS personnel are known to underreport work-related BBP exposures, there is evidence from local and national studies to show that needlestick injuries do occur at concerning frequencies. There are multiple job hazards related to functioning in an emergency response setting, including routine use of hollow-bore

needles, performing job duties in moving vehicles, providing care in the confined space of an ambulance, working in poorly lit conditions, and responding to critical calls and those involving uncooperative patients.

Impact of safer needle devices. While availability, use, and impact of ESIPs has been studied in a wide variety of healthcare professions, including home health care workers, hospice workers, and dental care personnel, little data exists regarding ESIPs and FFs and EMS personnel (Leiss, J.K., 2010; Cleveland, Baker, Cuny, et al., 2007). In a mail survey conducted in 2002-2003 involving paramedics in ten states, the incidence rate of NSI was found to be approximately one-fourth that of other states; this difference is important because California was the first state to mandate the use of ESIPs for paramedics (Leiss, Ratcliffe, Lyden, et al., 2006).

In a mail survey administered to a nationally representative sample, Mathews, Leiss, Lyden, et al. (2008) found that a notable percentage of paramedics did not use sharps safety devices, even when they were provided. In the same study, paramedics in California were more likely to use sharps safety devices than paramedics in other parts of the United States and the difference in usage rates varied between types of devices (Mathews, Leiss, Lyden, et al., 2008). For intravenous catheters, medics in the U.S. used the safety feature 83% of the time, while medics in California used the safety feature 95% of the time and safety features on prefilled syringes were implemented only 45% of the time in the national sample and 66% of the time in the California sample (Mathews, Leiss, Lyden, et al., 2008).

Peate (2001) documented a statistically significant decrease in NSI in EMS workers of a municipal fire department after introduction of a self-retracting lancet.

Therefore, sufficient evidence exists to demonstrate that risk factors for and NSI occur in the FF and EMS population and that safer needle devices have had some success among this same population.

Research Questions

IV stylets and needles used with syringes for injections are hollow bore needles routinely used by EMS personnel and FFs in the course of patient treatment for medical and traumatic injuries. Therefore, the risk for transmission of bloodborne pathogens exists for this type of personnel during the performance of their typical job duties. Despite this inherent risk, typical surveillance for needlestick injuries and occupational exposure to bloodborne pathogens among HCWs does not include FFs and EMS personnel (Perry & Jagger, 2003). However, there are several studies with local populations of EMS personnel that provide a glimpse of the frequency in which EMS personnel and FFs sustain needlestick injuries (NSI), at which stage of use the NSIs occur, and the types of events in which exposures are likely to occur.

To understand the risk of occupationally-related NSI and potential BBP transmission in the study population, the first two research questions must be answered: 1) what are the types of unsafe sharps techniques present in this FD, as observed in discarded, used sharps devices and 2) what is the frequency of the unsafe sharps techniques defined when investigating the first question?

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Chapter 2. Regulations that Impact Needle Safety and Sharps Devices

Several levels of regulations and standards exist to promote occupational safety among healthcare workers (HCWS) and firefighters. At the federal level, the Centers for Disease Control and Prevention (CDC) and the United States Occupational and Safety and Health Administration (OSHA) have promoted standards to reduce the likelihood of HCWS exposure to bloodborne pathogens. Many states have a state level Occupational Safety and Health Agency that adopts and enforces the federal standards or pass state standards that exceed the federal standards. Unlike the majority of states, Florida does not have a state-level Occupational Safety and Health Administration; consequently, federal OSHA guidelines apply to businesses and private enterprise within the state of Florida. However, agencies considered to be state, county, or local government entities are not governed by federal OSHA regulations. As a result, firefighters and EMS workers employed by county and city fire rescue agencies do not have the protection afforded by federal OSHA oversight.

There are two agencies within the state of Florida that potentially could address this gap in occupational health and safety regulation – the state Fire Marshall's Office or the Bureau of Emergency Medical Services (BEMS). Unfortunately, neither agency has provided standards or oversight related to the occupational health and safety issues inherent to EMS. Therefore, employees of county and city fire rescue departments must defer to the decisions of their individual employers regarding these issues, including prevention efforts for exposure to bloodborne pathogens and needlestick injuries.

Federal Guidelines and Legislation

In response to the emergence of the Human Immunodeficiency Virus (HIV) in the 1980s, the Centers for Disease Control and Prevention (CDC) established guidelines for Universal Precautions for healthcare workers at risk of exposure to blood or body fluids of patients (U.S. Centers for Disease Control, 1987). These initial guidelines recommended: "(1) increased use of personal protective equipment (PPE) such as gloves, fluid-resistant gowns, protective eyewear, masks, and other barrier garments to reduce contact with blood and contaminated body fluids; (2) safer handling and disposal of sharp medical devices; (3) hepatitis B vaccine offered at no cost to employees; (4) use of puncture-resistant sharps containers, placed as close as possible to the point-of-use; and (5) annual training of all at-risk workers in the protective measures included in the guidelines" (Jagger, Perry, Gomaa, & Phillips, 2008, p. 63). These guidelines served as the foundation for development of the Bloodborne Pathogens Standard in 1991, the Needlestick Safety and Prevention Act of 2000, and the subsequent revision of the Bloodborne pathogens standard in 2000. Figure 3 provides a timeline of the key federal guidelines and regulations related to needlestick injury prevention.

The Bloodborne Pathogens Standard of 1991. The United States Occupational Safety and Health Administration (OSHA) began procedures in 1987 for incorporating the CDC guidelines listed above and for enacting a regulatory standard related to occupational exposure to bloodborne pathogens (U.S. Department of Labor, 1987).

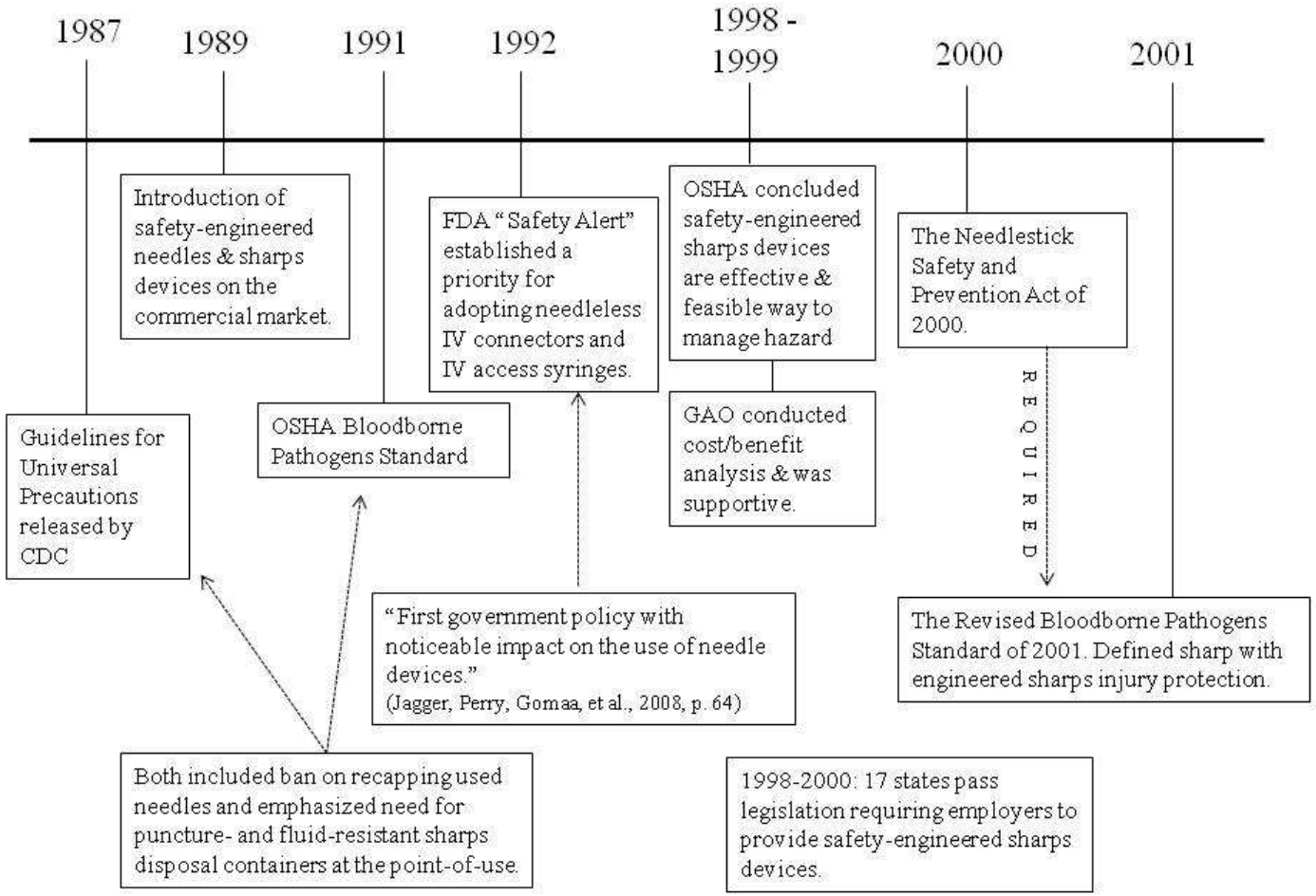

Figure 3. *Timeline of key federal regulations and legislation regarding needlestick injury prevention.*

In 1991, the OSHA Bloodborne Pathogens Standard (BPS) was promulgated (U.S. Department of Labor, 1991). The OSHA BPS mirrored the Universal Precaution guidelines established by the CDC and continues to be the primary authority protecting healthcare workers in the United States from occupational exposure to bloodborne pathogens.

The development of engineering controls. Both the CDC Universal Precaution guidelines and OSHA's BPS included a ban on recapping of contaminated (or used) needles and the need for puncture- and fluid-resistant sharps disposal containers at the point-of-use, "preferably within arms' reach of the user" (Jagger, Perry, Gomaa, & Phillips, 2008, p. 64; U.S. Centers for Disease Control, 1991; U.S. Department of Labor, 1991).

In addition to these measures, safety-engineered needles and sharps devices appeared on the commercial market around 1989. These devices were designed to reduce the risk of sharps injuries to healthcare workers (HCWS) through engineering controls. In 1991, the BPS listed 'engineering controls' as the preferred method to reduce the risk of needlestick injury to HCWS (Jagger, Perry, Gomaa, & Phillips, 2008). The availability of various brands, designs, and sharps devices with engineering controls increased rapidly in the early 1990's to include safety features in devices used for injections, vascular access (such as intravenous lines or IVs), phlebotomy (or blood drawing), and surgical procedures.

Emphasizing safer medical devices. In 1992, the U.S. Food and Drug Administration (FDA) issued a "Safety Alert" related to the dangers in using hypodermic needles for accessing IV ports and connecting IV lines ('piggybacking') (U.S. Food and

Drug Administration, 1992). The voluntary "Safety Alert" also established a priority for the adopting of needleless IV connectors and IV access syringes ('flushes') and is considered the "first government policy with noticeable impact on the use of needle devices" (Jagger, Perry, Gomaa, & Phillips, 2008, p. 64). This FDA "Safety Alert" used terminology that would persist as the definition of devices designed to reduce needlestick injury evolved. Table 2 summarizes this newly introduced terminology (U.S. Food and Drug Administration, 1992; Jagger, Perry, Gomaa, & Phillips, 2008, p.64).

Table 2

FDA "Safety Alert" Defining Devices Designed to Reduce Needlestick Injury

- Devices should have a fixed safety feature to provide a barrier between the hands and the needle after use.
- The safety feature should allow or require the hands to remain behind the needle at all times.
- The safety feature is an integral part of the device and not an accessory.
- The safety feature is in effect before disassembly and remain in effect after disposal [to protect users and trash handlers and for environmental safety].
- The safety feature is as simple as possible, and requires little or no training to use effectively.

Adapted from Jagger, Perry, Gomaa, & Phillips, 2008

The FDA, in conjunction with the National Institute for Occupational Safety and Health (NIOSH) and OSHA, issued a second significant "Safety Advisory" in 1999 related to the risks associated with glass microhematocrit capillary tubes (U.S. Food and Drug Administration, 1999). This equipment contained blood and was prone to breakage, thus creating a serious occupational risk of blood exposure for HCWS. The use of plastic or plastic-wrapped tubes was recommended, rather than glass tubes.

Moving towards needlestick injury prevention. Between 1998 and 2000, seventeen states passed legislation requiring employers to provide safety-engineered sharps devices (Jagger, Perry, Gomaa, & Phillips, 2008). Dr. Janine Jagger and

colleagues at the University of Virginia, through the EpiNet™ program, maintain a master list of these types of devices that can be accessed at http://www.healthsystem.virginia.edu/pub/epinet/new/safetydevice.html. Because these efforts occurred at the state level, the regulations were inconsistent between states and created a 'piecemeal' effect. In 1998, OSHA began seeking input from healthcare facilities regarding workplace experiences with engineering controls designed to reduce the risk of needlestick injury to HCWS. After OSHA concluded that "safer medical devices are an effective and feasible method of hazard control", the U.S. General Accounting Office (GAO) conducted a cost/benefit analysis of enacting a national requirement of the adoption of safety-engineered sharps (Occupational Safety and Health Administration, 1999). The GAO report was supportive of this effort, citing cost-effectiveness and the benefits of technology in avoiding the consequences of needlestick injury (Heinrich, 2000).

The GAO report resulted in a revision of the BPS giving OSHA compliance officers the authority to issue citations and levy fines against healthcare providers who failed to provide safety-engineered sharps for their employees (Occupational Safety and Health, November 5, 1999). The revised BPS emphasized that engineering controls must be used whenever available to reduce employee's exposure.

The Needlestick Safety and Prevention Act of 2000. The United States Congress passed the Needlestick Safety and Prevention Act of 2000 in order to expand and clarify the language used by OSHA in the BPS relating to needlesticks and sharps safety. In addition to requiring OSHA to revise the BPS, the law required: (1) HCWs providing direct patient care be included in the process of evaluating and selecting safety-

engineered needles and sharps; (2) employers document evaluation and implementation of safety-engineered devices; (3) employers update their evaluation plan annually to reflect the consideration of new technology; and (4) employers maintain a sharps injury log documenting the types of devices causing injuries and an explanation of the circumstances of each injury (Jagger, Perry, Gomaa, & Phillips, 2008). OSHA made the corresponding changes to the BPS and the revised BPS went into effect in April 2001.

The Revised Bloodborne Pathogen Standard (BPS) of 2001. One important task of the revised BPS (2001) was outlining a definition of a "sharp with engineered sharps injury protection" (SESIP) as a "non-needle sharp or needle device used to withdraw body fluids, accessing a vein or artery, or administering medication or other fluids, with a built-in safety feature or mechanism that effectively reduces the risk of an exposure incident" (U.S. Occupational Safety and Health, 2001a, p. 5320). Table 3 compares the earlier definition established by the FDA's "Safety Alert" in 1992 with the definition established in the revised BPS.

The revised BPS did not specify brands or product designs so that a variety of safety devices could be considered and/or implemented. In addition, this lack of specificity insured that the BPS would not serve as a barrier to implementation of new technology as industry developed new designs and safety devices. OSHA delegated the responsibility for choosing devices for use back to the individual healthcare facility, "OSHA does not approve or endorse any product. It is your responsibility as an employer to determine which engineering controls are appropriate for specific hazards, based on what is appropriate to the specific medical procedures being conducted, what is feasible, and what is commercially available (U.S. Occupational Safety and Health, n.d.).

The revised BPS requires that "[w]here conventional needles are being used, an employer is responsible for evaluating SESIPs available on the market for each particular procedure where there is a reasonably anticipated exposure to blood or OPIM and using appropriate, effective devices for those procedures" (Occupational Safety and Health, 2001c, p.1). However, OSHA emphasized that the revised BPS "does not impose new requirements for employers to protect workers from sharps injuries; the original standard already required employers to adopt engineering and work practice controls that would eliminate or minimized employee exposure from hazards associated with bloodborne pathogens" (Occupational Safety and Health, 2001b, p.2).

Table 3

Evolving Definitions of a Sharp with Engineered Sharps Injury Protection

FDA "Safety Alert" (1992)	• Devices should have a fixed safety feature to provide a barrier between the hands and the needle after use. • The safety feature should allow or require the hands to remain behind the needle at all times. • The safety feature is an integral part of the device and not an accessory. • The safety feature is in effect before disassembly and remain in effect after disposal [to protect users and trash handlers and for environmental safety]. • The safety feature is as simple as possible, and requires little or no training to use effectively.
Revised Bloodborne Pathogen Standard (2001)	• Non-needle sharp or needle device • Used to withdrawing body fluids, accessing a vein or artery, or administering medication or other fluids • With a built-in safety feature or mechanism that effectively reduces the risk of an exposure incident

Adapted from Jagger, Perry, Gomaa, & Phillips, 2008, p.64

OSHA interpretation of standards. In subsequent years, OSHA has published interpretations of standards in response to questions posed from external individuals, agencies, or businesses. These interpretations of standards provide guidance on expectations for compliance, as well as provide specifications for enforcement. OSHA has determined that the use (or lack of provision) of safety devices cannot be based solely on the additional expense associated with safety engineered devices. OSHA clarified, "The standard does not give the employer the option to forego appropriate, commercially available, and effective engineering controls" (U.S. Occupational Safety and Health, 2001d, p.1). OSHA further asserts, "[S]electing a safer device based solely on the lowest cost is not appropriate. Selection must be based on employee feedback and device effectiveness" (Occupational Safety and Health, 2001d, page 1). These efforts by OSHA and the CDC have resulted in well-developed and defined regulations regarding prevention of bloodborne pathogen exposure and needlestick injury.

State Oversight

There is an inconsistency among states regarding the existence of state-level OSHA agencies. Twenty-five states, Puerto Rico, and the Virgin Islands have federally-approved state-level OSHA agencies (U.S. Department of Labor, n.d.). When a state-level OSHA office exists, that state must enforce OSHA regulations that meet the federal standards, but may set regulations that exceed the federal standards. In the majority of cases, these state-level OSHA agencies have jurisdiction over state, county, and city government employers. In Connecticut, Illinois, New Jersey, New York and the Virgin Islands, the state-level OSHA only applies to state and local government employees (U.S. Department of Labor, n.d.). In instances where a state-level OSHA agency does not

exist, federal OSHA regulations are enforced by regionally located federal OSHA agents. Even in these instances, the federal OSHA does not have jurisdiction over state, county, and city government employers. In Florida, two state agencies could potentially regulate occupational health and safety issues related to emergency medical response in Florida: the state Fire Marshall's Office or the Department of Health, Bureau of EMS.

Florida State Fire Marshal. In 2002, two firefighters died during a live fire training exercise in Osceola County. These deaths were preventable and believed to be a consequence of lack of oversight during firefighter training. As a result, the Florida Firefighter's Occupational Safety and Health Act (FFOSHA) was created (Florida State Fire Marshal, n.d.). While the introduction to FFOSHA states, "It is the intent of the Legislature to enhance firefighter occupational safety and health in the state through the implementation and maintenance of policies, procedures, practices, rules, and standards that reduce the incidence of firefighter employee accidents, firefighter employee occupational diseases, and firefighter employee fatalities" (Florida Firefighter Occupational and Safety Act, F.S. 633.803), the corresponding information on the State Fire Marshall's web site covers solely fire-related occupational issues. FFOSHA further specifies that there should be a "continuous study of firefighter employee occupational diseases" and ways to control and prevent those diseases (Florida Firefighter Occupational Safety Act, F.S. 633.805).

However, the information presented by the Fire Marshall's website for FFOSHA does not address any health or safety issues related to bloodborne pathogens (Florida State Fire Marshal, n.d.). The only mention of an infectious disease issue is 2003 posting regarding rat bite fever (Florida State Fire Marshal, n.d.b.). The FFOSHA website

appears neglected, the last posting under fire safety and news are dated 2003, 2004, and 2005 (Florida State Fire Marshal, n.d.a).

Florida Department of Health, Bureau of Emergency Medical Services. A second state agency has the potential to provide structure for emergency medical technicians (EMTs) and paramedics regarding occupational safety and health. The Florida Department of Health, Bureau of Emergency Medical Services (BEMS) enforces legislation and enacts rules relating to a wide variety of EMS issues. However, a review of the rules governing EMS agencies, 64J-I, did not identify any requirements relating to needlestick injury prevention (Department of Health, 2010).

Ultimately, firefighters and EMS workers employed as civil servants within the state of Florida function without the occupational health safeguards afforded to their peers in other states or employed by privately operated ambulance companies. In an era of worsening budget constraints, state, county, and city agencies are unlikely to voluntarily implement safety initiatives without significant incentives. Due to the lack of state or federal mandates requiring safer needle devices, decisions regarding the provision of safer needle devices, as well as practices in using sharps devices, are determined largely by workplace culture and the presence or absence of a culture of safety.

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Chapter 3. The Impact of Work Environment, Culture of Safety, and Cultural Background

The lack of regulation and oversight for fire department and EMS agencies operated by local government allows for work environment, culture of safety, fire services and EMS culture to have significant impact on unsafe practices that increase the likelihood of NSI. In addition, the cultural history of Pasco County Fire Rescue (PCFR) may impact attitudes and beliefs regarding EMS duties or use of sharps devices.

Work Environment

Studies of traditional HCWs have identified multiple factors within the work environment that may increase the likelihood of NSI. In a study of hospital-based nurses, Clarke, Sloane, and Aiken (2002) used the Revised Nursing Work Index to determine "resource adequacy and nurse manager leadership" and the Maslach Burnout Inventory to determine if nurses felt overwhelmed by their work, in order to correlate those factors with NSI rates (p. 1118). Nurses assigned to hospital units with poorer work climates and lower staffing levels (higher patient to nurse ratios) were more likely to report risk factors associated with NSI (Clark, Sloane, & Aiken, 2002). Those assigned to units with less adequate resources, lower staffing, lower levels of nurse manager leadership, and higher levels of emotional exhaustion ('burn-out') were twice as likely to report risks due to factors such as staff carelessness and lack of experience, patient uncooperativeness, frequent recapping of needles, and inadequate knowledge and supplies (Clarke, Sloane, & Aiken, 2002). Higher frequencies of reported NSIs and "near misses" (incidents in which

a likelihood of NSI was high, but an injury did not occur) were observed on units that also experienced less adequate resources, lower staffing, lower levels of nurse manager leadership, and higher levels of emotional exhaustion (Clarke, Sloane, & Aiken, 2002). Using Clark, the methods described above, Sloane, Rockett et al. (2002) expanded their inquiry to 22 hospitals and found a clear association between staffing, organizational climate, and reported NSIs.

Culture of Safety

In addition to work environment, the culture of safety of a workplace is likely to impact the presence or absence of unsafe behaviors. Shared perceptions and attitudes of a group toward safety are often referred to as safety culture or safety climate. Development of a culture of safety includes: (1) allocating adequate resources to safety; (2) communicating an institutional commitment to safety from 'the top'; (3) making safety a higher priority than productivity and/or efficiency; (4) encouraging and developing communication among employees and administration; and (5) establishing blame-free policies to encourage the reporting of injuries and errors (Department of Health and Human Services, 2005). There are multiple dimensions that comprise a safety climate, including workers' perception of the level of safety in the work environment, administration's commitment to safety, the level of conflict among co-workers, cleanliness of the workplace, feedback to employees about safety, barriers to performing job duties, and the availability of personal protective equipment (PPE) (Grosch, Gershon, Murphy, et al., 1999).

The impact of safety climate is positive: organizations with strong safety climates consistently document fewer occupationally-related injuries than organizations with weak

safety climates. This effect is partially due to the presence of well-developed and effective safety programs, but is also impacted by the cues sent to employees by the very existence of these programs (Gershon, Karkashian, Grosch, et al., 2000). Gershon and colleagues (2000) detail how a positive safety climate supports and reinforces individual safety behaviors, that then contribute to the overall safety climate. A schematic of this effect is shown in Figure 4.

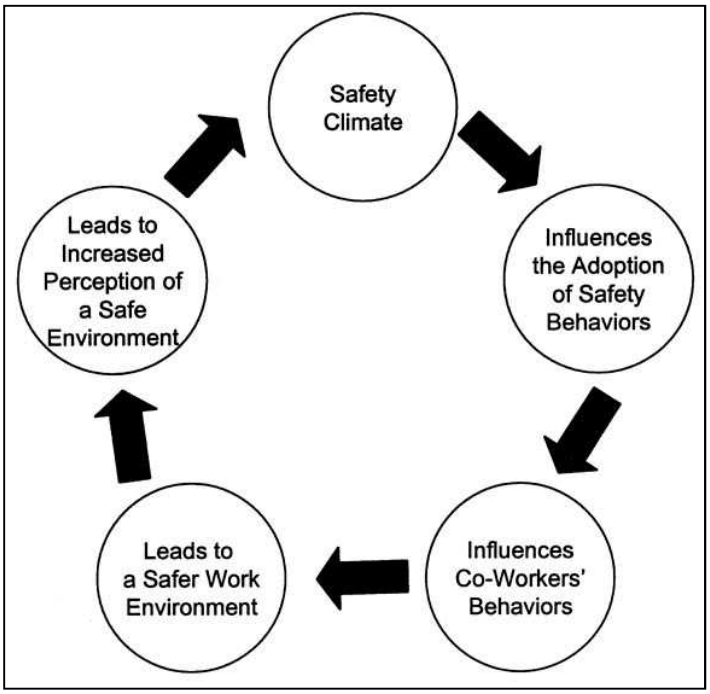

Figure 4. Influence of safety climate on individual safety behaviors and overall safety climate.
From: Gershon, Karkashian, Grosch, et al. (2000), p. 212.
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Developing a culture of safety. Improving or developing a culture of safety is challenging. Zohar (2002) proposed that safety climate is a changing entity and this change process is influenced by the individuals that occupy the work environment and changes in organizational climate and leadership.

Bohmer, Bloom, Mort, et al. (2009) describe efforts to foster a culture of safety at an academic health center. In a baseline survey, fewer than 50% of nurses and physicians

had positive perceptions of safety within the organization (Bohmer, Bloom, Mort, et al., 2009). The organization introduced a comprehensive strategy including a confidential electronic safety reporting system; announced their intention to share quality and safety data with all employees; elicited input from hospital employees who had also been patients to identify patient safety issues; and ultimately re-structured their quality improvement and safety departments (Bohmer, Bloom, Mort, et al., 2009). While information collected from hospital employees who had also been patients was likely to be heavily biased; these efforts were successful for this organization (Bohmer, Bloom, Mort, et al., 2009). The authors caution that in order to aChieve this success, safety has to become the main focus of the facility (Bohmer, Bloom, Mort, et al., 2009). Such efforts can serve as models for understanding the impact of culture of safety on safer needle practices in firefighters and paramedics.

The impact of culture of safety on bloodborne pathogen exposure and needlestick injury. While limited published data are available, safety climate has been linked to increased compliance with safe work practices and decreased exposure to blood and other body fluids (Gershon, 1996). In studies focusing on hospital-based nurses and other medical staff, higher levels of compliance with universal precautions (Grosch, Gershon, Murphy, et al., 1999; Gershon, Vlahov, Felknor, el al., 1995) and safer work practices (Gershon, Karkashian, Grosch, et al., 2000) were associated with safety climate dimensions such as higher levels of management commitment to safety, fewer job hindrances, higher feedback and training. In addition, employees who reported strong management support for safety and the availability of high levels of feedback regarding safety and training were half as likely to experience an exposure to blood or body fluids

(Gershon, Karkashian, Grosch, et al., 2000). In one study, employees who reported a strong commitment to safety at their organization had compliance rates three times higher than employees who reported low levels of commitment towards safety at their institutions (Gershon, Vlahov, Felknor, el al., 1995).

While prevention programs and the availability of safer needle devices have the capability to impact NSI rates, an effective program must include support from administration and also address dimensions of the safety climate and other factors in the work environment, such as staffing levels, morale and job dissatisfaction (Clarke, Sloane, & Aiken, 2002; Clarke, Sloane, Rockett, et al., 2002; Gershon, Karkashian, Grosch, et al., 2000; Avarado-Ramy, Beltraim, Short, et al., 2003).

Fire Department and EMS Work Environment

FFs and EMS personnel work in an environment that differs significantly from that of the traditional HCW. Patient care decisions are often made rapidly, in an uncertain setting. FFs and EMS personnel may be distracted by the surrounding chaos such as violent patients and distraught bystanders (Patterson et al., 2012). Patient care is often provided in a moving vehicle or in other locations with confined space or limited visibility, increasing the likelihood of NSI (Boal, Hales, & Ross, 2005). In addition, because care is often provided on the scene, FFs and EMS workers may be challenged to appropriately dispose of sharps resulting in increased risk for NSI (Boal, Hales, & Ross, 2005).

Role of poor sleep and fatigue. In a recent study of general injuries in EMS personnel, Patterson et al. (2012) found that 18% (n=91) of survey respondents were injured in the previous three months. Workers were 2.3 times more likely to incur injury

if suffering from poor sleep than those with good sleep and workers considered fatigued were 2.9 times more likely to incur injury than their non-fatigued peers (Patterson et al., 2012). In the same study, 90% of participants indicated that either their own safety or the safety of their patients had been compromised in the previous three months (Patterson et al., 2012). EMS workers with poor sleep were 2.7 times more likely to perceive compromised safety than those with good sleep; fatigued EMS workers were 4.9 times more likely to perceive compromised safety than non-fatigued workers (Patterson et al., 2012). Clearly, lack of sleep and fatigue has the potential to influence the frequency of needlestick injury in the fire service and EMS setting.

In a national prospective cohort study of medical school interns, Ayas and colleagues found that lapse of concentration and fatigue were contributing factors to percutaneous injury in 64% and 31% of injuries, respectively (Ayas, Barger, Cade, et al., 2006). NSIs were more frequent during extended work hours (1.31/1000 uses vs. 0.76/1000 uses) and during nighttime work hours (1.48/1000 uses vs. 0.70/1000 uses) (Ayas, Barger, Cade, et al., 2006). FFs and EMS personnel often work 24 hour shifts and 48 hour shifts are not uncommon; therefore, firefighter and EMS personnel exposure to extended work hours and nighttime hours meets or exceeds that of medical interns. It is likely that these types of working conditions are a contributing factor to NSI in FFs and EMS personnel and increase the risk of percutaneous injury due to occupation.

Safety culture in the fire service. In the context of developing a culture of safety within the fire department, Alan Brunacini provides a guideline for risk assessment, "Risk a lot to save a lot. Risk a little to save a little. Risk nothing to save nothing," (Alder & Fratus, 200, p. 90). In order to fulfill requirements for the Executive Fire

Officer program at the National Fire Academy, students are required to complete a thesis at the end of their coursework. Some students focused their thesis on evaluating culture of safety or organizational culture at their individual fire departments, including Anne Arundel County; the Woodlands, Texas; Coppell Fire Department; Lynchburg Fire Department; and Laconia Fire Department (Williams, n.d.; Windham, n.d.; Richardson, 2008; Campbell, n.d.; Pendergast, D.A., n.d.). These evaluations targeted behaviors related to fireground safety and data was collected using unique questionnaires, comprised of a combination of forced answer and open ended questions, for each inquiry. Data analysis for these studies was superficial and included only response counts and frequencies. The results provide a description of some of the issues surrounding culture of safety within the fire service. The similarities among reports are listed below:

- There is a disparity between what administration says in regards to safety and what actually takes place.
- There is a belief that injuries and deaths are an unavoidable consequence of the job.
- There are concerns regarding trust and communication between field personnel and administration.
- Standard operating procedures or guidelines intended to improve safety are often forgotten or ignored.
- FFs felt that fatigue placed them at risk for injury.

(Williams, n.d.; Windham, n.d.; Richardson, 2008; Campbell, n.d.; Pendergast, D.A., n.d.). However, addressing or changing these concerns is difficult in the context of the fire service.

Implementing change within the fire service. Alan Brunacini (2009) addresses the characteristics of the fire department (FD) culture that make implementing change difficult: FDs focus on solving urgent problems rather than long term goals; FFs tend to operate in tight knit groups and often lose track of outside perspectives; in between calls, FFs have down time, during which they can discuss, argue, and develop their own opinions about impending change; FDs operate on a structured schedule, with set ways to operate, that is resistant to change; and FFs tend to focus on the immediate task on fighting fire, other details or tasks will not catch their attention. Manning (n.d.) also discusses the difficulties in convincing FFs to change behavior and practices,

> First, "culture change" is viewed by some as a threat. Second, bad (unsafe) behaviors and attitudes are allowed to leach into what the membership see as part of "tradition". Third, safety and mission within organizational cultures are imbalanced. Fourth, the voices (and actions) of safety leadership have been either subconsciously muffled or consciously subdued. And fifth, the lessons from behavioral safety science haven't been embraced by fire service leaders… (p. 1)

These challenges to changing behavior among FFs are ingrained in the fire service culture and must be considered when planning for an effective intervention to minimize unsafe behavior or affect practices.

Safety culture within EMS. There is some overlap between fire service agencies and EMS agencies; some EMS agencies operate jointly with the fire department (like PCFR does), some are freestanding agencies within local government, some are private ambulance companies, and some are operated by volunteers. Therefore, it is important to assess the issue for culture of safety from both the fire service and EMS perspective.

Weaver, Wang, Fairbanks, and Patterson (2012) claim, "There is reason to believe that workplace safety culture impacts clinical and operational practices in EMS." (p. 43). These authors used a cross-sectional study design to examine the association between EMS workplace safety culture and provider safety outcomes (Weaver, Wang, Fairbanks, & Patterson, 2012). This 2010 survey among 21 EMS agencies throughout the United States yielded 416 completed surveys; among this group, approximately 16% reported a work-related injury in the preceding 3 months (Weaver, Wang, Fairbanks, & Patterson, 2012). Workers reporting a recent injury tended to have lower scores on survey instruments measuring safety climate, teamwork climate, perceptions of management, work condition, and job satisfaction than their peers who did not sustain a recent injury (Weaver, Wang, Fairbanks, & Patterson, 2012).

Most recently, the National Highway Traffic Safety Administration (NHTSA), the Health Resources and Services Administration's (HRSA's) EMS for Children (EMSC) Program, and American College of Emergency Physicians (ACEP) have partnered to develop a national EMS "Culture of Safety" strategy (EMS culture of safety, 2012). The draft strategy is in very early form, but the network for developing the strategy has been established and signifies a realization that a strong culture of safety is needed within EMS. Several factors that significantly shape EMS culture have been identified and described in a manner that captures the "feel" of EMS at the field level:

- "The sphere in which EMS operates is complex and frequently changing, and its mission is complicated by emotionally charged situations and public expectations that are not always reasonable or realistic…

- EMS culture is built on a history of adapting practices, vehicles, and equipment originally developed for other settings (the emergency room, intensive care unit, operating room, or mortuary) for use in the prehospital care setting…
- Many EMS systems maintain a 24-hour shift schedule, or even longer. When call volume does not allow for sufficient uninterrupted sleep, fatigue sets in and responder safety, public safety, and patient safety are put at increased risk…
- A common cultural phenomenon in which field-level EMS practitioners do not trust leadership and/or respond cynically to leadership directives and initiatives…
- Too often in EMS, unsafe outcomes lead to blaming and punishing the individual while overlooking system or process shortcomings, despite an environment in which risk-tasking is considered part of the job as long as nothing bad happens…"

  (EMS culture of safety, 2012, p. 32-34)

Safety culture is likely one component of many that impact NSI rates in FFs and EMS personnel; the department-specific culture is also likely to impact behaviors and practices.

Cultural background of Pasco County Fire Rescue

From 1973 until 1982, emergency medical services (EMS), or ambulances, and fire response operating as two distinctly separate organizations within Pasco County (Fossa, 2011). During this period, EMS response was either based at a rural hospital or

provided by a multitude of private ambulance companies. In 1977, Pasco County EMS was formed as a county agency to provide EMS service to the citizenry of the county (Fossa, 2011). From its formation until the merger with the fire service, Pasco County EMS was only joined by the fire department when responding to a motor vehicle collision (MVC) that might require extrication of the patient (Fossa, 2011).

After the formation of a 'public safety' agency in 1982, the county fire service and EMS were merged. However, the EMS side of the public safety agency was widely regarded as inferior: the EMS budget and equipment were pillaged by the parent agency of public safety and the fire service, EMS vehicles and equipment were not replaced, EMS crews were housed at county fire stations but isolated to specific rooms or only allowed access to the communal living areas during dinner time (Fossa, 2011). The EMS function of the agency was seen as secondary to fire suppression services; the EMS vehicles were so poorly maintained during this era that it was not uncommon to switch ambulances 4 to 5 times in a 24 hour period due to mechanical failure (Fossa, 2011).

Beginning in 1984, efforts commenced to more effectively merge the two halves of the County Public Safety agency. A five year plan was developed to encourage and provide a means for all FFs to become certified as emergency medical technicians (EMTs) and for all EMS personnel to become cross-trained as FFs; dual certification was not mandatory, but was strongly encouraged (Fossa, 2011). Any personnel who were not cross-trained would not be considered for future promotions.

The last firefighter who had been hired before the merger and resisted gaining his EMT certification retired from PCFR in 2009. The agency has grown tremendously since 1984; the majority of personnel are cross-trained as FFs and paramedics (a higher

certification than EMT). Personnel rotate assignments between fire engines and ambulances and both types of apparatus respond together to a variety of calls, both medical and fire related. However, many field personnel will cite the left over animosity between "fire guys" and "EMS guys" – those who feel strongly the agency where they started their careers is really the only side of the job that matters.

Research Questions

A multitude of factors within the work environment, a culture of safety, the culture within the professions of the fire services and EMS and the culture unique to PCFR all have the capacity to impact the occurrence of unsafe sharps techniques and practices. All seven research questions for this endeavor are listed on pages 1 and 2. In order to design an effective intervention, the following research questions must be answered regarding work environment and culture of safety within the workplace: 4) What factors are present that affect unsafe sharps techniques and practices in this population? and 5) What is the culture of safety as perceived by PCFR personnel and how does it impact the occurrence of unsafe sharps techniques and practices?

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Chapter 4. The PRECEDE/PROCEED Model

The PRECEDE/PROCEED model was used as a framework for assessing the problem of needlestick injuries in the selected population of this study, examining the factors that influenced the occurrence of behaviors that increased the risk for NSI, planning an intervention to reduce risky behaviors, and evaluating the impact of the evaluation.

The Theory

The PRECEDE/PROCEED model, also called the "planning model", provides a framework for an education diagnosis before an intervention and includes approaches and theories from multiple disciplines, such as epidemiology, health education, health administration, statistics, behavioral sciences, biomedical sciences, economic, and management sciences (Gielen & McDonald, 2002; Green & Kreuter, 1999). The PRECEDE/PROCEED model (PPM) rests on two fundamental propositions, as outlined by Green and Kreuter (1999), "(1) health and health risks have multiple determinants and (2) because health and health risks are determined by multiple causes, efforts to effect behavioral, environmental, and social change must be multi-dimensional or multi-sectorial" (p. 42-43). One of the basic tenets of this model is that input from the community, or targeted audience, and stakeholders is essential at each step in the process at each phase (Gielen & McDonald, 2002; Tones & Green, 2008; Gielen, McDonald, Gary, et al., 2008).

The ‘PRECEDE’ portion of the model stands for Predisposing, Reinforcing, and Enabling Constructs in Educational/Environmental Diagnosis and Evaluation (Green & Kreuter, 1999). A later edition to the framework, the ‘PROCEED’ portion signifies Policy, Regulatory, Organizational Constructs in Educational and Environmental Development (Green & Kreuter, 1999). While the PRECEDE and PROCEED portions of the model appear to operate in separate phases, this is not the case. Instead, PRECEDE and PROCEED interact to provide a continuous series of steps in planning, implementation, and evaluation (Green & Kreuter, 1999). In 2005, the PPM underwent minor revisions to incorporate the role of genetics in some health problems and merge the epidemiological assessment and behavioral and environmental assessment phases, among other changes (Gielen, McDonald, Gary, et al., 2008). The revision also clarified that some phases could be skipped when data was already available to address the questions posed in that phase (Gielen, McDonald, Gary, et al., 2008).

Overview of the PRECEDE component. This portion of the model is intended to identify priorities and set objectives that will impact the PROCEED phase (Green & Kreuter, 1999). The PRECEDE component of the model actually begins with outcomes, rather than inputs, or addresses the question of “why” before “how” (Green & Kreuter, 1999). This approach is based on the belief that “the determinants of health must be diagnosed before an intervention is designed,” (Green & Kreuter, 1999, p.37). By assessing those causes first, the intervention can be designed to specifically target these causes and reduce the likelihood of a misdirected and ineffective program (Green & Kreuter, 1999).

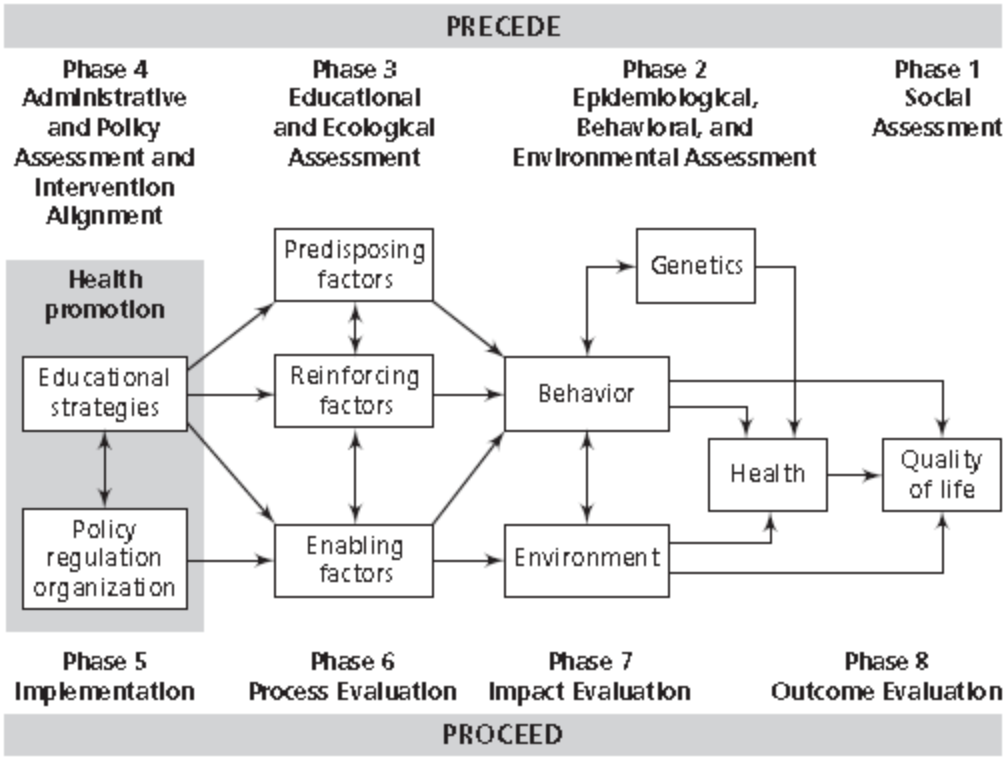

Figure 5. The PRECEDE-PROCEED planning model as presented by Gielen, McDonald, Gary et al., 2008.

A multitude of factors may be identified; choosing which factors to target involves 1) determining which factors contribute significantly to the problem under review and 2) evaluating the resources and abilities of the organization (Tones & Green, 2008).

Phase 1: Diagnosis - social assessment and situational analysis. This initial step of the PRECEDE phase involves the target population in identifying their own needs and aspirations, as well as quality of life (Green & Kreuter, 1999). This target population, or community, may be a "group with shared characteristics, interests, values, and norms", rather than a population delineated by geographical location (Gielen, McDonald, Gary, et al., 2008, p.411). Defining the target audience's perceived and actual needs and the context in which the intervention will be implemented, including the community's problem-solving capacity, strengths, resources, and readiness for change, will influence

the planning phases of the model (U.S. Department of Health and Human Services, 2005; Gielen, McDonald, Gary, et al., 2008).

Phase 2: Diagnosis – epidemiological, behavioral, and environmental assessment. This step identifies health goals or problems that affect the social goals and problems defined in the previous step, as well as behavioral and environmental factors that impact the problems identified in phase 1 (Green & Kreuter, 1999; Gielen, McDonald, Gary, et al., 2008). When analyzing behavioral determinants, it is important to recognize that these determinants occur at three levels: 1) behaviors that contribute to the occurrence and severity of the health problem, 2) the behaviors of others who can directly affect the behavior of individuals at risk, and 3) the behaviors of administration or other decision-makers that shape the social or physical environment that influences the individuals at risk (Gielen, McDonald, Gary, et al., 2008).

Health problems and resource allocation may be ranked based on available data regarding the health goals and problems, allowing for the formation of program goals and objectives (U.S. Department of Health and Human Services, 2005; Green & Kreuter, 1999). This step is particularly important because it defines the risk factors or conditions that the intervention will target (Green & Kreuter, 1999).

Phase 3: Diagnosis - educational and ecological assessment. There are three groupings within the educational and ecological assessment: predisposing, enabling, and reinforcing factors (Green & Kreuter, 1999). Generally speaking, this phase focuses on those factors that can influenced by an intervention (Green & Kreuter, 1999). A person's or population's knowledge, attitude, beliefs, values, and perceptions that encourage or discourage motivation for change fall into the category of predisposing factors (Green &

Kreuter, 1999). Enabling factors are barriers or vehicles, such as skills or resources, created mainly by societal forces or systems that help or hinder the desired behavioral and environmental changes (Green & Kreuter, 1999; U.S. Department of Health and Human Services, 2005). Reinforcing factors are based on rewards and feedback received from others once a behavior has been adopted; this feedback may encourage or discourage continuation of the target behavior (Green & Kreuter, 1999; U.S. Department of Health and Human Services, 2005).

Larson and colleagues (1997) identified predisposing, enabling, and reinforcing behaviors to guide an intervention to improve handwashing in an inpatient. In this example, predisposing factors for healthcare workers to perform handwashing included a perception or belief that handwashing was important and a feeling of personal responsibility to complete the task (Larson, Bryan, Adler, et al., 1997). Identified enabling factors included proximity of a sink; positive peer support and feedback about hospital acquired infection rates (Larson, Bryan, Adler, at al., 1997).

Phase 4: Diagnosis - administrative and policy assessment. The last phase of the PRECEDE portion of the model entails an assessment of the organizational and administrative capabilities, including resources, for program development and implementation (Green & Kreuter, 1999). In the administrative assessment portion of this phase, one must determine the resources needed (i.e. personnel, budget), inventory the available resources, and identify factors influencing implementation (Green & Kreuter, 1999). Implementation of an intervention may be impacted by staff commitment and attitudes, existing program or agency goals, complexity of the proposed change, and familiarity of staff with the procedures or methods to be used (Green & Kreuter, 1999).

The second piece of this phase, policy assessment, entails evaluation of the organizational mission, policies, and regulations and assessing political forces (Green & Kreuter, 1999).

Overview of the PROCEED Component. The PROCEED portion of the model is based on the outcome of the steps completed in the PRECEDE portion and involves setting policy, implementation, and evaluation (Green & Kreuter, 1999). Prior to commencement of the phase 5 (implementation), phases 7 through 9 (process evaluation, impact evaluation, and outcome evaluation) should be determined (U.S. Department of Health and Human Services, 2005).

Phase 5: Intervention and evaluation – implementation. This phase entails the actual implementation of the intervention, as designed to address the targeted and prioritized factors identified in the PRECEDE portion of the model.

Phase 6: Intervention and evaluation – process evaluation. This step requires assessment of the extent and means that the program is being implemented, as compared to the initial plan for program delivery (U.S. Department of Health and Human Services, 2005).

Phase 7: Intervention and evaluation – impact evaluation. This phase differs from Phase 7 in that it evaluates the extent to which factors that influence the environment and behavior and the likelihood these behaviors will continue, that may include predisposing, enabling, and reinforcing factors (U.S. Department of Health and Human Services, 2005).

Phase 8: Intervention and evaluation – outcome evaluation. Phase 8 involves the examination of the affect of the intervention on quality of life indicators, such as those identified in Phase 1 (U.S. Department of Health and Human Services, 2005).

The PRECEDE/PROCEED model can be effective in diagnosing a problem within a target audience and shaping intervention efforts so that resources are allocated to influencing the factors that are most likely to have a significant impact on the target behavior. There are several instances in which the PPM has been utilized to change behavior among healthcare workers (HCWs) (Haiduven, 2000; Araujo, 2009; Aboumatar, Ristaino, Davis, et al., 2012; Leonard, Scharff, Koors, et al., 2012; Larson, Bryan, Adler, et al., 1997; DeJoy, Searcy, Murphy et al., 2000; Han, Baumann, Cimprich, 1996; Nichol, Bigelow, O'Brien-Pallas, 2008; Bautista, Vila, Uso, et al., 2006; Chaffee, Bridges, Boyer, 2000).

PRECEDE/PROCEED Model with Healthcare Workers

The available examples of application of the PRECEDE portion of the PPM in understanding behaviors in healthcare workers (HCWs) suggest that this model is an effective approach in the healthcare setting. In particular, two unpublished studies (Haiduven, 2000; Araujo, 2009) apply the PRECEDE portion of the model to understanding blood exposures and needle safety in home health care nurses and recapping of needles by Venezuelan nurses in a public hospital, respectively. Table 4 summarizes the predisposing, enabling, reinforcing, and environmental factors identified in those two studies. Both studies address circumstances regarding needle safety or unsafe needle practices, such as recapping, and have similarities in identified factors. For example, both studies cite knowledge of self or others' experience with needlestick injury (NSI) as a predisposing factor (Haiduven, 2000; Araujo, 2009). Additional common predisposing factors between the two studies are attitudes about the safety of recapping and about practices considered safe; belief that a HCW will acquire a bloodborne

pathogen (BBP) infection if stuck or exposed; value placed on the personal safety of nurses; and the perception of risk from NSI (Haiduven, 2000; Araujo, 2009). First or second-hand previous experience with a NSI and adverse consequences for nurses recapping needles were reinforcing factors in each study setting (Haiduven, 2000; Araujo, 2009). Also, physical environment was an environmental factor in both studies (Haiduven, 2000; Araujo, 2009).

Other studies using PPM in the healthcare setting are available. For example, researchers at the Johns Hopkins Hospital studied a multi-faceted program to improve hand hygiene among HCWs at their facility (Aboumatar, Ristaino, Davis, et al., 2012). This group used the PRECEDE portion of the model to prioritize factors that influenced hand hygiene and chose two target behaviors for their intervention, which resulted in an overall improvement in hand hygiene practices (Aboumatar, Ristaino, Davis, et al., 2012). In this setting, the program developed using the PRECEDE model was determined to be comprehensive and when implemented in other hospitals within the same healthcare system aChieved positive results (Aboumatar, Ristaino, Davis, et al., 2012).

One study of EMS personnel's likelihood to participate in research used the PRECEDE/PROCEED model to identify why the behavior occurred and guide efforts to change the behavior based on identified determinants (Leonard, Scharff, Koors, et al., 2012). This project was exploratory and qualitative in nature and used the PRECEDE/PROCEED model to organize and analyze responses obtained during focus groups, which led to a recommendation that the framework be implemented when planning future research endeavors involving EMS personnel (Leonard, Scharff, Koors,

et al., 2012). Larson and colleagues (1997) used the predisposing, enabling, and reinforcing

portion of the PRECEDE model to design an intervention to improve handwashing among healthcare workers. An evaluation following the intervention indicated that the portions of the intervention designed to target predisposing and enabling factors continued after the intervention, but those portions intended to target reinforcing factors did not (Larson, Bryan, Adler, et al., 1997). However, using only a piece of the PRECEDE portion of the model may weaken the effectiveness of the intended assessment prior to designing an intervention. In a separate effort, the PRECEDE model was applied to understand HCWs' compliance or failure to implement Universal Precautions (DeJoy, Searcy, Murphy, et al., 2000). Results from a self-administered survey designed to elicit information about predisposing, enabling, and reinforcing factors led DeJoy and colleagues (2000) to conclude that the PRECEDE model provided an effective framework to evaluate the problem, particularly by emphasizing that individual, environmental, and organizational factors all contributed to the issue.

Han, Baumann, and Cimprich (1996) rigorously applied the PRECEDE model to understand factors that influenced HCWs' decisions to teach patients about breast self examination, but did not include development of an intervention as an objective of the study. However, the PRECEDE model was successfully used as a framework for understanding HCWs behavior (Han, Baumann, & Cimprich, 1996). When applying the PRECEDE model to exploration of nursing students' practice of oral hygiene of patients, McAuliffe (2007) noted that the PRECEDE model was a useful framework to guide formulation of survey questions, but that the accuracy of the findings

Table 4

Summary of PRECEDE components from Haiduven (2000) and Araujo (2009)

PRECEDE component	**Haiduven (2000)** Blood exposures and needle safety in home healthcare nurses	**Araujo (2009)** Needle recapping by nurses in a Venezuelan public hospital
Predisposing factors		
Knowledge of:	1. Needle safety practices 2. Specific safety devices & use. 3. Stressful waiting period post NSI. 4. Self or others' experience with blood exposure.	1. The risk of NSI. 2. Recapping as an unsafe practice. 3. Importance of disposing used needles into appropriate sharps containers. 4. Traumatic experience after an NSI. 5. Nurse/co-worker experience of NSI.
Lack of knowledge of:		1. About Venezuelan occupational safety and health regulations. 2. About 'preventive delegates'
Attitudes:	1. About the safety of recapping. 2. About the safety of devices designed as safe & practices considered safe	1. About the safety of recapping. 2. About practices considered safe.
Beliefs:	That one will get a BBP infection if stuck while recapping or not using a needle safety device.	Potential consequence of a needlestick NSI to acquire BBP.
Values:	1. Placed on the safety and comfort of the patient. 2. Placed on the personal safety of the nurse.	1. Placed on patient quality care. 2. Placed on the personal safety of nurses. 3. Placed on the safety of other HCWs.
Perceptions:	Of the risk of acquiring BBP infection post NSI or blood exposure.	Of the risk of acquiring BBP infection post NSI.
Reinforcing factors		
	1. Previous experience with a NSI or blood exposure. 2. Agency with safety climate supporting use of needle safety devices/practices 3. Adverse consequences for nurses recapping needles or not using available safety products. 4. Deterrents for using safer devices and practices. 5. Negative reinforcement for nurse for not using needle safety devices and practices.	1. Previous experience with a NSI (nurse or co-worker). 2. Adverse consequences for nurses recapping needles. 3. Not having NSI. 4. Hospital management's attitude toward safety and safety practices to prevent NSI 5. Attitude to protect other HCWs
Enabling factors		
Availability & accessibility:	**Availability:** 1. Of needle safety devices. 2. Of adequate planning time 3. Of options of use of safety devices. 4. Of realistic work assignments and job responsibilities. **Accessibility**: 1. Of needle safety devices.	**Availability & accessibility:** 1. Lack of sharps containers/ needle safety device. 2. Lack of PPE
Skills:	1. Familiarity of nurses with safety device. 2. Experience in using devices.	To perform routine procedures.
Environmental factors		
	1. Physical conditions 2. Control issues 3. Patient/situational factors 4. Procedural factors 5. Specific safety devices and qualities of such in home care setting	1. Physical conditions 2. Organizational climate 3. Patient/nurses relation

Adapted from Haiduven (2000) and Araujo (2009)

was influenced by the fact that they were collected by self-report. The PRECEDE model has also been used as a framework to review published literature in order to better understand the issue of effective prevention for occupationally-acquired common respiratory diseases (Nichol, Bigelow, O'Brien-Pallas, et al., 2008). While this application of the PRECEDE model also did not result in development of an intervention, factors were identified that influenced compliance with use of facial masks (Nichol, Bigelow, O'Brien-Pallas, et al., 2008).

An effort to understand nurses' acceptance of the influenza vaccine led researchers to develop questions to assess the predisposing, enabling, and reinforcing factors associated with the PRECEDE model and then complete a logistic regression model using the responses to the questions (Bautista, Vila, Uso, et al., 2006). This group concluded that educational efforts to increase influenza vaccination rates would be highly effective if they addressed predisposing and enabling factors (Bautista, Vila, Uso, et al., 2006). Chaffee, Bridges, and Boyer (2000) investigated the factors that influenced physicians' decisions to implement violence prevention services, such as contacting Child protective services, for adolescent patients. They concluded that, as predicted by the PRECEDE model, factors within the community and work environment, as well as patient and parental attitudes and beliefs, influenced physician's actions in this regard.

These examples of using the PRECEDE/PROCEDE model in regards to various behaviors in healthcare workers demonstrate the need to apply the PRECEDE component in its entirety when assessing a problem area; the opportunity to obtain a solid understanding of a problem or develop a strong program when the model is applied rigorously; the importance of critically evaluating the method in which the PRECEDE

model is applied, such as self report; and the possibility that the predisposing and enabling factors have a heavier influence than reinforcing factors. Lastly, the PRECEDE portion of the PPM encourages consideration of individual, environmental, and organizational factors in regards to the behavior under examination.

Due to the lack of available examples of implementation of the PROCEDE portion of the PPM in the healthcare setting, it is necessary to present an example involving another occupational health issue. The Minnesota Wood Dust Study sought to decrease exposure to wood dust in small wood-working businesses within the state (Lazovich, Parker, Brosseau, et al., 2002). The PRECEDE portion of the PPM was used in the assessment of the problem, then the PROCEED portion of the model was used to assess the effectiveness of the intervention (Lazovich, Parker, Brosseau, et al., 2002). While this intervention did not result in changes in wood dust exposure to the degree expected, because the interdisciplinary team rigorously applied the model, the complexity of the problem and the multitude of predisposing, enabling, and reinforcing factors were recognized (Lazovich, Parker, Brosseau, et al., 2002).

Application of the PRECEDE/PROCEDE model to decrease risky sharps behaviors and promote safer sharps behaviors will assist in the identification of both factors that influence the likelihood of positive behaviors and those that increase the frequency of negative behaviors, as well as increase the effectiveness, prioritize targeted factors, and improve resource efficiency of the planned intervention. When properly applied, the PPM is serves as a framework for applying theories that feed into the planning and evaluation of health behavior change programs (Gielen, McDonald, Gary, et al., 2008).

Summary and Research Questions

The PRECEDE/PROCEED model (PPM) serves as a framework for an educational assessment prior to implementation of an intervention, as well as evaluation after implementation. Consideration of the PPM can lead to effective and efficient interventions and avoid diverting limited resources to interventions that are unlikely to influence the targeted behavior or problem. Within the PPM, the educational and ecological assessment addresses predisposing, enabling, and reinforcing factors. Understanding these factors as they impact the occurrence of unsafe sharps behaviors is essential to planning an effective intervention to reduce these behaviors. These theoretical concepts can be applied when addressing research questions 4) what factors are present that affect unsafe sharps techniques and practices in this population? and 6) can an intervention tailored to this population impact the frequency of unsafe sharps techniques?

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Chapter 5. Methodology

Study Design

The purpose of this study was to determine the extent, if any, of undesirable sharps behaviors by firefighters at Pasco County Fire Rescue, explore the factors that influence these behaviors, and design an intervention to improve rates of undesirable sharps behaviors. This study employed both quantitative and qualitative methods and was arranged in three phases: 1) the diagnosis phase, including baseline sharps count and focus groups; 2) the intervention period, and 3) the evaluation period (See Figure 5). The diagnosis stage of the study design (See Figure 5) used a mixed methods approach of exploratory design, in which results from the quantitative baseline sharps count were used to guide the qualitative inquiry in the form of focus groups (Creswell and Clark, 2007). The PRECEDE/PROCEED model was used as the theoretical base for analysis of the focus group results, as well as to guide the intervention phase of the project. The evaluation phase of this study incorporated a post-intervention sharps count to allow for a before and after evaluation design, as well as a survey of the study population.

Approvals and consents. Prior to conducting each step of the study, approvals were sought from the appropriate agencies within the University of South Florida, as well as from Pasco County Fire Rescue. The University of South Florida Biosafety Office confirmed they had no regulatory jurisdiction over the sharps count protocol (see Appendix B). PCFR provided a letter of support prior to IRB review of the study (see Appendix C). The University of South Florida Institutional Review Board (IRB) deemed

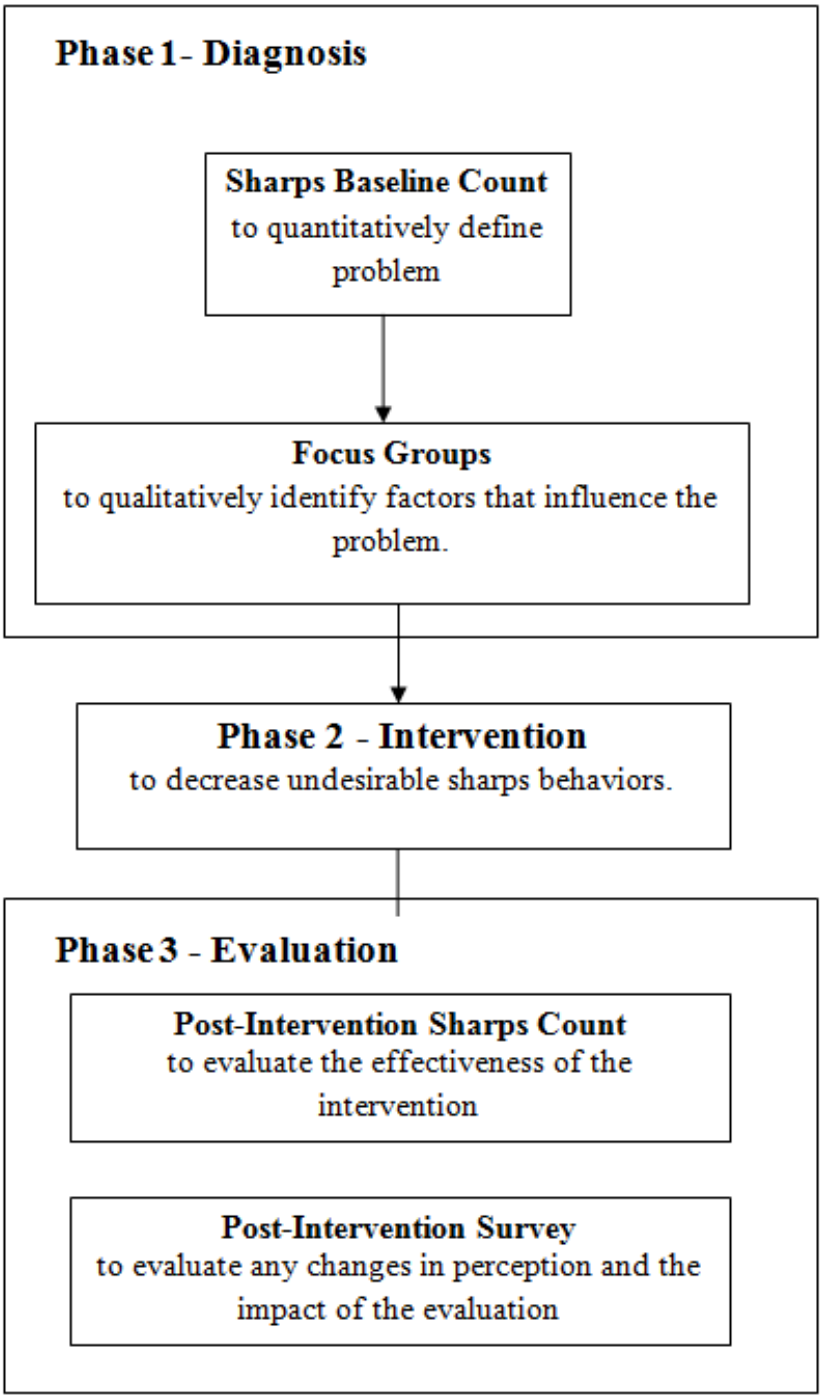

Figure 6. Study design incorporating a mixed method exploratory design in the diagnosis phase, an intervention period, and a quantitative evaluation phase resulting in a before and after evaluation design.

the baseline sharps count and the focus groups as “not human research activities” (see Appendices D & E). No consent was utilized for the sharps counts, as the collected materials had been discarded as waste and were not tracked to any specific individual. The project was reviewed and approved by the Risk Manager for Pasco County Fire Rescue, as well as the Director of the Emergency Services Division and the Rescue Chief of PCFR. All volunteers for the focus groups signed an IRB-approved informed consent prior to participation and completed a demographic and exposure information form (See Appendices F and G).

Participants

This study targeted firefighters and emergency medical services (EMS) personnel at Pasco County Fire Rescue (PCFR). PCFR operates 23 fire stations in a 745 square-mile response zone with a combination of suburban and rural characteristics. Four of the fire stations are staffed with only an engine and associated crew, 17 fire stations are staffed with an engine and an ambulance, or “rescue units,” and two stations are staffed with one engine and two rescue units. Typical staffing for an engine company is 2 to 4 firefighters. Typical staffing for rescue units is one paramedic and one emergency medical technician (EMT). At the commencement of this study, PCFR had approximately 397 firefighters, operating on a rotating schedule of 24 hours on-duty, 48 hours off-duty.

At PCFR, all firefighters must be cross-trained as either an emergency medical technician (EMT) or a paramedic. Therefore, ambulances respond to fire scenes and fight fire and fire engines respond to the more critical medical calls and provide medical care, either prior to arrival of or in conjunction with the ambulance crew. Crews respond

to a variety of 911 calls. Depending on the nature of the medical call, an ambulance might be the only crew sent or an engine crew may also respond. For more urgent calls, the engine crew may arrive on scene prior to the arrival of the ambulance and render emergency care. It is unusual for an engine crew to provide medications to a patient unless the call is urgent in nature. While all samples for this study were derived from Pasco County Fire Rescue, the samples for each phase were different due to the nature of the study design.

Phase 1- baseline sharps count sample. In Phase 1, discarded sharps were collected from eight stations from PCFR for the baseline sharps count. The manning assignments vary by the needs of the department on any given shift. Therefore, all 396 field personnel had the possibility of contributing to the discarded sharps collected. A baseline sharps count was conducted to document whether sharps devices were being used in less safe or undesirable ways at PCFR and, if so, at what frequencies. Following site selection, a pilot sharps count was conducted to validate the protocol, a target sample size was established, used sharps boxes were collected and the contents categorized and counted according to protocol.

Site selection. Call statistics were collected from PCFR's computer aided dispatch system (CAD) for each of 23 fire stations and tabulated according to percentage of total calls run per apparatus type (engine and rescue) and for total calls run for PCFR during the 2009 calendar year. Stations lacking an ambulance were excluded (n=4), as these "engine-only" stations do not dispose of their own sharps, but either hand off small sharps boxes to the ambulance crews for disposal or use the larger sharps boxes in the ambulances. The remaining 18 stations were classified according to call volume (Low,

Medium, High) and geographic location (West, Central, East). The percentage of total calls run by the station's ambulance(s) in 2009 was used to categorize the stations into low (equal to or less than 3%), medium (greater than three percent, but less than five percent), or high (equal to or greater than 5 percent). Geographic location categories were based on the battalion divisions already established by PCFR. Stations west of a direct line from the intersections of Gunn Highway/State Road 54 and Veteran's Expressway/State Road 52 were considered West Stations. Stations East of Interstate 75 were classified as East Stations. The remaining stations were considered Central Stations. Eleven stations were initially chosen to participate so that a representative sample of call volume and geographic location was obtained (See Figure 7 and Table 5).

Figure 7 depicts the locations of PCFR fire stations in 2009, along with the call volume percentages for each apparatus assigned to a station. For example, the notation after Rescue 10 (R10) states 6.84%. This means that in 2009, R10 responded to 6.84% of the emergency calls requiring an ambulance in Pasco County. The notation after Engine 10 (E10) states 7.98%. In 2009, E10 responded to 7.98% of the calls requiring a fire engine within the county. For station 10, there is a notation "site-12.0%". In 2009, apparatus assigned to Station 10 (both ambulance and fire engine) responded to 12.0% of the total dispatched emergency calls in Pasco County. Stations shown in blue were excluded from the sharps count because they did not have an assigned ambulance. Stations shown in purple had an assigned ambulance, but were not chosen to participate in the sharps count; stations shown in orange participated in the sharps collection. Table 8 summarizes stations included in the site sampling for the baseline sharps count, along with their classifications for call volume and geographic location.

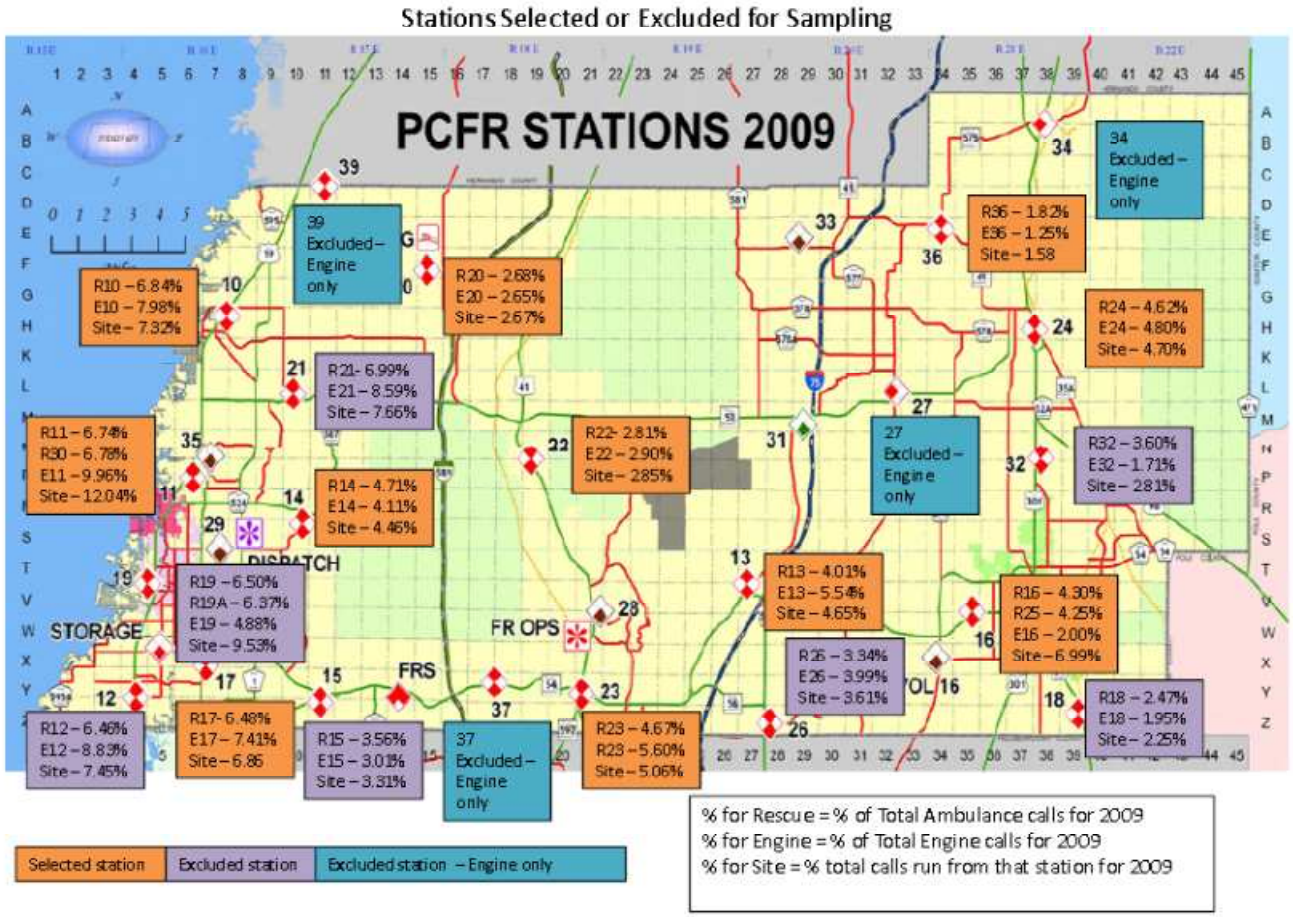

Figure 7. Location and call volume of fire stations throughout Pasco County, 2009

Note: R# designates the ambulance and number assigned to a particular station.
E# designates a fire engine assigned to a particular station.
Stations with notation "Excluded –engine only" do not have an ambulance assigned to their location.

Table 5

Site Sampling Selection, Including Call Volume and Geographic Location

Station	**Sampled? (Y/N)**	**Call Volume**	**Geographic Location**
10	Y	High	West
11	Y	High	West
12	N	High	West
13	Y	Medium	Central
14	Y	Medium	West
15	N	Medium	Central
16	N	Medium	East
17	Y	High	West
18	N	Low	East
19	N	High	West
20	Y	Low	Central
21	N	High	West
22	Y	Low	Central
23	Y	Medium	Central
24	Non-compliant	Medium	East
26	Y*	Medium	East
27	N	N/A – no ambulance	East
32	Y*	Medium	East
34	N	N/A – no ambulance	East
36	Y	Low	East
37	N	N/A – no ambulance	Central
39	N	N/A – no ambulance	West

* Added sites to compensate for non-compliance at St. 24 during baseline sharps count.

Target. The target sample size was to collect at least 50 medication sharps devices (syringes with or without the needle) and 500 IV devices. The minimum numbers were based on known sharps use rates for PCFR for 2009 and would ensure that the equivalent of 25% of the projected sharps use for the month of collection would be included in the sample. In 2009, 5837 medications were given (IV or IM) and 22,803 IVs were started (retrieved from TabletPCR software, PCFR).

Discarded sharps were collected from eight stations from PCFR for the baseline sharps count. The manning assignments vary by the needs of the department on any given shift. Therefore, all 396 field personnel had the possibility of contributing to the discarded sharps collected.

Phase 1 – focus group sample. Due to the rank structure within the fire department, it was important to conduct focus groups by rank, so that answers from lower ranking firefighters would not be influenced by the presence of officers. For example, an entry-level firefighter would not be participating in a focus group with a driver/engineer or captain. Groups for emergency medical technicians (EMTs), paramedics, driver/engineers, and captains were conducted separately. For similar reasons, focus groups were conducted in a neutral location, off of fire department property.

Following review by the USF IRB, recruitment posters were distributed to all PCFR's fires stations (See Appendix H). A similar e-mail recruitment flyer was distributed to the station e-mail accounts. Volunteers were offered a $40 gift card to Wal-Mart or Target stores as a gratuity for their participation. In order to participate, volunteers had to be employed by PCFR and assigned to the field. Employees holding a rank above captain were excluded from participation; as those individuals fill administrative positions and do not typically provide patient contact or use needles or other sharps devices regularly. Employees assigned to Operations or the Training Bureau were also excluded due to limited patient contact.

The target within the focus group phase of the project was to conduct a total of twelve groups, three each of EMTs, paramedics, drivers, and captains, or until saturation was reached or recruiting methods exhausted.

Phase 2 sample. In Phase 2, the intervention was provided to all 396 field personnel at 23 stations. Personnel were required to submit documentation to the training bureau of participation in the training; employees who had not certified they completed the training were notified by the training bureau that the documentation was missing and must be completed.

Phase 3 sample. The post-intervention sharps count included in the Phase 3 was similar to the baseline sharps count in that all personnel had the potential to have used the sharps boxes that were collected. Sharps disposal boxes were collected from the same stations that were sampled during the Phase 1 baseline sharps count.

The Phase 3 post-intervention survey was administered to all 396 field personnel; respondents self-selected to participate.

Phase 1 – Data Collection

Baseline sharps count. The baseline sharps count data was collected and analyzed based on descriptive categories, specifically medication and device type. This data was then tabulated and analyzed for both trends and associations.

Devices and medications at PCFR. At PCFR, a wide variety of medications are available to both the engine and ambulance crews, including those given by intravenous route (IV), intramuscular injection (IM), inhaled (nebulizer) or oral (p.o., e.g. Tylenol). This research focused on medications given by IV and IM routes, as these are the medications that require a syringe and/or needle for administration. There are also a variety of devices, both traditional and those with engineered sharps injury protection (ESIP), used at PCFR. Some medications are used only in specific types of medical calls; other medications are used more generally. Table 6 lists medications used at

PCFR, the route of administration, and, if applicable, the type of call the medication is typically used on (indication).

Table 6

Available Medications, Typical Route and Indication

Medication Name	**Route typically given**	**Indication**
Adenosine	IV	Cardiac
Amiodarone	IV	Cardiac
Ativan	IV or IM	Sedation, seizures, anxiety
Atropine	IV	Cardiac
Benadryl	IV or IM	Allergic reaction, anaphylaxis
D50, Dextrose	IV	Hypoglycemia
Dopamine	IV drip (via IV bag)	Cardiac
Epinephrine	IV	Cardiac
Glucagon	IM	Hypoglycemia
Labetolol	IV	Hypertension
Lidocaine	IV	Cardiac
Morphine	IV or IM	Pain control
Narcan	IV or IM	Overdose
Normal Saline	IV	Routine
Sodium Bicarbonate	IV	Cardiac
Valium	IV or IM	Sedation, seizures, anxiety
Verapamil	IV	Cardiac
Versed	IV	Sedation

Categories were established for devices, based on device design and potential uses (Table 7). Two behavior classifications were defined, “desirable” or “safer” and “undesirable” or “riskier”. These classifications were based on information obtained during the literature review detailed in Chapter 1, such as the increased risk of needlestick injury during recapping, and identified breaches in safety protocols, such as alteration of the safety device on IV stylets.

Table 7

Anticipated Categories of Devices and Classification as Desirable or Undesirable

Type of Device	**Desirable vs. Undesirable**
Intravenous stylets (IVs)	
Safety device activated	Desirable
Safety device altered	Undesirable
Failed attempt/stylet intact	Neither
Prefilled syringes	
With luer tip	Desirable
Traditional needles	
Uncapped	Desirable
Recapped	Undesirable
Miscellaneous	

Note: Categories were based on available information at the time of study design and were revised following the pilot sharps count.

Pilot sharps count. A pilot sharps count was conducted from November 04, 2009 to November 19, 2009 involving seven sharps containers of various sizes (total sharps devices counted =264). Several issues were identified and the final study protocol was altered to improve the reliability of the technique, as well as the validity of the results. Initially, the protocol called for collection of the sharps containers that were in use on the day of collection. However, on the day of the pilot collection, many of the sharps containers were empty resulting in a low yield. Consequently, the collection period was extended to one week. Issues affecting sharps safety, other than needle recapping and altering of the safety device of the IV stylets, were identified. The categories of devices are summarized in Table 8.

A variety of sharps containers were collected, including one type carried on the engines and rescues in the "jump bags", taken on to the scene for immediate patient care and two types used within the ambulance (See Figure 8).

Table 8

Categories of Devices

Type of Devices		**Desirable vs. Undesirable**
Intravenous catheters (IVs)		
	Safety device activated	Desirable
	Safety device altered	Undesirable
	Failed attempt/stylet intact	Neither
Prefilled syringes		
	With luer tip	Desirable
	With needle exposed or added*	Undesirable
	With needle added & recapped*#	Undesirable
Traditional needles		
	Uncapped	Desirable
	Recapped	Undesirable
Miscellaneous		

*category added after pilot sharps count

this category includes two unsafe behavior

Figure 8. Examples of sharps disposal boxes available on ambulances and carried in jump bags on engines and ambulances.
Note: Example of sharps box carried in jump bag is shown next to largest syringe carried by PCFR.

Baseline sharps collection. An administrative order (AO) was issued by the Rescue Chief of PCFR on April 21, 2010 instructing the selected stations to place their sharps containers in an OSHA approved bin located on site during the collection period from May 4 to May 11, 2010 (AO #10-30, see Appendix I). A similar AO was issued on May 24, 2010 to include stations that had low sharps quantity during the first count and two stations added to compensate for the non-compliance of Station 24 during the first collection.

Sharps boxes were collected from Stations 10, 17, 20, 22, 26 and 32 from May 28 to June 4, 2010 (AO #10-33, see Appendix J). The AOs included directions for labeling the sharps containers with date, apparatus, and location (jump bag or apparatus). During the initial one week collection period, Station 24 was non-compliant in collection. In order to maintain a representative sample, Stations 26 and 32 were added to the list of stations sampled in the second one-week collection period.

At the end of each one-week collection period, a state certified biohazard transport company transported the used sharps boxes from the individual fire stations to the lab located at the University of South Florida, College of Public Health.

Protocol for sharps handling. On the day of the sharps count, the researcher covered the horizontal surfaces of a fume hood with absorbent pads. Prior to contact with the sharps containers, the researcher donned a gown, puncture-resistant gloves [Sharps Master 7080 with HexArmor Nitrile coated gloves, ISEA Level 5, Elbow length; Grand Rapids, MiChigan], and plastic safety goggles with side splash shields, hereafter referred to as "PPE". If possible, the researcher used a set of tweezers or large tongs to release the plastic latch holding the lid of the sharps container closed. If necessary, the researcher

used bolt cutters to cut the plastic lid of the sharps container approximately 1.5 inches from each end so that the center portion of the lid could be removed and discarded in the biohazardous waste container. Each opened sharps container was soaked in full strength hypochlorite solution for at least 30 minutes prior to proceeding with the count.

After 30 minutes, the researcher then poured the entire sharps container and contents into a fine mesh rectangular colander to allow the bleach fluid to drain off the sharps. The researcher then used tongs, tweezers, and hemostats to sort the used sharps devices, one at a time, and placed the sharps in holding bins according to classification. At regular intervals, the researcher would perform a visual count, record the count on a sorting sheet, and photograph the sharps. Sharps from the used containers were sorted and classified according to presentation. Information about the station and apparatus (engine or rescue) of origin was recorded. Categories used in the sharps count were the same as those identified and used during the pilot study. In addition, medication names, as indicated by manufacturer's labeling on the syringes, were recorded along with device type. Following the sorting and categorization process, the sharps were digitally photographed and then discarded in a large sharps bin and all surfaces wiped with 1:10 hypochlorite solution. For a full listing of material used in the protocol, refer to the materials list in Appendix K.

The baseline sharps count did demonstrate that there are safety issues occurring with this particular group in regards to use of sharps devices. Focus groups were planned to explore what sorts of internal and external factors influenced sharps behavior.

Focus groups. In order to control for bias and to avoid leading questions, an introductory script and focus group questions were developed under the supervision of two professors (Dr. Donna Haiduven and Dr. Jaime Corvin) experienced in focus group research (see Appendix L). Photos from the baseline sharps count were used as the basis for focus group questions and participants were asked to refer to a photo booklet during the session (see Appendix M). The booklet contained examples of prefilled syringes with needles added on, prefilled syringes with a needle was exposed or added when the luer option was available, IV stylets with the safety shield altered, recapped needles, and prefilled syringes with both the luer adapter intact and the needle exposed or added.

Focus group sessions and data collection. In March, April, and May 2011, focus group sessions were conducted with medics (3 sessions), driver/engineers (2 sessions), captains (1 session), and EMTs (2 sessions). Particularly in March, many scheduled groups were cancelled due to low levels of response. Focus groups were required to have at least four scheduled participants to proceed. Recruitment of captains was particularly difficult and may have been a function of rank and lack of involvement in rescue related activities. Focus groups were audio-taped using a digital audio recorder with a second audio recorder for back-up. Both the moderator and a volunteer, student assistant took field notes to summarize important points and document non-verbal cues and interactions. The worksheet used for both the focus group moderator and to record notes is available in Appendix O. Efforts to schedule focus groups ceased when feedback during session became repetitive (saturation) (EMTs, medics, driver/engineers) or when recruitment was exhausted (captains).

Feedback from the focus groups provided insight regarding internal and external factors that influenced firefighter behaviors regarding sharps devices. This feedback was used to plan an intervention to decrease rates of less safe or undesirable sharps behaviors among the firefighters at PCFR.

Phase 2 - Intervention

The multi-faceted intervention included multiple approaches, including development of a logo and slogan to increase visibility and recognition of the project. Pre-existing tools, in the form of an annual bloodborne pathogens training and a bimonthly newsletter, were amended to include information about the risk of needlestick injury and means to prevent NSI. A separate training to review high risk practices for NSI and the appropriate use of needleless devices was disseminated, and posters reviewing the information were distributed to all stations.

Intervention: The firefighter sharps safety project. In the fall of 2011, a logo for the firefighter sharps safety project was developed with input from a field medic who was known within PCFR for her artistic ability; see figure 9 for the initial draft of the logo.

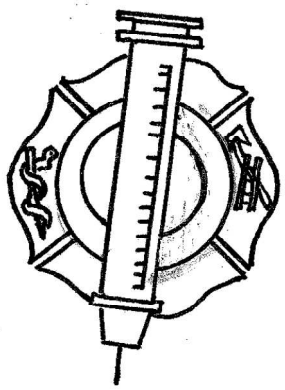

Figure 9. Draft logo developed by Firefighter/Paramedic Angela Pratt.

Additional field personnel reviewed the draft and provided feedback that was included in the final version of the slogan and logo, displayed in figure 10. A slogan of 'The risk is real – choose safety' was implemented. Both the logo and slogan were used in the subsequent steps of the intervention. 'Station representatives' were recruited from each

Figure 10. Final version of logo.

station to serve as recipients of the intervention materials, facilitate communication of ideas, and act as proponents of the program. In order to increase awareness of the project, each station representative received a mug with the logo and slogan imprinted on it, filled with candy as well as a magnet and pens with the logo on it. The mug and pens were to be left at the station for increased visibility with the crews.

Intervention: Annual bloodborne pathogens training. In April of each year, all employees of PCFR are required to complete a four hour bloodborne pathogens training module. Although the Florida Department of Health, Bureau of EMS (BEMS) BEMS does not provide the content of the training module, the module is required by

BEMS in order to renew EMT and paramedic certifications; in turn, current certifications are required in order for PCFR EMTs and paramedics to continue employment with the department. The module consists of an audio-recorded narration and Power Point presentation that is available to all crews on a shared drive of the station computers. An administrative order (AO) is issued that instructs all employees to complete the training and sign and submit paperwork verifying they have completed the training. In April of 2012, a section was added to the existing bloodborne pathogens training that outlined the risk of NSI, defined high risk behaviors for NSI, ways to prevent NSI, and steps to take in the event of an exposure. Therefore, all active EMTs and paramedics with PCFR submitted signatures attesting that they had completed the entire module, including the new NSI section.

Intervention: Needleless devices training. Feedback from participants in the focus groups indicated that they found the computer-based Power Point trainings cumbersome to complete in between calls and lacking in hands-on opportunities. This feedback was used to develop a booklet and devices kit to reinforce the proper use of needleless devices and the risk of improper use of the devices. This training also introduced new vial adapters that allow for withdrawing the medication without the use of a needle; these particular devices were new to PCFR and a direct result of increased awareness regarding sharps safety. In June 2012, another AO was issued to all field personnel instructing them to complete the needleless devices training with the kit and sign and submit paperwork to the Training Bureau verifying completion. Each station representative was instructed on the training materials and provided with a training

booklet and a box containing the various needleless devices. The training booklet is included for reference in Appendix P.

Intervention: Posters. In order to reinforce the messages presented in the training booklet, three posters (see appendix Q) were developed reviewing risky behaviors for NSI and encouraging safer sharps practices. The posters were distributed in 3 week cycles, beginning July 1, 2012 and ending August 27, 2012. The AO mentioned above instructed station commanders to insure that the posters were hung on the sharps disposal boxes in the ambulances. For stations that did not have an ambulance, the posters were to be hung in the storage location for EMS supplies. Posters were delivered to the station representatives, who were responsible for hanging them in the designated locations. In addition, the regional trauma center at Bayonet Point granted permission for the posters to be hung in their EMS room. This was a high visibility location as trauma patients from all over Pasco County, as well as neighboring counties, are transported there due to specialized services that are not available at other county hospitals.

Phase 3 - Data Collection

Evaluation: Post-intervention sharps count. On September 17, 2012, another AO (#12-40) was issued ordering that stations 10, 11, 13, 14, 16, 17, 20, 23, 26, and 32 collect their used sharps disposal boxes from that day until October 2, 2012 (See Appendix Q). The collection time frame was extended due to concerns about low yield. The sharps boxes were collected on October 9, 2012 by a representative from the certified biohazard transport company. In accordance with the protocol developed in the pre-intervention sharps count, a post-intervention sharps count was completed using the same categories.

Evaluation: Survey. The AO mentioned above (#12-40) also included information about completion of a survey regarding sharps practices and the impact of the Firefighter Sharps Safety Project. These surveys were sent to all 23 stations within PCFR on September 19, 2012. Although the instructions on the survey indicated that it should be returned prior to October 3, 2012, the collection period was extended until October 10, 2012 to insure that any late submissions were included in the sample.

The survey consisted of fifteen (15) Likert scale questions with 5 choices (strongly disagree, somewhat disagree, I have no opinion, somewhat agree, strongly agree). Seven of these Likert scale questions focused on attitudes and behaviors regarding sharps use. The remaining eight directly addressed changes in sharps behaviors and awareness since the implementation of the intervention, worded as "compared to six months ago"; see Appendix R. In order to prevent identification of survey respondents in this 'tightly knit' community, only minimal demographic information was collected (how many years worked in EMS and how many years worked for PCFR).

Analysis

The study design necessitated separate analysis and each step of data collection: phase 1 sharps count, phase 1 focus groups, phase 3 evaluation/post-intervention sharps count, and phase 3 evaluation/post-intervention survey.

Phase 1 – sharps count. Total counts and frequencies of categories were calculated in order to identify common practices. Behaviors were classified as "desirable" (more safe) or "undesirable" (less safe), as depicted in Table 9. Sharps practices were analyzed among stations with low, medium, and high call volume, as well as between apparatus (engine and ambulance). Medications were compiled into

"advanced life support" or "all others" (see Table 10); these medication types were used to analyze desirable and undesirable behaviors. Chi-square tests were completed with call volume vs. desirable/undesirable behaviors for 1. IV (safety deployed/altered), 2.

Table 9

Categories of devices and classification of behavior

Categories of Devices	**Classification of Behavior**
Intravenous catheters (IVs)	
Safety device activated	Desirable
Safety device altered	Undesirable
Failed attempt/stylet intact	Hazard not influenced by behavior
Prefilled syringes	
With luer tip	Desirable
With needle added	Undesirable
With needle added & recapped	Undesirable
Traditional needles	
Uncapped	Desirable
Recapped	Undesirable
Miscellaneous	

pre-filled syringes (luer lock/needle exposed or added), and 3. traditional needle (uncapped/recapped). Chi- square tests were also completed for medication type (advanced life support drugs vs. all other) vs. desirable/undesirable behaviors for 1. IV (safety deployed/altered), 2. pre-filled syringes (luer lock/needle added), and 3. traditional needle (uncapped/recapped). Statistical significance was set at $p<0.05$ and EpiInfo 6.0 was used for all quantitative analysis.

Phase 1 – focus groups. The focus group sessions were transcribed using ExpressScribe software (NCH Software; Greenwood Village, Colorado) and coded for common themes. Initial codes were identified for themes that emerged during the focus group sessions, such as physical work environment, work place culture, urgency of call, training, and types of devices supplied. As analysis progressed, additional codes were

added and/or revised as necessary. A second coder was utilized to ensure consistency and accuracy (Dr. Jaime Corvin). Atlas-ti software was used for coding and analysis of qualitative portions of the project (Atlas-ti; ATLAS.ti Scientific Software Development GmbH; Berlin, Germany).

Table 10

Medication Types

Advanced Life Support Drugs		**All Other Drugs**
Adenosine	Narcan	Benadryl
Amiodarone	Sodium	D50
Ativan	Bicarbonate	Glucagon
Atropine	Vasopressin	Labetolol
Epinephrine	Verapamil	Lasix
Lidocaine	Valium	Morphine
	Versed	Normal Saline
		Unlabeled

Phase 3 – evaluation/ post-intervention sharps count. The initial analysis of the post-intervention sharps count mirrored the analysis completed for the phase 1 baseline sharps count. In addition to the category frequencies and associations explored in the phase 1 baseline sharps counts, comparisons were made by device category for pre- and post-intervention frequencies of safer and riskier behaviors. Comparisons of pre- and post-intervention sharps behaviors were also calculated when stratified by apparatus type and medication types.

Phase 3 – evaluation/ post-intervention survey. Survey results were compiled and reported by frequency in EpiInfo 6.0.

Summary of Research Questions

Each step described in Figure A was implemented as described. Results for the diagnosis and post-intervention evaluation will be reported and discussed by phase in future chapters in order to answer each of the following research questions:

1) What are the types of unsafe sharps techniques present at Pasco County Fire Rescue (PCFR), as observed in discarded, used sharps?
2) What is the frequency of the unsafe sharps techniques defined in research question 1?
3) What sharps practices occur in this fire department (FD) that increase the likelihood of occupationally-acquired needlestick injury (NSI), as identified in focus groups of firefighters (FF) and emergency medical services (EMS) personnel?
4) What factors are present that affect unsafe sharps techniques in this population?
5) What is the culture of safety in this FD and how does it impact the occurrence of unsafe sharps techniques and practices?
6) Can an intervention tailored to this population impact the frequency of unsafe sharps techniques?
7) Can an intervention tailored to this population improve the culture of safety regarding sharps use and NSI?

Chapter 6. Results

Diagnosis: Sharps Baseline Count

A total of 2473 sharps devices from 50 discarded sharps boxes, sometimes referred to as “red boxes”, were counted and classified using the methods previously described. The three main categories of IV stylets, prefilled syringes, and traditional needles contained 1882, 468, and 84 sharps, respectively. Figures 11-15 provide examples for each type of sharp: IV cathlon with safety device deployed; prefilled syringes with luer adapter or exposed/added needle; capped and recapped traditional needles. Counts for each type of sharps are summarized in Table 11.

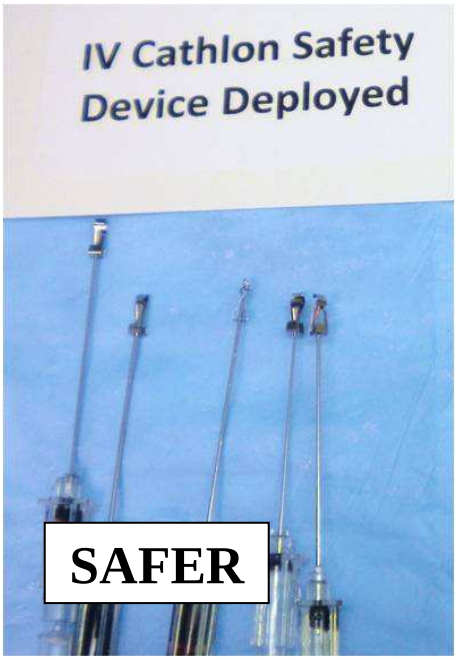

Figure 11. IV Stylets with safety device deployed, a safer sharps practice.

Figure 12. IV stylet from failed IV attempt, an unsafe occurrence for which there is no alternative.
Note: Metal sharp is still present and unprotected.

Figure 13. IV stylet with altered safety device, an unsafe sharps practice.

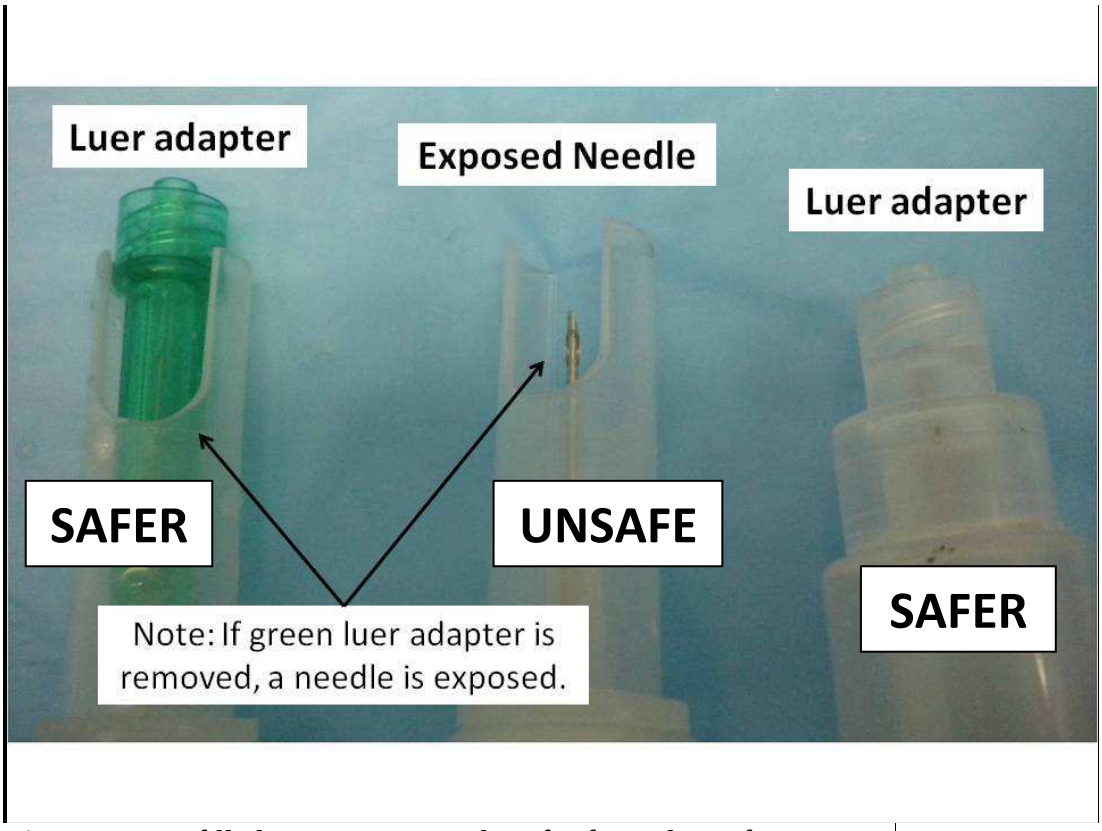

Figure 14. Prefilled syringes, examples of safer and unsafe practices.

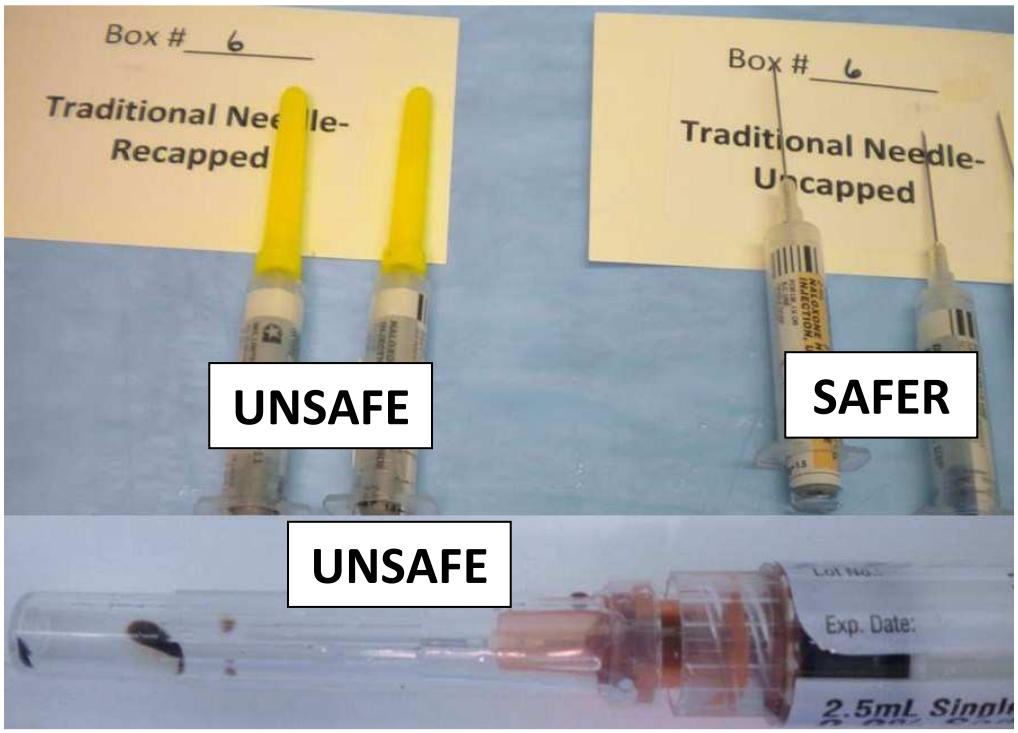

Figure 15. Traditional needles, capped and recapped as examples of safer and unsafe practices.

Table 11

Total Sharps Baseline Counts and Frequencies by Device Type at Baseline

Type of Sharps Device	**Count**	**Percentages**
Total sharps counted	2473	
IV stylets	1882	76.1% of total
Safety device activated*	1398	74.3% of IV stylets
Failed IV attempt†	379	20.1% of IV stylets
Altered safety device	105	7.5% of IV stylets
Prefilled syringes	468	18.9% of total
Luer adapter*	429	91.7% of prefilled syringes
Needle exposed/added	33	7.1% of prefilled syringes
Needle recapped	6	1.4% of prefilled syringes
Traditional needle	84	3.4% of total
Uncapped*	31	36.9% of traditional needles
Recapped	53	63.1% of traditional needles
Other	39	1.6% of total
Intraosseous needles (IO)	10	25.6% of other
Patient's personal syringes	29	74.4% of other

* Safer, desirable behavior

† Unsafe finding, but necessary behavior when IV attempt fails

Within the total counts and frequencies by device type, several notable results were identified. Failed IV attempts pose a real danger for needlestick injury (NSI) and bloodborne pathogen (BBP) transmission but cannot be avoided or addressed with behavior changes, therefore these types of sharps were discounted from further analysis. IV stylets with an altered safety device were the most commonly identified sharps risk, both by count and frequency (n=105, 7.5% of IV stylets, 2.4% of all sharps counted). Recapped needles had the highest frequency within device type (n=53, 63.1% of traditional needles) and the second highest frequency of all sharps counted (2.1%).

Sharps device types and the presence of unsafe behaviors were analyzed by apparatus type and medication type. Due to low cell counts, most categories were analyzed using Fisher's exact one-tailed test; when cell counts allowed, Chi-square tests

were used. All reported probability statistics (p values) were obtained using the Fisher's exact one-tailed test, unless a χ^2 value is reported. The significance level was established at $p<0.05$ for all tests.

Apparatus type. Categorized sharps were also examined in regards to apparatus type (Engine or Rescue); results are shown in Table 12. Paramedics on an engine may arrive at the patient's side prior to the ambulance crew. If this happens and the patient is stable, the engine crew will obtain patient information and provide basic care. Typically, the engine crew only gives medications prior to the arrival of the ambulance crew if the patient is in critical condition. Sharps devices used by the engine crew are an indication that an IV and medications were urgently needed. This trend of engine crews only giving medications in urgent circumstances is supported by the low cell counts for sharps devices obtained from engine crews.

Table 12

Sharps Baseline Count by Apparatus Type and Device Category

Apparatus Type	IV with Safety Device Activated*	IV with Safety Device Altered	Failed IV Attempt†	Prefilled: Luer Adapter*	Prefilled: Needle Exposed or Added	Prefilled: Needle Recapped	Traditional: Uncapped*	Traditional: Recapped	Total∞
Engine	10	16	13	2	0	0	1	2	53
Rescue	1388	89	266	427	33	6	52	29	2420
Total	1398	105	379	429	33	6	53	31	2473

*Safer, desirable behavior
† Unsafe finding, but necessary behavior when IV attempt fails
∞ Miscellaneous types of sharps not included in this table as they were not included in further analysis. Information regarding miscellaneous sharps is reviewed in Table C. Columns included in Table D may not add to total columns due the omission of the miscellaneous category.

For the relationship of apparatus type to safer or riskier behaviors of all types of devices (IV stylets, prefilled syringes, and traditional needles), a statistically significant

relationship (p=0.000) was identified. Table 13 shows the 2x2 tables that were constructed and Fisher's exact one tailed tests calculated for apparatus type (engine or rescue) vs. safer (desirable) and riskier (less desirable) behaviors within each device type (IV stylets, prefilled syringes, and traditional needles). For IV stylets, safer behavior was defined as IV stylets with the safety device activated, riskier behavior was defined as IV stylet with safety device altered; failed IV attempts were not included in the analysis. For the IV stylet category, a statistically significant difference was found between apparatus type and the occurrence of desirable behaviors (p=0.000). There were no statistically significant findings for apparatus type and the occurrence of desirable behavior within the prefilled syringe (p=0.840) or the traditional needle (p=0.305) categories.

Medication type. Counts and frequencies regarding safer needle use and medication type were collected. Advance Life Support (ALS) medications are given when the patient is in critical condition, including cardiac arrest. Other types of medications may be needed by the patient prior to arrival at the hospital but do not necessarily signify that patient's life was at risk in the immediate future. Therefore, evidence that an ALS medication was given signifies that the call was more urgent in nature. Adenosine, Amiodarone, Atropine, Epinephrine, Lidocaine, Sodium Bicarbonate, Valium, and Versed were considered ALS or "urgent" medications. Category counts by medication type are presented in Table 14 by use of luer adapter (the safer/desirable behavior) vs. exposed, added, or recapped needle (the riskier/less desirable behavior) for prefilled syringes and uncapped (the safer/desirable behavior) vs. recapped (the riskier/less desirable behavior) for traditional needles. For medication type (ALS and all

other) vs. all safer (desirable) or riskier (undesirable) behaviors, a statistically significant relationship was identified ($\chi^2 = 162.58$, p=0.000).

Table 13

Apparatus Type vs. Behavior Type for IV Stylets, Prefilled Syringes, and Traditional Needles

Device Type	Classification	Behavior	Engine	Rescue	Total
IV stylets					
	Safer/Desirable Behavior	Safety device deployed	10	1388	1398
	Riskier/Undesirable Behavior	Safety device altered	16	89	105
	Total		26	1477	1503
					Fisher's exact one-tailed test p=0.000*
Prefilled Syringes					
	Safer/Desirable Behavior	Luer adapter	2	427	429
	Riskier/Undesirable Behavior	Needle added or needle added/recapped	0	39	39
	Total		2	466	468
					Fisher's exact one-tailed test p=0.840
Traditional Needles					
	Safer/Desirable Behavior	Uncapped	1	52	53
	Riskier/Undesirable Behavior	Recapped	2	29	31
	Total		3	81	84
					Fisher's exact one-tailed test p=0.305

*Statistically significant

Table 14

Sharps Baseline Count, Prefilled Syringes and Medication Type

Medication	**Prefilled: Luer Adapter***	**Prefilled: Needle Exposed & Recapped**	**Traditional: Uncapped***	**Traditional: Recapped**
Adenosine	4	3	4	-
Amiodarone	7	2	-	-
Atropine	16	9	-	2
Benadryl	1	-	2	4
D50	12	-	-	2
Epinephrine	16	20	-	2
Glucagon	-	1	1	-
Lidocaine	1	0	-	-
Morphine	7	2	-	-
Narcan	-	-	19	15
Normal Saline	355	2	8	2
Sodium Bicarbonate	-	-	7	-
Unknown	5	-	12	4
Valium	3	-	-	-
Versed	2	-	-	-
Total	**429**	**39**	**53**	**31**

*Safer, desirable behavior
Shaded medications are considered Advanced Life Support (or urgent)

Tables 15 shows the 2x2 tables constructed and Chi-square or Fisher's exact one tailed tests calculated for medication type (ALS, all other) vs. safer (desirable) behavior and riskier (undesirable) behavior for each device category (prefilled syringes and traditional needles). A statistically significant relationship was identified between medication type and desirable behavior with prefilled syringes ($\chi^{2=}$140.63, p=0.000). No such relationship was found between medication type and desirable behavior within the traditional needle category (p=0.329).

Other findings. Prior to and during the pilot sharps count, categories were established regarding sharps that might pose a risk for NSI. During the baseline sharps count, there were some risks for NSI that had not been anticipated or included in the

Table 15

Medication Type vs. Behavior for Prefilled Syringes and Traditional Needles

Device Type	Classification	Behavior	ALS drugs	All other	Total
Prefilled Syringes					
	Safer/Desirable Behavior	Luer adapter	49	380	429
	Riskier/Undesirable Behavior	Needle added or needle added/recapped	34	5	39
	Total		83	385	468
					$\chi^2 = 140.63$, p=0.000*
Traditional Syringes					
	Safer/Desirable Behavior	Uncapped	11	4	15
	Riskier/Undesirable Behavior	Recapped	42	27	69
	Total		53	31	84
					$\chi^2 = 0.82$, p=0.365

*Statistically significant, p<0.05

pre-determined categories. In much smaller frequencies, patient's personal syringes and intraosseous needles (those that are inserted into the bone) were identified. It was noted that the patient's personal syringes often had caps that did not fasten and, therefore, appeared to be securely recapped when, in fact, they were not. There were several other sharps injury risks that were not known or expected at the onset of the baseline sharps count, including broken glass medication vials, razor blades, and syringes containing probable illicit substances. Figures 16-22 provide example of each of these risks.

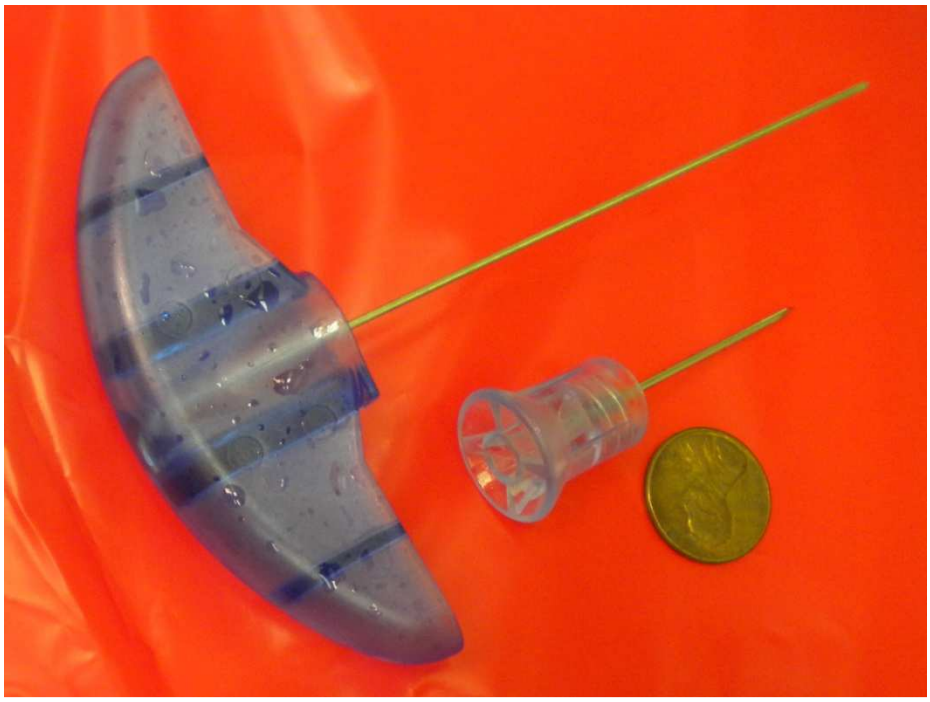

Figure 16. Intraosseous needles, an example of an “other” type of sharp.

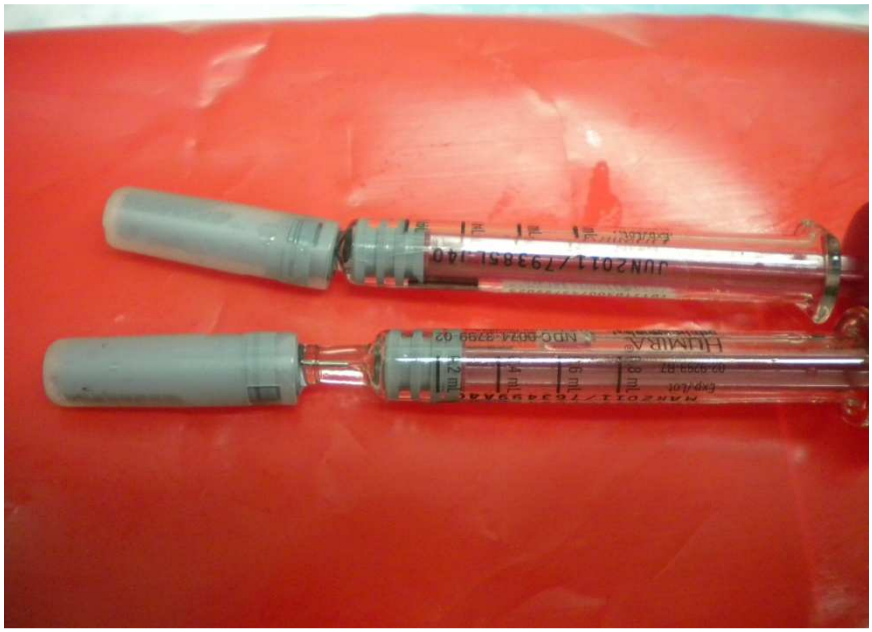

Figure 17. Patient’s own syringes, an unexpected finding.

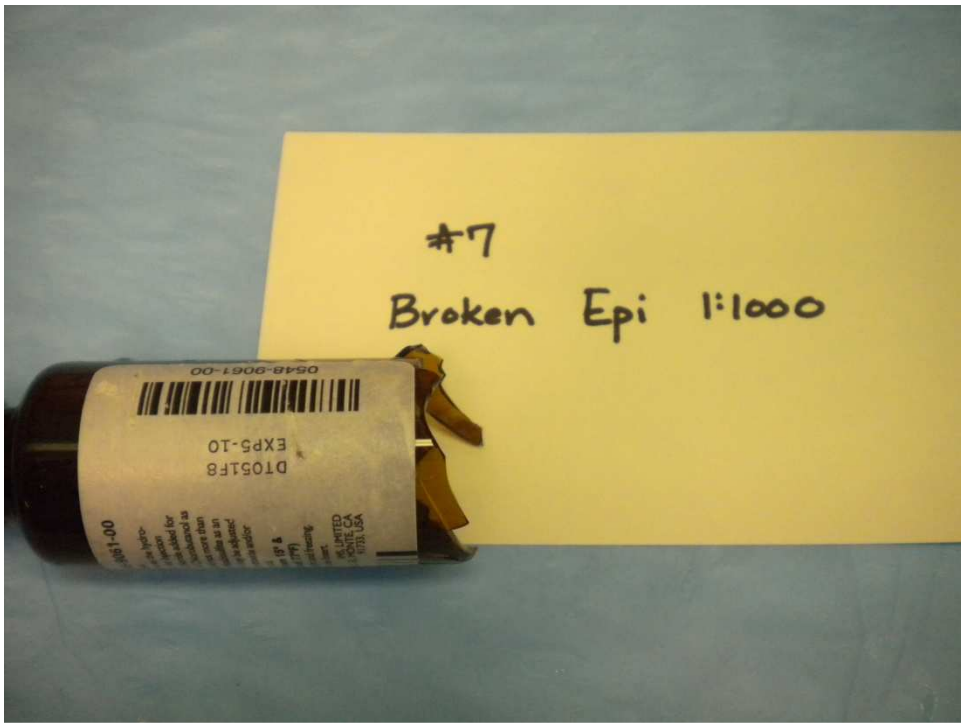

Figure 18. Broken glass medication vial (example 1), an unexpected finding.

Figure 19. Broken glass medication vial (example 2), an unexpected finding.

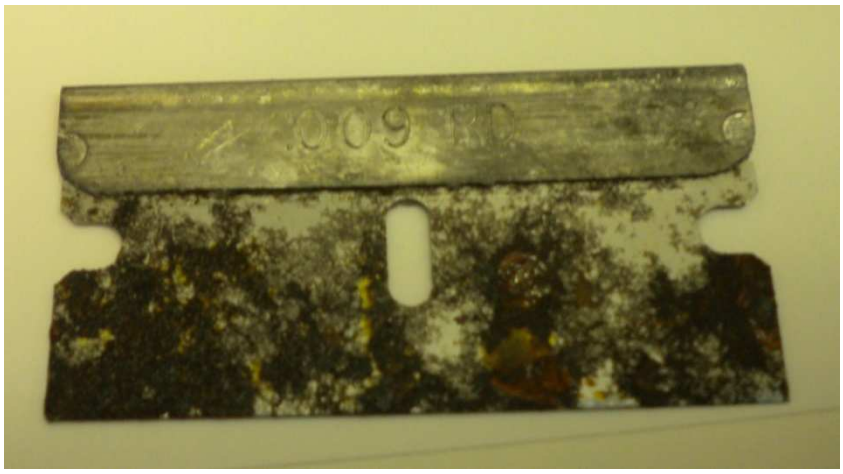

Figure 20. Razor blade, an unexpected finding.

Figure 21. Probable illicit substances (example 1), an unexpected finding.

Figure 22. Probable illicit substances (example 2), an unexpected finding.

Summary. The most commonly observed risky behavior was IV stylets with an altered safety device, followed by recapped traditional needles. Statistically significant findings included: 1) engine apparatus, as opposed to rescue, increased the likelihood that overall risky behaviors would occur (IV stylets with altered safety devices, prefilled syringes with needles exposed/added, and recapped traditional needles); 2) engine apparatus, as opposed to rescue, increased the likelihood that risky behaviors would occur with IV stylets (altered safety devices); 3) ALS medication type, as opposed to all other medications, increased the likelihood that overall risky behaviors would occur (IV stylets with altered safety devices, prefilled syringes with needles exposed/added, and recapped traditional needles); and 4) ALS medication type, as opposed to all other medications, increased the likelihood that risky behaviors would occur with prefilled syringes (needle exposed, added, or recapped). Several unanticipated sharps injury risks were identified, including intraosseous needles, broken glass medication vials, razor blades, patient's own syringes, and syringes with probably illicit substances.

Diagnosis: Focus Groups

The information gathered from the baseline sharps count about device types and occurrences of unsafe sharps behaviors was used as the framework for development of focus group questions designed to further explore the factors that influenced the occurrence of these practices and behaviors. In particular, focus group questions were based around photos taken during the baseline sharps count. The qualitative data collected from the focus groups served to identify factors that influenced unsafe sharps techniques and practices, identify the culture of safety within PCFR, and explore the impact of culture of safety on the occurrence of unsafe sharps techniques and practices.

Identification of themes. Several themes were identified from the focus groups transcripts, including issues related to disposal of sharps, factors specific to the call and treatment, factors related to the individual, risks related to the nature of the job, safety, and training. These themes and associated sub-themes are portrayed in Table 16.

Table 16

Themes and Sub-Themes Identified from Focus Groups

Issues related to disposal of sharps, including recapping
Perception of increased safety
Lack of disposal options
Disposal of D50*
Inappropriate disposal of needles
Factors specific to the call and patient treatment
Level of urgency
Type of medication
Location of the scene
Obtaining a blood sugar level
Factors specific to the individual
Apathy
Desensitization
Preference and habit
Risks related to the nature of the job
Space in the ambulance
Moving vehicles
Safety
Role of the individual
Work environment
Training
Luer adapter on prefilled syringes
Introduction of new equipment
Future training

* D50 is a sugar mixture given to patients with low blood sugar levels. It is supplied in a very large syringe.

Issues related to disposal of sharps, including recapping. There were several issues identified relating to the disposal of sharps and barriers to safer needle practices. Often, FFs and EMS personnel engage in what are traditionally classified as riskier behaviors, such as recapping, due to a belief that engaging in these behaviors provides a

protective factor against needlestick injury. This perception that covering a used needle by recapping decreases the risk of one's self or co-workers incurring an NSI leads to behavior that actually places the worker at increased risk. Barriers such as lack of access to disposal boxes, location of the call, and large medication syringes that do not fit into the disposal boxes decrease the likelihood of appropriate disposal of sharps. Disposal of D50 presents a special challenge and is likely to result in a riskier disposal option because of the large size of the syringe and the increased likelihood that it will be administered in the house, when only a small sharps container is accessible. Example quotes for each of these sub-themes are presented in Table 17.

Perception of increased safety. Respondents provided several explanations of engaging in recapping due to a perception that recapping was a safer alternative when they were unable to dispose of the sharp in an appropriate container. When shown a photo of a recapped needle and asked why someone would dispose of the sharp in that manner, one Paramedic answered, "Someone didn't have access to the sharps container and they were trying to keep it as safe as they could until they could get it into a sharps container." This concept was repeated by several other participants, as shown in Table 17.

Lack of disposal options. Sometimes, the choice to inappropriately dispose of sharps devices is a logistical matter of not having access to a sharps disposal box. Participants indicated that this might happen due a full sharps box or not having the correct size box. As a Driver reported, "I think sharps containers too, are another issue. Like I was on a scene yesterday where we gave glucagon…I went to hand somebody the

Table 17

Issues Related to Disposal of Sharps, Including Recapping: Sub-Themes

Perception of increased safety
"Having the sharps container close by and in a convenient location in the ambulance, so there's not my only option at the far back of the truck and I'm sitting at the head. My only way to put it down is back there. I might be thinking recap it or, hey, set it down…because I don't want to pass it through four people while we are in the midst of doing critical care." (Paramedic)
"Someone didn't have access to the sharps container and they were trying to keep it as safe as they could until they could get it into a sharps container." (Paramedic)
"Maybe they're where they felt it was necessary to re-cap them because they didn't have a readily available sharps container. " (Paramedic)
"Recapping is fine to do. It's better than letting it sit there without a cap." (Driver)
Lack of disposal options
"I think sharps containers too, are another issue. Like I was on a scene yesterday where we gave glucagon…I went to hand somebody the sharps container, the small one that was in the bag and it was pretty much full. It was fuller than it should have been." (Driver)
"Sometimes there's not a sharps container…I'll look in there and, of course, it's empty. There's just not one in there cause either they don't have one that fits there or it's an old truck and we don't carry that type of sharps container any longer." (EMT)
"The only time I've seen where we haven't had access to is because…the sharps containers become locked where you don't have access to it, or somebody didn't restock the bag appropriately so it wasn't actually in the bag when you were on the scene of a call." (Paramedic)
"We don't have the appropriate things to do it. So we are looking for the sharps… I don't know how many times you've opened this and there's no sharps container…" (Paramedic)
"If the sharps container is full, sometimes you can't fit it in some of the sharps containers that you bring into the house with you." (Paramedic)
Disposal of D50
"That box won't take the big ole D50 needle there. You might just recap it." (Driver)
"If a red box is not around or let's say you push D50 in a house and you only have the small red box in the bag, so you recap it until it gets dumped into the bigger box." (Driver)
"Those D50s that come with a needle. Even if the sharps box is empty you can't get it in there." (Driver)
"I've seen the D50 recapped, just because it is such a large syringe with a pretty large needle." (Paramedic)
"With the D50 being too large, usually it's recapped and then taken back out to the truck." (Paramedic)
Inappropriate disposal of needles
"It used to be back in the day, you'd get on an a big ole trauma scene and have multiple patients being stuck 3,4,5 times trying to get IVs and you'd have needle marks in the seat, people poking needles through the seat cushion and that was kind of your temporary sharps container…disgusting." (Paramedic)
"For example, I used to be passed on a truck every morning and instead of using a sharps container, they used the cushion on the seat. And I was close one time to getting stuck…stick it in the cushion instead of a sharps container." (Paramedic)
"Sometimes people stick it between the cushion and the wall of the rescue and then forget it's there. And you either come in to clean the truck in the next morning and you almost stick yourself because one was left there." (EMT)
"And then sometimes you find…lying around the truck with the cap off, lying behind the bench seat and behind the seat across from it." (EMT)
"People put them on the seat, they roll off, and then when you go to clean up, you are getting stuck." (Paramedic)

sharps container, the small one that was in the bag and it was pretty much full. It was fuller than it should have been." An EMT, the rank most often tasked with stocking or re-stocking supplies in the ambulance, advised, "Sometimes there's not a sharps container…I'll look in there and, of course, it's empty. There's just not one in there cause either they don't have one that fits there or it's an old truck and we don't carry that type of sharps container any longer."

Disposal of D50. D50, a type of glucose given intravenously, comes in the largest syringe carried on the ambulance and frequently does not fit into the sharps disposal containers. This is particularly problematic because D50 is often given in the house where the only available sharps container is quite small. One Paramedic participant stated, "I've seen the D50 recapped, just because it is such a large syringe with a pretty large needle" and a Driver participant indicated, "That box won't take the big ole D50 needle there. You might just recap it, that's what I've seen." Additional quotes supporting this sub-theme are provided in Table 17.

Inappropriate disposal of needles. In addition to barriers to proper disposal and riskier options that are implemented with good intentions, participants identified sharps disposal behaviors that were clearly unsafe, such as sticking the needles in the cushion of the seat in the back of the ambulance. When relating these disposal options focus group participants often expressed verbal or non-verbal disapproval and an understanding that these options were not acceptable and created additional risk for needlestick injury. "It used to be back in the day, you'd get on an a big ole trauma scene and have multiple patients being stuck 3,4,5 times trying to get IVs and you'd have needle marks in the seat,

people poking needles through the seat cushion and that was kind of your temporary sharps container…disgusting" (Paramedic).

Factors specific to the call and patient treatment. In addition to issues surrounding disposal, such as where to place the needles or the availability of sharps boxes, factors inherent to the call were identified as influential in sharps disposal behavior. Additional sub-themes that were specific to the call or patient treatment were identified: level of urgency, type of medication, location, and need for blood sugar level. Table 18 provides examples of statements from participants that illustrate these subthemes.

Table 18

Factors Specific to the Call and Patient Treatment: Sub-Themes

Level of urgency
"The dramatic-ness of the call…If it's serious or its trauma and there's blood everywhere, you don't want to stop what you're doing to pull the needle and put it in the sharps container." (Driver)
"I would say during any kind of cardiac arrest, respiratory, or…when you're in a hurry and you just push the drug and throw it down on the seat or something until you get the box. When you're not actually paying attention to worrying about getting it into the sharps container. And somebody's recapping it obviously, so it doesn't poke somebody." (Paramedic)
"There is just so many things going on when you're working a code…and it's just two birds killed with one stone and you go onto something else to try and save this guy's life." (Captain, re: obtained blood sugar level from IV stylet).
"If it's a code, sometimes they wait until all the drugs are used and then one of the engine guys will back and account for everything and see how many Atropines, just to leave it around for documentation purposes, so they don't lose track of what they've given." (Driver)
"We start IVs in moving vehicles every day. It's because we are working critical patients and we have a patient that is crashing…If you are responding to the hospital with a patient, pulling over on the side of the road and sitting there while you try to get an IV, doesn't seem to be in the best interest of patient care." (Captain).
"If you are in a code situation, you might see a paramedic use a drug and just toss it up on the bench so you remember what they gave." (Paramedic)
Type of medication
"Pain medications…If they don't use all of the morphine, then they're gonna recap it." (EMT)
"Like Narcan, you're giving .4, .4,.4 [mgs] so you're putting the needle on, giving them a little hit and then taking it off and this is one of those situations where you then have to handle a needle again." (Captain)
"You give them the point four [mgs of Narcan] and then you either leave it in there [IV port] and hope he doesn't thrash around or you take the needle out and then you have to recap the needle." (Captains)
"[I]f you give 4mg of Morphine, you still have 6mg in the syringe you have to account for, that you have to hang on to until you can dispose of [with a witness] or until you use it again, so you have to resheath the needle until you give it or dispose of it." (Driver)

Table 18 (continued)

"Sometimes we have problems with the Amiodarone and it won't push through that thing so we put a needle on it and then you can give it through the needle port on the IV tubing." (Driver)
"We've had times before where we couldn't get it [needleless syringe] to go at all…it's just the Amiodarone." (Driver)
"It you have a patient in SVT [supraventricular tachycardia]…and you're trying to push Adenocard, and you're trying to give the 12 mg…quickly so you put the two needles in the [IV] port at the same time." (Captain)
"We'll stick 2 needles in one port and then you'll have one guy pushing those two and another guy in there chasing it with a 20 cc syringe for a flush. So you need needles for that." (Captain)
"When you are giving 12 mg of Adenosine you can put both needles in the needle hub and push at the same time so you get a better response from the patient." (Driver)
Location of the scene
"The only issue you may see is working a code in the house…basically, laying needles down. It happens. We lay them down on the floor and that's cause we're rushing." (Captain)
"[W]hen you are at houses when you push D50, when they're in bed…don't have sharps boxes in the bag big enough." (Paramedic)
"D50 inside of the house – you usually just have your portable sharps container which is a lot smaller…it doesn't fit." (Driver)
"If you are giving the medication in the house, you don't always have a sharps container readily available." (Paramedic)
"Location, for one. Like we mentioned earlier, if it's in a house or it it's in the truck where we have a larger sharps box."
Obtaining a blood sugar level
"I know a lot of people with a common practice to get a blood sugar off the needle…you can pull those back [IV safety devices] to get a blood sugar off the needle." (Paramedic)
"Probably one of the worst things that I see is when we are getting an accucheck and even though the tip is covered with the shroud [safety device] with the needle, it still gets passed amongst each other and you know when the truck is moving down the road…it just takes one person to not pay attention." (EMT)
"I believe I've heard of somebody trying to remove one to try and get an accucheck sample out of the IV catheter." (Paramedic)
"Instead of doing finger pricks…we are just as guilty, people take blood from the sharp capped IV needle and I am just as guilty as doing it." (Driver)
"Usually starting IVs, it's somebody's responsibility to get a sugar off of it. A lot of times the medic, or whoever, will lay it down between the person's legs on the sheet…As soon as we can, within seconds, somebody else has it within their hand and is obtaining a sugar off of it…" (Medic)

Level of urgency. Emergency medical calls involve a wide range of calls, from the mundane to calls that are truly life-threatening. Personnel participating in the focus groups indicated that riskier sharps disposal behaviors tended to occur during calls that were more critical in nature. The most common critical calls involve cardiac arrest, respiratory arrest, and serious trauma. "The dramatic-ness of the call…If it's serious or its trauma and there's blood everywhere, you don't want to stop what you're doing to pull

the needle and put it in the sharps container" (Driver). A "code" situation is one in which the patient is in cardiac arrest and CPR [cardiopulmonary resuscitation] is in progress. These types of calls are among the most challenging for paramedics in terms of medical skills, but also required detailed documentation about a large number of medications used. One Paramedic explained a tracking system for medications, "If you are in a code situation, you might see a paramedic use a drug and just toss it up on the bench so you remember what they gave."

Type of medication. Participants identified several types of specific medications that might encourage inappropriate means of disposal, such as D50, Narcan, pain medications, Amiodarone and Adenocard (also known as Adenosine). Both Narcan and pain medications are given in small incremental doses until the desired effect is achieved. Because the entire syringe of medication is not used with the first dose, medics often recap the needle in order to save it for the next dose. "Pain medications…If they don't use all of the morphine, then they're gonna recap it" (EMT). Or as a Driver explained, "[I]f you give 4mg of Morphine, you still have 6mg in the syringe you have to account for, that you have to hang on to until you can dispose of [with a witness] or until you use it again, so you have to resheath the needle until you give it or dispose of it."

There appears to be design issues with the Amiodarone syringes that necessitate adding a needle to the syringe to give the medication. The amiodarone prefilled syringe has a unique white collar that must be pushed down towards the barrel of the syringe in order to break a glass ampule that provides access to the liquid medication, as shown in Figure 23. "Sometimes we have problems with the Amiodarone and it won't push

through that thing so we put a needle on it and then you can give it through the needle port on the IV tubing." (Driver)

Figure 23. Amiodarone prefilled medication syringe.

Adenocard was also identified as a medication that influenced the occurrence of riskier needle behaviors. Adenocard comes in 6mg syringes. The first dose is 6 mg. If that doesn't have the desired results, then the second dose is 12 mg. In order to give this second dose of the medication properly, two doses of 6 mg each and a 20 cc normal saline must be pushed into the IV very rapidly. To accomplish this appropriate administration of Adenocard, crews have designed unique approaches that require adding a needle to the prefilled syringe, shown in Figure 24. Typically, two crew members will work together to insert the three needles (2 syringes of Adenocard of 6 mg each and 1 syringe with saline) simultaneously into the only traditional port on the IV tubing, thereby eliminating the amount of time that would be needed to insert one syringe at a time. "When you are giving 12 mg of Adenosine you can put both needles in the needle hub and push at the same time so you get a better response from the patient." (Driver)

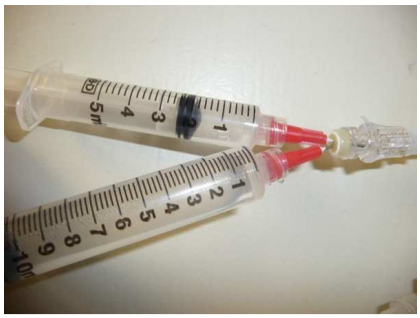

Figure 24. Administration of Adenocard using two syringes with needles in a traditional IV port. Retrieved from: http://roguemedic.com

Location of the scene. Depending on the situation, some patients are treated and given medications at the scene (i.e. in their home or on a roadway before being loaded into the ambulance). Situations in which medications are given in an alternate location other than the back of the ambulance contribute to the occurrence of riskier sharps behaviors. One Paramedic advised, "If you are giving the medication in the house, you don't always have a sharps container readily available." The risk of needlestick injury is compounded by the fact that scenes in which medications are given immediately are often more chaotic and critical in nature. "The only issue you may see is working a code in the house…basically, laying needles down. It happens. We lay them down on the floor and that's cause we're rushing" (Captain).

Obtaining a blood sugar level. Blood sugar levels, also known as "accu-checks" or "fingersticks", are collected to measure the amount of glucose circulating in a patient's blood. These are commonly used on patients with diabetes, but may also be used to look for low blood sugar in patients who have fainted or might be malnourished, among other conditions. The approved means to collect this measurement is through a small finger stick with a lancet, similar to a pin prick. However, participants reported that the drop of blood needed for this test is often obtained from the distal end of the IV stylet, after

altering the safety device that encases the tip of the sharp IV stylet. One EMT described this practice, “Probably one of the worst things that I see is when we are getting an accucheck and even though the tip is covered with the shroud [safety device] with the needle, it still gets passed amongst each other and you know when the truck is moving down the road…it just takes one person to not pay attention.” Additional quotes describing this practice are available in Table 18.

Factors specific to the individual. The themes and sub-themes identified thus far are external factors that influence sharps behavior, but there are also internal factors related to the beliefs and preferences of the individual firefighter, EMT, or paramedic. This theme is divided into apathy, desensitization, and preference/habit. Quotes for each sub-theme are available in Table 19.

Apathy. Within the culture of fire departments that respond to fire and emergency medical services (EMS) calls, it is common for the medical calls or ambulance-related job tasks to be less favorable than those associated with fire suppression related tasks. This tendency and individual attitudes influence apathy about completion of duties related to the ambulance, including safety and potential blood borne pathogen exposure. One paramedic described this phenomenon, “You are going to have people who are passionate about this job and you are going to have people who are passionate about their combat job…You’ll always have people that are on a rescue truck that don’t want to be there…And they are going to have different attitudes about whether there is blood on the [kitchen] table or not.”

Desensitization. Over time, with repeated exposure to sharps devices, blood, and body fluids, EMS personnel can become desensitized or lose a perception of risk

associated with these items. "If they were at the grocery store and picked up a can of food and there was an IV syringe right there you would know they would flip out, but for some reason when they come here [work] it seems like no big deal" (Paramedic).

Table 19

Factors Specific to the Individual: Sub-Themes

Apathy
"I just think a lot of it is…I just don't care." (Paramedic)
"You are going to have people who are passionate about this job and you are going to have people who are passionate about their combat job…You'll always have people that are on a rescue truck that don't want to be there…And they are going to have different attitudes about whether there is blood on the table or not." (Paramedic)
Desensitization
"If they were at the grocery store and picked up a can of food and there was an IV syringe right there you would know they would flip out, but for some reason when they come here [work] it seems like no big deal." (Paramedic)
"It just seems like as soon as they get here it's just like no big deal…" (Paramedic)
Preference and habit
"Personal preference. When you have an EMT, for example, who works with a medic for 2-3 years, now that EMT becomes a medic. He's probably gonna shadow what he is used to seeing. So if he is used to seeing bad habits, that's the way he's gonna work…They form their own bad habits…The same bad habits continue on." (Captain)
"You form your habits, and why change them, until something happens or you have somebody telling for the hundredth time…" (Paramedic)
"I always have a needle. Because it's an option and it's how I learned to use it." (Captain)
"It goes back to habit. I learned it – getting accuchecks off of needles, people who come up underneath us do it that way and have learned to do it that way." (Captain)
"With the needleless system, I have to think about the actual system. With the needles, I am thinking about patient care and treatment and protocol and algorithms. I'm thinking about things other than mechanics of getting the juice into the person." (Captain).
"I guess if you locked the needles in the glove compartment then I would use needleless." (Driver)
"I prefer needles. I don't like screwing things into some of these IVs. I've seen IVs from the pressure of pushing the med through the luer lock…I prefer the needles." (Driver)

One Driver demonstrated this desensitization to needles by relaying a story of using a clean IV stylet on Thanksgiving, "I've used a 14 gauge [IV needle] to baste a turkey and I fought for 10 minutes trying to get that damn thing [safety device] back." FFs and EMS personnel at PCFR work 24 hours shifts and reside in a dorm setting during

that time period. Crews may respond to a cardiac arrest call requiring CPR and advanced life support medications and immediately thereafter return to the station to cook and eat dinner in the kitchen. It is not uncommon for personnel to run a critical call involving large amounts of blood and return to the station dorm to sleep. The sudden shift from routine activities of daily living (i.e. eating, sleeping, watChing television) to immersion in a critical medical or trauma call is likely to contribute to the desensitization process.

Preference and habit. There are some personnel who simply prefer using needles over needleless devices. The method the medic was trained in, level of comfort, and habit contribute to this preference. "With the needleless system, I have to think about the actual system. With the needles, I am thinking about patient care and treatment and protocol and algorithms. I'm thinking about things other than mechanics of getting the juice into the person" (Captain). Some participants were adamantly against using needleless options. "I guess if you locked the needles in the glove compartment then I would use needleless" (Driver). A crew member would have to exit the back of the ambulance, where patient care occurs, to reach the glove compartment in the cab area of the truck. Storing needles in the glove compartment would render them inaccessible. This statement illustrates the determined refusal of some FFs and EMS personnel to use the newer, safer devices; so long as the option to use a needle is available, a segment of the crews will insist on using them.

Risks related to the nature of the job. There are aspects of working at the fire department or within EMS that add to the risk of needlestick injury. One response from an EMT summarizes this risk thoroughly. "I don't see why we shouldn't be needleless. Because we are not in a controlled environment, a nice, clean hospital room. We're in a

truck that's moving down the road, bouncing all over the place…and then you've got combative patients. To make the job safer, is better." The theme of risks related to the nature of the job is divided into three sub-themes: risk perception, space in the ambulance, and moving vehicles. Table 20 provides additional examples of responses for each sub-theme.

Table 20

Risks Related to the Nature of the Job: Sub-Themes

Risk perception
"We have an inherently dangerous job…Things happen. Mistakes happen. Stuff happens. It's an inherently dangerous job." (EMT)
"You don't want to be scared all the time either. You're constantly being hit with it. Electricity, car wreck, fire. There's so many things that can get you, you get to the point, yeah, yeah, yah. Nothing's gotten me yet, so f#$* that mentality...Nothings gotten me yet, what are the chances?" (EMT)
"This little needle can't possibly kill me. I just fought a fire and pulled three kids out of a car…Mr. Tough Guy." (EMT)
Space in the ambulance
"There's a lot of hands in a small area. You can't always keep track of where everybody's twisting and moving around to." (Paramedic)
"It's tight quarters in the back of the rescue. A lot of times, you have 4 or 5 guys standing around a stretcher. They are all working on one person, multiple different tasks at the same time. The space…just the space is a risk. Cause you are kind of cramped in the back of a Rescue." (Driver)
"If you are in the back of the rescue…and then you got somebody at the head of the patient, you got a needle, you got to squeeze by him. You got to squeeze by a lot of stuff. There's IV tubing, oxygen tubing…" (Captain)
Moving vehicles
"We start IVs in moving vehicles every day. It's because we are working critical patients and we have a patient that is crashing…If you are responding to the hospital with a patient, pulling over on the side of the road and sitting there while you try to get an IV, doesn't seem to be in the best interest of patient care." (Captain).
"It [IV needle] still gets passed amongst each other and you know when the truck is moving down the road…It just takes one person to not pay attention." (EMT)
"Moving vehicles…That's why we have the protocol that says you are not supposed to start an IV en route. I've been stuck that way." (Paramedic)

Risk perception. Firefighters and EMS personnel face a multitude of risks while performing job duties. Efforts to prevent needlestick injuries can be hampered by beliefs that the other risks encountered pose a greater threat than NSI. "This little needle can't possibly kill me. I just fought a fire and pulled three kids out of a car…Mr. Tough Guy." (EMT)

Space in the ambulance. A significant portion of patient care occurs in the confined space in the back of the ambulance. Typically, if a patient is more critical, there will be more personnel in the back of the ambulance. This lack of space increases the risk that a FF will bump into a sharp or be stuck while another FF is trying to dispose of a needle. One Driver explained, "It's tight quarters in the back of the rescue. A lot of times, you have 4 or 5 guys standing around a stretcher. They are all working on one person, multiple different tasks at the same time. The space…just the space is a risk. Cause you are kind of cramped in the back of a Rescue."

Moving vehicles. When transporting, or responding, a patient to the hospital, additional patient care must be rendered. Subsequently, needles may be used to give medications while the ambulance is moving. Participants identified this as a risk unto itself. "Moving vehicles…That's why we have the protocol that says you are not supposed to start an IV en route. I've been stuck that way." (Paramedic)

Safety. Two sub-themes emerged regarding safety: role of the individual and work environment. Participants expressed the need for personal responsibility for safety, while conveying dismay or criticism about the lack of response to safety from administration of the organization. Additional quotations to illustrate each sub-theme are available in Table 21.

Role of the individual. Without exception, participants directly expressed or agreed that the individual FF, EMT, or medic was burdened with a level of responsibility for ensuring their own safety. Additionally, when providing examples of safety violations or risky behavior participants often provided examples of the actions of co-workers, as opposed to themselves. "I feel it should be everybody for themselves, for their own safety…If they get stuck cause they're lazy…that's going to be their problems. And they should care enough to try to not let it happen." (Driver)

Participants also identified the need for each individual to conceptualize the risk associated with NSI. "It will only change for some people until it affects them. Until they get stuck with a needle or until they get hepatitis…" (Paramedic)

Work environment. The focus group participants were familiar with each other due to a pre-existing work relationship. Therefore, prior to the start of the focus group sessions, FFs would frequently discuss work related issues and controversies. In five of the focus groups, members were openly discussing various issues tied to safety, criticizing the decisions or actions of administration, and indicating that safety was not a priority in the agency. However, once the focus group started and a direct question was asked about safety, the response initially indicated that safety was a priority at the department. As the focus group progressed, it seemed that participants were less guarded about providing opinions on this issue and began to provide responses that spoke negatively about the perceived priority of safety from administration.

Firefighters indicated that they looked out for each other and that crews aimed for safety out of obligation to each other. As one EMT succinctly stated, "Nobody wants to see anybody get hurt and we all look out for each other." At times, respondents indicated

Table 21

Safety: Sub-Themes

Role of the individual
"I feel it should be everybody for themselves, for their own safety…If they get stuck cause they're lazy…that's going to be their problems. And they should care enough to try to not let it happen." (Driver)
"It will only change for some people until it affects them. Until they get stuck with a needle or until they get hepatitis…" (Paramedic)
"Some people are just kind of lazy…[T]hey don't want to take the time to use some of the safety equipment we have." (Paramedic)
"The safer, the better. I know I don't want to get hurt." (EMT)
Work environment
"The office [administration], it's a big unknown." (Captain)
"Nobody wants to see anybody get hurt and we all look out for each other." (EMT)
"I have to say my biggest thing about Pasco is that they don't seem to be very aggressive in [safety] programs." (Paramedic)
"On the fire scene, for example, things went bad but the fire went out. And the motto in Pasco is nobody got hurt, so it's OK. The problem is those acts are not addressed. Eventually, on the fire ground, it will lead to an injury…Some people say, "Well, the fire went out and nobody got hurt." (Captain)
"I think it's a priority. I mean, nobody wants to get hurt during the shift; nobody wants anybody to get infected with anything during the shift. And, if you are going to be here for 30 years, potentially, there is a lot of opportunities for getting sick, or getting stuck with a needle, or getting infected…or run over by a car, for gosh sake." (EMT)
"It [safety] is a priority. It's always a priority." (Captain)
"Sometimes it's very questionable about the safety at Pasco County." (Driver)
"It [safety] could be a little lax." (Driver)
"It seems that it [safety] is not a top priority. It is increasingly becoming a priority." (Driver)
"It is probably on the list of priorities, but it's not at the top." (Driver)
"I don't think safety is a priority from the administration's perspective. I think budget is a priority." (EMT)
"I'd say it is not a priority. It's always been after the fact. They're not very progressive; they're reactive. When something happens, then they deal with the issue. But until it happens, they don't worry about it…[2nd participant] I would agree with that – it's very reactive." (Paramedic)

that safety was a priority; at other times, the same participation would advise that it was not. Many of the FFs provided a criticism of the administration in that safety concerns tended to be handled reactively instead of proactively. "On the fire scene, for example, things went bad but the fire went out. And the motto in Pasco is nobody got hurt, so it's

OK. The problem is those acts are not addressed. Eventually, on the fire ground, it will lead to an injury…Some people say, 'Well, the fire went out and nobody got hurt.' " (Captain). The majority of personnel are aware of near-miss situations that have occurred while crews are extinguishing fires. These near-miss situations are usually preventable and the result of either policies or common practices that deviate from best practices within the profession. It is the perception of field crews that the administration does not take steps to improve policies or enforce best practices until a FF is actually injured. One exchange between participants confirmed this concept. "I'd say it is not a priority. It's always been after the fact. They're not very progressive; they're reactive. When something happens, then they deal with the issue. But until it happens, they don't worry about it…[2nd participant] I would agree with that – it's very reactive." (Paramedics).

Training. Input from the focus groups provided valuable information for planning future training efforts aimed at this population. Lapses in training for luer adapters on prefilled medication syringes served as an example of how a simple training could impact behavior. FFs also provided feedback for how new equipment is currently introduced to the field personnel and provided suggestions for future training.

Luer adapter on syringes. In order to use this type of needleless adapter, one must have access to a needleless hub on the IV tubing. These needleless hubs allow for the luer adapter to be screwed on and the medication given without introducing a needle. The alternate is to use a different type of hub into which a needle can be inserted and the medication given. The later was the traditional means of administering IV medication, until the introduction of luer adapters and needleless hubs. It appears that there was a synchronization issue with introduction of the prefilled syringes with luer adapters and

the IV tubing that included a needleless hub. Once this issue was resolved and the correct tubing was available, no official training or clarification was provided. For newer EMS personnel, this was not an issue as they received training in school on how to use the needleless devices. However, this proved problematic for older medics that initially were schooled when there were no needleless options. "We learned to use the device by pulling the green hub off because we did not have compatible tubing at the time. We had no needleless system. Had to pull off green [cap] off…in order to get the needle into the hub." (Driver) "The only time I hadn't seen them used that way [luer lock] is when people aren't educated that the cap is used to be needleless." (Paramedic)

Introduction of new equipment. In response to the discussion about luer adapters and other training lapses, participants offered opinions about the current method of providing information about new equipment. When asked about training on these types of new equipment, the majority of FFs were quick to scoff or chuckle. "This particular agency that we work for, there's no education sent out. They give you a new item to use on the truck, just an example is the syringes like these. And they don't explain anything to you, they just say, "Oh, we've got new prefilled syringes" but that is it" (Paramedic). "The education and the trickle down process down communication process, doesn't work very efficiently. Sometimes, it's three weeks in before you find an e-mail that got sent out" (Paramedic). "It's the one place I've worked that doesn't do specific hands on training…I've never worked anywhere that doesn't do things that way" (Paramedic).

Future training. Lastly, FFs and EMS personnel provided ideas for structuring future training over safer needle devices and prevention of NSI. Provision of an opportunity for 'hands-on' learning of the new device, as well as the need for safety were

identified by participants as critical components in this type of training. "If you just showed one person at each station and told them to tell everyone…" (Driver). "If something changes, have them show the changes and you know how to use it" (Driver). "Specifically include [in training] any new equipment the month we get it or the month before we get it" (Paramedic). "Educate them about safety and say I'm more concerned about safety and you catChing some sort of disease, let's do it the safe way" (Captain).

Post-Intervention Sharps Count

Following the intervention period, a total of 2178 sharps devices from 30 discarded sharps boxes, "red boxes", were counted and classified using the methods previously described. The three main categories of IV stylets, prefilled syringes, and traditional needles contained 1677, 417, and 61 sharps, respectively. Table 22 provides a summary of the category counts for the post-intervention sharps count.

The most frequently occurring unsafe sharps behavior was alteration of the IV safety device (N=50, 2.3% of total sharps), followed by recapping of traditional needles (N=27, 1.23% of total sharps); prefilled syringes with needle exposed or added (N=17, 0.78%); and prefilled syringes with a needle added, then recapped (N=6, 0.28%). IV stylets and prefilled syringes had low percentages of unsafe behaviors when compared to safe or unavoidable behaviors within the same device category, 3% (N=50) and 5.4% (N=23), respectively. However, with the traditional needle category, 44.3% (N=27) demonstrated the unsafe practice of recapping. Within the three main sharps device categories, IV stylets, prefilled medication syringes, and traditional needles, there were increases in safer behaviors and decreases in unsafe behaviors.

Table 22

Total Sharps Counts and Frequencies by Device Type, Post-Intervention

Type of Sharps Device	Count	Percentages	Change in Percentages from Baseline
Total sharps counted	2178		
IV stylets	1677	77.0% of total	0.9%
Safety device activated*	1354	80.7% of IV stylets	6.4%
Failed IV attempt†	273	16.3% of IV stylets	-3.8%
Altered safety device	50	3.0% of IV stylets	-4.5%
Prefilled syringes	417	19.1% of total	0.2%
Luer adapter*	394	94.5% of prefilled syringes	2.8%
Needle exposed/added	17	4.0% of prefilled syringes	-3.1%
Needle recapped	6	1.4% of prefilled syringes	0%
Traditional needle	61	1.6% of total	-1.8%
Uncapped*	34	55.7% of traditional needles	18.8%
Recapped	27	44.3% of traditional needles	-18.8%
Other	23	1.0% of total	1.0%
Intraosseous needles (IO)	4	17.4% of other	-8.2%
Patient's personal syringes	2	8.7% of other#	-65.7%

* Safer, desirable behavior

† Unsafe finding, but necessary behavior when IV attempt fails

Bag of patient's personal syringes, approximately 8, not included in count as they could not be safety disentangled from plastic bag.

Note: Percentages values may not add to 100% due to rounding.

Sharps categories from the baseline and post-intervention sharps counts were compared to identify changes in desirable and undesirable behaviors. Statistically significant decreases in risky (undesirable) behavior and corresponding increases in safer (desirable) behavior were detected for all categories of devices combined (χ^2=25.71, p=0.0000), IV stylets (χ^2=16.87, p=0.0000), and traditional needles (χ^2=5.07, p=0.0244). These findings are presented in Table 23.

Table 23

Comparison of Sharps Counts and Frequencies, Baseline vs. Post-Intervention

Device Category				
	Safer/Desirable Behavior	Risky/Undesirable Behavior	χ^2	p
All categories (IV stylets, prefilled syringes, traditional needles)				
Pre	1858 (90.4%)	197 (9.6%)		
Post	1782 (94.7%)	100 (5.3%)	25.71	0.000*
IV stylets				
Pre	1398 (93.0%)	105 (7.0%)		
Post	1354 (96.4%)	50 (3.6%)	16.87	0.000*
Prefilled syringes				
Pre	429 (91.7%)	39 (8.3%)		
Post	394 (94.5%)	23 (5.5%)	2.69	0.101
Traditional needles				
Pre	31 (36.9%)	53 (63.1%)		
Post	34 (55.7%)	27 (44.3%)	5.07	0.024*

* Statistically significant, $p<0.05$

Apparatus type. As with the baseline sharps count, devices were categorized by apparatus type (engine or rescue) and can be seen in Table 24. When analyzed as an aggregate group (IV stylets, prefilled syringes, and traditional needles), discarded sharps collected from engine apparatus were significantly more likely to have been used in a risky or less desirable manner (Fisher's exact one-tailed test p=0.000). A similar relationship was identified in the prefilled syringes category (Fisher's exact one tailed p=0.000). There were no statistically significant differences found in the occurrences of undesirable behavior and apparatus type in the IV stylet or traditional needle categories, p=0.538 and 0.693, respectively.

Apparatus type and sharps device behavior, pre- and post-intervention. It is useful to examine changes in sharps device categories, in regards to apparatus type, as use of sharps devices on Engines is consistent with the occurrence of critical calls. If call urgency is, in fact, a predisposing factor for unsafe sharps behaviors it is important to

assess whether the targeted behavior change occurs during critical situations. A disproportionate number of prefilled syringes with the needle exposed or added were from engine sharps boxes (35%, N=17).

Table 24

Sharps Count by Apparatus Type and Device Category, Post-Intervention

Apparatus Type	IV with Safety Device Activated*	IV with Safety Device Altered	Failed IV Attempt†	Prefilled: Luer Adapter*	Prefilled: Needle Exposed/ Added	Prefilled: Needle Recapped	Traditional: Uncapped*	Traditional: Recapped	Total∞
Engine	17	0	3	5	6	0	1	1	34
Rescue	1337	50	270	389	11	6	33	26	2144
Total	1354	50	273	394	17	6	34	27	2178

*Safer, desirable behavior
† Unsafe finding, but necessary behavior when IV attempt fails
∞Columns may not add to total column, due to miscellaneous types of sharps not included in this table

Using the Mantel Hanszel Summary Chi-Square, comparisons were made by apparatus type and sharps device behavior for all devices (IV stylet, prefilled syringes, and traditional syringes), as well as each individual device category. Statistically significant ($p<0.05$) changes were found between pre- and post-intervention frequencies of desired and undesired behaviors for all devices ($\chi^2=106.24$, $p=0.000$); IV stylets ($\chi^2=76.41$, $p=0.000$); and prefilled syringes ($\chi^2=31.38$, $p=0.000$). Table 25 summarizes this data.

Medication type. In a manner similar to the baseline sharps count, device categories were stratified by type of medication (ALS vs. all other) as presented in Table 26. For the aggregate count of safer behaviors (IV stylets with safety device deployed, prefilled syringes with luer adapter, and traditional needles uncapped) vs. medication type, a statistically significant decrease in risky behavior was identified ($\chi^2=9.28$,

p=0.002). A similar relationship was identified for prefilled syringes (χ^2=25.30, p=0.000), but not for traditional needles (Fisher's exact, p=0.88).

Table 25

Summary of Apparatus and Sharps Device Behavior Type, Pre- and Post-Intervention

Category	**Engine**	**Rescue**	**χ^2**	**p**
Overall			**106.24**	**0.000***
Pre-Intervention Safe	13	1867		
Pre-Intervention Risky	18	157		
Post-Intervention Safe	23	1759		
Post-Intervention Risky	7	93		
		IV Stylets	**76.41**	**0.000***
Pre-Intervention Safe	10	1388		
Pre-Intervention Risky	16	89		
Post-Intervention Safe	17	1337		
Post-Intervention Risky	0	50		
		Prefilled Syringes	**31.38**	**0.000***
Pre-Intervention Safe	2	427		
Pre-Intervention Risky	0	39		
Post-Intervention Safe	5	389		
Post-Intervention Risky	6	17		
		Traditional Needles	**0.22**	**0.6382**
Pre-Intervention Safe	1	52		
Pre-Intervention Risky	2	29		
Post-Intervention Safe	1	1		
Post-Intervention Risky	33	26		

* Statistically significant, p<0.05

Table 26

Sharps Post-Intervention Count, Prefilled Syringes and Medication Type

Medication	**Prefilled: Luer Adapter***	**Prefilled: Needle Exposed, Added, and/or Recapped**	**Traditional: Uncapped***	**Traditional: Recapped**
Adenosine	4		4	-
Amiodarone	-	-	-	-
Atropine	12	4	-	-
Benadryl	-	-	-	-
D50	8	-	-	-
Epinephrine	8	5	-	-
Glucagon	-	-	-	-
Lidocaine	2	-	-	-
Morphine	4	1	-	-
Narcan	13	1	3	-
Normal Saline	333	9	-	-
Sodium Bicarbonate	5	3	-	-
Unknown	3	-	7	7
Valium	2	-	-	-
Versed	-	-	-	-
Needle Alone	-	-	20	20
Total	**394**	**23**	**34**	**27**

*Safer, desirable behavior

Shaded medications are considered Advanced Life Support (or urgent)

Medication type and sharps device behavior, pre- and post-intervention.

Comparisons were made by medication type (ALS vs. all other) and sharps device behavior for all devices (Prefilled syringes and traditional syringes), as well as each individual device category. There is no category for IV stylet because desirable/undesirable behavior for that sharps device is not related to the administration of medication. For all devices combined, there was a statistically significant decrease in risky behaviors and increase in safer behaviors by medication type (χ^2=68.40, p=0.000). This type of relationship was also displayed for prefilled syringes (χ^2=152.06, p=0.000), but not for traditional needles (χ^2=2.05, p=0.152).

Post-Intervention: Survey

A total of 165 surveys were returned from a total of 383 active personnel, who had been on the job greater than 6-10, 11-5, and >20 years, as shown in Figure 25.

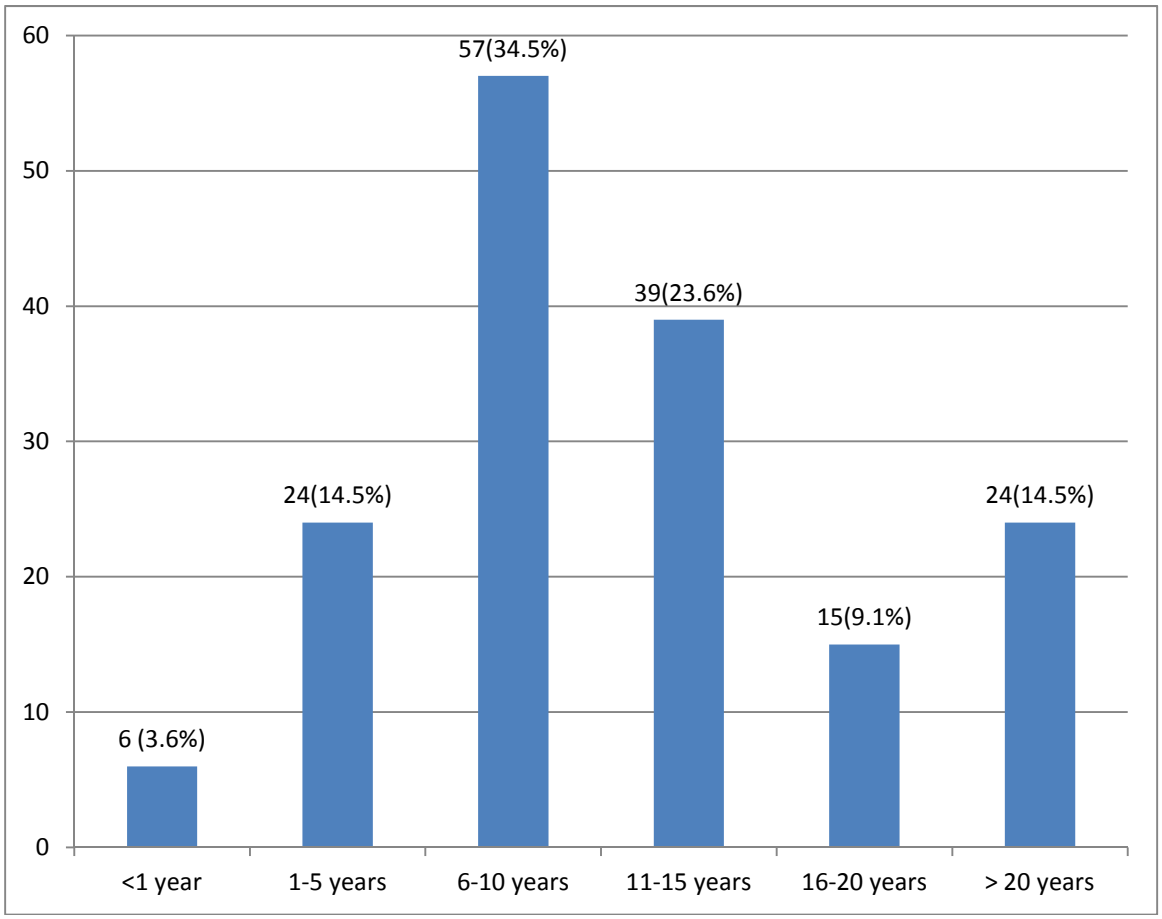

Figure 25. Post-intervention survey respondents by number of years working for PCFR.

Three questions were designed to assess perception of risk and belief that the individual had some control to prevent NSI. In response to the statement, "Needlestick injuries pose a real risk while on the job at PCFR", 4.2% (n=7) indicated they strongly disagreed, 9.7% (n=16) somewhat disagreed, 4.2% (n=7) had no opinion, 27.3% (n=45) somewhat agreed, or 54.5% (n=90) strongly agreed. Eighty-one percent of respondents (n=135) agreed to some extent that NSI posed a risk while on the job. The question, "If I am stuck by a needle or other sharp device while on a call, I would worry about

contracting a bloodborne disease such as HIV or Hepatitis C", elicited 1 (0.6%) strongly disagree, 2 (1.2%) somewhat disagree, 3 (1.8%) no opinion, 32 (19.4%) somewhat agree, and 127 (77.0%) strongly agree responses. Only 6 survey participants, or 3.6%, who answered this question did not perceive a risk of contracting a bloodborne pathogen in the event of NSI. An overwhelming majority of respondents (92.7%) indicated that they either strongly agreed (n=114, 69.1%) or somewhat agreed (n=39, 23.6%) that "there are steps I can take to reduce my risk of NSI while on the job."

Two questions were posed regarding needle preference, either needleless or traditional needles. First, survey participants were presented with the statement, "I use safer needle devices if they are available to me." Answers included 124 (75.2%) strongly agree, 21 (12.7%) somewhat agree, 16 (9.7%) no opinion, 2 (1.2%) somewhat disagree, and 2 (1.2%) strongly disagree. Next, the statement "I prefer to use "old fashioned" needles was introduced, resulting in 2.4% (n=4) and 4.2% (n=7) strongly and somewhat agreeing, respectively; 9.7% (n=16) with no opinion, and 15.8% (n=26) and 67.9% (n=112) strongly disagreeing, respectively.

The remainder of the survey addressed changes in behavior during the time frame of and beliefs about the sharps safety project. Those responses are summarized in Table 27. Responses regarding the impact of the sharps safety project are displayed graphically in Figures 26-28 below.

Table 27

Post-Intervention Survey, Responses to Likert-Scale Questions Regarding Changes in Behavior and Perceived Effectiveness of The Sharps Safety Project

	Strongly Agree	**Somewhat Agree**	**No opinion**	**Somewhat Disagree**	**Strongly Disagree**
I re-cap needles less now than I did six months ago.					
	41 (24.8%)	39 (23.6%)	42 (25.5%)	9 (5.5%)	34 (20.6%)
From my observations, it appears that my co-workers re-cap used needles less now than they did six months ago.					
	43 (26.2%)	44 (26.8%)	50 (30.5%)	10 (6.1%)	17 (10.4%)
Compared to six months ago, I am less likely to get a drop of blood for a blood sugar reading from an IV stylet.					
	21 (12.8%)	37 (22.6%)	27 (16.5%)	51 (31.1%)	28 (17.1%)
From my observations, it appears that my co-workers are less likely to get a drop of blood for a blood sugar reading from an IV stylet now when compared to six month ago.					
	14 (8.6%)	43 (26.5%)	29 (17.9%)	45 (27.8%)	31 (19.1%)
Compared to six months ago, I am more likely to administer IV medications using the luer lock or needleless hub.					
	69 (42.1%)	40 (24.4%)	46 (28.0%)	3 (1.8%)	6 (3.7%)
From my observations, it appears that my co-workers are more likely to administer IV medications using the luer lock or needleless hub when compared to six months ago.					
	68 (41.5%)	50 (30.5%)	38 (23.2%)	5 (3.0%)	3 (1.8%)
Since implementation of the firefighter sharps safety project, I am more aware about sharps safety.					
	59 (36.4%)	70 (43.2%)	18 (11.1%)	6 (3.7%)	9 (5.6%)
Since implementation of the firefighter sharps safety project, my co-workers seem to be more aware about sharps safety.					
	51 (31.1%)	71 (43.3%)	29 (17.7%)	4 (2.4%)	9 (5.5%)
Since implementation of the firefighter sharps safety project, crews are using needles and other sharps devices in a safer manner.					
	39 (23.8%)	80 (48.8%)	39 (23.8%)	3 (1.8%)	3 (1.8%)
The posters about sharps safety were an effective reminder about risky behaviors to avoid with needles and other sharps devices.					
	43 (26.2%)	63 (38.4%)	35 (21.3%)	14 (8.5%)	9 (5.5%)

Note: Total responses may differ by question due to some participants not answering all questions.

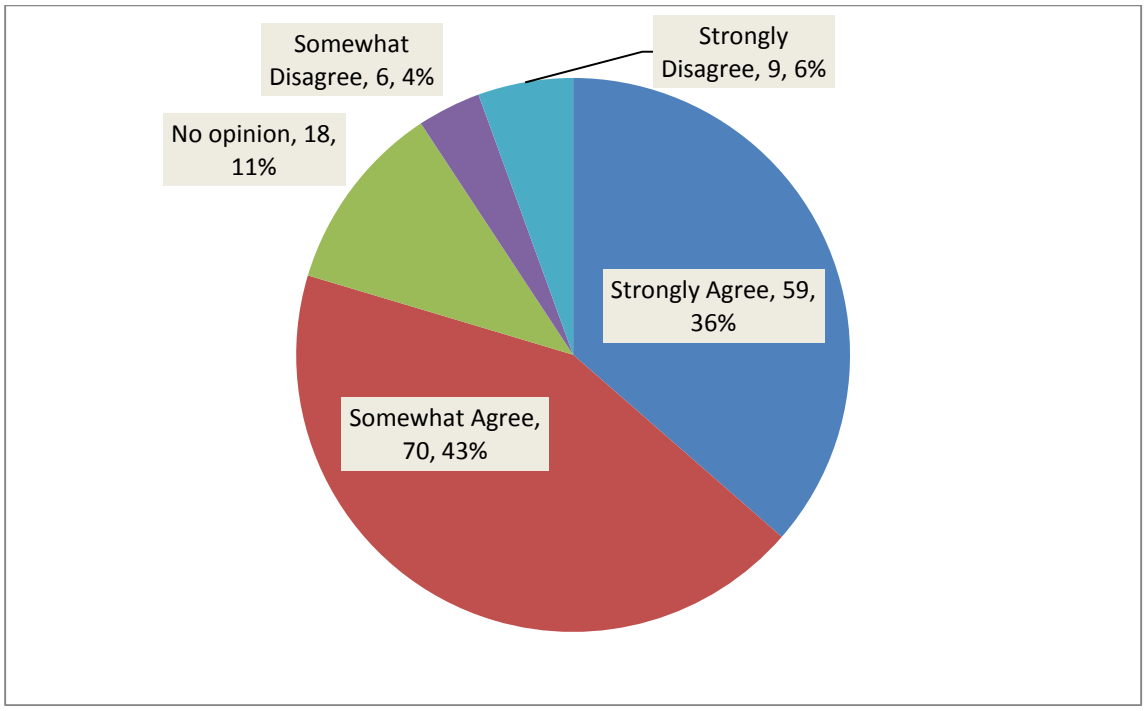

Figure 26. Post-intervention survey, respondents' level of agreement with the statement, "Since implementation of the firefighter sharps safety project, I am more aware about sharps safety."

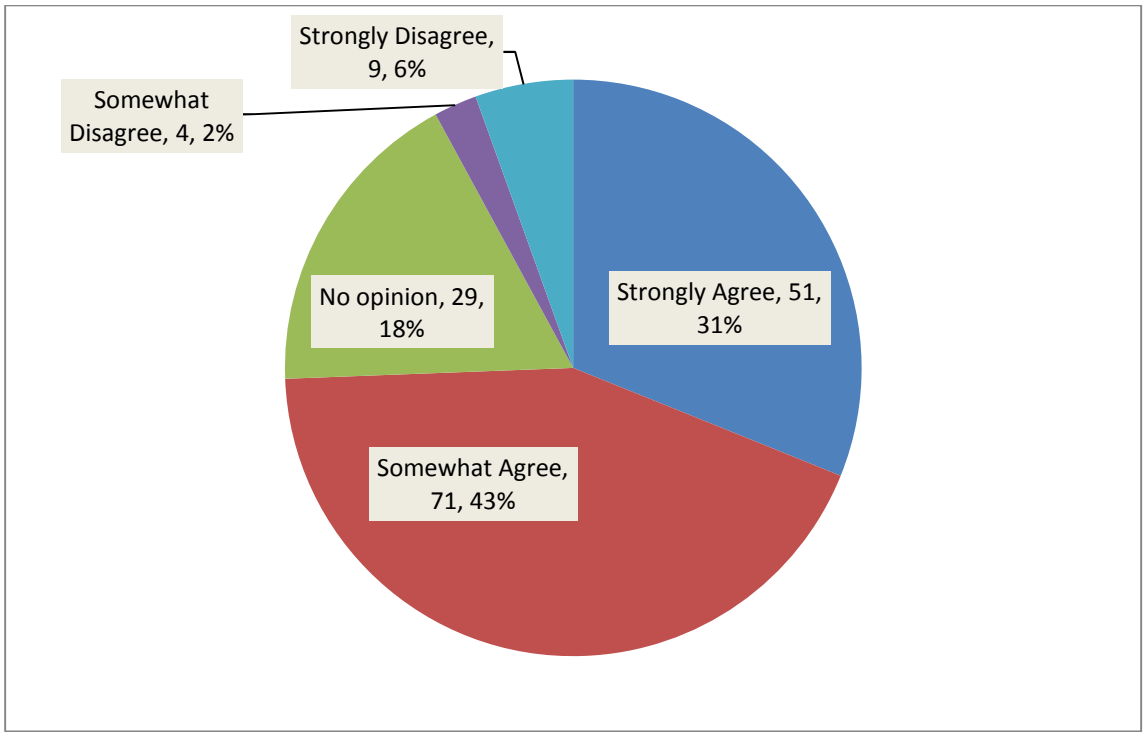

Figure 27. Post-intervention survey, respondents' level of agreement with the statement, "Since implementation of the firefighter sharps safety project, my co-workers seem to be more aware about sharps safety."

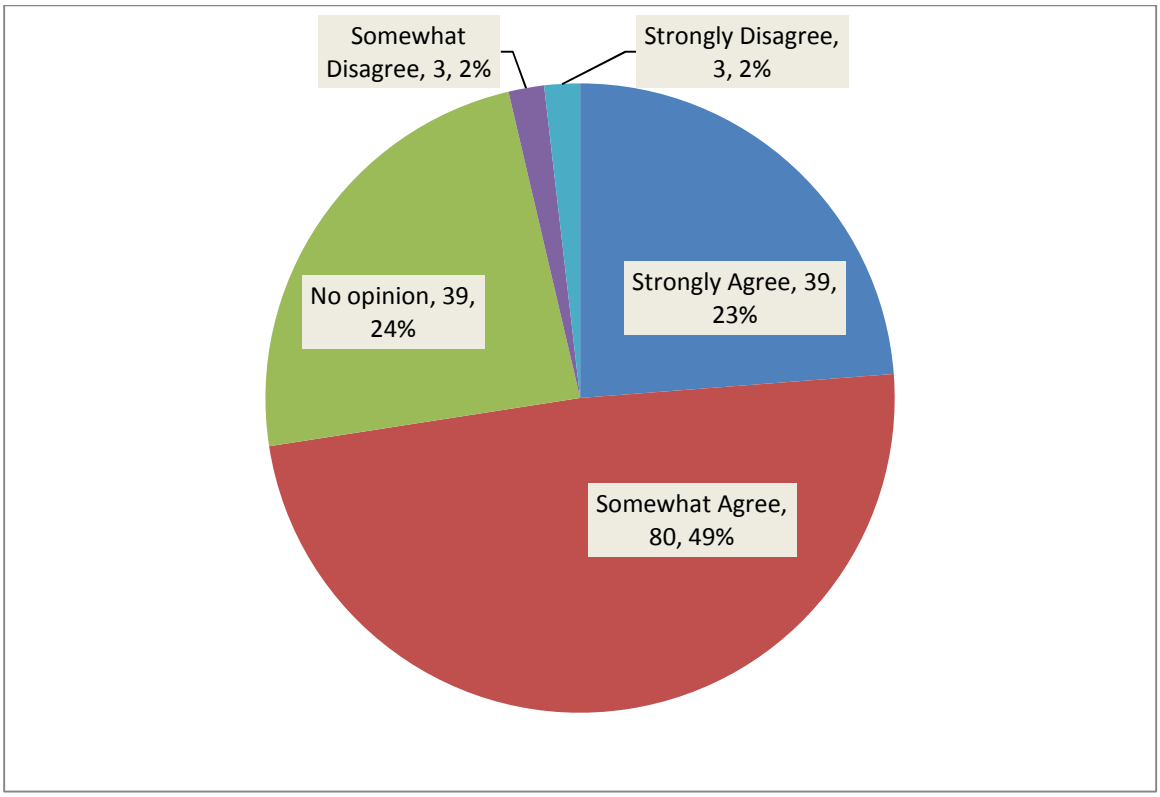

Figure 28. Post-intervention survey, respondents' level of agreement with the statement, "Since implementation of the firefighter sharps safety project, crews are using needles and other sharps devices in a safer manner."

The impact of the presented results on the proposed research questions, as well as identified areas for further research will be discussed in the coming Discussions chapter.

References

Green, L.W. and Kreuter, M.W. (1999). *Health Promotion Planning: An Educational and Ecological Approach* (3rd Edition). Mountain View: Mayfield Publishing Corporation.

Chapter 7. Discussion

This study provided insight into current practices and factors that influenced sharps behaviors in firefighters (FFs) and emergency medical services (EMS) personnel at Pasco County Fire Rescue (PCFR). While some previous studies attempt to quantify bloodborne pathogen (BBP) exposure or NSI rates among EMS personnel, FFs, or public safety officers, these studies do not address the factors and practices that increase the risk of NSI (Reed, Daya, Jue, et al., 1993; Merchant, Nettleton, Mayer, & Becker, 2009; El Sayed, Kue, McNeil, & Dyer, 2011; Averhoff, Moyer, Woodruff, et al., 2002; Marcus, Srivastava, Bell, et al., 1995; Rischetelli, Harris, McCauley, et al, 2001; Chen & Jenkins, 2007; Reichard, Marsh, & Moore, 2011; Heick, Young, & Peek-Asa, 2009; Heick, Young, & Peek-Asa, 2009; Leiss, Ratcliffe, Lyden, et al., 2006; Boal , Leiss, Ratcliffe et al, 2010). Each step of the current study informed gaps in the areas of NSI prevention in FFs and EMS personnel not previously explored, identified opportunities for education and outreach with other FF and EMS populations, and provided areas for future research and inquiry.

PRECEDE/PROCEED Model

Application to the PRECEDE/PROCEED model. The PRECEDE portion of the PRECEDE/PROCEED model (PPM) serves as a construct to conceptualize factors, based on input from the focus groups, that increase or decrease the likelihood that the target behaviors related to sharps safety will be performed.

Target behaviors. The desired target behaviors identified in the initial, quantitative phase of this study included 1) use of the luer adapter on syringes of prefilled medications; 2) use of safety device on IV stylets; and 3) leaving traditional needles uncapped. In addition, the objective was to decrease certain risky behaviors; these were defined as 1) adding a needle to the syringe of prefilled medications, rather than using the needleless option; 2) altering the safety device on IV stylets; and 3) recapping traditional needles. As outlined in the PPM, predisposing, reinforcing, enabling, and environmental factors were developed. The factors presented here are based solely on responses provided by participants of the focus groups.

Predisposing factors. Predisposing factors are defined as a person's or population's knowledge, attitude, beliefs, values, and perceptions that encourage or discourage motivation for change (Green & Kreuter, 1999). EMS personnel and firefighters typically place others' safety and well-being above their own. This focus on patient outcome (life or death) or on the best interest of the patient can influence choices regarding use and disposal of sharps devices simply because the focus on the scene is on rushing and patient care, rather than the crew's personal safety. Additional perceptions and beliefs about the job, risks, and safety impact decisions on whether to use needleless devices and/or dispose of traditional needles without recapping. Predisposing factors are listed in Table 28.

Individual FF, EMT, or medic apathy towards the job and safety certainly impacts choices about safer needle behavior. In particular, lack of focus regarding proper disposal of sharps can be linked to apathy. This apathy, or as described by focus group participants "laziness", manifests itself in lack of code of conduct to seek the proper

means to perform the tasks involved in patient care, including application of safer needle behaviors.

Attitude about and desire to provide medical care, as compared to firefighter duties, directly impacts the apathy discussed above and feeds into decisions and knowledge about safer needle devices. Those employees who believe the EMS portion of the job is a negative thing are less likely to seek out information on new equipment or improved techniques and, therefore, may lack the knowledge or ability to use safer needle options.

A FF's perception of the risk or normalcy of needles in the work environment impacts whether or not they attempt to avoid risky behaviors. If a needle or sharp is simply perceived as a part of the setting and does not register a perception of increased risk, then the individual is less likely to see a need to approach the needle or sharp carefully. Repeated exposure to needles and sharps devices while on the job can contribute to this perception as the individual becomes desensitized to the presence of needles and other sharps devices.

Some FFs or EMS personnel may a strong preference for traditional needles. This preference may prevent a willingness to learn or try new needleless options or to objectively evaluate the risk in using needles in a traditional way. This preference for traditional needles may also be influenced both knowledge of how to use needleless devices or dispose of sharps appropriately and/or comfort level with the needleless and disposal options.

The belief or acceptance that a job in the fire service or EMS is inherently dangerous may discourage learning new behaviors intended to increase safety. If the FF

accepts that the job is dangerous and that this element of risk is a necessary price for working in the field, they are less likely to see the possibility or need for safer behaviors, including needleless devices and appropriate disposal of needles. This belief or acceptance of danger may coincide with a feeling of invincibility or luck ("nothing's gotten me yet") or a perception that the risk of needlestick is minor to other risks faced on the job. If an individual feels that the consequences of NSI are minor compared to being trapped in a house fire and burned, they are less likely to expend energy to avoid what they perceive to be as a minor consequence.

Lastly, FFs and EMS personnel may be predisposed to inappropriately disposing of sharps devices due to a belief that recapping a needle is the safest option in a given circumstance. They may feel that recapping the needle will prevent another crew member from incurring NSI. In this sense, the decision to recap is intended to elicit a protective benefit for other people on the scene.

Enabling factors. Enabling factors are those factors that serve as either barriers or vehicles created mainly by societal forces that help or hinder the targeted behavioral changes (Green & Kreuter, 1999). In this context, the enabling factors exist within the organization and the ways in which the crews work and interact with each other, as well as provision of information and training. Enabling factors identified in the focus groups are listed in Table 28.

As EMTs progress in their careers and then complete their paramedic training, they often incorporate techniques and habits practiced by the paramedic under which they initially worked. Similarly, entry level firefighters learn habits from Drivers and Captains.

Table 28

Predisposing, Enabling, Reinforcing, and Environmental Factors Identified from Focus Group Responses

Predisposing Factors
Focus on patient outcome or best interest of the patient
Apathy towards the job and safety
Desire to provide EMS care vs. firefighter duties
Perception of risk vs. normalcy of needles in the work environment (desensitization)
Preference for traditional needles
Knowledge of how to use needleless options and dispose of needles appropriately
Comfort level with use of needleless devices
Belief/acceptance that the job is inherently dangerous
Perception of invincibility
Belief that consequence of NSI is small compared to that of other job hazards
Perception that recapping will provide safety benefit
Enabling Factors
Exposure to techniques and habits from mentors and more senior personnel
Method taught during training
Individual and crew ingrained work flow and habits
Lack of information/familiarity with new equipment
Unavailability of 'hands on' training and practice
External need for documentation
Reinforcing Factors
Crew response to deviation from established work practice/flow
Co-worker's reactions/ expression of beliefs regarding individual responsibility for NSI
Unknown or negative reaction from administration if NSI occurs
Prioritization of safety from administration
Influence of Captain, enforcement of policies
Environmental Factors
Level of urgency of call
Need to titrate or provide multiple doses of the same medication
Provision of medication in a form that necessitates a needle
Availability of appropriate sharps container
Inconsistency among supplies, including tubing

If the mentor is practicing a behavior that is unsafe or less desirable, that increases the likelihood that the new medic or new firefighter will adopt the practice in future situation. For example, if Paramedic Smith always gives IV medications by adding a needle onto a prefilled syringe and EMT Brown works for Paramedic Smith for 5 years, when EMT

Brown becomes a paramedic, he is more likely to implement the practice of adding needles to prefilled syringes.

Personnel are more likely to adhere to the method of medication administration (needle vs. needleless) and disposal (recapped vs. uncapped) that they were taught during the practical portions of their professional training. For medics who entered the field 15 years ago, needleless options were unavailable. These older personnel tend to prefer the "old-fashioned" needles and shy away from implementing the new, safer alternatives.

Both individuals and crews have established a pattern of obtaining a blood glucose check off of a drop of blood from an IV stylet. This work flow has been repeated multiple times on multiple scenes and is, to a certain extent, ingrained. A crew that has worked with each other over time establishes a means of interacting on a call without verbal communication. In this type of setting, changing the behavior of one individual is unlikely to change the outcome. For example, if a crew has a routine that after every IV start, a drop of blood is obtained for a blood sugar check, someone from that crew will pick up the IV stylet and obtain the drop of blood without being told to do so. In order to stop this practice, the entire crew must perceive the risk and choose to change the behavior.

A lack of communication of information about new equipment introduced to the field leads to a lack of familiarity with the new devices by field crews. Personnel that are unaware of or unfamiliar with the new equipment, such as needleless devices, are less likely to use these devices. To increase comfort levels and likelihood of use for new devices, crews need to have an opportunity for 'hands-on' training and practice. Lack of

provision of didactic training for new devices contributes to the individual's risky behavior in continuing to add a needle to prefilled syringes.

Lastly, the organization places a requirement on EMS personnel regarding documentation needed following an EMS call. Critical situations, where the patient may change cardiac rhythms multiple times and multiple medications may be given, are particularly challenging to document after the fact. At times, the enforcement of documentation policies and punitive response when they are not met are noteworthy. In an attempt to accurately capture the medications given, crews may not immediately dispose of used syringes (with needles) so that they can use the empty syringes as an indication of which medications were given. This external requirement impacts behavior of the individual and crews.

Reinforcing factors. This category of factors encompasses those factors that are based on rewards and feedback received from others once a behavior has been adopted. These factors can encourage or discourage continuation of the target behavior (Green & Kreuter, 1999). Crews often have an accepted and established work flow. Deviation from this work flow, such as immediately disposing of used needles and syringes when they are typically saved for documentation purposes, may elicit a negative reaction from the crew; thus, providing punishment for the target behavior.

Individuals who do sustain NSI or who witness NSI of others, their co-workers' response and expression of the beliefs regarding individual responsibility and fault for NSI may positively impact adoption of safer sharps behaviors in the future. A desire to avoid the negative perception and blame associated with NSI may motivate change in the direction of safety. Similarly, the experienced or anticipated negative reaction from

administration in response to NSI may serve as an impetus for maintaining or adopting safer behaviors.

The expression and examples from administration that safety is a priority can serve as a positive reinforcing factor for the target behaviors. This first step in changing the perception of crews regarding administration's approach and attitude towards safety is likely to have a positive impact on behavior and in improving a culture of safety within the workplace. The influence of the station or crew Captain can be significant in reinforcing behavior. Captains are often in the first-line position to reward or provide discipline for behaviors. Captains who express a dedication to safety and who are quick to enforce existing policies are more likely to have crew members who exhibit the target behaviors.

Environmental factors. In this category, external factors are identified that encourage or discourage the targeted behavior (Green & Kreuter, 1999). These factors are typically not within the control of the individual (Green & Kreuter, 1999). Many of the environmental factors identified relate to the nature of the job, while others are related to supply issues. A summary of these factors can be seen in Table 28.

The level of urgency of the call or the critical status of the patient may encourage risky behaviors such as recapping. The need to titrate or give multiple doses of the same medication might also lead to recapping so that that the medication can be used later in the call. When medications are provided in a form that may necessitate a needle, when the appropriate sharps container is not readily available, or when there is inconsistency among supplies, FFs and EMS personnel may be more likely to engage in risky behaviors or less likely to practice safer behaviors. This inconsistency of supplies impacts both the

logistical opportunity for use of needleless devices but also decreases familiarity and comfort with supplies, including safer needle devices.

Summary of PRECEDE Factors. One of the strengths of the PPM is the description of the interplay between the predisposing, enabling, reinforcing, and environment factors and target/actual behavior. Predisposing, reinforcing, and enabling factors all influence each other, as well as behavior. Enabling factors impact the environment, which also contributes to behavior. Figure 29 displays details for these factors obtained from focus group responses and applied to the PRECEDE portion of the PPM.

The PRECEDE/PROCEED Model as a Framework for Study Design

The PRECEDE/PROCEED model (PPM) was a useful framework for developing the study design. Phase 1 of the PPM, the social assessment, was not necessary as the targeted health issues was identified by the aims and objectives of the study; needlestick injury (NSI) and potential bloodborne pathogen (BBP) transmission were the health issues of concern. The epidemiological and behavioral assessments of phase 2 were collected during the baseline sharps count. The environmental assessment of phase 2 was addressed with focus group responses, as was phase 3, the educational and ecological assessment. Predisposing, reinforcing, enabling, and environmental factors identified during the focus groups have been listed in detail. An informal assessment was made prior to developing an intervention to determine which types of interventions would be non-invasive and likely to garner support from PCFR administration; this informal assessment comprised phase 4 of the PPM, administrative and policy assessment and intervention alignment. The health promotion activity was the promotion of safer sharps

practices. The educational and awareness strategies used included posters, hands-on training, and an added NSI module to an existing, mandatory, bloodborne pathogens training. The policies and regulations of the organization were also informally reviewed; this assessment was aided by the researcher's familiarity with PCFR. Phase 5 consisted of implementation of the intervention. Phase 6, or process evaluation, was not included in this study design. The impact evaluation defined in phase 7 of the PPM was aChieved by the post-intervention survey and the outcome evaluation defined in phase 8 of the PPM was completed by the post-intervention sharps count.

This utilization of the entire PRECEDE/PROCEED model provides a valuable example of how the model can aid in the successful diagnosis, planning, implementation, and evaluation of an intervention. Various studies were located which used the PRECEDE components or just the predisposing, reinforcing, enabling, and environmental factors to conceptualize a problem (Haiduven, 2000; Araujo, 2009; Aboumatar, Ristaino, Davis, et al., 2012; Leonard, Scharff, Koors, et al., 2012; Larson, Bryan, Adler, et al., 1997; DeJoy, Searcy, Murphy, et al., 2000; Han, Baumann, & Cimprich, 1996; McAuliffe, 2007; Nichol, Bigelow, O'Brien-Pallas, et al., 2008; Bautista, Vila, Uso, et al., 2006; Chaffee, Bridges, and Boyer, 2000), but none of these studies used the PROCEED portion of the model. Figure 30 shows the application of the PRECEDE/PROCEED model in this study; phases on the model are shown in black and the corresponding steps of this study are shown in red.

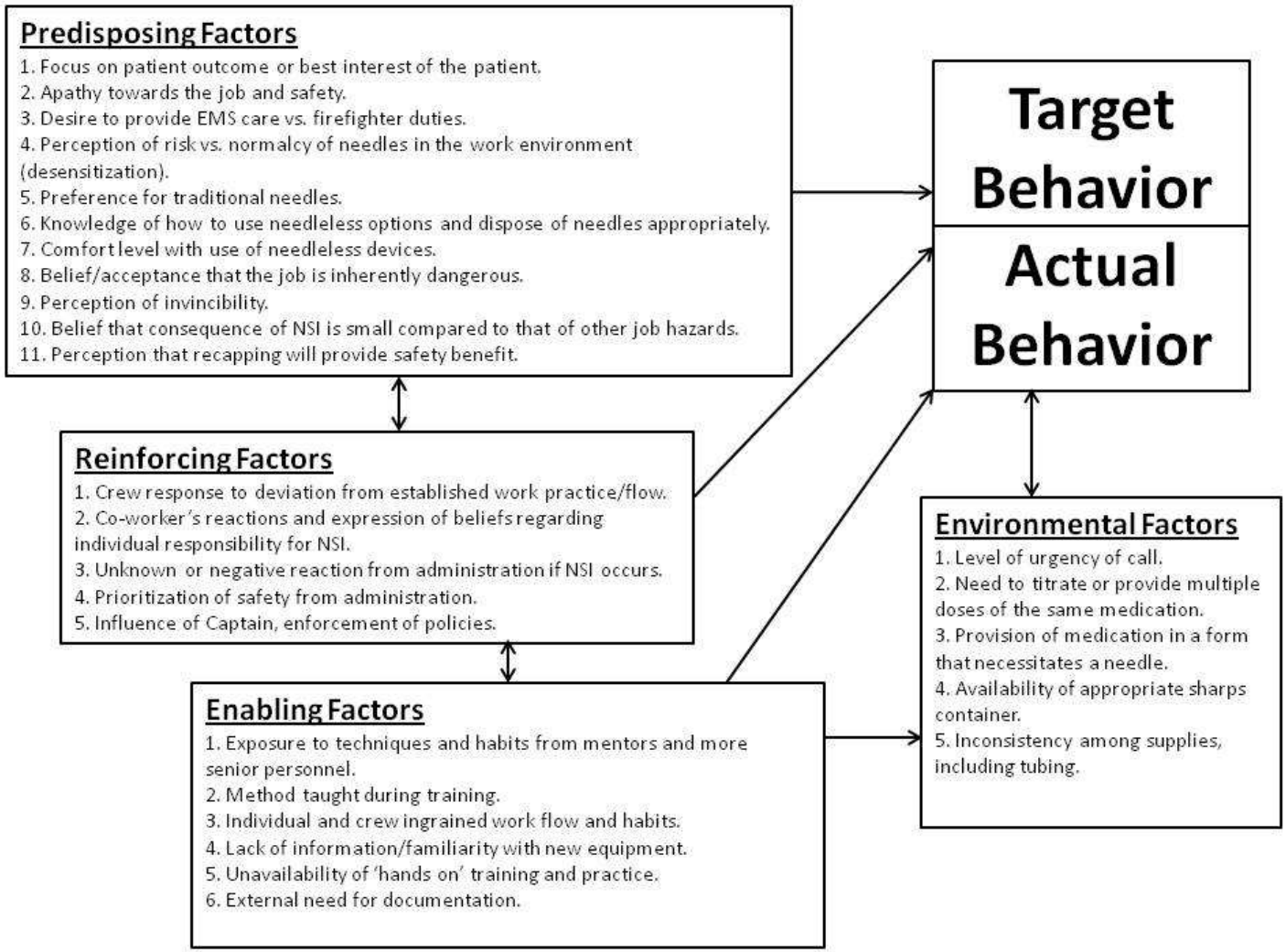

Figure 29. Diagram of PRECEDE components, as informed by focus group responses of Firefighters and Paramedics.

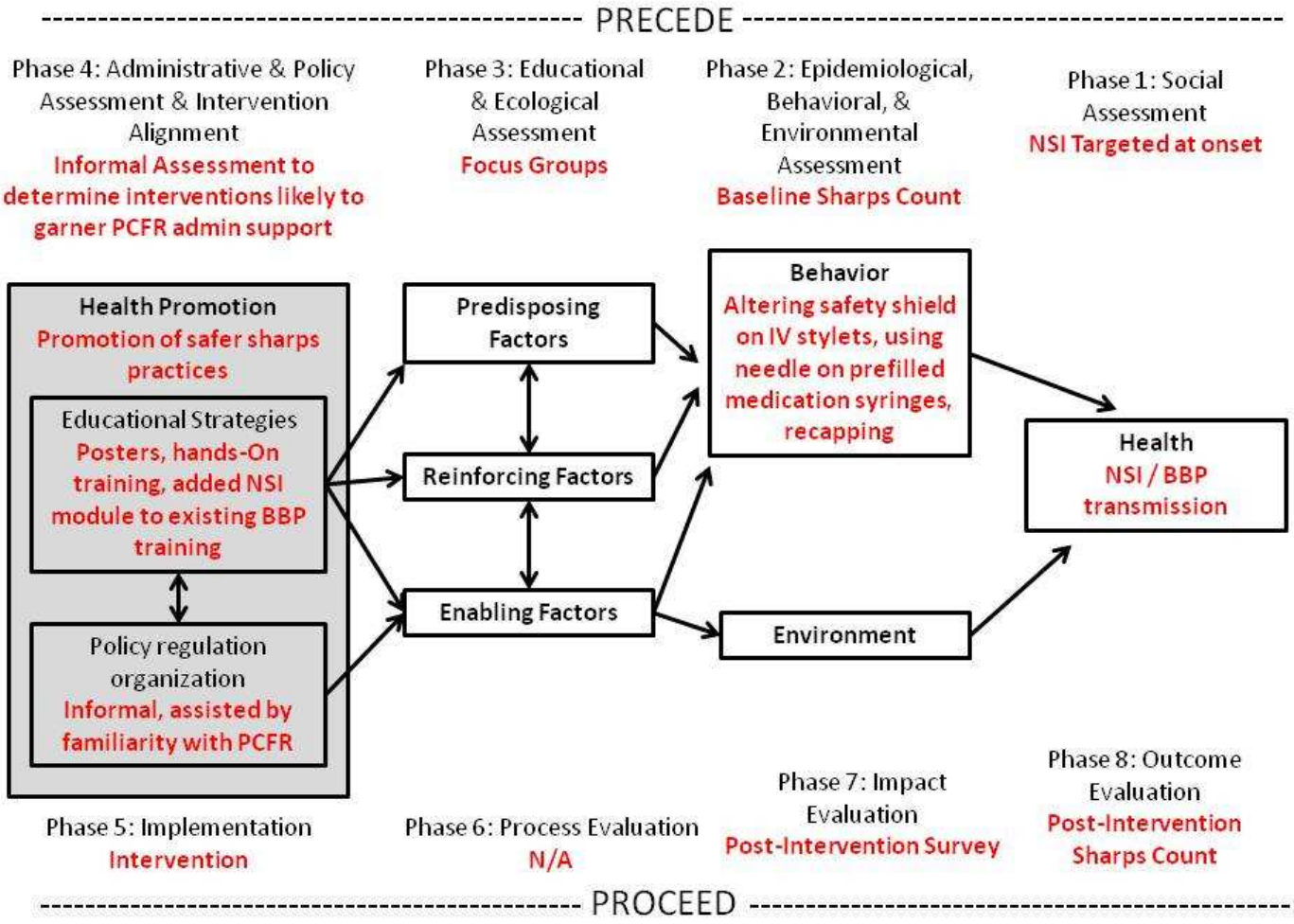

Figure 30. *PRECEDE/PROCEED model and corresponding study design steps used in the Firefighter Sharps Safety Project.*

Similarities with other PPM findings regarding NSI. Haiduven (2000) and Araujo (2009) used the PRECEDE component of the PPM to examine blood exposures and needle safety in home healthcare nurses and needle recapping by nurses in a Venezuelan public hospital, respectively. There are several overlapping predisposing factors in those studies and the current one. Value placed on the safety and comfort of the patient (Haiduven, 2000) and value placed on patient quality care (Araujo, 2009) were similar to the focus or value on patient outcome or best interest of the patient described by the participants in these focus groups. Haiduven (2000) identified knowledge of specific safety devices and use as a predisposing factor, while knowledge of how to use needleless options was an identified factor in the current study. Knowledge of how to dispose of needles appropriately was abstracted from the focus group data for FFs and EMS personnel and also revealed by Araujo (2009). Both Haiduven (2000) andAraujo (2009) listed "attitudes about the safety of recapping" as a predisposing factor; the current findings cite "perception that recapping will provide safety benefit" as a factor.

Study Findings as they Relate to Research Questions

Research question 1: What are the types of unsafe sharps techniques present at Pasco County Fire Rescue (PCFR), as observed in discarded, used sharps? Several unsafe sharps practices and techniques were identified in the baseline sharps count and focus groups. These unsafe or less desirable practices were present, to a lesser degree, in the post-intervention sharps count. Labeled as unsafe practices due to the increased risk of NSI when used, these behaviors included altering the safety device on

an IV stylet; using a needle with a prefilled medication syringe when a luer adapter option was available; and recapping traditional needles after use. Additional sharps risks that were not quantified or targeted in this study included intact, bloody IV cathlons and stylets due to failed IV attempts, patient's personal syringes, intraosseous needles, broken glass medication vials, razor blades, and syringes containing probable illicit substances.

Research question 2: What is the frequency of the unsafe sharps techniques defined in research question 1? The frequencies of unsafe sharps behaviors, primarily IV stylets with altered safety devices, prefilled medication syringes with needles, and recapped traditional syringes/needles, are described in detail in Chapter 6. Noteworthy trends are the increased likelihood of unsafe sharps behaviors among discarded sharps from engine apparatus, as opposed to ambulances, and the increased likelihood of unsafe sharps behaviors with advanced life support (ALS) medications, as compared to all other types of medications. In the baseline sharps count, IV stylets with an altered safety device were the most commonly identified sharps risk by count and frequency (n=105, 7.5% of IV stylets, 2.4% of all sharps counted) . Recapped traditional needles presented the highest frequency of risky behavior within device type category and the second highest frequency of all sharps counted (n=53, 63.1% of traditional needles, 2.1% of all sharps counted).

Research question 3: What sharps practices occur in this fire department (FD) that increase the likelihood of occupationally-acquired needlestick injury (NSI), as identified in focus groups of firefighters (FFs) and emergency medical services (EMS) personnel? Using photographs of sharps devices observed in the baseline sharps count, focus group participants identified several unsafe sharps practices

that were likely to increase the possibility of occupationally acquired NSI. These unsafe practices included altering the safety shield on IV stylets in order to obtain a drop of blood for a glucose level; recapping needles; disposing of needles places other than approved sharps boxes, such as the seat cushion in the ambulance; and neglecting to use the luer adapter feature on prefilled medication syringes.

Research question 4: What factors are present that affect unsafe sharps techniques and practices in this population? Input from the focus groups was extensive and revealed multiple issues related to sharps safety within PCFR. In regards to disposal of sharps, including the unsafe practice of recapping, personnel perceived that recapping provided protection from NSI when appropriate disposal boxes were not available. Additional factors related to disposal included lack of disposal options, such as full or missing sharps boxes and challenges presented in disposing of the large D50 syringe. Several factors likely to be unique to EMS were identified that increased the likelihood of sharps unsafe practices such as increased level of call urgency, need to administer ALS medications, rendering care in a location other than the back of an ambulance, and need to obtain a blood sugar level. Factors within the individual such as apathy, desensitization, preference, and habit were also identified as contributing to use of less desirable practices.

The lack of space within the ambulance and the need to provide patient care while the vehicle was in motion were listed as factors inherent to the job that increased the risk of NSI. In large frequencies, focus group participants cited a lack of training regarding new equipment in general, including prefilled medications with the luer adapter option, as an issue that impacted sharps behaviors.

Research question 5: What is the culture of safety as perceived by PCFR personnel and how does this culture impact the occurrence of unsafe sharps techniques and practices? Focus group participants provided mixed input regarding culture of safety. Prior to the start of formal focus group sessions, which included digital audio recording, personnel discussed various safety issues and concerns which portrayed the administration and safety culture at PCFR in a negative light. At the onset of the focus groups, members seemed to provide the "acceptable" answer that safety was a priority within the organization. However, as the sessions progressed, participants provided more negative information about safety. Overall, personnel seemed to feel that the administration of PCFR addressed safety issues in a reactive, rather than a proactive manner, waiting for a consequence to occur before action was taken. Some participants perceived that administration had an unpredictable response in NSI were reported or had budget as a higher priority than safety.

Research question 6: Can an intervention tailored to this population impact the frequency of unsafe sharps techniques? Focus group participants consistently provided advice for simple interventions that could improve sharps safety behaviors, including training on how to use existing and new devices, emphasizing personal risk, and need for a "hands-on" component to the training. These suggestions were used to target the unsafe behaviors identified in the baseline sharps count and the focus groups: altering the safety shield on IV stylets to obtain a drop of blood for a glucose level; using a needle on a prefilled medication syringe instead of the luer adapter option; and recapping used traditional syringes/needles. The formal intervention included a series of four posters to increase awareness and remind personnel about safer needle behaviors and

the risks of less desirable practices, an added NSI prevention module to existing annual, required bloodborne pathogen training, and a hands-on training program for needleless devices. In addition, the focus groups, in themselves, served as an education and intervention opportunity. Several participants provided informal feedback following their focus groups regarding addressing safety issues with their own crews or expressing appreciation for the opportunity to voice safety concerns.

In the post-intervention evaluation phase of the study, the null hypothesis was developed: H_0 = There will be no detectable decrease in risky sharps behaviors in the post-intervention sharps count compared to the baseline sharps count. Data collected from the post-intervention sharps count provided overwhelming evidence of behavior change towards safer practices. Statistically significant decreases in risky behavior were identified in the following categories: all categories of devices combined (IV stylets, prefilled syringes, traditional needles); IV stylets; traditional needles; all categories of devices combined when stratified by apparatus (engine or rescue); IV stylets when stratified by apparatus; prefilled syringes when stratified by apparatus; all device types combined when stratified by medication type (ALS or all other); and prefilled medications when stratified by medication type. Therefore, the null hypothesis was rejected.

The post-intervention survey included questions requiring self-report about decreases in risky behaviors, as well as reporting on observations of risky behaviors of co-workers. Responses for these questions provided results that initially appeared to conflict with the significant decreases identified in the post-intervention sharps count. For example, for the question, “I re-cap needles less now than I did six months ago”,

20.6% (n=34) strongly disagreed and 5.5% (n=9) disagreed to some extent. Upon review of the comments provided by survey respondents, it appears that personnel who said they never recapped, even at baseline, responded with "strongly disagree". This would tend to skew these survey results to appear that the intervention was not effective, when the sharps count results shows statistically significant findings supporting the conclusion that behavior change occurred.

One area of the survey that did appear to be consistent with the sharps count findings, were questions relating to use of the luer adapter on prefilled medication syringes, both for self and co-workers. This is an important finding, as this one needleless option was identified in the focus groups as one in which no training had been provided prior to the intervention.

Research question 7: Can an intervention tailored to this population improve the culture of safety regarding sharps use and NSI? Responses to the post-intervention survey indicated that 81% (n=153) strongly or somewhat agreed that NSI posed a risk on the job at PCFR and only 3.6% (n=6) of respondents did not perceive a risk of HIV or Hepatitis C in the event of NSI. An overwhelming majority agreed to some extent (strongly or somewhat) that there were steps they could take to reduce their own risk of NSI while on the job (n=114, 69.1%). In other words, for most personnel, there is a perception of risk of NSI, of potential consequences of NSI, and a belief that the individual can protect themselves to some extent.

Survey participants were also asked three questions that started with "Since the implementation of the firefighter sharps safety project…" to assess possible changes in attitudes, knowledge, and practices. The first question in this group, "…I am more aware

about sharps safety" elicited a positive response, with 36% strongly agreeing (n=59) and 43% somewhat agreeing (n=70) to the statement. The next question, "…my co-workers seem to be more aware about sharps safety" resulted in similar feedback (31% strongly agreeing and 43% somewhat agreeing). The last question, "…crews are using needles and other sharps devices in a safer manner", obtained strong agreement from 23% (n=39) and somewhat level of agreement from 49% (n=80) of respondents. These questions provide some insight into the evolving culture of safety regarding NSI within the organization and suggest a move towards the adoption of safer sharps device practices

Limitations and Strengths of the Study

There are several strengths and limitations to this study, influenced by the role of the investigator; sample technique and sample selection; focus group, baseline sharps, and post-intervention study design. The mixed methods, multi-phase design allowed for triangulation of data in the diagnosis phase (Phase 1), that is beneficial in minimizing threats to internal validity (Creswell, 2009). Table 29 summarizes the strengths and weaknesses as discussed below.

The role of the principal investigator as a firefighter/paramedic within the community allowed access to this special population that is typically closed off to "outsiders". Without this "insider" status, it is unlikely that a researcher would be granted access or receive feedback from this population. However, this strength can also serve as a weakness in the form of bias within each step of the study. An emerging concept of "embedded researcher" supports the role of a researcher who also participates as a team member within the organization that is under study (Lewis & Russell, 2011; Reiter-Theil, 2004; Nevo, 2001). With this approach, the researcher holds or obtains an

in-depth knowledge of the organization that can provide significant benefit to the effort under study. An essential tenet of this approach is that the research effort is still considered separate from the daily operations of the organization itself, so that the researcher is simultaneously part of and separate from the organization (Lewis & Russell, 2011). Efforts were made within each phase of the study to reiterate the investigators affiliation with the University, display the adopted logo of the project and, in doing so, identify the project as a separate effort. All station visits and focus groups related to the project were conducted in street clothes, rather than in uniform. All focus groups were completed in a neutral location, not affiliated with the fire department.

Sampling technique and sample selection. The sampling method used for this study was purposeful. In both the baseline and post-intervention sharps count, stations were chosen for inclusion to represent stations with varied levels of call volume and geographical location. This study could not use a control group within Pasco County Fire Rescue (PCFR), such as a group of stations that did not receive the intervention, due to the fact that personnel from different shifts and stations are re-assigned on a regular basis to meet the staffing needs of that particular day. Therefore, no particular staff, station, or shift is isolated from the others. The possibility of using a second fire department as a control was considered, but rejected due to the unique characteristics of culture of safety, agency policies and procedures, supplies, and daily operations that influence sharps behavior vary widely from one fire department to another. Creation of a control group from another fire department would have weakened internal and external validity, as these factors that are known to influence behavior, are too complex to be accurately matched between departments.

Table 29

Summary of Study Strengths and Weaknesses

	Strengths	**Weaknesses**
Study Design	Triangulation of data via mixed methods, multi-phase design	
Role of Investigator	"Embedded researcher" Access to unique population	Potential for bias
Sampling Technique and Selection	Purposeful Stations for sharps collection representative of call volume and geographic location	No control group
Focus Groups	Focus groups separated by rank Large amount of qualitative data re: NSI and risky practices	Self-selected Only one group with Captains Potential for participants to be influenced by other members' of the group
Sharps Counts	Collection over a period of 2 weeks	Personnel aware that boxes would be collected, may have influenced behavior – Hawthorne effect
Post-Intervention Survey	Anonymous	Self-selected Concern with wording and available answers of some questions Culture of safety not adequately addressed in survey

For the focus groups, participants self-selected. This self-selection can be a threat to internal validity, as there is no means to assess whether employees who volunteered for the focus groups were fundamentally different from those who did not (Creswell, 2009). Efforts were made to recruit volunteers from all ranks (EMTs, paramedics, drivers, and captains) to aChieve homogeneity within groups. Focus groups for these individual ranks were kept separate from each other so that responses would not be influenced by the presence of a superior rank or a subordinate and to create heterogeneity

between groups. Only one focus group was conducted with Captains, as that rank was resistant to recruitment for participation, and may have led to underrepresentation from this rank. There are several potential reasons that the Captain group was not easily recruited for participation: 1) Captain's salaries tend to be higher than those of lower ranks, therefore the offered gift card of $40 for participation may have not have had the same motivation; 2) Captain's tend to be fairly removed from providing medical care on scene and, therefore, may not have had much interest in participating in a focus group related to a medical topic; 3) Captain's tend to have been employed with PCFR for a longer duration than those of other ranks, are more likely to be approaChing retirement, and may, therefore, be less invested in bringing about changes to the department.

The post-intervention survey was provided to all field personnel. Due to confidentiality concerns, demographic data was not collected on the surveys and there is no comparison available regarding survey respondents compared to those who did not respond. For this reason, it cannot be determined whether the group that returned surveys is representative of the department as a whole, thereby introducing a threat to internal validity.

Focus groups. The focus groups were successful in collecting a large amount of qualitative data regarding NSI and risky sharps practices. The risk in conducting focus groups is that groups will interact in such a way that individuals provide the response they believe is expected or will be approved by other group members. To avoid this problem, the introduction and questions for the focus groups were scripted, reviewed by two professors (Donna Haiduven and Jaime Corvin) prior to implementation, and administered in the same way with each group (Kreuger & Casey, 2009). Systematic

data collection procedures in the form of field notes and digital recording were used to insure that the data were accurately collected for analysis. Coding techniques and analysis were constructed with finite definitions and overseen by a professor with expertise in qualitative analysis (Jaime Corvin) and this protocol was implemented when analyzing all focus group transcripts (Kreuger & Casey, 2009).

Participants were encouraged to express views and no agreement, disagreement, or judgment was expressed by the moderator in response to these views. While focus group participants were known to and familiar with the moderator (Christine McGuire-Wolfe), there was evidence of disagreement between group participants, as well as wide variety of opinions. Discussions were, at times, lively between participants with differing opinions. Participants did not appear to be fearful or shy about expressing an unexpected or unpopular opinion. The presence of these techniques and behaviors suggest that the potential for bias or led responses in the focus groups was minimized.

Baseline and post-intervention sharps count. Personnel at stations where discarded sharps boxes were collected were aware that the boxes would be opened and examined. They were also aware, particularly in the post-intervention sharps count, which behaviors were "desirable" and "undesirable." Therefore, personnel at these stations may have altered their behavior because, essentially, they knew they were being watched. This phenomenon has previously been identified as the Hawthorne effect (Teddie & Tashakkori, 2009). The sharps boxes were collected over a period of 2 weeks, rather than a day or two. To maintain altered behavior over this longer period of time would be more difficult and tedious. In addition, the sharps practices and behaviors targeted for examination are often completed by rote memory during a call, based on

training and habit, which suggests that efforts to change sharps practices merely for the purpose of providing expected findings for the researcher would be fleeting, at best. Lastly, it could be argued that an attempt to engage in safer sharps behavior when one is aware that they are being observed signifies that the individual is aware of what type of behavior is safer and/or desirable and is able to effect the change in their behavior to display that result. If present, this occurrence suggests that 1) there is a level of knowledge about what type of behavior should occur and 2) the individual is able to knowingly perform the preferred technique.

Post-intervention survey. The post-intervention survey was intended to provide insight into changes in frequency of unsafe sharps techniques (research question 6) and changes in culture of safety regarding NSI (research question 7); however, some of the comments provided by survey participants to certain question suggested that an additional possible answer should have been offered with the statement, such as "In the past, I did not recap used needles. My behavior has not changed." Some participants who felt they already practiced safer practices, answered survey questions, like "I re-cap used needles less now than I did six months ago" with "strongly disagree." This mismatch of intended meaning and submitted responses is problematic in interpreting the survey data. Additionally, while responses to some of the survey questions do provide input regarding culture of safety regarding needle, it is felt that in order to obtain a thorough understanding of changes in culture of safety, a second set of focus groups would be needed. While attempts have been made by other researchers to capture the concept of culture of safety in the hospital setting via questionnaires, there was no standard tool used among varies research groups and the specific constructs within the

culture of safety differed among studies (Gershon, 1996; Grosch, Gershon, Murphy, et al., 1999; Gershon, Vlahov, Felknor, el al., 1995; Gershon, Karkashian, Grosch, et al., 2000; Clarke, Sloane, & Aiken, 2002; Clarke, Sloane, Rockett, et al., 2002; Alvarado-Ramy, Beltraim, Short, et al., 2003). The evolution of a culture of safety is a complex phenomenon that may require a qualitative approach to explore more thoroughly.

Implications

For Pasco County Fire Rescue. The baseline sharps count and focus groups revealed several issues or areas for action within PCFR that were not addressed by the intervention in this study. One concern that focus groups consistently voiced and was validated by findings of the sharps counts is the inconsistency among supplies of medications. The same medication, for example D50, may be provided in a prefilled medication syringe, a traditional syringe, or in a vial. This leads to confusion among the crews, especially during critical calls. In addition, these changes are often not communicated to the field personnel prior to implementation. While there are some external factors, such as national drug shortages, that affect which types of devices the medications are delivered in, there are internal purchasing issues within PCFR that should be resolved. Primarily, "low bid" or cost should not be the determining factor in which type of delivery device is selected for a particular medication. When decisions are made regarding the type of device to be stocked on the apparatus, a representative panel, including field personnel, should provide input.

Issues with the availability of appropriate sharps disposal boxes are a contributing factor to improper sharps disposal. Sharps disposal boxes may be full, an incorrect size, or missing from the assigned location. Enforcement of existing written policies regarding

emptying a sharps box when it is 75% full and immediately replacing it and maintaining an extra supply of replacement sharps boxes on the ambulance should be reinforced and enforced to address this issue. Focus group participants reported confusion regarding which size and type of sharps box to order due to the wide variety and confusing numbering system from the supply division. Various types of ambulance designs require different sizes and styles of sharps boxes. A clarification manual or other listing of the vehicle identification numbers and the corresponding sharps box to order would be helpful in alleviating this confusion.

As with many merged fire rescue and EMS agencies, the priority on the EMS side of the agency is sometimes below that of the fire suppression activities. This attitude can influence the way that officers respond to "near-misses" such as used, bloody, uncapped needles in the back of the ambulance at shift change. This emphasis or favoritism for the fire side of the job will be difficult to eliminate; however, one step towards valuing the EMS aspects of the job is to enforce existing policies and document breaches. In addition, a new policy should be drafted to require that "near-misses" for NSI be documented and submitted for review at the existing safety committee. Depending on the circumstances surrounding the near-miss, i.e. blatant and repeated negligence, a disciplinary issue may exist, but these near-misses are also important for identifying training needs or the need for policy clarification.

Participants in the focus group noted that, at times, used syringes are left on the floor of a residence or on the bench seat in the ambulance to assist the paramedic with documenting the medications given during a cardiac arrest. If the used syringes are saved, then the crew is able to obtain the total dose given of each medication for the

patient care record. There are alternate options currently available to accurately document medications given during a code. The cardiac monitor/defibrillator, which is an essential piece of equipment present on all calls, has a code documentation feature. A touch screen displays all available medications; if an employee pushes the medication button when the dose is delivered, it will be documented on the cardiac rhythm strips with a time stamp. In past years, it was not uncommon to have one paramedic on the scene of a code, assisted by multiple EMTs. Therefore, job tasks that required paramedic attention, including documentation of medications given, were prioritized. Recently, the staffing and availability of paramedics has improved within the agency such that multiple paramedics are available on scene. Therefore, one paramedic of this group could be delegated as the "recorder" for the code and note times and doses of medications as they are given. This technique of an assigned "recorder" is common in the hospital setting. Currently, neither of these techniques is used but either could be implemented with simple training and policy revision.

While both administration and field personnel routinely comment on poor morale among personnel or a feeling of hopelessness to change work conditions, both administration and field personnel willingly volunteered and cooperated with this study. Administration provided no obstacles to soliciting input from crews or from implementing the intervention. Personnel at all ranks volunteered for the focus groups and appeared to participate in an open and sincere way. Several focus group participants approached the investigator after the group to express appreciation for an opportunity to discuss the issues, express that talking about the problems made them feel empowered, or to discuss the issues further. This type of involvement from both administration and the

field suggests that a similar approach of eliciting input via focus groups or survey to plan an intervention for a problem may be beneficial to both conflict resolution and improving morale within the department.

For the wider audience. Input from emergency medical technicians (EMTS), paramedics, drivers, and captains identified several themes regarding sharps safety and risky practice that are unique to the fire service or EMS: call urgency, the location of patient care, limited space in the back of the ambulance, and providing patient care in the back of a moving vehicle. Previous exploration has identified the critical status of a patient as a risk factor for NSI or blood exposure (Reed, Daya, Jue, et al., 1993; Chen & Jenkin, 2007). Studies of hospital-based personnel defined additional risk factors for NSI associated with overcrowded work areas, poor lighting, combative patients, and being rushed or fatigued (Knapp, Grytdal, Chiarello, et al., 2009; Fisman, Harris, Sorock, et al., 2003; Fisman, Harris, Rubin, et al., 2007). These factors are all present in the unique work environment and warrant further emphasis for injury prevention. One EMT summarized the regular risk faced by crews, “Because we're not in a controlled environment, a nice, clean hospital room, we're in a truck that's moving down the road, bouncing all over the place...and then you've got combative patients.”

The review of existing regulations clearly delineates a gap in the oversight of occupational health and safety among FFs and EMS workers employed by state or county agencies. This gap must be addressed at the state level, either through new legislation, new regulations established by the Department of Health, Bureau of EMS, or by the Florida Firefighter Occupational Safety and Health Administration (FFOSHA). In an era

of tightening budget, fire and EMS agencies are unlikely to implement new safety devices that may cost slightly more without legislative or regulatory pressure to do so.

Information on unexpected sharps risks identified in the baseline sharps count: intraosseous needles, patient's own syringes, broken glass medication vials, razor blades, and syringes with probable illicit syringes should be disseminated and discussed with EMS personnel and FFs at the national level, as these risks are not usually topics of general discourse. One credible and efficient way to spread this information would be through a National Institute for Occupational Safety and Health (NIOSH) alert.

One unavoidable sharps risk that was identified in the sharps count related to attempts to start an IV that were not successful. The unsuccessful attempts required that the IV stylet and cathlon be withdrawn from the patient's arm as one unit. As a result, the safety shield that covered the sharp end of the stylet was not activated. There is no safety device or change in practice that can avoid the occurrence of these intact IV devices that pose an increased risk for BBP transmission in the event of an NSI. This is because they are a hollow-bore device with a reservoir of potentially contaminated blood at the distal tip. It is important to notify the manufacturer to the device (B. Braun Medical, Inc; Irvine, California) so that future product development and improvement efforts can address this design flaw.

Future Research and Outreach

This study was designed to investigate safety issues with the specific sharps devices available and used at PCFR. Other agencies are likely to have an overlap in devices, but may use devices not included in the current study. Therefore, replicating the baseline sharps count and associated focus groups at additional fire departments and EMS

sites would identify additional sharps practices and factors that may increase the likelihood of occupationally-acquired NSI.

The problems of NSI and lack of NSI prevention within the fire service or targeting EMS personnel are largely ignored. Following data collection about other factors and practices impacting NSI and sharps safety at other agencies, an intervention program targeting this population at the national level should be developed. Findings about the effectiveness of the intervention at PCFR would likely serve as evidence that an intervention can improve the safety of FFs and EMS personnel. The awareness posters and hands-on training program used at PCFR can serve as a pilot project for future development of additional posters and educational supplies for a wider audience.

Some factors listed as impacting the frequency of riskier sharps behavior bear further exploration, in themselves. These include: 1. the divide between EMS and fire duties and the perception that EMS duties are less desirable; 2. the role of "invincibility" or the "tough guy" mentality as it impacts risk taking and culture of safety within the workplace; and 3. the concept of desensitization to needles and blood over time.

Focus group participants did not cite fatigue as a factor contributing to risky sharps practices; however fatigue has been associated with NSI in hospital-based personnel (Fisman, Harris, Sorock, et al., 2003; Fisman, Harris, Rubin, et al., 2007). The focus group questions were designed to ask specifically about risky sharps practices, not risk factors for NSI. Future inquiry into risk factors for NSI, including the role of fatigue, would be beneficial in targeting additional areas for intervention to reduce occupationally related NSI.

Several topics tangential to the research questions were identified during the focus groups. While not included in the current effort, future research should address these issues in the interest of enhanced safety for FFs and EMS personnel. Participants spoke about the stigma and shame of needlestick injury, including reluctance to report NSI to administration and co-workers. One EMT advised, "A paramedic getting stuck with a needle is like a cop shooting himself in the foot with his own gun." While previous studies have demonstrated a trend of underreporting for NSI and blood exposures among EMS personnel, FFs, and healthcare workers, these studies did not explore the factors contributing to under-reporting (Carillo, Fleming & Lee, 1996: Boal, Leiss, Sousa, et al., 2008; Boal, Leiss, Ratcliffe et al, 2010; Centers for Disease Control, 2010). It is likely that there are predisposing, reinforcing, and enabling factors in the form of knowledge, attitudes, beliefs, and fire department culture that impact NSI under-reporting. To effectively address and improve on this issue, these factors must first be delineated.

One EMT of more advanced age spoke at length about his experience responding to emergency medical services (EMS) calls during the early days of the AIDS epidemic. Pasco County was predominantly rural at that time and relatively sheltered from urban trends. Experiences of FFs and EMS personnel in regards to sources of information, provision of patient care, fears, beliefs, and attitudes are important historical pieces of the initial AIDS epidemic in the United States that should be documented and explored. These stories may also provide lessons for communication, risk perception, and reaction to future epidemics. Many of the public safety personnel active in the early 1980s have recently or are approaching retirement age; opportunities to interview these personnel will dwindle over time.

Sharps Safety Challenges in the Fire Service and Emergency Medical Services

Within the last 18 months, there have been several national medication shortages, particularly involving prefilled medication syringes (USDA, 2012). These shortages were due to closure of some medication manufacturing and distributing facilities or simply a manufacturing shortage and impacted several advanced life support medications, including Atropine, Epinephrine, Amiodarone, Sodium Bicarbonate, Lidocaine, Lasix, Valium, and D50. While prefilled medication syringes are the preferred and safer method for delivering IV medications to patients, alternate methods were needed to stock ambulances during these shortages. Alternate methods included the provision of the medication in the same dose in a vial requiring it to be drawn up in a syringe prior to administration; providing the medication in a traditional syringe with no safety feature; or providing the medication in a different concentration than previously stocked, requiring that the medication be mixed with a needle and syringe in some fashion. It is likely that these medication shortages will continue on a sporadic basis. As the availability of medications in various forms and devices changes, it is important that the field crews who are actually administering the medications are aware of the changes prior to opening the box to give the medication. As these notifications are dispersed, it is crucial that messages about how the temporary solutions for the shortages are to be implemented also contain instructions about how these alternatives can be executed in a way that implements safer needle practices.

To effectively address NSI and safety issues that contribute to a workplace culture of safety, fire departments or independent EMS agencies must have a dedicated safety or infection control officer. Often, due to budget constraints or lack of personnel with

appropriate training, these tasks are assigned as secondary job responsibilities for someone in a tangentially-related position, such as training or quality assurance. While resources are limited, creation of these dedicated positions is unlikely to happen. Therefore, the challenge in the fire service is to successfully promote safety and prevent injury in a resource-efficient manner. At PCFR, an intervention entailing posters printed on an office computer and laminated in-house, sample supplies of devices already stocked by the supply division, and the addition of a module to an existing PowerPoint training presentation significantly decreased the frequency of risky sharps behaviors. This type of intervention can be replicated with very little funding and a small amount of staff time.

For PCFR, the challenge will be to periodically provide training reminders about sharps safety and risky behaviors, as well as ongoing training about new devices, so that the gains made during this intervention and study period are not lost. As medication and device availability changes, new administrative officers and policies are implemented, and older employees retire, it is important to continually assess the nature of the problem and predisposing, enabling, reinforcing, and environmental factors that influence behavior. Future interventions should build on, but differ from the intervention offered during this study. Efforts should be made to involve field personnel in the design or implementation of these programs. For example, a call for posters regarding sharps safety and awareness could include an incentive for participation and winning posters could be used in place of the posters used during the first intervention. In addition, inclusion of various ranks (Captain, Driver, Firefighter) and privilege (Paramedic, EMT) as peer educators would likely increase the level of receptiveness from personnel

receiving the training. For example, it would be most effective for a Captain/Paramedic to provide training for another Captain/Paramedic in an on-site station setting. This interaction away from the classroom setting and among colleagues with identical rank and privilege would likely strengthen the effectiveness of the intervention over time.

Conclusion

The unique work environment of FFs and EMS personnel is rich with risk factors for NSI. In this suburban fire department, risky sharps behaviors such as altering the safety shield on an IV stylet, using a needle with a prefilled medication syringe when a needleless option was available, and recapping used traditional syringes do occur. A low-cost intervention was designed, implemented, and evaluated using the PRECEDE/PROCEED model as a framework. This intervention resulted in significant decreases in risky sharps behavior and associated increases in safer sharps behaviors. Data collected during the focus groups informed the design of the intervention, but also provided guidance for future areas of research related to FFs and EMS personnel, NSI, and bloodborne pathogens.

There is a need to define and investigate the problem of NSI among FFs and EMS personnel at different agencies, but it is likely that the current study can inform these projects and encourage funding for efforts targeting a wider audience within the fire service and EMS community.

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Appendices

Appendix A: Glossary of Terms

Altered IV stylet - A category used for this study to describe an IV stylet in which the safety shield designed to cover the sharps distal tip has been removed and slid away from the tip, thereby revealing the sharp end.

ALS - Advanced Life Support, may refer to medications or general EMS care given to a patient.

Apparatus - Any type of truck/vehicle used in the fire service or EMS.

BBP - Bloodborne pathogen

Bloodborne Pathogen - Any pathogen that causes disease and is transmitted through contact with contaminated blood. Typically refers to HIV, Hepatitis B, and Hepatitis C.

Cardiac arrest - A condition in which the patient has no heart beat and is clinically dead.

Code - A patient in cardiac arrest (no heart beat).

Crew - Group of people working on a fire truck or ambulance.

D50 - A mixture of dextrose and water typically given to patients with a low blood sugar level. This medication is significant for this study because it comes in a very large syringe.

EMS- Emergency Medical Services

EMT- Emergency Medical Technician. Lower level of training than paramedic. Cannot give medications.

Engine apparatus - A fire truck

Field personnel - Firefighters or EMS personnel who are assigned to stations and actively respond to 911 calls. Also known as "line personnel" or "crews."

Intraosseous needle – A sharp device used, in a manner similar to an IV stylet, as a guide when placing a line directly through a patient's bone directly into the vascular space in the patient's bone marrow. This approach is used only when no other means of IV access can be secured.

Jump bags - "Grab and go" bag kept on both ambulances and engines which contains medical equipment to be taken into residences and other types of scenes. Typically contains a small sharps container.

HBV - Hepatitis B Virus

HCV - Hepatitis C Virus

HCW - Healthcare worker

Hollow-bore needle - A needle with a hollow space or tube running through the center of it which allows fluid (e.g. medication, blood) to pass through it.

IV - A minor medical procedure that involves inserting a small plastic into a patient's vein so that medication can be administered intravenously. To start an IV, personnel must use an IV stylet which is sharp.

IV cathlon - A clear, plastic tube that is placed in the patient's vein to allow for administration of fluids and medications to be administered directly into the patient's vein.

IV stylet - A sharp metal guide that is initially located in the middle of an IV cathlon during insertion. After insertion, the stylet is removed and the cathlon remains in the patient's vein. The stylets studied here had a safety shield that automatically deploys over the distal sharp tip of the stylet to cover it.

IV tubing - The tubing that is attached to a patient's IV site that allows for fluids and medications to be dripped directly into the patient's veins. This tubing may have traditional hubs, which require a needle, or needleless hubs that are compatible with luer adapters.

Luer adapter – A design at the tip of a syringe that allows for use of the syringe and injection of medication without the use of a needle. This tip allows for the syringe to be screwed into a needleless hub or luer adapter on IV tubing.

Near-miss- Unsafe situation that occurs in which the risk for injury was high, but no injury actually occurred.

Needleless hub - A port on IV tubing that allows for syringes with a luer adapter at the tip to be screwed in, thereby allowing medication to be injected intravenously without the use of a needle.

NSI - Needlestick injury

Percutaneous injury - Injury that occurs when the skin is penetrated by a needle or other sharp device. If the needle or sharp device was in contact with blood, tissue, or other body fluids prior to the injury, then a "percutaneous exposure" to BBP has occurred.

Personal Protective Equipment (PPE) - Barriers and filters between the worker and the hazard used to used to prevent exposure to blood and body fluids. Examples: eye goggles, gloves, masks, and gowns.

PRECEDE/ - PROCEED Model A model used for the assessment, planning, and implementation of an intervention targeting a specific health-related behavior. PRECEDE = Predisposing, Reinforcing and Enabling Constructs in Educational Diagnosis and Evaluation. PROCEED = Policy, Regulatory and Organizational Constructs in Educational and Environmental Development.

Recapping - Placing the cap or cover back on to a needle after use.

Red boxes- Sharps disposal boxes.

Rescue (truck) - An ambulance.

Responding - Driving to a scene or to a hospital with the lights and sirens on. When transporting a patient to the hospital, this is typically only done with critical patients.

Seroconversion - A change in the lab results (from negative to positive) measuring antibodies to specific bloodborne pathogens during the time period after a BBP exposure.

Solid sharp - A sharp that does not have a space running through the middle of it. This type of sharp is the opposite of a hollow-bore needle.

Traditional needle/ syringe - A needle that is embedded in the tip of a syringe so that the needle cannot be removed or used in a safer fashion.

"Working a code" - Attempting to resuscitate a patient in cardiac arrest (with no heart beat and no respirations). Involves administering CPR and giving ALS medications.

Appendix B: Review by USF BioSafety Office

January 19, 2010

Christine McGuire-Wolfe, MPH, EMT-P
College of Public Health
Department of Global Health
cwolfe@health.usf.edu

Dear Dr. Wolfe,

The USF Biosafety Office received your notification regarding research project involving contaminated sharps. The Institutional Biosafety Committee (IBC) assures compliance of research regarding the safe use of recombinant DNA, infectious agents, biological toxins, and Select Agents/Toxins with the appropriate regulations.

The use of sharps does not currently require registration with the IBC. However, the IBC recommends that the contaminated sharps be manipulated in accordance with *Biosafety in Microbiological and Biomedical Laboratories, 5th Edition* (CDC/NIH) - Biosafety Level 2 practices and policies (see attachment) and OSHA blood borne pathogen standard - (29 CFR 1910.1030). The IBC recommends that staff handling the sharps use *Standard Precautions*.

If you have any questions regarding this matter, please do not hesitate to contact me at 974-0954.

Sincerely,

Farah I. Moulvi, M.S.P.H
Institutional Biosafety Officer

FM
Encl: BSL-2 Practices

OFFICE OF RESEARCH
DIVISION OF RESEARCH INTEGRITY AND COMPLIANCE
INSTITUTIONAL BIOSAFETY COMMITTEE
University of South Florida · 12901 Bruce B. Downs Blvd., MDC35 · Tampa, FL 33612-4799
(813) 974-0954 · FAX (813) 974-7091

Appendix C: Letter of Support from Pasco County Fire Rescue

PASCO COUNTY, FLORIDA

Fax	(813) 929-2756	Emergency Services Department
Land O' Lakes	(813) 929-2750	David "Hap" Clark, Jr., Building
New Port Richey	(727) 847-2411, Ext. 2750	4111 Land O' Lakes Blvd., S-208
Dade City	(352) 521-4274, Ext. 2750	Land O' Lakes, FL 34639-4402

March 09, 2010

University of South Florida
Institutional Review Board
Division of Research Integrity and Compliance
12901 Bruce B. Downs Blvd., MDC 35
Tampa, FL 33612-4799

RE: Baseline Sharps Count/ ID # Pro00000461

Dear Sir or Ma'am:

Please accept this letter of support from Pasco County Fire Rescue in regards to the study listed above. The Director of Emergency Services, as well as the Risk Management Manager and Personnel Director for Pasco County, have approved collection of sharps containers to be counted in this protocol. Pasco County Fire Rescue will defer to the University of South Florida's Institutional Review Board for human subjects compliance oversight.

Sincerely,

C. Duncan Hitchcock
Rescue Chief

CDH/ck

cc: Anthony F. Lopinto, Emergency Services Director
Barbara DeSimone, Personnel Director
Jane Calano, Risk Management Manager
Christine McGuire-Wolfe, Paramedic, Special Projects

Appendix D: IRB Review for Baseline Sharps Count

USF
UNIVERSITY OF
SOUTH FLORIDA

DIVISION OF RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd. MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-5618

April 14, 2010

Ms. Christine McGuire-Wolfe
Global Health
13121 Shadberry Lane

RE: **Not Human Research Activities Determination**

Activity Title: Baseline Sharps Count (Pro00000461)

Dear Ms.McGuire-Wolfe:

I have reviewed the information you provided regarding the above referenced project and have determined the activities do not meet the USF definition of human subjects research activities; therefore, IRB approval is not required. If, in the future, you change this activity such that it becomes human subjects research activities, prior IRB approval is required. If you wish to obtain a determination about whether the activity, with the proposed changes, will be human research activities, please contact the IRB Office for further guidance.

All research activities, regardless of the level of IRB oversight, must be conducted in a manner that is consistent with the ethical principles of your profession and the ethical guidelines for the protection of human subjects. As principal investigator, it is your responsibility to ensure subjects' rights and welfare are protected during the execution of this project

Also, please note that there may be requirements under the HIPAA Privacy Rule that apply to the information/data you will use in your activities. For further information about any existing HIPAA requirements for this project, please contact Vinita Witanachchi, J.D., HIPAA Program Coordinator, at 813-974-5478.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-9343.

Sincerely,

Barry Bercu, MD IRB Chairperson, USF Institutional Review Board
Cc: Valentina Lepsky-Perla, USF IRB Professional Staff

Appendix E: IRB Review for Focus Groups

USF
UNIVERSITY OF
SOUTH FLORIDA

DIVISION OF RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 336124799
(813) 974-5638 • FAX (813) 974-5618

February 22, 2011

Christine McGuire-Wolfe, MPH, EMT-P
Global Health
13121 Shadberry Lane
Hudson, FL 34667

RE: **Not Human Research Activities Determination**

Activity Title: Practices and Factors Influencing Sharps Use and Safety in Suburban Fire Departments and Emergency Medical Services Personnel : Focus Groups

Dear Ms. McGuire-Wolfe:

I have reviewed the information you provided regarding the above referenced project and have determined the activities do not meet the USF definition of human subjects research activities; therefore, IRB approval is not required. If, in the future, you change this activity such that it becomes human subjects research activities, prior IRB approval is required. If you wish to obtain a determination about whether the activity, with the proposed changes, will be human research activities, please contact the IRB Office for further guidance.

All research activities, regardless of the level of IRB oversight, must be conducted in a manner that is consistent with the ethical principles of your profession and the ethical guidelines for the protection of human subjects. As principal investigator, it is your responsibility to ensure subjects' rights and welfare are protected during the execution of this project

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

John A Schinka, Ph.D.

John A. Schinka, Ph.D., USF IRB Chairperson

Cc: Sarah Croker, USF IRB Professional Staff

Appendix F: IRB Approved Informed Consent for Participation in Focus Groups

USF
UNIVERSITY OF
SOUTH FLORIDA

Informed Consent to Participate in Research

Information to Consider Before Taking Part in This Research Study

IRB Study # Pro00002850

You are being asked to take part in a research study. Research studies include only people who choose to take part. This document is called an informed consent form. Please read this information carefully and take your time making your decision. Ask the researcher or study staff to discuss this consent form with you, please ask him/her to explain any words or information you do not clearly understand. We encourage you to talk with your family and friends before you decide to take part in this research study. The nature of the study, risks, inconveniences, discomforts, and other important information about the study are listed below.

We are asking you to take part in a research study called:
Practices and Factors Influencing Sharps Use and Safety in Suburban Fire Departments and Emergency Medical Services Personnel: Focus Groups.

The person who is in charge of this research study is Christine McGuire-Wolfe. This person is called the Principal Investigator. However, other research staff may be involved and can act on behalf of the person in charge. Ms. McGuire-Wolfe is a candidate for a PhD. degree at the University of South Florida (USF), College of Public Health, in the Department of Global Health. Dr. Donna Haiduven is her advisor and is guiding this research project.

The research will be conducted at various sites throughout Pasco County. Research will be conducted at the Pasco County Health Department, 10841 Little Road, New Port Richey, Forida.

This research is sponsored by the Student Research Award from the College of Public Health's Interdisciplinary Research Innovation & Creativity and the Samuel P. Bell III Endowed Scholarship.

Purpose of the study

The purpose of this study is to:

- Gain an understanding of how firefighters, paramedics, and EMTs use various types of sharps devices.
- Identify factors or characteristics that encourage specific patterns of sharps use.
- To fulfill a portion of the Ph.D. degree requirements for Ms. McGuire-Wolfe.

Should you take part in this study?

- This form tells you about this research study. After reading through this form and having the research explained to you by someone conducting this research, you can decide if you want to take part in it.
- You may have questions this form does not answer. If you do have questions, feel free to ask the principal investigator or the person explaining the study, as you go along.
- Take your time to think about the information that is presented to you.

This form explains:

- Why this study is being done.
- What will happen during this study and what you will need to do.
- Whether there is any chance of benefits from being in this study.
- The risks involved in this study.
- How the information collected about you during this study will be used and with whom it may be shared.

Providing informed consent to participate in this research study is up to you. If you choose to be in the study, then you should sign the form. If you do not want to take part in this study, you should not sign this form.

Why are you being asked to take part?

We are asking you to take part in this research study because you have been employed as a firefighter, EMT, or paramedic employed with a suburban fire department. We want to find out how firefighters and EMS personnel use sharps devices and what factors influence the way the sharps devices are used.

In order to participate, you must meet the following criteria:

- **Inclusion Criteria**
  - Employment at Pasco County Fire Rescue as a firefighter/EMT or higher rank for at least 12 months preceding the date of the focus group.
  - Assignment in the field (ambulance or engine).

In order to participate, you should <u>not</u> fall into any of these categories:

- **Exclusion Criteria**
  - Employment of less than 12 months with Pasco County Fire Rescue.
  - Assignment to the Training Division or Operations.
  - Rank above Captain.

What will happen during this study?

If you agree to participate, the following will occur:

- You will participate in a 90 minute discussion (focus group session) regarding sharps devices, such as needles, and sharps safety. The focus group to which you are being invited will be conducted at the Pasco County Health Department in New Port Richey, outside of your regularly scheduled working hours. The focus group will not be conducted at a Pasco

County Fire Rescue station. A series of open-ended questions relating to observations and experiences with sharps devices will be directed to the group. An interviewer will moderate, listen, and observe the discussion. One or two research assistants will observe the discussion, take notes, and ask questions to clarify certain issues.

- You will receive a letter from Christine McGuire-Wolfe confirming directions, the time, and place of the focus group session.
- During the focus group session, an audio tape will be made of the discussion.
- Before the session starts, you will be asked to complete a short questionnaire about your education and work experience.

Total Number of Participants

About 75 individuals will take part in this study.

Alternatives

You do not have to participate in this research study.

Benefits

Although you may not receive any direct benefit from this research, the information that is obtained from the focus group may be used to help firefighters and EMS personnel perform their jobs in a safer way. These potential benefits to you cannot be guaranteed.

Risks or Discomfort

The following risks may occur:

- Some of the focus group questions may touch on personal or sensitive experiences. You may choose not to discuss anything that you do not want to talk about.
- If you choose, you can leave the focus group session at any time.
- The session will be audio recorded, but no individual names will be mentioned on the tapes. All of the information obtained from you during the session will be kept confidential. The tapes and discussion notes will be stored in a locked cabinet. Only the study investigators will have access to them.
- After the focus group, the tapes will be transcribed into written form. In addition, the researchers will listen to the tapes and extract common themes and attitudes expressed.

Compensation

You will be paid $40 if you complete the entire focus group session and demographic survey. If you withdraw for any reason from the study before completion, you will not be paid. Payment will be in the

form of a gift card to a major retailer, such as Walmart or Target.

Cost

There will be no additional costs to you as a result of being in this study.

Privacy and Confidentiality

Participation in research means a loss of privacy. Therefore, a potential risk to you is some loss of privacy by participating in a group discussion of your attitudes, practices, and opinions. All participants will be asked, in a group setting, about their personal work experience and opinions. The researchers will ask you and the other people in the group to use only first names during the session. Your individual responses will be heard by others who are present in the group. This might pose some risk to you if your responses are shared by others outside of the focus group. Therefore, please do not disclose anything during the focus group discussion that is personal or confidential. Please don't discuss what was said during the discussion outside of the focus group. The goal is to preserve everyone's confidentiality. However, the researchers cannot guarantee that everyone will keep the discussions private.

Your responses will remain confidential. There will be no identifying information retained on the written transcripts of the focus group session. No attempts will be made to link information on the transcripts to individual subjects. The results of the focus group will be reported in summary form, not individual responses.

Your employer will only see a summary report and will not be able to identify individuals involved in the focus group. No information by which you can be identified will be released or published.

We will keep your study records private and confidential. Certain people may need to see your study records. By law, anyone who looks at your records must keep them completely confidential. The only people who will be allowed to see these records are:

- The research team, including the Principal Investigator, study coordinator, and all other research staff.
- Certain government and university people who need to know more about the study. For example, individuals who provide oversight on this study may need to look at your records. This is done to make sure that we are doing the study in the right way. They also need to make sure that we are protecting your rights and your safety.
- Any agency of the federal, state, or local government that regulates this research. This includes the Florida Department of Health, and the Department of Health and Human Services (DHHS) and the Office for Human Research Protection (OHRP).
- The USF Institutional Review Board (IRB) and its related staff who have oversight responsibilities for this study, staff in the USF Office of Research and Innovation, USF Division of Research Integrity and Compliance, and other USF offices who oversee this research.
- The results of this study may be published. However, the data obtained from you will be

combined with data from others. The published results will not include your name or any other information that would personally identify you in any way.

Voluntary Participation / Withdrawal

You should only take part in this study if you want to volunteer. You should not feel that there is any pressure to take part in the study. You are free to participate in this research or withdraw at any time. There will be no penalty or loss of benefits you are entitled to receive if you stop taking part in this study. Pasco County Fire Rescue administration will be unaware of your decision to participate or not participate.

You can get the answers to your questions, concerns, or complaints.

If you have any questions, concerns or complaints about this study, call Christine McGuire-Wolfe at 727-207-4986.

If you have questions about your rights, general questions, complaints, or issues as a person taking part in this study, call the USF IRB at (813) 974-5638.

Consent to Take Part in Research

It is up to you to decide whether you want to take part in this study. If you want to take part, please read the statements below and sign the form if the statements are true.

I freely give my consent to take part in this study. I understand that by signing this form I am agreeing to take part in research. I have received a copy of this form to take with me.

_____ _____

Signature of Person Taking Part in Study Date

_____

Printed Name of Person Taking Part in Study

Statement of Person Obtaining Informed Consent and Research Authorization

I have carefully explained to the person taking part in the study what he or she can expect from their participation. I hereby certify that when this person signs this form, to the best of my knowledge, he/ she understands:

- What the study is about;
- What procedures/interventions/investigational drugs or devices will be used;
- What the potential benefits might be; and
- What the known risks might be.

I can confirm that this research subject speaks the language that was used to explain this research and is receiving an informed consent form in the appropriate language. Additionally, this subject reads well enough to understand this document or, if not, this person is able to hear and understand when the form is read to him or her. This subject does not have a medical/psychological problem that would

compromise comprehension and therefore makes it hard to understand what is being explained and can, therefore, give legally effective informed consent. This subject is not under any type of anesthesia or analgesic that may cloud their judgment or make it hard to understand what is being explained and, therefore, can be considered competent to give informed consent.

_____ _____

Signature of Person Obtaining Informed Consent / Research Authorization Date

_____

Printed Name of Person Obtaining Informed Consent / Research Authorization

Appendix G: Demographic Information Form

Practices and Factors Influencing Sharps Use and Safety in Suburban Fire Departments and Emergency Medical Services Personnel

Demographic and Exposure Information

We are interested in the characteristics of participants in the study and would greatly appreciate a few moments of your time to complete this brief survey. For each question, please check all the choices that apply, when applicable. Return this form to the check-in desk when finished. Stipend payment will not be processed without this form.

Note: As with all portions of this study, this information will not be used to identify particular participants. Identities will be kept anonymous. The information will be used to describe the characteristics of the group that participated in the study.

1. Current age, in years: _____
2. Gender: ___Female ___Male
3. Highest level of education received: ○ Technical certificate ○ AA/AS ○ BA/BS ○ Other:_____
4. What is your rank?
   ○ FF/EMT ○ FF/P ○ Paramedic only ○ D/P ○ D/E ○ Cpt./E ○ Cpt./ P
5. Where are you assigned the majority of the time?
   ○ Rescue ○ Engine ○ I rotate and split my time evenly
6. How long have you worked in the fire service and/or EMS? _____
7. How long have you been employed by PCFR?_____
8. During an average on duty day, how many EMS calls do you run?_____
9. Are you currently working in any other healthcare setting in addition to PCFR? ___Yes ___No

   If yes, please specify_____

Exposure Questions

10. In the past 12 months, have you been injured by a sharp object, such as a needle or IV cathlon, that was previously used on a patient? ___Yes ___No

    If yes, how many needlestick or sharps injuries did you sustain in this time period? ____
    For how many of these exposures did you submit an exposure report?____

11. In the course of your career with PCFR, have you been injured by a sharp object, such as a needle or IV cathlon, that was previously used on a patient? ___Yes ___No

    If yes, how many needlestick of sharps injuries have you sustained in your career? ____
    For how many of these exposures did you submit an exposure report? ___

Appendix H: Recruitment Poster for Focus Groups

CALLING ALL FIREFIGHTERS:

HELP IMPROVE SAFETY at PCFR through Research!!

Volunteers are needed to participate in a 90 minute discussion about needles & sharps devices. Compensation provided ($40 gift card to Wal-Mart or Target) upon completion.

Personnel assigned to Training or Operations or with a rank above Captain may not participate.

The following groups are scheduled at the NPR Health Department on Little Rd.:

Drivers (D/E or D/P)	April 27th, 10:30 am – 12:00 pm
FF/EMTs	May 5th, 10:30 am – 12:00 pm
Paramedics	May 12th, 10:30 am – 12:00 pm

new dates

The following groups are scheduled at the Dade City Health Dept:

FF/EMTs	April 29th, 1:30 pm – 3:00 pm
Paramedics	April 21st, 1:30 pm – 3:00 pm

Please e-mail Christine McGuire-Wolfe at cwolfe@health.usf.edu or call 727-207-4986 if you are able to participate.

USF HEALTH

Appendix I: AO #10-30

EMERGENCY SERVICES DEPARTMENT
4111 Land O' Lakes Boulevard
Land O' Lakes, Florida 34639

ADMINISTRATIVE ORDER **APRIL 21, 2010**
NUMBER 10-30

USF RESEARCH PROJECT

Pasco County Fire Rescue is partnering with the University of South Florida's College of Public Health in several occupational health projects. As part of this effort, the stations listed below will be required to collect their used sharps containers from May 3rd until May 11th rather than disposing of them at the hospital.

- On May 2nd and May 3rd, a representative from USF will deliver an OSHA approved Biohazard box to the following stations: 10, 11, 13, 14, 16, 17, 20, 22, 23, 24, and 36. This box will be stored in the rescue supply closet.
- A reminder placard will be affixed to the sharps container case in the Rescue unit.
- For this time period, any full sharps containers, including the small sharps containers used in the jump bags, will be sealed, labeled with the apparatus information and date, and placed in the box. Labels will be provided for this purpose.
- On May 11th, a representative from DNA Extreme Clean will collect the boxes. A receipt will be left with the Captain of the station. This receipt will be forwarded to FF/P Christine McGuire-Wolfe at Operations.
- On May 11th, the Station Commander will remove any remaining placards from the Rescue Units.

Any questions about this project can be forwarded to Christine McGuire-Wolfe or me at Operations.

CDH/ckc

Distribution: Battalion Chiefs I, II, III, IV
Stations 10, 11, 13, 14, 16, 17, 20, 22, 23, 24, and 36.
Destruction: May 12, 2010

cc: Anthony F. Lopinto, Emergency Services Director
Cynthia Holland, Acting Assistant Chief
Christine McGuire-Wolfe, Firefighter/Paramedic, Special Projects

Charles D. Hitchcock
Rescue Chief

Appendix J: AO# 10-33

EMERGENCY SERVICES DEPARTMENT
4111 Land O' Lakes Boulevard
Land O' Lakes, Florida 34639

ADMINISTRATIVE ORDER **MAY 24, 2010**
NUMBER 10-33

USF RESEARCH PROJECT

Pasco County Fire Rescue is partnering with the University of South Florida's College of Public Health in several occupational health projects. As part of this effort, the stations listed below will be required to collect their used sharps containers from May 28th until June 4th rather than disposing of them at the hospital.

- On May 28th, a representative from USF will deliver an OSHA approved Biohazard box to the following stations: 10, 17, 20, 22, 26, and 32.
  This box will be stored in the rescue supply closet.
- A reminder placard will be affixed to the sharps container case in the Rescue unit.
- For this time period, any full sharps containers, including the small sharps containers used in the jump bags, will be sealed, labeled with the apparatus information and date, and placed in the box. Labels will be provided for this purpose.
- At approximately 0800, on June 4th, crews should exchange their used sharps containers for new ones and place the used ones in the box.
- On June 4th, a representative from DNA Extreme Clean will collect the boxes. A receipt will be left with the Captain of the station. This receipt will be forwarded to FF/P Christine McGuire-Wolfe at Operations.
- On June 4th, the Station Commander will remove any remaining placards from the Rescue Units.

Any questions about this project can be forwarded to Christine McGuire-Wolfe or me at Operations.

CDH/ck

Distribution: Battalion Chiefs I, II, III, IV
Stations 10, 17, 20, 22, 26, and 32.

Destruction: June 5, 2010

cc: Anthony F. Lopinto, Emergency Services Director
Cynthia Holland, Acting Assistant Chief
Christine McGuire-Wolfe, Firefighter/Paramedic, Special Projects

Charles D. Hitchcock
Rescue Chief

Appendix K: Materials For Sharps Count

Item	Description	Quantity	Purpose
1:10 Bleach solution	Mixed on day of sharps count	As needed	Disinfection of equipment and table tops
Spray bottle	Standard manual spray bottle	1	To spray surfaces after sharps count
Bleach	Full Strength	As needed	For soaking sharps prior to count
Paper towels	Standard paper towels	2 rolls	To wipe down surfaces after disinfection
Assorted tweezers and hemostats	-	As needed	To maneuver used sharps during count
Large tongs	Aluminum, 18 inches in length	1 pair	For removing used sharps from sharps container
Holding trays	Pyrex 12x8 pans. Pre-marked in accordance with the categories listed on the sorting sheet.	4	For holding sharps after removing from initial sharps container and during sorting process
Sharps container "Discard"	New, puncture-resistant, leak-proof	1	For disposal of sharps after count
Puncture resistant gloves	Sharps Master 7080 with HexArmor Nitrile coated gloves. ISEA Level 5. Elbow length	1 set	To provide protection for researcher during manipulation of used sharps container and used sharps count
Biohazard disposal "Red Bag"	Red biohazard bag in marked waste basket	1	For disposal of paper towels used in disinfection process
Latex gloves	Nitrile, small gloves	1 box of 100 gloves	For use during disinfection process
Draining trays	Teflon coated, mesh aluminum trays, 12" x 4"	2	For draining bleach away from sharps
Paper gown	Plastic lined paper gown	1	To protect researcher's clothing during sharps manipulation
Safety goggles	Plastic goggles with side splash shields	1	To protect researcher during sharps manipulation
Fume Hood		1	To provide controlled environment for

			sharps manipulation
Chux	Absorbent pads	12	To line work surface of hood while manipulating used sharps.
Metal clipboard	Standard size, to hold 8.5 x 11” sorting sheet	1	To hold sorting sheet
Pencil		5	To fill out sorting sheet.
Bolt cutters	12” standard manual bolt cutters	1	For removing top of used sharps container
Used sharps container	Various sizes, provided by EMS/Fire agency. Containing used sharps devices	To be determined	To be counted

Appendix L: Focus Groups Script and Questions

Practices and Factors Influencing Sharps Use and Safety in Suburban Fire Departments and Emergency Medical Services Personnel – Focus Groups

Moderator Introduction

Welcome to the session today. Thank you for taking the time to discuss needles and sharp device usage. My name is Christine McGuire-Wolfe and I am the primary researcher for this project. I am a doctoral candidate at the University of South Florida, College of Public Health. I am interested in hearing your viewpoints and opinions on issues relating to the use of needles and other sharps devices at Pasco County Fire Rescue. I will be asking a variety of questions for the group to discuss.

I will be reading this introduction and the discussion questions. I plan to meet with additional groups and I want to be sure to say the same thing to each group.

The purpose of these focus groups is to get input from firefighters, EMTs, and paramedics on the ways in which needles and sharps devices are used and disposed of. While Pasco County Fire Rescue is supportive of this effort, the administration is not involved with this research effort. This is a study that is serving as my doctoral dissertation for the University and is completed on my "off duty" time from Pasco County Fire Rescue.

There are no right or wrong answers to any of the questions that I will ask today. However, people may have different points of view. Please feel free to share your point of view, even if it differs from what others have said. Please feel free to expand on what others have said.

My role in this focus group is to serve as a facilitator. I will ask questions for the group to discuss. I will be accompanied by _____ [tbd] who will help clarify any issues they think is unclear.

Before we begin, let me remind you of some ground rules. Because this is a research project, we will be tape recording this session. Therefore, you will need to speak up. Only one person should speak at a time. I don't want to miss anyone's comments.

Please do not disclose anything during the discussion that is personal and/or confidential. Please don't discuss what was said during the discussion outside of the focus group. My goal is to preserve your confidentiality. As stated in the consent form that you signed, the tapes will be held by the researchers in a locked cabinet.

This session will last approximately 90 minutes and we will not take a formal break. Feel free to get up anytime you need to, but please do so quietly.

Let's get started.

Focus Group Questions

Q1. Please introduce yourself using your first name and tell us how long you have worked in EMS and how many of those years have been as a medic.

Q2. Before we get into specific questions about needle use and needlestick injuries in EMS, we would like to get a better understanding of the environment in which you work every day. Please describe the role of safety in the day to day work environment at Pasco County Fire Rescue.

Potential follow-ups:
Describe some instances in which safety concerns impact the way you perform your work duties.
Comment on whether or not safety is a priority at PCFR and give some reasons to support your opinion.

Q3. I'd like for you to look at Figure 1 and describe what you see. [Figure 1 shows prefilled syringes with a needle added on].

Potential follow-ups:

How does this syringe come packaged?

Q4. Now I'd like for you to look at Figure 2 and describe what you see. [Figure 2 shows prefilled syringe with the needle exposed].

Potential follow-ups:
How is the device in the photo different than how it is initially packaged?

Q5. Let's return to Figure 1. This is an example of a medication that comes in a prefilled syringe. Earlier, we or [name of participant] identified that this syringe had a needle added on to it. What might be some reasons for using the syringe in this way?

Potential follow-ups:
This photo shows a syringe filled with Amiodarone. What circumstances or types of calls influence the syringe to be used in this way?
What types of calls might encourage someone to use the syringe in this way?

Q6. Now let's go back to Figure 2. Earlier, we or [name of participant] talked about how the green Luer cap had been removed. What might be some reasons for using this device in this way?

Potential follow-ups:
This photo shows syringes of Epinephrine, Atropine, and Sodium Bicarb. What factors influence the way someone uses this device?
What types of calls might encourage someone to use the device in this way?

Q7. Please look at Figure 3 and tell me what you see. [Figure 3 shows an IV stylet with the safety device altered].

Potential follow-ups:
This is a photo of an IV stylet after use. Please describe the positioning of the safety shield.

Q8. While we are looking at Figure 3, can you think of reasons for the device to be used in this way? In what circumstances would a medic or EMT need to use the device in this way?

Q9. Please look at Figure 4 and describe what you see. [Figure 4 shows a traditional needle that is recapped].

Q10. What might be some reasons for disposing of syringes in the manner shown in this way?

Potential follow-ups:
What type of call might encourage someone to dispose of these needles in the way shown in the photo?

Q11. [Figure 5 shows two images of a pre-filled safety syringe, one with a luer tip and one with a needle]. I'd like for you to think back to either the first time you encountered this type of syringe or to your first days of medic with Pasco County Fire Rescue, how did you learn to use this device?

Potential follow-ups:
What type of training did you receive on this device?
Please comment on the effectiveness of the training you received.

Q12. What factors influence how you use and dispose of the types of sharps shown here today?

Potential follow-ups:
What are some possible reasons why others would do this differently? What factors influence your co-workers use?

Q13. To what degree are needlestick injuries a problem in EMS? Please explain your answer.

Q14. Describe other ways that sharps devices are used in EMS that would make them less safe than intended?

Q15. Please share any other thoughts that you would like to share regarding sharps safety and needlestick injuries? If you believe any important points have been missed, please describe them now.

Appendix M: Photo Booklet Used in Focus Groups

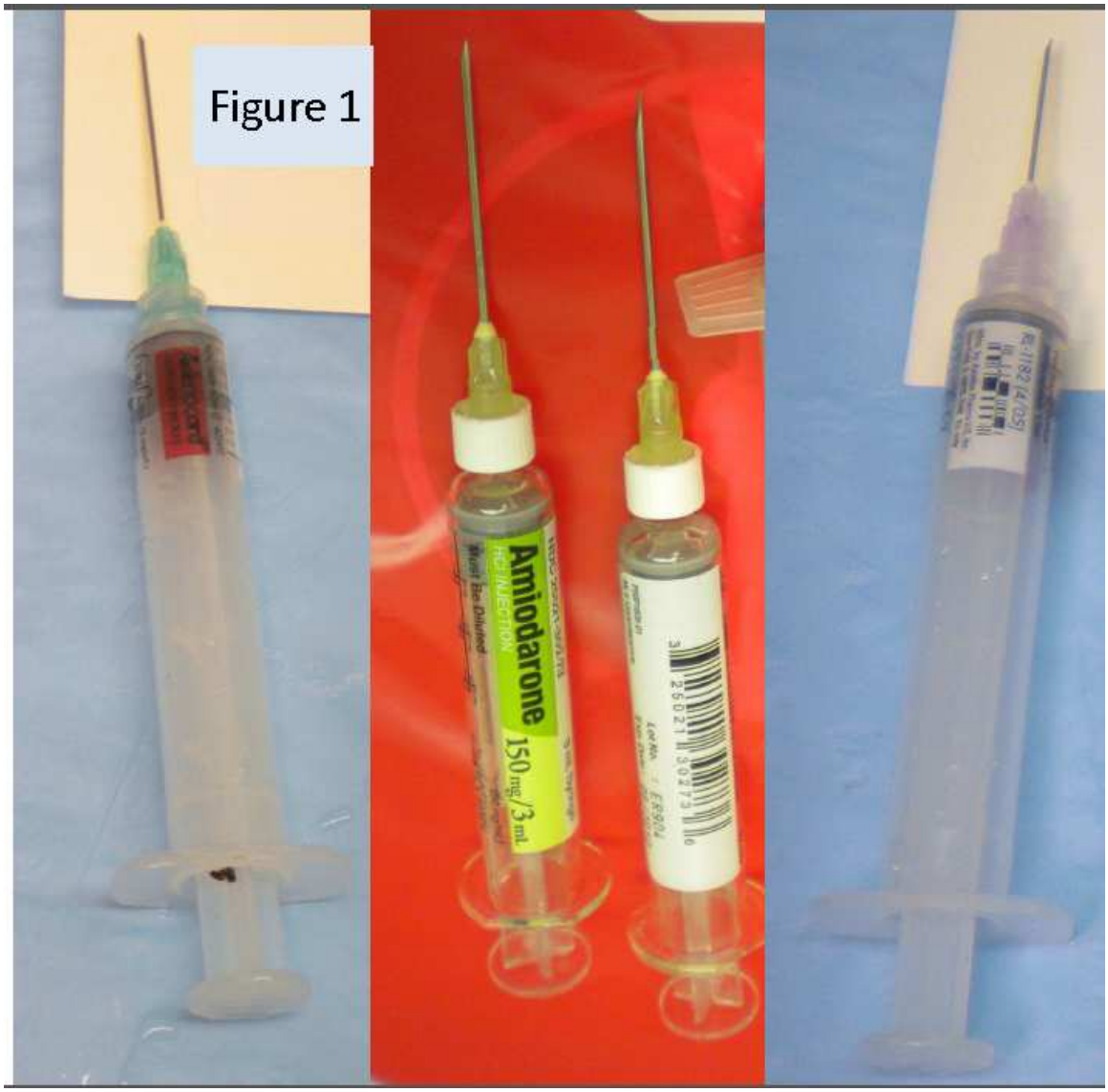
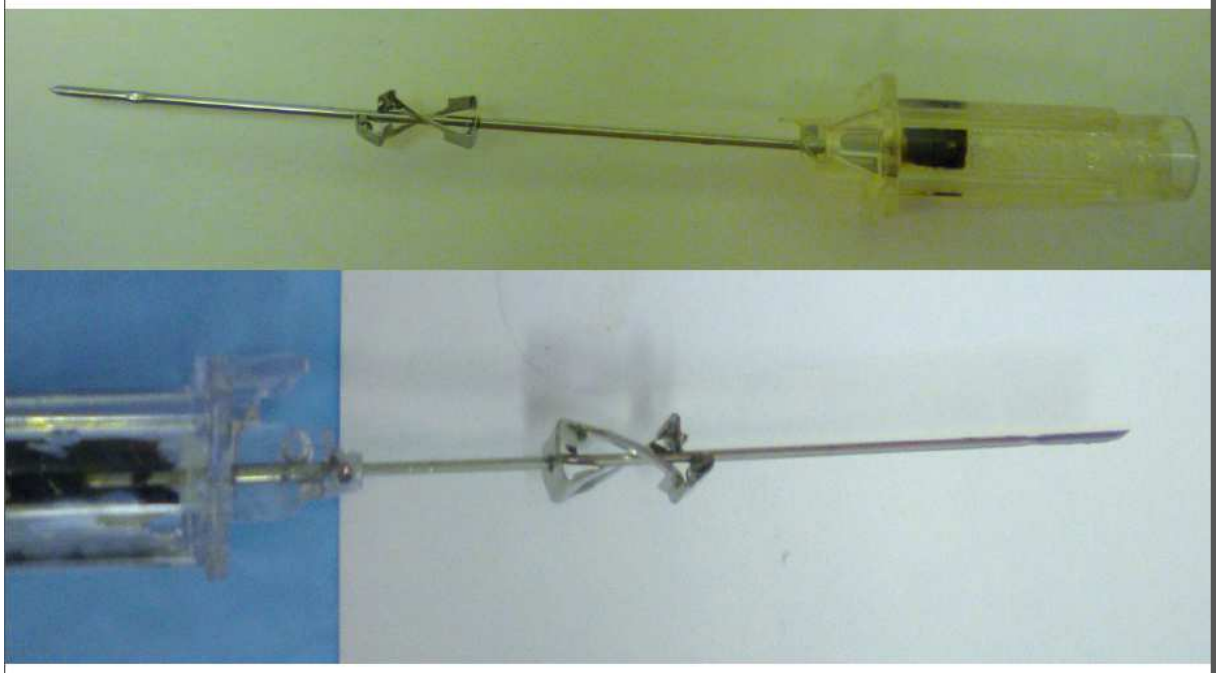


Figure 2

Figure 3



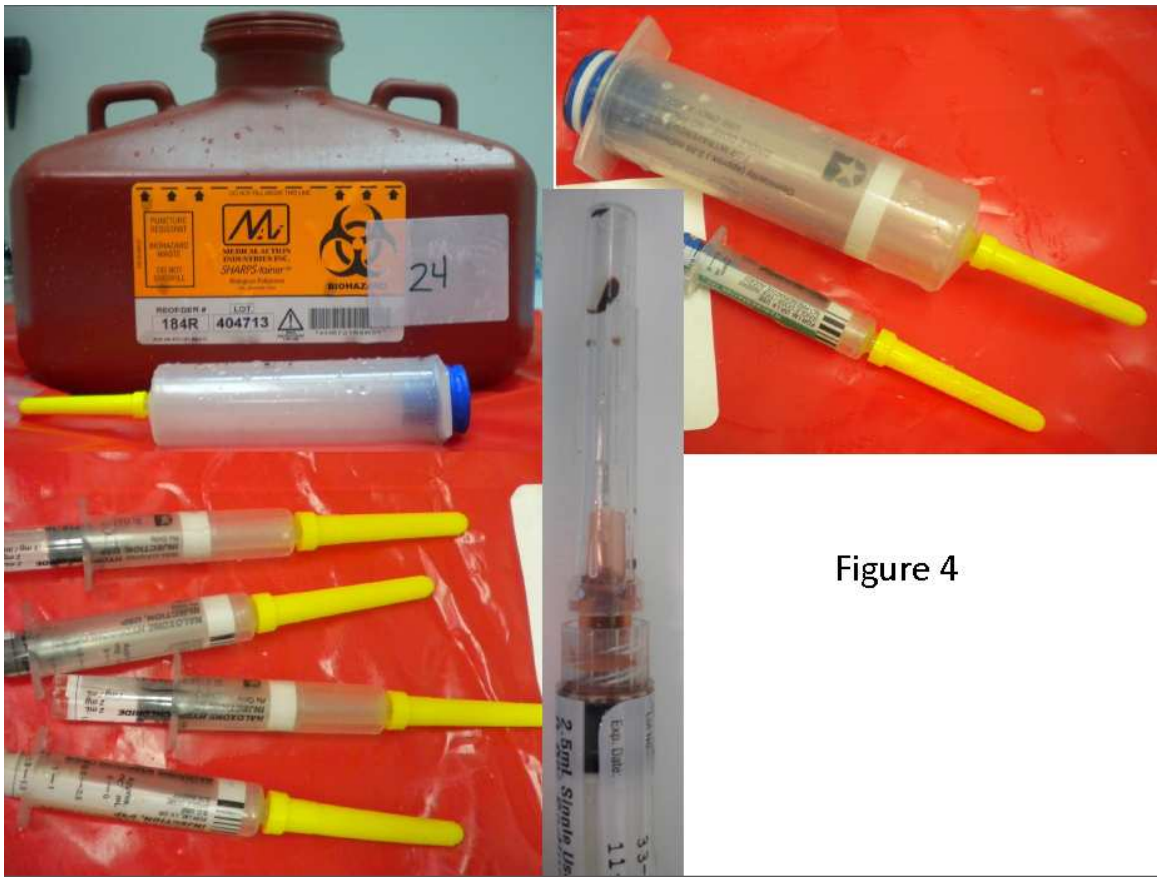

MEDICAL ACTION INDUSTRIES INC.
SHARPS Xpress
BIOHAZ
24
REORDER #
184R
LOT
404713
2.5ml Single Use

Figure 4

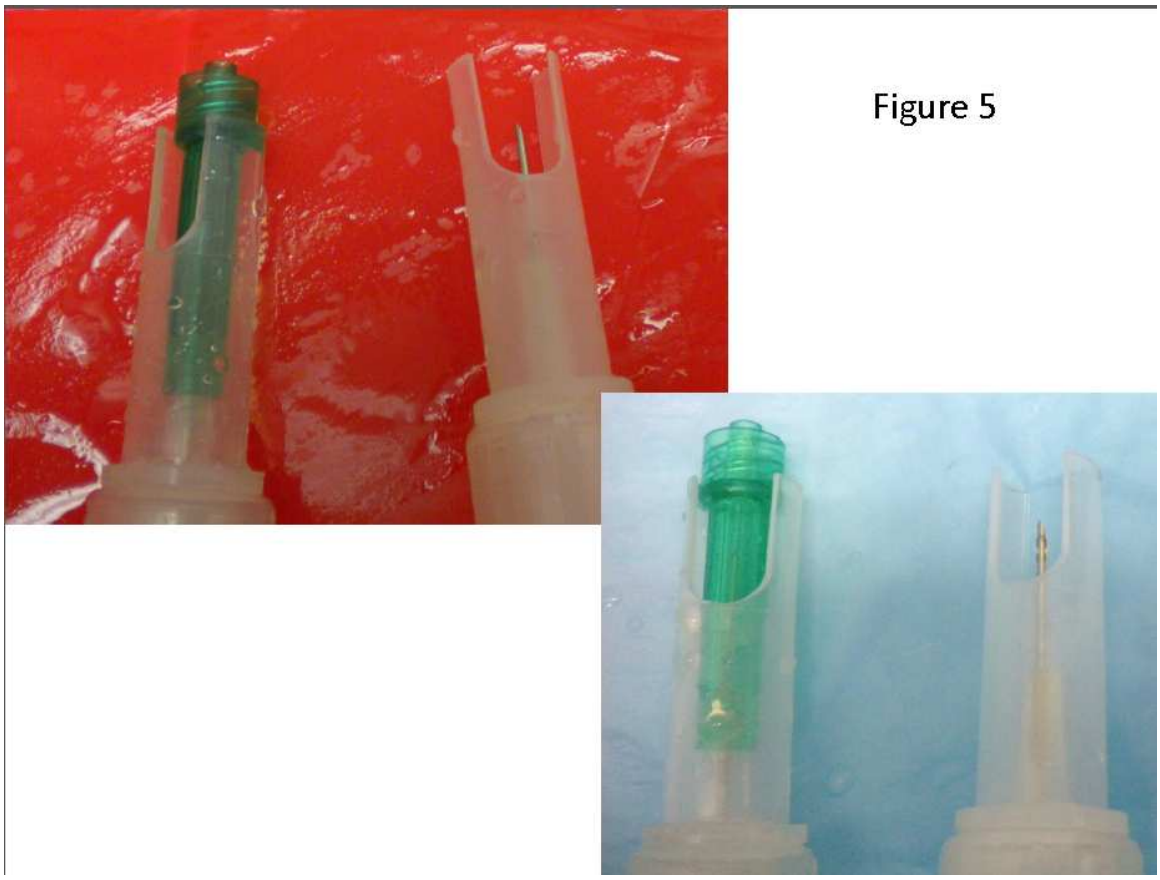


Figure 5

Appendix N: Focus Group Field Notes Form

FOCUS GROUP FIELD NOTES

Date of Focus Group:	**Location:**
Number of Participants:	
Moderator Name:	
Assistant Name:	
Time Started:	**Time Ended:**
Misc. comments about setting, group, etc.	

Responses to Questions

[Prompts and follow-ups are listed after the respective question; box should be checked if these prompts or follow-ups are used]

Q1. Please introduce yourself using your first name and tell us how long you have worked in EMS and how many of those years have been as a medic. Also, please let us know if you have a second job in the EMS or healthcare field.

Brief Summary / Key Points:

Notable Quotes:

Comments/Observations:

Q2. Before we get into specific questions about needle use and needlestick injuries in EMS, we would like to get a better understanding of the environment in which you work every day. Please describe the role of safety in the day to day work environment at Pasco County Fire Rescue.

- ☐ Describe some instances in which safety concerns impact the way you perform your work duties.
- ☐ Comment on whether or not safety is a priority at PCFR and give some reasons to support your opinion.

Brief Summary / Key Points:

Notable Quotes:

Comments/Observations:

Q3. I'd like for you to look at Figure 1 and describe what you see. [Figure 1 shows prefilled syringes with a needle added on].

- How does this syringe come packaged?

Brief Summary / Key Points:

Notable Quotes:

Comments/Observations:

Q4. Now I'd like for you to look at Figure 2 and describe what you see. [Figure 2 shows prefilled syringe with the needle exposed].

- How is the device in the photo different than how it is initially packaged?

Brief Summary / Key Points:

Notable Quotes:

Comments/Observations:

Q5. Let's return to Figure 1. This is an example of a medication that comes in a prefilled syringe. Earlier, we or [name of participant] identified that this syringe had a needle added on to it. What might be some reasons for using the syringe in this way?

- This photo shows a syringe filled with Amiodarone. What circumstances or types of calls influences the syringe to be used in this way?

- What types of calls might encourage someone to use the syringe in this way?

Brief Summary / Key Points:

Notable Quotes:

Q6. Now let's go back to Figure 2. Earlier, we talked about how the green Luer cap had been removed. What might be some reasons for using this device in this way?

- This photo shows syringes of Epinephrine, Atropine, and Sodium Bicarb. What factors influence the way someone uses this device?

- Potential follow-up: What types of calls might encourage someone to use the device in this way?

Brief Summary / Key Points:

Notable Quotes:

Comments/Observations:

Q7. Please look at Figure 3 and tell me what you see. [Figure 3 shows an IV stylet with the safety device altered].

- This is a photo of an IV stylet after use. Please describe the positioning of the safety shield.

Brief Summary / Key Points:

Notable Quotes:

Comments/Observations:

Q8. While we are looking at Figure 3, can you think of reasons for the device to be used in this way? In what circumstances would a medic or EMT need to use the device in this way?

Brief Summary / Key Points:

Notable Quotes:

Q9. Please look at Figure 4 and describe what you see. [Figure 4 shows a traditional needle that is recapped].

Brief Summary / Key Points:

Notable Quotes:

Comments/Observations:

Q10. What might be some reasons for disposing of syringes in the manner shown in this way?

- What type of call might encourage someone to dispose of these needles in the way shown in the photo?

Brief Summary / Key Points:

Notable Quotes:

Comments/Observations:

Q11. [Figure 5 shows two images of a pre-filled safety syringe, one with a luer tip and one with a needle]. I'd like for you to think back to either the first time you encountered this type of syringe or to your first days of medic with Pasco County Fire Rescue, how did you learn to use this device?

- What type of training did you receive on this device?
- Was the training you received helpful?

Brief Summary / Key Points:

Notable Quotes:

Comments/Observations:

Q12. What factors influence how you use and dispose of the types of sharps shown here today?

- Are there reasons why others would do this differently? What factors influence your co-workers use?

Brief Summary / Key Points:

Notable Quotes:

Comments/Observations:

Q13. Are needlestick injuries a problem in EMS? Please explain your answer.

Brief Summary / Key Points:

Notable Quotes:

Comments/Observations:

Q14. Describe other ways that sharps devices are used in EMS that would make them less safe than intended?

Brief Summary / Key Points:

Notable Quotes:

Comments/Observations:

Q15. Please share any other thoughts that you would like to share regarding sharps safety and needlestick injuries? If you believe any important points have been missed, please describe them now.

Brief Summary / Key Points:

Notable Quotes:

Comments/Observations:

Appendix O: Training Booklet

The Risk is Real, Choose Safety

Needleless Devices Training
2012

USF HEALTH

FIRE
PASCO COUNTY
FLORIDA
RESCUE

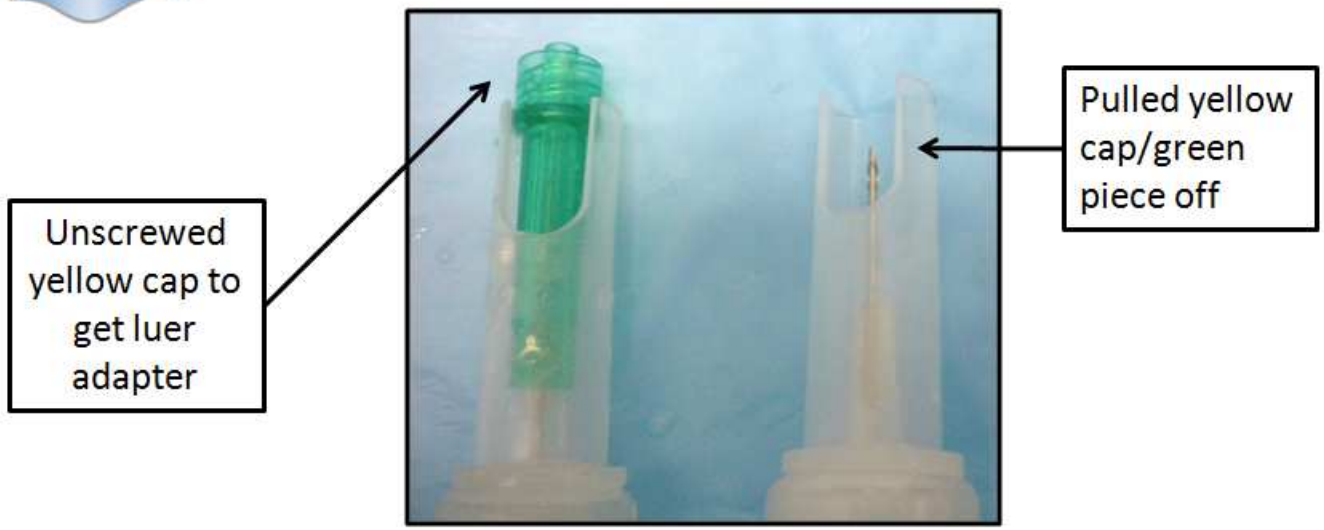
The Risk is Real, Choose Safety

We will never be able to completely eliminate needles; however, using sharps wisely decreases your risk for needlestick injury.

USF HEALTH

FIRE
PASCO COUNTY
FLORIDA
RESCUE

Luer Adapters



You can use this type of prefilled syringe without exposing the needle. When you open the package, instead of pulling the yellow cap off the end of the green piece, unscrew it. If you pull, the entire green piece will come off and the device will look like the one on the right.

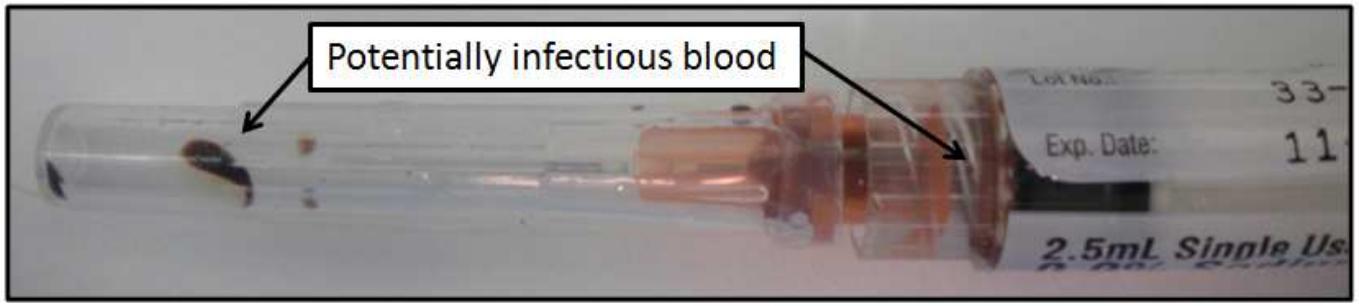
Prefilled Syringes

This syringe is prefilled with luer adapter on the end. Needle was added after opening package.

Prefilled syringes should be used without a needle

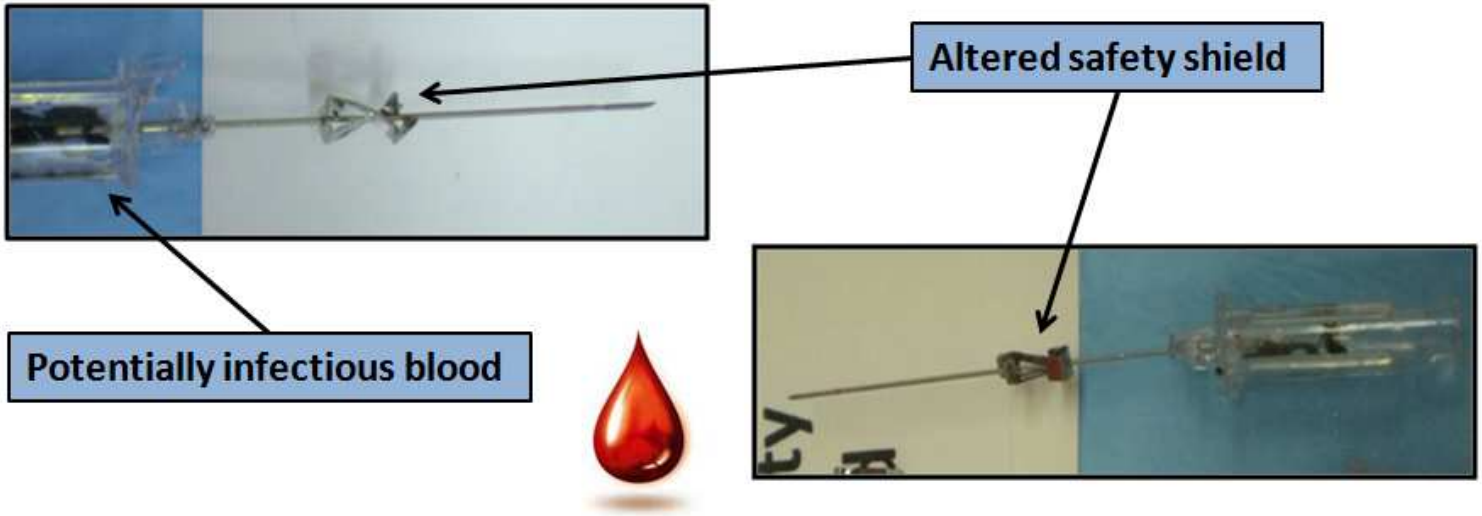
We are finding a large percentage of needles added to the prefilled syringes. Even though these medications are typically given IV, there is still a risk of transmission of bloodborne pathogens if you are stuck. Take advantage of the safety features when they are available and administer medications using the luer adapter/connection.

Needle Recapping



For medications that are provided in "old fashioned" syringes with an embedded needle, avoid recapping. Needle recapping is one of the leading causes of needlestick injuries. Dispose of used needles directly into a sharps container.

I.V. Stylets & Blood Sugars



We found several IV stylets with the safety shield altered or retracted. When crews were asked about these findings, many indicated that the safety shield is often pushed back in order to get a drop of blood for a blood glucose reading. This is a very risky practice, as the stylet holds potentially infectious blood.

Risk Analysis

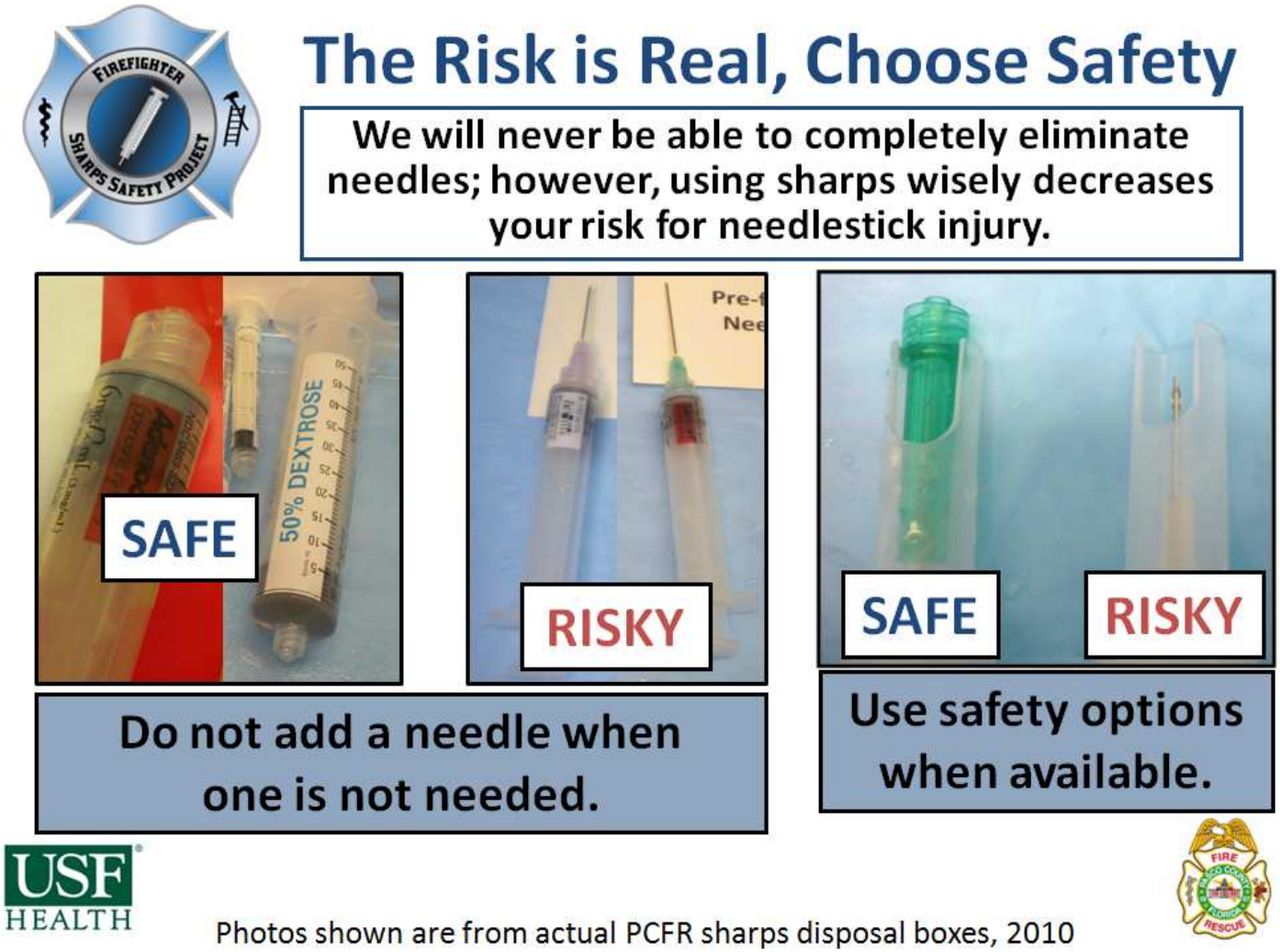
Sometimes, we perform duties out of habit without really thinking about the risk involved. Often, habits involve risky behaviors that do not bring about a significant benefit. Does the benefit of recapping a needle outweigh the risk of needlestick injury? Does adding a needle to a prefilled syringe provide an additional benefit to the patient?

Instructions for Trainers

- While reviewing manual, have “examples box” available.
- Complete special training log for those who participate.
- Return logs to Christine at OPS.
- Re-use/Re-cycle examples equipment whenever possible.
- Rotate posters on rescue approximately every third shift.
- Do not discard posters, return to OPS attn: Christine.
- E-mail or phone (727)207-4986 any questions.

Thank you for your help.

Appendix P: Training Posters

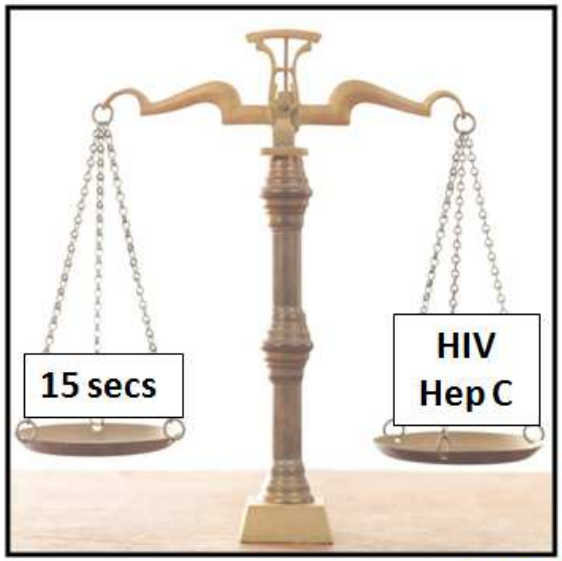


The Risk is Real, Choose Safety

We will never be able to completely eliminate needles; however, using sharps wisely decreases your risk for needlestick injury.

Disabled safety shield

IS A DROP OF BLOOD WORTH THE RISK?

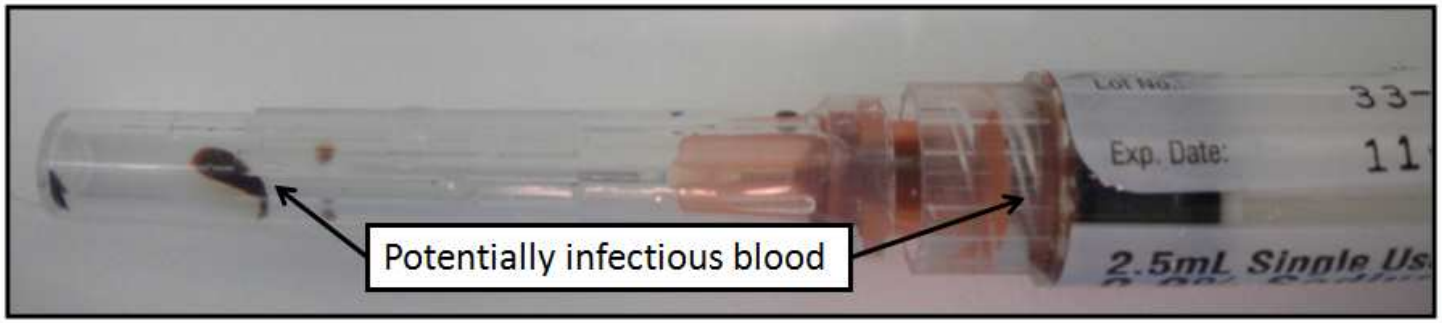


USF HEALTH

Photos shown are from actual PCFR sharps disposal boxes, 2010

The Risk is Real, Choose Safety

We will never be able to completely eliminate needles; however, using sharps wisely decreases your risk for needlestick injury.



Avoid needle recapping. Discard used syringes in sharps boxes immediately.

USF HEALTH

Photos shown are from actual PCFR sharps disposal boxes, 2010

Appendix Q: AO #12-40

EMERGENCY SERVICES DEPARTMENT
4111 LAND O' LAKES BOULEVARD
LAND O' LAKES, FLORIDA 34639

ADMINISTRATIVE ORDER
NUMBER 12-40

September 17, 2012

USF RESEARCH PROJECT

Pasco County Fire Rescue is partnering with the University of South Florida's College of Public Health for the Firefighter Sharps Safety Project. There are two remaining tasks for completion of the project.

1. **The stations listed below will be required to collect their used sharps' containers from September 17, 2012 through October 3, 2012, rather than disposing of them at the hospital.**
   a. **Between September 15 and 17, 2012, a representative from USF will deliver an OSHA-approved biohazard box to the following stations: 10, 11, 13, 14, 16, 17, 20, 22, 23, 26, 32, and 36. This box will be stored in the rescue supply closet.**
   b. **A reminder placard will be affixed to the sharps' container case in the Rescue unit.**
   c. **For this time period, any full sharps containers, including the small sharps' containers used in the jump bags on the engine, will be sealed, labeled with the apparatus information and date, and placed in the box. Labels will be provided for this purpose.**
   d. **On October 3, 2012, a representative from DNA Extreme Clean will collect the boxes. A receipt will be left with the Captain of the station. This receipt will be forwarded to F/P Christine McGuire-Wolfe at Operations.**
   e. **On October 3, 2012, the Station Commander will ensure removal of any remaining placards from the Rescue Units.**

2. **In the next week, surveys will be sent to all stations for completion by the crews. The intent of the surveys is to collect feedback about the training and posters encouraging needle and sharps safety. Participation in the survey is voluntary and anonymous; however, your participation is encouraged. Completed surveys should be returned to Operations in an envelope marked "SURVEY".**

Any questions about this project can be forwarded to F/P Christine McGuire-Wolfe or me at Operations.

AF/CMW/jlh

Distribution: J, and T

Destruction Date: October 17, 2012

cc: Scott M. Cassin, Emergency Services Director
Cynthia Holland, Assistant Chief
Andrew Fossa, Training Chief
Michael Gordon, Support Battalion Chief
Christine McGuire-Wolfe, Firefighter/Paramedic, Special Projects

Timothy Reardon
Rescue Chief

Appendix R: Post-Intervention Survey

Firefighter Sharps Safety Project

This survey is about your attitudes, practices, and beliefs regarding sharps use while on the job. Please answer the questions from your memory, without referring to additional materials. These surveys are anonymous, so you should not write your name, bunker number, station or shift on the survey. Your participation is completely voluntary. However, your help is needed to understand how and why the crews at PCFR use sharps the way they do. After finishing the survey, please place in the envelope provided which is labeled "survey", and return it to Operations. Surveys should be returned by October 3, 2012.

How many years have you worked in EMS?

< 1 year	1-5 years	6-10 years	11-15 years	16-20 years	> 20 years

How many years have you worked for PCFR?

< 1 year	1-5 years	6-10 years	11-15 years	16-20 years	> 20 years

Needlestick injuries pose a real risk while on the job at PCFR.

Strongly Disagree	Somewhat Disagree	I have no opinion	Somewhat Agree	Strongly Agree

If I am stuck by a needle or other sharp device while on a call, I would worry about contracting a blood borne disease such as HIV or Hepatitis C.

Strongly Disagree	Somewhat Disagree	I have no opinion	Somewhat Agree	Strongly Agree

There are steps that I can take to reduce my risk of needlestick injury while on the job.

Strongly Disagree	Somewhat Disagree	I have no opinion	Somewhat Agree	Strongly Agree

I use safer needle devices, such as pre-filled medications in syringes without needles and vial adapters, if they are available to me.

Strongly Disagree	Somewhat Disagree	I have no opinion	Somewhat Agree	Strongly Agree

I prefer to use "old fashioned" needles (those without safety devices).

Strongly Disagree	Somewhat Disagree	I have no opinion	Somewhat Agree	Strongly Agree

I re-cap used needles less now than I did six months ago.

Strongly Disagree	Somewhat Disagree	I have no opinion	Somewhat Agree	Strongly Agree

Please turn over. More questions on the back.

From my observations, it appears that my co-workers re-cap used needles less now than they did six months ago.

Strongly Disagree	Somewhat Disagree	I have no opinion	Somewhat Agree	Strongly Agree

Compared to six months ago, I am less likely to get a drop of blood for a blood sugar reading from an I.V. stylet.

Strongly Disagree	Somewhat Disagree	I have no opinion	Somewhat Agree	Strongly Agree

From my observations, it appears that my co-workers are less likely to get a drop of blood for a blood sugar reading from an I.V. stylet now when compared to six months ago.

Strongly Disagree	Somewhat Disagree	I have no opinion	Somewhat Agree	Strongly Agree

Compared to six months ago, I am more likely to administer I.V. medications using the luer lock or needleless hub.

Strongly Disagree	Somewhat Disagree	I have no opinion	Somewhat Agree	Strongly Agree

From my observations, it appears that my co-workers are more likely to administer I.V. medications using the luer lock or needleless hub when compared to six months ago.

Strongly Disagree	Somewhat Disagree	I have no opinion	Somewhat Agree	Strongly Agree

Since implementation of the firefighter sharps safety project, I am more aware about sharps safety.

Strongly Disagree	Somewhat Disagree	I have no opinion	Somewhat Agree	Strongly Agree

Since implementation of the firefighter sharps safety project, my co-workers seem to be more aware about sharps safety.

Strongly Disagree	Somewhat Disagree	I have no opinion	Somewhat Agree	Strongly Agree

Since implementation of the firefighter sharps safety project, crews are using needles and other sharps devices in a safer manner.

Strongly Disagree	Somewhat Disagree	I have no opinion	Somewhat Agree	Strongly Agree

The posters about sharps safety were an effective reminder about risky behaviors to avoid with needles and other sharps devices.

Strongly Disagree	Somewhat Disagree	I have no opinion	Somewhat Agree	Strongly Agree

Please provide any other comments or concerns that you have about sharps safety at PCFR and the Firefighter Sharps Safety Project.

Thank you for your help.