NEEDLESTICK INJURIES IN THE WORKPLACE: HEALTHCARE, VETERINARY AND RESEARCH

DECAP RESEARCH AND DEVELOPMENT

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EXECUTIVE SUMMARY

Every year there are over 2 million reported needle-stick injuries among healthcare, veterinary and research workers globally, causing losses of more than USD $1 billion in direct (medical/injury compensation costs) and indirect costs (lost-work productivity) (estimated sum from known case studies). Consequences of needle-stick injuries include exposure to pathogens, contraction of blood-borne diseases (HepB, HepC, HIV), limb amputation, and death. In the US there are 400,000 needle-stick injuries every year, costing upwards of USD $190 million, and each needle-stick injury on an individual basis costs on average USD $596 in direct medical care and other indirect costs.

Needle-stick injuries occur when the tip of a medical needle accidentally and unintentionally punctures the skin, injuring the needle-user. These events happen because needle-users must repeatedly uncap and recap needles to perform injections as part of standard-practice. Although recapping is advised-against in practice, it is an extremely common practice and more than 90% of clinicians, veterinarians and research workers admit to recapping needles regularly.

While common, there are few preventative methods for reducing needle-stick injury risk available. Standard-practice is to 'recap slowly,' and little has been done to improve the process of needle-use under the incorrect assumption that this issue is 'not a big deal' – in fact, it is consistently ranked in the top 3 concerns of healthcare staff, and needle-sticks go unreported upwards of 50% of the time in healthcare and veterinary care, meaning that that even the conservative estimation of 2 million needle-sticks per year is likely a gross underestimate.

HOW DO NEEDLE-STICK INJURIES HAPPEN?

Needles are used in healthcare, veterinary practice, and academic research. In healthcare, 16-20 billion needles are used globally and result in more than 2 million needle-stick injuries every year (WHO, 2018; Bouya et al., 2020). Bulk population data for veterinary and research environments is scarcer, but research suggests that 2-5 billion needles are used, with several hundred thousand needle-stick injuries (up to 90% of veterinarians have experienced needle-stick injuries) (Mishra & Palkhade, 2020). Contrary to popular belief, needle-stick injuries are frequent and have serious or material consequences including include exposure to pathogens, contraction of blood-borne diseases (HepB, HepC, HIV), limb amputation, and death.

Needle-stick injuries occur when the tip of a syringe needle accidentally and unintentionally punctures the skin, injuring the needle-user. These events happen because needle-users must uncap, recap, uncap and then recap again in order to perform injections as part of standard-practice (Figure 1).

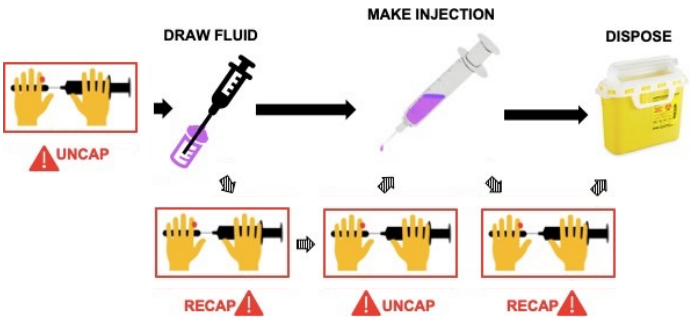

Figure 1: Needle-use workflow with risk-event points.
Typical workflow of how syringe needles are prepared, used, and disposed: fresh syringe needle is removed from packaging, cap on the needle is removed, needle is inserted into a vial to draw up fluids, needle is removed from vial, needle is recapped to maintain sterility when transferring needle (often preps are done in back-rooms/clean-rooms), needle is uncapped again once syringe is ready to be used for an injection, injection is given, needle is recapped again until it can be disposed, needle is disposed in a sharps waste bin. Over the course of a standard injection, the user is at-risk of receiving a needle-stick injury up to 4 times.

> *In healthcare, 16-20 billion needles are used globally and result in more than 2 million needle-stick injuries every year*
>
> *WHO, 2018; Bouya et al., 2020*

Common ways that needle-stick injuries occur include recapping, uncapping, disposal, administering injections, and performing surgical procedures, with the prevalence of each varying between healthcare specialties (Shah et al., 2000; Abadiga et al., 2020). More than 75% of needle-stick injuries occur due to recapping, which, although strongly advised against by OSHA, is still an extremely common practice in every field where needles are used (McCormick and Maki, 1981; Ruben et al., 1983; Krasinski 1987; McCormick et al., 1991; NIOSH, 1999; OSHA Directives; Wright et al., 2008; Sharma et al., 2009; Lin, Chen, and Chang, 2011; De Carli et al., 2015; Abadiga et al., 2020; Ghatage et al., 2020). Contrary to popular belief, risk of needle-sticks does not decrease with training or years of experience; in fact, a recent study found that needle-stick injury-risk increases over time (Zhang et al., 2020).

WHAT ARE THE CONSEQUENCES OF NEEDLE-STICK INJURIES?

Needle-stick injuries can lead to illness, limb amputation and death. According to a study in 2005, there were 1000 cases of NSIs per year leading to an HIV-positive result. In addition to these cases, there were an additional 82,000 infections with hepatitis caused by needle-stick injuries each year, and this remains one of the major drivers of the hepatitis epidemic in the healthcare industry (Guo et al., 1999; Assen et al., 2020).

Within the medical field, accidental transmission of HIV, HepC, or HepB is the most common concern from needle-stick injuries. The rate of infection per 100 health care workers exposed to these viruses after needle-stick injuries are 0.3%, 1.8%, and 6-30% respectively. WHO statistics show that

needle-stick injuries cause 1,000, 16,000, and 66,000 cases of HIV, HepC, and HepB respectively among healthcare workers every year (Pruss-Ustun, et al., 2005). Case studies of needle-stick injuries in the veterinary field typically address transmitted bloodborne pathogens between humans and animals, leading to zoonotic infection, digital amputation or tissue injury (Oliveira et al., 2010; Lin, Chen, and Chang, 2011; Ghatage et al., 2020).

The consequences of needle-stick injuries have a wide range of severity from death, direct exposure to blood-borne pathogens (ie: HIV, HepB, HepC, zoonotic diseases), carcinogens, toxic chemicals and drugs, to severe irritation or infection. A result of these exposures can lead to acute illness, chronic illness, life-threatening infections, amputations, psychological stress, post-traumatic stress disorder, and death (Bandolier Extra, 2003; O'Neill et al., 2005; Sharma et al., 2009; Fowler et al., 2016). Consequences from the effects of needle-stick injuries can lead to work loss and significant financial costs to the employer and the workers themselves (Panlilio et al., 2004, Cooke and Stephens, 2017).

> ***At the University of British Columbia, needle-stick injuries account for approximately 10% of all workplace incidents***
>
> *UBC Risk Management, 2014*

Researchers face risk factors that combine those faced in healthcare and veterinary medicine. Researchers work with human pathogens, zoonotic pathogens and mutant pathogens that carry the risk of infection and potential community spread. Needle-sticks are the most common type of injury resulting in illness or disease in laboratories, with case studies in literature describing life-threatening injury events despite statistical data being widely unavailable (Herwaldt and Juranek, 1993).

At the University of British Columbia (UBC), needle-stick injuries are a leading cause of staff and student exposure to potentially hazardous biological materials, accounting for approximately 10% of all workplace incidents (this figure includes all workplace accidents, including slips, falls, and groundskeeping injuries) (UBC Risk Management, 2014). Aside from pathogens, researchers also work with toxic chemicals, drugs and cancer stem-cells, and the consequences of exposure range from severe tissue damage to heightened cancer risk, auto-immune event, or death (Sanprasert et al., 2018; Vidal, 2020).

Examples of diseases that have been transmitted in research laboratory settings due to needle-stick injuries include dengue, malaria, leishmaniasis, meningitis and other infectious diseases (Herwaldt and Juranek, 1993; Lee et al., 2016; Drager et al., 2019). For example, in the US, 50% of all zika-associated infections in the laboratory were caused by needle-stick injuries. (Hills 2021).

WHAT ARE THE COSTS OF NEEDLE-STICK INJURIES?

Needle-stick injuries cause severe economic loss as well as debilitating disease and death. These economic costs of needle-stick injuries include healthcare costs, work-loss and potential long-term disability.

In the US, each individual needle-stick injury costs approximately USD $596 per injury. Cumulatively, the annual cost in the USA as a direct medical cost from needle-stick injuries was USD $188.5 million each year (direct medical costs of USD $107.3 million and indirect costs from lost-work productivity of USD $81.3 million) (Leigh et al., 2007).

England and Wales estimate that needle-stick injuries have an economic burden of EU $300 million per year, and Germany estimates an annual cost of EU $30 million per year (reported) and more than EU $133 million annually (direct costs, unreported) (Saia et al., 2010). Between these four countries alone, the annual projected cost of needle-stick injuries already exceed 1 billion without accounting for total expected rates of unreported needlesticks.

Between Germany, the UK, and the US alone, the annual projected cost of needlestick injuries exceeds 1 billion

Leigh et al., 2007; Saia et al., 2010

Indirect costs of needle-stick injuries include post-traumatic stress, anxiety, long-term disability, and other mental-health challenges arising from needle-stick injuries. Healthcare workers who have experienced needle-stick injuries were found to exhibit higher levels of anxiety and depression after needle-stick injuries (Sohn et al., 2006). Following needle-stick injuries, 60% of nurses reported enhanced fear of needles and 42% reported feeling anxious, depressed, or stressed, leading some to leave their jobs entirely (Lee et al., 2005; Worthington et al., 2006). Nearly two-thirds of U.S. nurses say needle-stick injuries and blood borne infections remain major concerns, and 55 percent believe their workplace safety climate negatively impacts their own personal safety (ANA, 2008).

Workers shared stories with DECAP of being placed on anti-retroviral treatments for months after inadvertent needle-sticks with HIV+ blood-containing syringes, trips to the ER during normal workdays, and of colleagues' fingers being amputated due to necrotizing infections. In many cases, due to the stigma of reporting, supervisors themselves do not report their own needle-sticks and further advise injured workers not to report their needle-sticks in an attempt to avoid completing paperwork, which leads to heightened stress and trauma among workers experiencing needle-sticks, including guilt at being part of a 'cover-up' and feelings of ostracization.

HOW ARE NEEDLE-STICK INJURIES CURRENTLY ADDRESSED IN THE WORKPLACE?

Attempts at reducing needle-stick injuries can be divided into: (a) behavioural directives (advising against recapping), (b) engineering controls (eg. safety needles), and (c) risk-reduction tools (eg. poke-proof gloves, NeedleSafe II, DECAP devices).

Unfortunately, it is well-documented that workers often do not comply with behavioural directives, such as training and guidelines against recapping. This is due to an unresolvable conflict between the proposed theory of safety protocols and the actual practice and reality of needle-use procedure and protocols. The practice and procedure of needle-use requires the user recap needles to maintain sterility or avoid an accidental poke while transferring the needle-syringe to another room to perform the injection, thus needle-users frequently recap (up to 90% of the time in some fields) while performing injections.

Safety-needles are a mechanism of attempting to use engineering controls to reduce needle-stick injuries. However, they are cumbersome, difficult to use, not environmentally friendly, and 10-times more expensive than regular needles, making them an unworkable solution in some environments. Ssafety needles can also still cause needle-stick injuries, despite their name: up to 20% of all needle-stick injuries come from safety-needles (ANA, 2008).

Behavioural directives advising against recapping do not work. This is due to an unresolvable conflict between the proposed theory of safety protocols and the reality of needle-use procedures.

During DECAP's customer interviews, we observed workers removing needle-caps with teeth, on desk-edges, or with pinky-fingers while holding multiple vials of drugs (all defined as unsafe-use). Current on-market needle-uncappers such as NeedleSafeII come with limitations on syringe needle type and workplace adaptability and are ergonomically unfriendly (unliked by workers).

NEEDLE-STICK INJURIES IN HEALTHCARE, VETERINARY CARE, AND RESEARCH

More than 90% of all academic research on needle-stick injuries comes from the healthcare sector, with 10% from veterinary practice, and no academic data on needle-sticks in research, despite a similar prevalence of needle-sticks based on our own surveys at the University of British Columbia (UBC) and the Hebrew University of Jerusalem (HUJI). This paucity of research is likely due to the heightened concern in healthcare/veterinary care of zoonotic diseases and blood-borne illnesses (HepB/C, HIV).

An additional factor in needle-stick data collection is severe underreporting; up to 94% of needle-sticks are not reported by healthcare workers and up to 99% of needle-sticks in veterinary care in some areas of the world, with common reasons for non-reporting being belief that the needle was sterile, lack of concern for needle-stick injuries, perception that reporting injuries are inconvenient or time consuming, and desire to avoid associated stigma (Kralj et al., 1998; Hasselhorn et al., 1999; Beie, et al., 2001; Smith and Leggat, 2005; Tabak et al., 2006; Mshelbwala, Weese, and Idris, 2016; Deipolyi et al., 2017; Hasak et al., 2018; Sethi, Evans, and Murray, 2020).

This practice also extends to students: up to 65% of needle-sticks are not reported by medical students in two separate studies (Osborn et al., 1999; Panilio et al., 2004). In a pilot survey we performed that included academic researchers at UBC and HUJI in 2019, we found that while nearly all respondents experienced needle-sticks, up to 50% of needle-sticks went unreported (Figure 2A, B, C).

Annually, healthcare workers experience more than 2 million needle-stick injuries around the world with more than 400,000 in North America alone, although this number may be a dramatic underestimate as a recent study of 50,000+ workers found a 1-year occurrence of 44.5% for needle-stick injuries in healthcare workers (Bouya et al., 2020). Globally, healthcare workers receive an average of 1.72 sharps injuries per healthcare worker per year (WHO). Our pilot study indicates over half of these needlestick injuries occur due to uncapping or recapping needles (Figure 2D, E). Despite recommendations against recapping needles, most respondents claimed to recap needles in practice (Figure 2F).

Up to half of all Canadian nurses report having experienced at least one sharps-related injury, with 11% reporting one in the past year (Shields and Wilkins, 2006). Additionally, incidences of needle-stick injuries were five times greater at 2009 pandemic influenza mass vaccination sites than would normally be expected, which suggests that during the current COVID19 pandemic we should expect an even greater increase as the world attempts to vaccinate 7 billion people (NIEHS, 2021).

In veterinary practices, up to 90% of all veterinary workers have experienced a needle-stick, often in the past year (Hill, Langley, and Morrow, 1998; Weese and Jack, 2008; Weese and Faires, 2009; Gibbins and MacMahon, 2015; Robertson et al., 2016; Fowler et al., 2016). Our own study at UBC and HUJI corroborated these results as we discovered that over 90% of vet-techs have experienced at least one needle-stick over the course of their career (Figure 2). Many of these injuries are likely due to unsafe recapping: studies show that up to 84.3% of veterinarians recap their needles and 74.2% reported at least one unintentional needle-stick injury (Whitney et al., 2009).

Despite the lack of data in research environments, it appears that less than half of needle-sticks that researchers experience actually get reported based on our conversations with workers in-the-field (Figure 2C). Under similar conditions, up to 90.9% of medical technologists, who perform procedures in laboratories that most closely resemble working conditions of researchers, suffered needle-stick injuries (Shim and Kim, 2003).

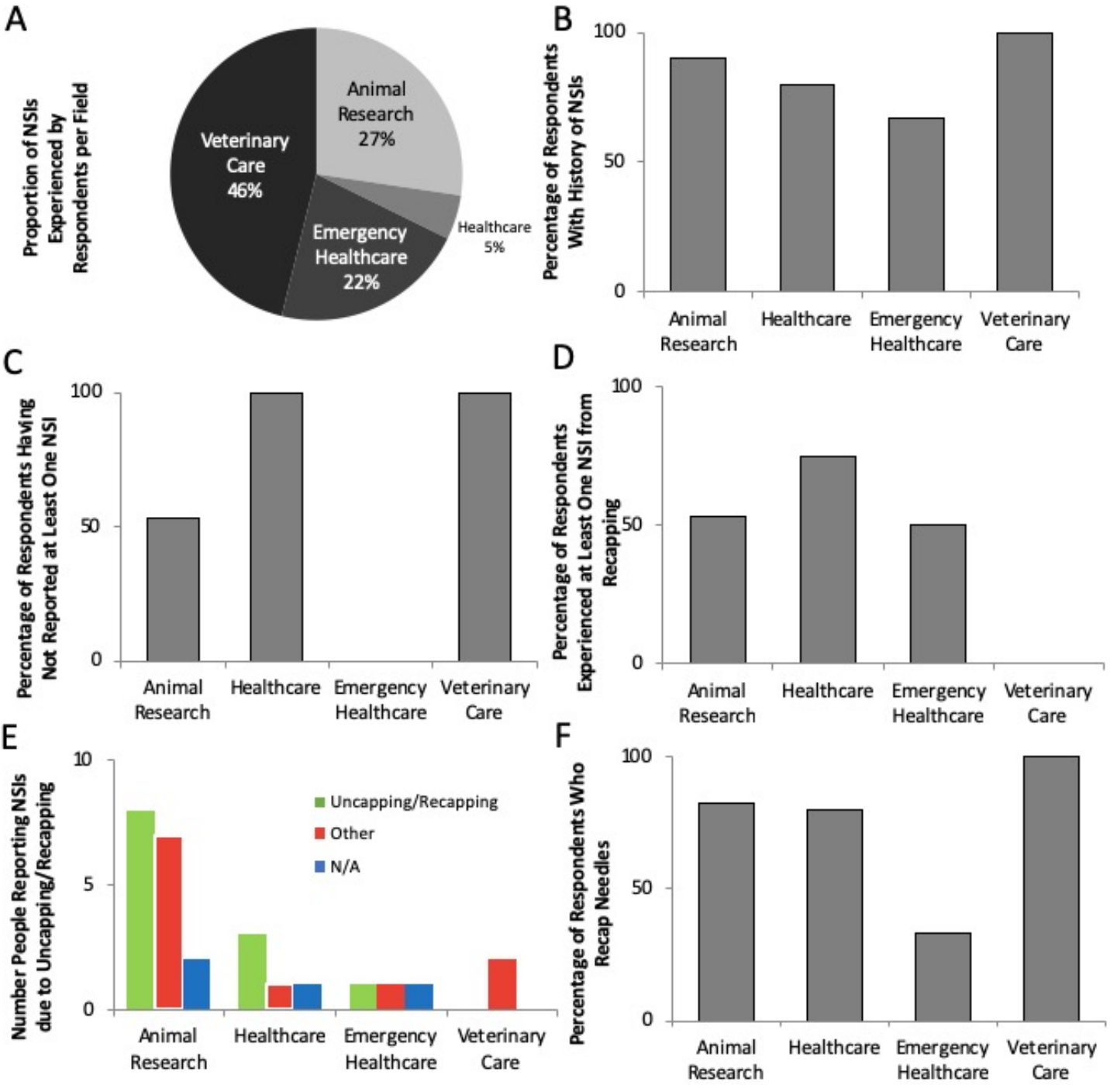

Figure 2. Needle-stick injury data from workplaces across BC.

(A) Total proportion of respondents by field. Percentage of respondents (A) reporting a history of NSIs in the workplace, (B) reporting recapping as regular practice, (C) admitting to not reporting at least one NSI, (D) reporting at least one NSI from recapping from a sample of workers in BC. Number of respondents (E) reporting/not reporting NSIs. (F) Proportion of respondents who recap needles. (n = 30).

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