

Sharps and high-pressure injection injuries in veterinary and animal workers

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Needlestick and 'sharps' injuries among those working with animals are a significant, under-reported and often ill-understood problem. Many patients present initially to Emergency Departments, where their potential to cause local and systemic infections and injury, zoonoses, allergic or anaphylactic reactions and death may be unrecognized. Increased awareness of the possibility of adverse effects and the consequences of these specific injuries is essential. *European Journal of Emergency Medicine* 00:000–000 © 2014 Wolters Kluwer Health | Lippincott Williams & Wilkins.

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Introduction

Needlestick and similar penetrating injuries are common in people who work with animals [1–4]. In 2013, ~25% of all suspected adverse events in humans reported to the Veterinary Medicines Directorate related to needlestick injuries. The resulting injury and exposure to animal blood, vaccines, drugs (including anaesthetics, sedatives, antibiotics, hormones and adjuvants) may result in local and/or systemic complications and deaths have been reported [4,5]. The majority of patients experiencing these injuries who seek help present to Emergency Departments or primary care facilities. Awareness and knowledge of the risks, complications and management of these patients is often limited. This paper outlines the common presentations, potential problems and initial care of such cases.

Mechanisms of injury

For the Emergency Department practitioner, the most important aspect is the need to promptly recognize the nature of the injury and its potential complications. Individuals likely to sustain these injuries come from three main groups: veterinary practitioners, veterinary nurses and technicians, farmers and vaccinators (most often in fish, poultry and pig farms). For the first two groups the most common injury mechanism involves needlestick and other 'sharps' injuries – either from scalpel blades or suture needles [6]. In the UK, there is no formalized mechanism for reporting of such events and it appears that many episodes are unrecorded. In other countries, needlestick injury rates of 9–75/100 person years are documented [6,7]. In Canada and Australia almost three-quarters of veterinary technicians and nurses had experienced at least one needlestick injury in the preceding year [1,3].

Small animal veterinary practice often involves wriggling, irate animals (who may also bite or scratch the handler) and

accounts for more events numerically. Large animal practice in the field is a different, but equally hazardous environment. Here, sterility is a problem, while wet, cold operator hands reduce dexterity and increase the risk of accidental injury. Unsurprisingly, the incidence of injury is increased in less experienced practitioners, those who treat more animals per week and those working longer hours [6].

Fish and animal vaccinators commonly use high-pressure multiple-dose devices to inject vaccines and drugs percutaneously without the involvement of needles. These systems permit mass vaccination techniques. The volume of agent delivered may vary from 0.1 ml (fish) to 2 ml (pigs) [8,9]. The pressure required to deliver the agent into the animal depends upon the species involved, but usually exceeds the 69 N/cm² (100 lb/psi) level required to breach intact human skin. The resulting tissue insult depends upon:

- (1) The kinetic energy involved: Kaufmann [10] investigated the pathophysiology of high-pressure injection injuries and calculated that the kinetic insult was roughly equivalent to dropping a weight of 1 lb from a height of 124 ft (~0.45 kg from 38 m). After penetrating the skin, the fluid blasts through the soft tissues shearing between structures and following the path of least resistance.
- (2) The volume and consistency of the material injected: This is an important issue in inoculations involving larger animals. Commonly, a pig inoculation involves ~2 ml of material. When injected, volumes of this magnitude can create local pressure effects in the affected digit with haemodynamic problems involving reduced arterial supply or venous obstruction [8]. The doses commonly used for fish or chickens,

0.1–0.2 ml, do not usually create local perfusion problems.

- (3) The nature of the material injected: Many vaccines contain adjuvants and are delivered as an emulsion or in an oil carrier to prolong absorption and improve antibody response. Mineral oil is a potent tissue irritant and can cause inflammation, granuloma formation and scar proliferation tissue [8,9,11].

The number of animals involved is considerable. In the UK ~18 million chickens are produced for food consumption per month with similar numbers of egg layers (<http://www.defra.co.uk>); 20–100 million fish are reared annually (<http://fishcount.org.uk>). All are vaccinated at least once. Vaccinators may inject up to 2500 fish per hour and professional vaccinators report up to 50 stabs or self-injections during a vaccination season [12].

For small animal operators and vaccinators the animal is customarily held in the nondominant hand so this is the most common site of injury. As in human practice, resheathing and disposal of needles is especially hazardous. Uniquely, and particularly worryingly, a not infrequent site of injury and injection is to the operator's face and mouth. This occurs when a single-handed operator holds the plastic needle sheath clenched between the teeth to allow the needle/syringe unit to be removed for use. Following administration of the injection the operators then may attempt to resheath the needle – inadvertently stabbing themselves in the face.

Agents which may be injected accidentally include active and passive vaccines, euthanasia drugs, anaesthetics, sedatives, antibiotics and animal blood [3,7]. Although the proportion of needlestick events that cause a severe or systemic side-effect is relatively small (~4% of those producing a side-effect) the potential for a major event exists. One accidental self-injection of a prostaglandin compound was followed by a spontaneous abortion for the female veterinarian involved [7].

Given the wide diversity of (often unfamiliar) agents involved and the potential for adverse events, it is advised that, for any patient presenting with the possibility of drug or vaccine injection, the National Poisons Information Service (<http://www.toxbase.org>) is consulted to facilitate definitive, up-to-date clinical advice and reporting. Where possible following such injuries, patients presenting to the Emergency Department, or their supervisors, should bring product information leaflets relating to the substance involved.

Specific complications arising from injuries to the hands

Pulp space infections

Of the infections arising from needlestick injuries of the hand this group probably represents the majority. Syringe contents, skin contaminants or animal waste may be

driven into the pulp. Infections may develop in 24–48 h involving a wide spectrum of gram-positive and gram-negative organisms. Because the pulp comprises large numbers of fat-filled compartments created by fibrous bands that anchor the skin to the distal phalanx, pressure rises swiftly creating severe pain at an early stage (Fig. 1). Immediate referral to a hand surgeon is advised. Under appropriate anaesthesia, limited incision and drainage with Gram-stain, culture and sensitivity of the pus is required together with administration of a broad-spectrum antibiotic, for example co-amoxiclav to cover likely contaminants. The choice of antibiotic can be adjusted later when swab culture results are available.

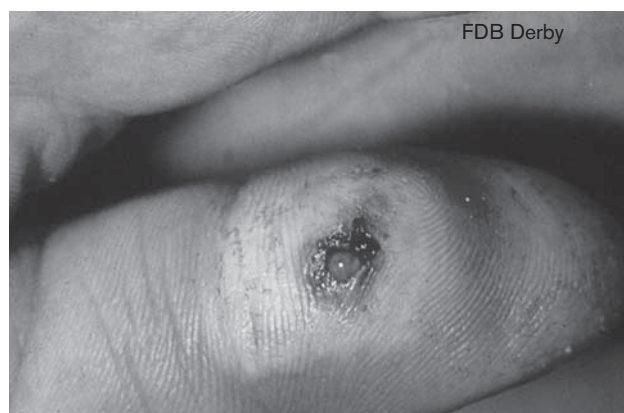
Pulp space infections are usually limited and more proximal extension of the infection is rare. However, late presentation affects outcome. Infection may spread with osteomyelitis of the distal phalanx, on occasion requiring amputation, whereas extensive loss of pulp fat can lead to loss of fine manipulative skills.

Flexor tendon sheath infections

These are less common, but have a significant risk of severe long-term complications. In these cases, the needle tip or the high-pressure injection device deposits contaminated or irritant material into the flexor tendon sheath. The flexor sheath extends from the distal inter-phalangeal (DIP) joint to the palm with the synovial sheath lying more proximally. In the fingers at the level of the DIP and proximal inter-phalangeal joint creases the sheath is very superficial and even shallow wounds to the area may involve the sheath. A needlestick or pressure injection injury to the flexor crease of a finger almost invariably involves the flexor sheath.

In contrast to pulp infections, presentation of flexor tendon sheath infections is often delayed. This is because pressure associated with infection does not rise locally. Infection spreads proximally, and rapidly, along

Fig. 1



Digital pulp space pressure effect following accidental self-injection.

the length of the finger, through the palm and wrist into the forearm. Presentation may be 3–4 days after the injury with increasing pain in a swollen finger the usual complaint. The affected finger is held semiflexed and attempts at passive extension are extremely painful. On palpation there is tenderness over the sheath extending into the palm.

Urgent admission and specialist referral, with rapid surgical decompression at the DIP joint crease and in the palm and saline irrigation to the sheath together with intravenous antibiotics will usually control the infection. The hand is rested on a volar slab for a few days until the infection is controlled and the patient then referred to hand therapy for mobilization. Late presentations can lead to tendon necrosis and sloughing, giving rise to a need for amputation or multiple reconstructive procedures and compromised outcomes.

High-pressure injection injuries

The patient is usually aware of the diagnosis at the time of injury, although there may be some delay when working in cold/wet conditions, for example fish farms. Information on the vaccine, its volume and carrier media is important. Refer these cases urgently to a specialist hand surgeon for exploration and debridement.

Doses of at least 0.5 ml will, almost invariably, require exploration and debridement. Doses of 0.1–0.2 ml may allow more local debridement and less radical exposure but still require close monitoring; if local symptoms do not resolve within 48 h more extensive debridement will be required.

In one series of industrial high-pressure injection injuries to the hand 45% of cases required the exploration to extend proximal to the carpal tunnel and into the lower forearm [13]. Subsequently, early mobilization with hand therapy reduces the risk of stiffness.

Early debridement is likely to result in lower amputation rates subsequently and better functional outcomes [14,15]. An overview of reported series noted an amputation rate for industrial high-pressure injection injuries of ~48% [16]. Debridement is, however, only one factor. The toxicity and volume of the injected material critically affect outcome and digit viability.

Similar factors are likely to apply to veterinary inoculation injuries. Oil-based veterinary vaccines have been reported to cause prolonged chronic granulomatous reactions with sterile abscess formation that may result in significant morbidity requiring multiple operations for debridement [17]. The injection of only 2 ml of pig vaccine experienced by one of us (F.D.B.) could not be controlled by repetitive debridement and led to thumb amputation [8].

Amputation of digits at the metacarpophalangeal joint has been reported following injection of a pig parvovirus

vaccine, [8] and combined bovine vaccine, [18] and another patient, following injection of fowl pest vaccine, lost the terminal phalanx of a finger [19]. Other long-term sequelae include neuralgic pain and cold intolerance at the site of the injection.

Potential for transmission of zoonoses

Veterinarians are at increased risk of contracting zoonoses (diseases and infections transmitted between vertebrate animals and man). There are ~40 potential zoonoses in the UK. Although 'exotic' zoonoses, for example rabies, Crimean Congo Haemorrhagic fever have occurred, these have usually occurred in individuals travelling outwith the UK, although this is not exclusive. A human case of Seoul hantavirus infection was confirmed in 2012 and this virus and a new hantavirus (Tatenale) have been isolated from wild rodents in the UK (DEFRA Zoonoses Report 2013). The majority of zoonoses, for example influenza, hepatitis E, brucellosis, campylobacteriosis, vero cytotoxin producing *Escherichia coli*, listeriosis, salmonellosis etc. are most commonly transmitted by ingestion or inhalation and data for penetrating injuries and disease transmission are sparse or out of date [20,21]. Numerically, brucellosis may be the greatest problem. Acute brucellosis has been reported following unintentional injection with attenuated *Brucella melitensis* strains [22]. The potential for transmission of disease with human sequelae also exists with other live vaccines, for example orf, *Toxoplasma gondii*, *Chlaydophila abortus* (sheep enzootic abortion), and pregnant women and the immunocompromised are at particular risk. For some vaccines differentiating between the local effects of the vaccine and its carrier are more complex [23].

Stratagems for prevention and possible lessons from human medicine

For the foreseeable future, the use of solid and hollow needles and other sharp instruments in human and veterinary medicine and surgery will continue. The recognition of the particular hazards of hepatitis B and C and HIV to human healthcare staff sustaining sharps injuries has prompted major efforts to minimize such events. For these diseases the risks of transmission and the potential severity of their sequelae are considerable and much effort has been expended to reduce the potential for these episodes to occur. Stratagems employed include risk assessment, implementing safe procedures when using and disposing of sharps, the introduction of devices that incorporate safety-engineered protection mechanisms and the use of personal protective equipment. Nursing staff have been particularly at the forefront of such initiatives and their implementation (RCN Sharps safety 2011) and often lead the way in training medical staff and maintaining standards.

In contrast, there appears to be a marked lack of similar attention and change of habits in veterinary practice. In part, this may relate to a relative paucity of potentially blood-borne pathogens in the animals involved. The situation is not dissimilar to that which existed in human medical practice before the recognition of hepatitis B and C and HIV. The incidence of disease transmission from vaccines in the UK is unknown, but a recent Canadian study indicated that in the previous 5 years, 26% (214/810) of veterinarians had reported accidental exposure to vaccines (West Nile virus, *Giardia*, *Leptospira* spp.) due to needlesticks [24]. Further, common pathogens from animal skin or tissues, for example *Streptococcus*, *Staphylococcal*, *Pasteurella*, *Pseudomonas* spp. etc. are all well recognized as causing local and systemic disease in humans.

In addition to the possibility of disease transmission and local trauma, inadvertent injection of highly potent drugs and vaccines may occur. It is worrying that inadvertent self-injection of euthanasia, sedative and anaesthetic drugs account for 17–28% of reported episodes [2,3].

The problem of safe needle use and disposal is particularly important. Approximately 75% of needlestick injuries relate to incorrect handling, for example resheathing and disposal [25]. Nevertheless, 86% of US Zoo veterinarians reported regularly recapping needles [26].

Engineering solutions to assist the reduction in injuries are increasingly being adopted in human medicine and have been shown to be effective [27–29]. Whether the additional complexity and cost of introducing self-resheathing or retracting needles and cannulae and needle-less intravenous systems can be introduced in veterinary practice is, however, uncertain.

Conclusion

Needlestick and ‘sharps’ injuries among those working with animals are a significant, under-reported and often ill-understood problem. The potential for local and systemic infections and injury, zoonoses, allergic or anaphylactic reactions is considerable. Lessons from human medical practice including, avoidance of needle resheathing, immediate and easy access to sharps containers and protective equipment can be usefully employed. The majority of these patients present to Emergency Departments or Primary Care. Increased awareness of the possibility of adverse effects and the consequences of injury is essential.

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Conflicts of interest

There are no conflicts of interest.

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