Clinical Practice

INFECTIOUS DISEASES AND THE PRE-HOSPITAL PRACTITIONER

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Abstract

Ambulance officers and other emergency service personnel may be exposed to the body fluids of their patients due to the unpredictable nature of their work. As it is not possible to predict which patients may have a communicable disease, standard precautions must be practiced at all times. This is part of an occupational health and safety strategy that includes appropriate immunisation, education, and post-exposure counselling of staff. The actual risk of acquiring blood-borne viruses or other communicable diseases is less than is generally perceived and post-exposure prophylaxis is available for several of these. Hepatitis B is the most transmissible of the blood-borne viruses but there is very effective pre- and post-exposure prophylaxis available. There is effective post-exposure prophylaxis available for HIV but not for hepatitis C. An ambulance officer exposed to tuberculosis or meningococcal disease should also be offered post-exposure counselling and protective therapy as appropriate, although the risk of subsequent disease is very small. Education of staff about the actual risks involved following an exposure and the correct procedures to follow will allay fears and allow the safe and efficient management of patients outside of the hospital.

Keywords: *hepatitis B; hepatitis C; HIV; needlestick injury; tuberculosis; meningococcal disease; ambulance officer.*

Introduction

Of most concern to emergency service personnel is the risk of acquisition of blood-borne viruses such as HIV, hepatitis B and hepatitis C. The highest risk of transmission is usually from a needlestick injury (NSI). In some circumstances additional measures, such as personal protective equipment will be required to reduce the risk of exposure to the patient's body fluids.

There are a number of other infectious diseases, such as tuberculosis and meningococcal disease that ambulance officers may be exposed to during the management of patients outside of the hospital setting. These exposures may go unrecognised at the time, making post-exposure counselling and management a priority.

What is necessary to assess the potential risk from any given exposure is an understanding of the nature and likelihood of the infection in the source patient, the type of exposure and efficiency of transmission of the infection, and the susceptibility of the exposed worker to that infection.

BLOOD-BORNE VIRUSES

Source Patient

Since it is not possible to predict which patients may be carrying a blood-borne virus standard precautions should be practiced in all situations, regardless of the known diagnosis or infection status of the patient. Standard precautions are practices such as hand washing, the use of personal protective equipment, and correct sharps disposal designed to reduce the risk of transmission of infectious agents to and from health care workers and their patients. The risk of exposure to any infection is a function of the prevalence of that infection in the local population serviced by the ambulance officer. For example, the seroprevalence for hepatitis C virus will be much higher in an inner city, young, intravenous drug using population compared to an elderly population from a country location. In some inner city areas of the large cities of the U.S.A. the seroprevalence of hepatitis C may be as high as 18%.¹ The estimated seroprevalence in Australia for hepatitis C is 0.7% but in Australian long term IV drug users it may be as high as 90-100%.² In comparison, in some African countries the hepatitis C seroprevalence approaches 15%.³

Most important for the risk of transmission of hepatitis C is the ability to detect the hepatitis C **ribonucleic acid** (RNA) in the blood of the source patient. Transmission from hepatitis C RNA-negative sources is very unlikely. A comparison of the characteristics of the blood-borne viruses is shown in Table 1.

Nature of the Exposure

Fresh blood is the most communicable body fluid for hepatitis B, hepatitis C, and HIV. The number of infectious virion in blood may vary depending on the stage of disease, but an acutely or chronically infected person may have a million copies of viral genome/ μ L. The viral load in HIV-infected patients may be anywhere from undetectable by the current assays to similarly high.

Of the types of exposure possible during the pre-hospital management of patients, a NSI from a needle contaminated with fresh blood is considered the highest risk compared to exposure of skin or mucous membrane. Studies from the U.S.A. have documented that emergency service personnel receive 87-370 NSI's per 1,000 workers each year, compared to 92-230 NSI's/1,000 nurses/yr and 50-2,000 NSI's/1,000 doctors/yr.⁴ Improper disposal of used needles and unnecessary attempts at recapping needles account for about 50% of NSI's.⁴ Simulation of a NSI using a 2 μ L syringe and a 0.5 mm needle predict about 0.03 μ L of blood is transferred but there is wide variation. Compare this to the sharing of needles during intravenous drug use where about 20 μ L of blood is exchanged.⁵

Non-parenteral exposures are much more common. Exposure to skin, accounts for the majority (62-95%) of non-parenteral exposures. Studies from the U.S.A. have found either fewer (200-800 exposures/1,000 workers/yr) or similar (12,300 exposures/1,000 workers/yr) rates of non-parenteral exposures in emergency service personnel compared to health care workers.⁴ Contact of infected blood with intact skin is a low risk contact. HIV, Hepatitis B and hepatitis C are poorly transmitted in this way, if at all.

Body fluids such as saliva or vomitus, not contaminated with blood, pose a much lower risk of transmission. The exception to this is genital fluids for sexually transmitted diseases such as hepatitis B and HIV. There has never been a documented case of hepatitis B, hepatitis C, or HIV from unprotected CPR.

Efficiency of Transmission

The risk of acquiring a blood-borne virus is a function of the viral load of the source patient, the ability of the virus to survive outside the source patient, and its innate transmissibility. Data from the CDC in 1991 stated the likelihood of contracting hepatitis B from a significant NSI was up to 30%.⁶ The risk for hepatitis C is approximately 4% for a hepatitis C antibody-positive source but up to 10% if the source has hepatitis C RNA detected in their blood.⁷ The risk of contracting HIV is significantly less, estimated to be 0.32%. In comparison the risk of acquiring HIV from receptive anal intercourse is thought to be 0.8-3.2%.⁸ However, the risk may vary significantly for any individual incident depending on the viral load present in the source patient, and the nature of the exposure. For example a large hollow needle used to aspirate blood from the source patient is a greater risk than a solid needle or a smaller needle used to give an intramuscular injection.

Protection of the Pre-Hospital Practitioner

The quoted figures estimating transmission following a parenteral exposure do not take into account post-exposure prophylaxis (PEP) for hepatitis B and HIV, or the hepatitis B immunisation status of the recipient.

The rate of HIV infection in the Australian community is very low. Screening of Australian blood donors from 1985 to 1992 detected only 46 cases with anti-HIV antibodies out of 5, 400,000 donors.⁹ The incidence in homosexual males attending sexual health clinics from 1993 to 1999 was 2.1%¹⁰ and the prevalence in Australian prison entrants 1991-1997 was 0.2%.¹¹ In the USA health care workers are estimated to receive up to a million NSI's each year. Since the advent of testing in the 1980's only 56 cases of HIV seroconversion have been documented.⁶ In comparison over 5,000 hepatitis B seroconversions are reported each year. Fairfield Hospital in Melbourne found no seroconversions following 77 significant NSI's from HIV antibody positive source patients, despite only 13 recipients receiving PEP.¹² Despite this low prevalence, PEP for HIV is of primary concern for workers receiving a NSI from a high risk source. Post exposure prophylaxis of health care workers with zidovudine has been reported to reduce transmission by as much as 79%.¹³ Prophylaxis for high-risk exposures is recommended within 4 hours of exposure and involves the use of several antiretroviral medications, usually for four weeks.

Post-exposure prophylaxis for hepatitis B is also very effective. It is recommended for recipients who have a significant exposure from a proven or an at-risk source that have either not been immunised against hepatitis B or have not had an adequate immune response following immunisation recently documented. Hepatitis B hyperimmune globulin is recommended within 72 hours of exposure together with commencement of vaccination. Vaccination can be commenced up to 7 days after exposure and still give some protection, due to the long incubation period for this virus.

Prior to the routine immunisation of emergency service providers several studies found an increased incidence of hepatitis B compared to control groups. A 1986 Seattle study found 22% of their paramedics had serological evidence of hepatitis B exposure compared to 4.5% of matched controls. The risk of exposure to hepatitis B has also been correlated with length of service. It is now routine for all service personnel potentially exposed to blood-borne viruses to be immunised against hepatitis B. In contrast, the seroprevalence rate for hepatitis C and HIV in emergency service personnel is similar to the local population.

There is no proven PEP for protection against hepatitis C and there is no vaccine likely to be available for hepatitis C or HIV in the near future.

At the time of the exposure washing of the skin with soap and water or rinsing of the mouth, nose or eyes with water or saline is recommended to remove and inactivate any remaining virus.

Post exposure blood testing

It is recommended that, following a NSI or other blood exposure, the source patient be tested for the presence of hepatitis B surface antigen, hepatitis C antibodies, and HIV antibodies. This can only be performed after pre-test counselling and informed consent. If hepatitis C antibodies are detected then testing for hepatitis C RNA by polymerase chain reaction (PCR) can be performed. The recipient should also be tested for hepatitis C and HIV antibodies to exclude an existing infection, and checked for immunity to or past infection from hepatitis B, unless this has been recently performed. Further testing of the recipient is performed at 3 and 6 months post exposure. In known or high-risk HIV exposures testing at 6 weeks post exposure is often recommended. Testing for hepatitis C RNA and liver function 4 weeks after exposure may be recommended for significant exposures from known hepatitis C RNA-positive sources.

TUBERCULOSIS

In Australia up to 80% of active tuberculosis infections occur in migrants from Asia, Southern and Eastern Europe, and the Pacific Islands. Following primary infection 90% of cases enter a latent phase where the bacteria remain viable but undetectable. Reactivation of latent infection is most likely within the first year. Peaks of tuberculosis reactivation have been found in the very young (less than 3 years old), young adults and the elderly. Tuberculosis may reactivate to cause pulmonary or extrapulmonary disease.

Latent infection with *Mycobacterium tuberculosis* can be difficult to detect since infection may leave no clinical or chest X-ray sign. Mantoux testing is often employed; this involves testing for delayed hypersensitivity to a purified protein derivative of *M. tuberculosis* inoculated into the skin. The Mantoux reaction becomes evident 2-10 weeks after infection but may wane to negative after many years of latent infection. Immunisation with Bacille Calmette-Guerin (BCG) vaccine will also result in a reactive Mantoux test in 90% of recipients. The QuantiFERON-TB test is a new test to detect latent infection with *M. tuberculosis* that is performed on blood. It is a simpler test for the patient but measures the patient's immune response to *M. tuberculosis* antigen in a different way from the Mantoux reaction.

In Australia the rate of tuberculosis is very low such that active disease is often not recognised early thus presenting a diagnostic problem. Actively infected patients may present to emergency departments with a variety of symptoms. One study from the USA found only one third of patients suffering active tuberculosis presented with classic pulmonary symptoms such as cough or haemoptysis.¹⁴

Transmission of Tuberculosis

Only open pulmonary tuberculosis, where the tuberculous lung lesions are in contact with the airways, is communicable via respiratory droplets. Significant health care worker exposures therefore involve contact with respiratory secretions such as during tracheal suctioning or close contact for a number of hours. Those at greatest risk are usually household contacts of coughing open pulmonary tuberculosis cases that are exposed over a long period of time. Studies of commercial airline passengers exposed to tuberculosis during their flight have

found an increased risk of infection, as measured by conversion to Mantoux positivity, in those sitting within close proximity to the communicable case during long-haul flights (over 8 hours).¹⁵

To assess the risk of transmission, samples of respiratory secretions are examined under the microscope for the acid-fast bacilli. If these are not found on multiple specimens then the patient is considered “smear negative” and poses a very low risk of transmission. Infectivity can also be greatly reduced by coughing and sneezing into a handkerchief. If a known communicable case requires transportation then a high efficiency facemask can be applied. Up to 40% of cases of tuberculosis are extrapulmonary with no risk of transmission to others. Likewise, no additional precautions are necessary for non-tuberculous mycobacterial disease.

Prevention of tuberculosis

The only immunisation available for prevention of tuberculosis is BCG vaccine. Unfortunately the protection offered has been difficult to assess due to varying results (0-80% protection) from field trials.¹⁶ The only definite protection appears to be preventing extrapulmonary disease in children less than 5 years old. It is therefore not routinely recommended for health care workers in Australia.

Workers exposed to a communicable case of tuberculosis are usually assessed by Mantoux testing. Those with negative results are then retested after 3 months. If there is a conversion of the test to reactivity then the worker is assessed for active tuberculosis. If this is confirmed multi-drug anti-tuberculous treatment is administered. Those found to be recently infected but without signs of active disease may be offered preventive treatment.

MENINGOCOCCAL DISEASE

Few diseases attract so much media attention as invasive meningococcal disease. Although the typical petechial rash is easily recognisable by health professionals many cases present in a less obvious manner, with either a maculopapular rash considered viral in origin or no rash at all. The infection can result in either meningitis or septicaemia. The case fatality rate is approximately 10% in most western countries, and a number of survivors suffer neurological sequelae from meningitis or lose digits or limbs. It can present at any age but is more likely in young children and adolescents. There is a seasonal variation in Australia with most cases occurring in late winter and spring.

Transmission

Neisseria meningitidis initially colonises the nasopharynx and is transmitted from person to person via respiratory secretions. Cross-sectional surveys have found carriage rates up to 37% in young adults.¹⁷ The acquisition of a new strain virulent for that person precedes invasive disease by about 2-10 days. Smoking increases the risk of infection several fold.¹⁸ Secondary cases have been known to occur in close contacts, usually within 10 days of presentation of the index case. Those most at risk are household contacts but the attack rate is still low, estimated at about 3 cases per 1,000 close contacts.¹⁹ Students in the same classroom or fellow university students are at even less risk.

The risk to health care workers has been difficult to define due to the paucity of cases. Most occupational cases occur in laboratory workers who handle pure cultures of the bacterium. The few clinical cases that have been reported have been exposed to the respiratory secretions of infected patients through mouth-to-mouth resuscitation, intubation or emergency

resuscitation.²⁰ The estimated attack rate from documented secondary cases in Britain is 0.8/100,000 at-risk health care workers.²¹ Twenty four hours after the administration of ceftriaxone or cefotaxime the nasopharyngeal carriage of the patient is eliminated and contacts are no longer considered at risk.

Prevention of meningococcal disease

Close contacts, including health care workers with significant exposure to the patient's respiratory secretions, are prescribed chemoprophylaxis. This can be given as either single doses of ciprofloxacin or ceftriaxone or a two-day course of rifampicin. Although very effective, a small risk of disease persists and therefore contacts are advised to seek medical help if illness develops.

A vaccine for meningococcal disease has been available for many years. Unfortunately it does not cover serogroup B *N. meningitidis*, which accounts for the majority of cases in Australia, and the protection is relatively short-lived. A new conjugate vaccine has been licensed which provides long-lived protection against serogroup C *N. meningitidis* but is likewise ineffective against the other serogroups. There is no role for the routine immunisation of health care workers in Australia.

VIRAL HAEMORRHAGIC FEVERS

There are a number of viruses from other countries that can cause a severe illness of fever with haemorrhagic complications, often with a high mortality rate. Several viruses from Africa such as Ebola virus, Marburg virus and Lassa Fever virus have been implicated in person-to-person spread, but only in Africa. Despite a number of infected passengers returning from Africa on long-haul flights there has never been a secondary case reported among fellow passengers.¹⁵ Infections transmitted from unrecognised cases admitted to hospitals in Western countries have never been reported despite large numbers of health care workers being exposed.¹⁵ Patients whose blood, urine, and other body fluids are contained do not pose a significant risk to others.

Preventing transmission of Viral Haemorrhagic Fevers

The most likely contact of an ambulance officer with a patient infected by one of these viruses is during the transfer of an ill ex-Africa passenger to a local hospital. For the transfer of a high-risk patient it is recommended that gloves are used for handling the patient or the patient's body fluids, a mask and goggles if the patient has a cough, or is splashing body fluids, and a gown to prevent soiling of clothing with body fluids. Following the transfer of the patient all surfaces and equipment contaminated with body fluids should be disinfected.²² There is no vaccine but treatment with intravenous ribavirin is available.

SUMMARY

Although ambulance officers are exposed to a large number of infectious diseases through the daily practice of their work, the risk of acquisition is usually very small and much less than is generally perceived. However, it is not possible to predict which patient may be carrying a communicable disease and there is a documented risk of ambulance officers being occupationally exposed to blood. This is the basis for the practice of standard precautions, to prevent contact of all patients' body fluids with your own. The role of correct disposal of

sharps, the use of personal protective equipment when appropriate, and vaccination for hepatitis B in preventing transmission of blood-borne viruses cannot be overestimated. Post-exposure prophylaxis is very useful but it is not 100% effective. It is always better to prevent significant exposures than to try and treat them after the fact. Many significant exposures occur because of failure to follow established guidelines, such as improper disposal of sharps.

Some illnesses such as tuberculosis or meningococcal disease may not be suspected until after the contact has occurred. Appropriate testing and follow-up in these instances is essential and is an important role of the Occupational Health and Safety Officer. This Officer should be the resource point for the education of ambulance staff in the transmission and prevention of communicable diseases.

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Table 1. Comparison of blood-borne viruses in Australia

	Hepatitis B	Hepatitis C	HIV
Risk groups	Patients from high seroprevalence countries Some in *IVDU population Indigenous populations	Mostly in IVDU population Some in patients from high seroprevalence countries	Mostly homosexual community Some in IVDU population
Transmission	Sexual transmission Vertical transmission Some from IVDU	From IVDU Poorly transmitted sexually Some vertical transmission	Sexual transmission Vertical transmission Some from IVDU
Acute illness	Mild to severe in adults Minimal or no disease in neonates	Mild or asymptomatic	Seroconversion illness or asymptomatic
Risk of long-term (chronic) infection following acute illness	5% in adults 90% in neonates without prophylaxis	Approximately 75%	100%
Chronic infection	No symptoms in 70% May have recurrent flares with jaundice	No symptoms in 27% Mild symptoms in 40-60%	No symptoms until immunodeficiency
Risk of cirrhosis	1-2% of chronic infections/yr	About 5-10%	none
Vaccine available	yes	no	no
Effective post-exposure prophylaxis available	yes	no	yes
Antiviral treatment for chronic infection available	yes	yes	yes

* IVDU intravenous drug use

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