18

Understanding zoonotic disease: Minimising infection risk for animal management officers

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Abstract

Zoonoses are infections that are transmitted from vertebrate animals to humans. Zoonotic diseases, as a group, represent only a small proportion of the full spectrum of diseases to which humans are susceptible. The susceptibility of humans to zoonotic infection depends on three things: the pathogenicity of the organism in question, the exposure dose received, and the immune competence of the person. Zoonotic infections range from those that pose a small risk to those that can be life threatening. It should be noted that humans are far more likely to be debilitated by a disease acquired from another person than they are to be severely affected by a disease contracted from an animal. The risk to Animal Management Officers from zoonotic disease is greater than the public risk in general on account of their job role which, similar to veterinarians, involves the handling of animals that may be unwell or at least may have uncertain health backgrounds. The zoonotic infection risk to Animal Management Officers should be minimised where possible. This paper is intended to clarify issues relating to the understanding of zoonotic infections including probabilities, susceptibilities and risk minimisation measures that can be adopted in the interests of the occupational health and safety of Animal Management Officers.

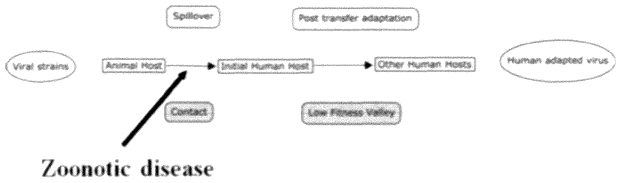
Zoonosis - Humanosis

A zoonosis is a disease that can be transmitted from a vertebrate animal to a human. Note that the animal host has to be a vertebrate animal. Swine influenza (H1N12009) was a zoonotic virus that transmitted from pigs to humans (although the exact transmission event was not identified), became human adapted and caused an influenza pandemic. The reverse also applies: a humanosis is a disease that can be transmitted from a human to a vertebrate animal. A good example of a humanosis was that during the swine influenza epidemic of 2009, there were several examples where workers in piggeries acquired H1N12009 from humans and then took the infection to work and infected pigs. So strategies that decrease the risks of pathogens transmitting from animals to humans will also protect animals from humanoses. To finish with the influenza example, all workers in piggeries should be vaccinated against influenza and, if they have an influenza-like illness, they should wear masks or not come to work (Gray & Baker 2007). An Animal Management Officer that protects himself against zoonoses also protects the animals in his charge against humanoses. It works both ways!

Zoonoses in perspective

Most diseases in humans are acquired from other humans. Pathogens (bacteria, viruses, fungi, parasites, prions) tend to become adapted to particular hosts and form host-adapted strains which transmit most commonly among that host, but occasionally spillover to other hosts. Most zoonotic diseases result from a spillover event of a pathogen that is adapted to an animal host (Fig. 1).

Figure 1 Spillover of virus from animal host to human host, transmission human to human and then subsequent adaptation of the virus to humans.



In most events there is no ongoing transmission from first infected human to subsequent humans. However, since it is a numbers game (ie, probability), the more individual spillover events there are for a pathogen, the greater is the chance that subsequent human to human transmission will occur. The first successful human to human transmission is usually to family members. Bear in mind that if you get a

zoonosis your immediate family and other close contacts are next in line (Baker et al 2006). Once the first human to human transmission occurs, there is then the possibility that a pathogen will become adapted to humans and move from being a zoonosis to becoming a human pathogen. The classic example of this is HIV/AIDS. Simian retroviruses spilled over from non-human primates to humans in Africa through "bushmeat" hunting for many years (and still do). Most did not get beyond the next hurdle to transmit human to human, but two strains did; one to become HIV1 originating from the chimpanzee and the other to become HIV2 from the sooty mangabey (Tebit & Arts 2011). Lesson: any steps to reduce transmission of zoonotic diseases (tip the numbers against the pathogen) are valuable not only to the individual, but to *Homo sapiens* in general. Think of this greater cause when you practice your infection control!

Three factors determine whether disease is likely to occur when a pathogen enters a host: virulence of the pathogen, inoculating dose, and susceptibility of the host. Pathogens vary in their intrinsic ability to cause severe disease; some cause only minor ailments, others can kill. This property is called virulence. A pathogen that can cause severe disease is said to be highly virulent; sometimes shortened to "virulent". Inoculating dose: Whether a pathogen causes disease or not at any transmission instance depends on the number of particles (eg, number of bacteria) that enter the host's body. If the number of bacteria (for example) is low and the pathogen is of low virulence, disease is unlikely. Where as if large numbers of the bacteria enter the body, disease is highly likely to result. The susceptibility of the host is the third factor: humans that are immunosuppressed by drugs (eg, corticosteroids, cytotoxics), disease (eg, HIV/AIDS), or even physiological state (eg, pregnant, infancy, old age) are much more likely to become ill than humans whose immune system is normal. Acquired immunity through specific vaccinations can also protect humans against the specific pathogen vaccinated for.

Zoonotic diseases in Australia

There are at least 85 zoonotic diseases in Australia. Which ones should the Animal Management Officer be aware of? Two groups are important: 1) the zoonoses that they are most likely to acquire on the job (ones with the highest incidence) and 2) zoonoses that are rare, but if acquired, will cause serious disease and even death. Since there are no statistics on the zoonotic diseases acquired by Animal Management Officers to guide us, we can use zoonoses in veterinarians as a proxy.

Zoonoses most likely to be acquired

Ringworm: The most common zoonosis acquired by Animal Management Officers is likely to be ringworm (tinea) (Gummow 2003). This is not generally a serious disease, but it can be unsightly. Ringworm is a disease in which the top layers of the epidermis (top layer of the skin) are invaded by a fungus. It typically starts as a red spot that rapidly grows outward. As it expands the central area becomes less red and the lesion looks like a red ring on the skin with a sharply defined outside edge. Inside the ring the hairs are broken off and the skin is slightly scaly (Fig. 2).

Figure 2 Ringworm due to *Microsporum canis* acquired from a kitten. Note the inflamed (red) sharply demarcated margin forming a ring with a central non-inflammed area. Downloaded from Mycology on Line, University of Adelaide (http://www.mycology.adelaide.edu.au/Mycoses/Cutaneous/Dermatophytosis/index.html)

Animals with ringworm typically have circular areas of hair loss with scaly skin and no inflammation. Transmission is by spores that pass from the animal to invade the intact skin of humans. A number of different species of fungus can cause ringworm. *Microsporum canis* is the most common species

acquired from dogs and cats and *Trichophyton mentagrophytes* is the most common species acquired from livestock. However, be aware that ringworm is most commonly caught from other humans.

Risk minimisation: Cover skin with protective clothes (eg, overalls) when handling animals. Wearing gloves will increase the protection. Remove work clothes before departing for home. Hand hygiene.

Management: Treat with topical creams for tinea (ringworm) from pharmacists (no script needed). If a proper diagnosis is wanted, see a doctor and ask for a fungal culture.

Animal bites and scratches: Apart from the traumatic effect of an animal bite, there is always the risk that the bite inoculates a pathogen or allows it to enter the wound. Up to 20% of dog and cat bites may become infected. If the bite wound becomes infected, oral bacteria are most likely to be the cause. Usually, the infection is due to multiple bacteria (polymicrobial) and there are typically up to five species of bacteria in infected wounds (Talan et al 1999). Occasionally the bacteria can spread beyond the bite site and even cause systemic infection and death (Morgan & Palmer 2007). Scratches can also become infected, but less commonly than bites.

Risk minimisation: Avoid being bitten or scratched. To lessen the risk of infection wash the wound immediately with water and subsequently clean with antiseptic (eg, Betadine).

Management: If the bite is deep or involves tears in the skin, seek medical advice as soon as possible as infection can develop rapidly. In lesser wounds, seek medical attention if the wound becomes inflamed at any time.

Cat scratch disease: Cats carry a bacterium (*Bartonella henselae*) that can cause cat scratch disease (CSD). This bacterium has no effect on the cat and in some areas up to 40% of cats can have it in their bloodstream (Chomel et al 1995). It is inoculated into the skin by a bite or scratch from a cat. Occasionally, a bite from a cat flea can transmit the infection. CSD mainly manifests itself as a red skin lesion at the inoculation site followed by a swollen painful lymph node draining the bite site. The skin lesion usually develops 3-7 days after the injury and the lymph node swelling about 2 weeks later (Carithers 1985).

Risk minimisation: Avoid being bitten or scratched. To lessen the risk of infection wash the wound immediately with water and subsequently clean with antiseptic (eg, Betadine).

Management: Seek medical advice.

Scabies: Animals with scabies have irregular areas of hair loss associated with inflamed skin which in some cases may be rough and thickened. Scabies is due to a mite *Sarcoptes scabiei* that lives in tunnels in the top layer of the epidermis (same layer as ringworm). Scabies can occur in all animal species, but is most common in dogs. Humans can be infected by mites that move across onto their skin and burrow in. Clinical signs in humans are due to an allergic reaction: itch with development of small red lumps (papules) spread symmetrically over the body (mainly truck, thighs, upper arms).

Risk minimisation: Insect repellants may be ineffective in keeping mites off. Using overalls impregnated with permethrin, gloves and disposable plastic apron has greater efficacy.

Management: Most cases of scabies acquired from animals are transient and disappear within a few days. Lyclear (5% permethrin cream) can be used to treat scabies and is available from pharmacists without a prescription.

Methacillin resistant *Staphylococcus aureus* (MRSA): MRSA is a bacterium that can cause serious infections in both animals and humans. MRSA arose in humans, but has now become relatively common in dogs, horses and pigs. MRSA is now recognised as a significant zoonotic hazard for veterinarians (Moodley et al 2008). It can be carried by healthy animals and humans; so detecting a carrier animal visually is not possible. Laboratory culture is needed. Transmission from animals is by direct contact. If a person carries MRSA (usually in nose or axilla), they have a higher risk of developing infection from MRSA.

Risk minimisation: Hand hygiene. Wear protective clothing including gloves. Change work clothes before leaving for home.

Management: If infections develop (eg, boils, other skin infection, other infections), seek medical advice.

Gastrointestinal parasites: Two protozoa (*Giardia*, *Cryptosporidium*) can cause diarrhoea in both animals and humans. Transmission is by oral infection.

Risk minimisation: Hand hygiene. Always practice hand hygiene before smoking or eating. Wear protective clothing including gloves. Change work clothes before leaving for home.

Management: If diarrhoea is severe or persistent, seek medical advice.

Gastrointestinal bacteria: Animals commonly carry the bacterium, *Salmonella*, in their gastrointestinal tract. In most cases it causes no clinical signs in the animal host, but it can cause diarrhoea and occasionally systemic infection. Nutritional stress

will increase the excretion of salmonellas in the faeces. Salmonellosis in humans presents as a diarrhoea with fever. *Yersinia* is another bacteria carried by animals, excreted in their faeces, and capable of causing diarrhoea with fever in humans. However, it is much less common than excretion of *Salmonella*. Both bacteria infect humans through the oral route. *Salmonella* can cause disease from a very low inoculating dose (<100 bacteria); so good hygiene is important to reduce the level of contamination of hands and clothes.

Risk minimisation: Hand hygiene. Always practice hand hygiene before smoking or eating. Wear protective clothing including gloves. Change work clothes before leaving for home. In NZ seasonal epidemics of salmonellosis were found to be due to farmers carrying *Salmonella* from sheep into their homes and infecting family members (Baker et al 2007). This was controlled by better hand hygiene and care with work clothes.

Management: If diarrhoea is severe or persistent or diarrhoea is present with fever, seek medical advice.

Serious zoonotic diseases

Fortunately, serious zoonotic diseases have a low incidence. However, Animal Management Officer should be aware of some of these. Particular diseases may be highly relevant to Animal Management Officers working with specific groups of animals (eg, livestock and Q fever and leptospirosis) and with particular species groups (eg, bats and Australian bat lyssavirus).

Rabies: Rabies does not occur in Australia. However, rabies is spreading towards Australia across Indonesia and has arrived in Flores and Bali (Susetya et al 2008, Gautret et al 2011). It will enter West Papua and then move to Papua New Guinea. The question is not whether it will do this, but when. Being alert for rabies is an important role for Animal Management Officers. All mammals can be infected with the rabies virus, but dogs are typically the most significant host. A dog with rabies has signs of brain disease: particularly ataxia (wobbly) and aggression, plus a range of other signs. Rabies is transmitted in the saliva; so a bite inoculates the rabies virus into the wound. The virus multiplies at the bite site; then moves up the nerves to the brain. Incubation period may be long. In humans it is typically 3 months, but can be faster (10 days for bites to head) or very prolonged (6 years). Scratches that result in bleeding from a rabid animal are treated the same as a bite.

Risk minimisation: Avoid bites. Immediately wash the wound thoroughly with water.

Management: Seek medical advice immediately. Post exposure rabies vaccinations and use of rabies immunoglobulin are close to 100% effective. If a dog has nervous signs, veterinary advice should be sought as diagnosis of rabies can only be made from the dog's brain. The animal will have to be sacrificed.

Australian bat lyssavirus (ABLV): Flying foxes and the yellow-bellied sheath tailed bat in Australia carry ABLV. Bats with ABLV show neurological signs such as aggression (hard to distinguish from normal behaviour in a harassed flying fox!), inability to fly and paralyses. ABLV is transmitted by a bite. In humans ABLV causes signs similar to classical rabies virus (Hanna et al 2000).

Risk minimisation: Avoid bites. Wash the wound thoroughly with water. Animal Management Officers whose job description includes handling bats should be vaccinated using rabies vaccine. Information on the rabies vaccine for ABLV is available at http://www.health.gov.au/internet/immunise/publishing.nsf/Content/Handbook-lyssavirus

Management: Seek medical advice immediately. Post exposure rabies vaccinations and use of rabies immunoglobulin appear to be 100% effective in preventing ABLV infection. The bat will have to be sacrificed to confirm the diagnosis.

Hendra virus: Hendra virus (HeV) disease illustrates a chain of spillovers involving three species of hosts. HeV originates in flying foxes (*Pteropus*), spills over to horses and then to humans. In horses HeV can cause such a range of clinical signs that any ill horse in coastal Queensland or NSW is a HeV suspect. HeV is also excreted in respiratory secretions before clinical signs develop. Fortunately, HeV is poorly contagious to humans and requires a high inoculating dose to cause infection. However, once it has infected a human, HeV is highly virulent. Of seven infected humans, 4 have died (Playford et al 2010). Transmission to humans is from horses via droplets or potentially blood via a needle stick injury.

Risk minimisation: Animal Management Officers dealing with horses must be aware of HeV and follow guidelines. Comprehensive advice for veterinarians and others handling horses is available at http://www.dpi.qld.gov.au/4790_2900.htm

Management: Seek medical advice immediately if exposure to a HeV horse is suspected. A monoclonal antibody treatment is being trialed for people exposed to HeV positive horses.

Q fever: Animals carrying the bacterium (*Coxiella burnetii*) that causes Q fever are not ill and show no clinical signs. All mammals can be carriers and the highest risk of transmission is during birthing. Q fever used to be an infection associated with cattle and sheep. However, increasing numbers of cases are associated with cats and dogs (Komiya et al 2003, Cooper et al 2011) and birthing in cats can be a high

risk event (Porter et al 2011). The infectious stage is resistant to drying; so Q fever can be transmitted in dust. In humans Q fever is acquired by droplet or aerosol transmission and causes persistent fever sometimes associated with pneumonia or endocarditis (heart infection).

Risk minimisation: Hand hygiene. Wear protective clothing including gloves. Change work clothes before leaving for home. Be particularly careful if dealing with animals giving birth – add goggles and mask. Q fever vaccine is effective, but it would be difficult to decide whether vaccination is warranted apart from Animal Management Officers that largely deal with livestock. Information on the vaccine is available at http://www.health.gov.au/internet/immunise/publishing.nsf/Content/Handbook-qfever

Management: Seek medical advice for fever, particularly if it persists.

Leptospirosis: Animals with leptospirosis can be seriously ill and even die. However, many are carriers (particularly cattle, pigs and rodents) and show no obvious clinical signs. Leptospirosis is caused by a bacterium *Leptospira* which infects the kidneys and is excreted in urine. Leptospires survive well outside the body as long as they are in fresh water or even mud. Transmission of leptospirosis to humans is through the skin via micro-abrasions or through mucous membranes (eg, conjunctiva, mouth). Animal urine splashing into a droplet cloud is a risk as well as urine contaminating the skin. Humans develop a febrile illness which if very severe will result in renal failure and sometimes pulmonary haemorrhage (Slack 2010).

Risk minimisation: Hand hygiene. Smokers particularly must make sure they practice hand hygiene before smoking. Wear protective clothing including gloves. Change work clothes before leaving for home. If urine splash is a risk, add goggles and mask. Hosing out vehicles used to carry animals may be a risk for leptospirosis, Q fever and gastrointestinal pathogens.

Management: Seek medical advice for fever, particularly if it persists.

Risk minimisation measures

Hand hygiene: Hand hygiene is the mainstay of controlling transmission of most zoonotic pathogens. It works by reducing the inoculating dose of an organism and making it less likely to cause infection. However, hand washing may be difficult when animal management officers are working in the field. Alcohol hand gels or liquids should be used after every handling of an animal. They are very effective, but less so if the hands are contaminated with visible dirt. Frequent use of hand hygiene will reduce the contamination of hands with zoonotic pathogens and reduce risks of infection by direct contact, orally (eating) and by mucosal contact (eg, touching lips, touching eyes, smoking).

Smoking: Smoking is an infection control hazard (Whelan et al 2011). People who smoke need to recognise that handling and putting a cigarette in the mouth can allow transmission of zoonotic pathogens that transmit by the oral route and the mucosal route. Smokers must practice hand hygiene prior to smoking.

Protective clothes for work: Overalls or other protective clothes used at work may become contaminated with zoonotic pathogens. If these clothes are worn home, zoonotic pathogens can be taken into the home environment and infect family members or contacts *en route*. An excellent example of this was the recurring seasonal epidemic of salmonellosis due to *Salmonella* Brandenberg in the South Island of New Zealand which was found to be due to farmers becoming infected with *Salmonella* from sheep and taking the *Salmonella* into the home on their work clothes (Baker et al 2006). Protective clothes should be removed at work and other clothes worn home. Ideally, the protective clothes should be laundered at work, but if this is not possible, laundering at home in a hot wash may remove zoonotic pathogens. Gloves reduce the risks of contamination of hands.

Additional protection: When indicated by risks of animal products becoming droplets with potential to contaminate mouth and eyes, goggles and mask should be worn.

Cleaning: When cleaning vehicles that have been used to transport animals, Animal Management Officers should always consider zoonotic risks. Creation of droplets or aerosols should be minimised and consideration given to wearing protective clothing including goggles and mask.

Vaccines: Rabies vaccine is recommended for any Animal Management Officer that handles bats. Q fever vaccine is recommended for any Animal Management Officer that handles livestock or animals giving birth.

Inform the doctor

Doctors and nurses often do not think of zoonotic diseases as a likely cause for infections. If you do visit the doctor with a possible infectious disease, tell him that you work as an Animal Management Officer and describe what animals and risks you are exposed to. This will allow zoonoses to be at least included in the differential diagnosis and appropriate tests done.

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BIOGRAPHY

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Rick Speare is a Professor with the School of Public Health, Tropical Medicine and Rehabilitation Sciences and Director of the Anton Breinl Centre for Public Health and Tropical Medicine. His main interest is in infectious diseases and their control. His areas of special expertise are human parasitology and amphibian diseases. Rick's qualifications include Bachelor of Veterinary Science (1st hons) (BVSc) *Uni Queensland 1970*, Bachelor of Medicine, Bachelor of Surgery (MB BS) *Uni Queensland 1975* and Doctor of Philosophy (PhD) *James Cook University 1987*. He is a member of the Australian College of Veterinary Science (MACVS) *1987, a f*ellow of Australasian College of Tropical Medicine (FACTM) *1991* and a fellow of the Australasian Faculty of Public Health Medicine (FAFPHM) *1995*. In a career of more than four decades of practice in both medical and veterinary professions as well as tertiary research and teaching in public health, Rick is a uniquely placed to speak with authority on the subject of zoonotic diseases.

19

OH&S in the AMO role: It's all in a day's work

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Bathurst Regional Council, NSW

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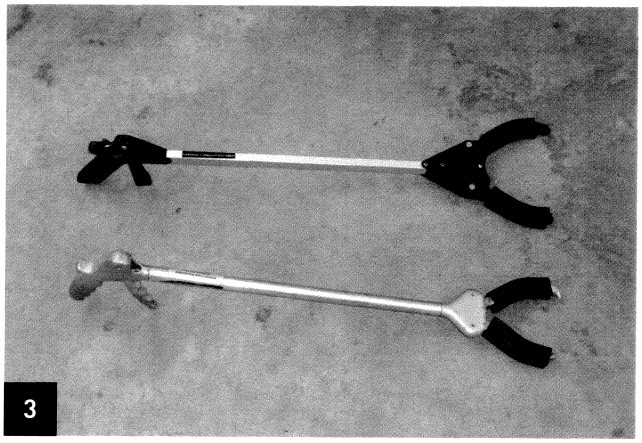

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1 Types of gloves available

2 Disinfectants used daily

- Parvo
- Cleaning of the small animal shelter including: cat cages; equipment; and floors

3 Cat graspers: Used by staff to control cats

4 Cat trap and cat crush: Used for collection of cats wild or otherwise

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5 Cat housing: Individual cages or can be out in larger enclosure

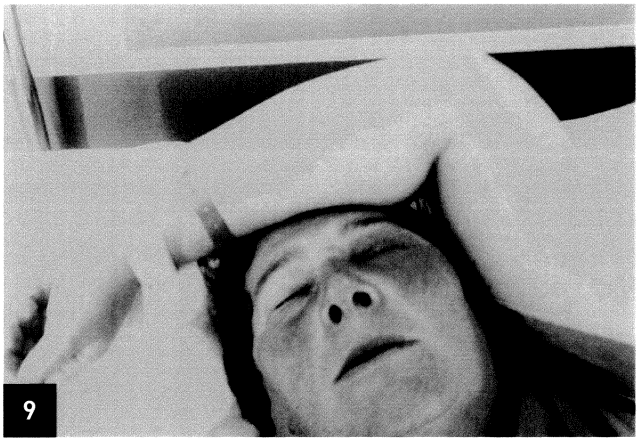
6 Hand wash/sanitizer – when gloves are taken off
Floor sanitizer - daily

7 ***It was just another Thursday (or was it?)***

I was carrying out my duties attending TAFE in the morning to assist the staff with animal related matters returned to the animal shelter to prepare for an animal expo on Saturday, checking dogs and cats that would be suitable to display and hopefully rehouse.

We had received a kitten in surrendered by a member of the public, I thought it may be suitable to be displayed at the expo, checked and found that it was an entire male, and thought that it would not be suitable for rehousing at the expo so I returned the cat to the enclosure.

8 Something irritated my eye so I rubbed my eye with the sleeve of my long sleeve shirt unknowingly transferring some disease to my eye and face.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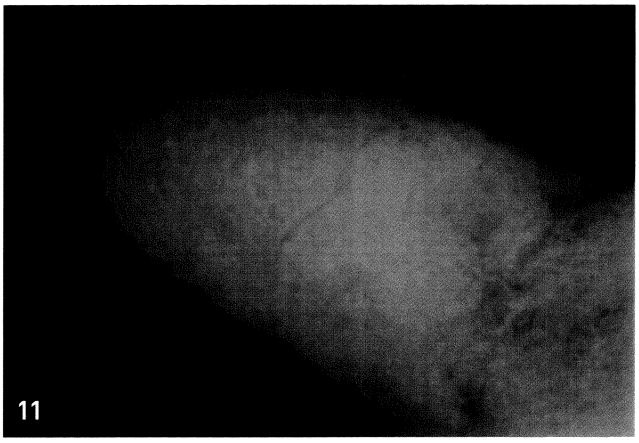
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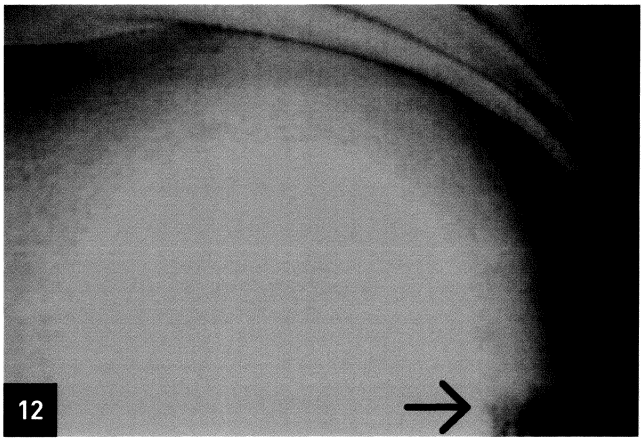
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9 By Saturday the side of my face was starting to swell near the eye that I had rubbed on Thursday, by Sunday I had to go to the hospital as an outpatient and they admitted me immediately. By this time my face was swelling with the infection travelling across from one side of my face to the other via the bridge of my nose.

10 The pain was excruciating like someone was poking my face and eye with a white hot poker. My blood pressure had increased considerably and the hospital couldn't contain the infection and there were concerns that the infection may affect my brain (luckily that didn't happen).

I was in hospital for 5 days, off work for 7 weeks and returned to work on light duties and reduced hours for a further 2 weeks.

11 The cat was tested for the disease and it was not confirmed that the cat had the same disease, the cat was subsequently destroyed.

I am extremely particular about handling animals and hygiene. It is amazing that unknowingly by doing a normal action as simple as wiping your face could have such an effect on both my family and me.

12 The medication load (including morphine for pain relief and penicillin) was immense with hourly antibiotics delivered by cannulas. This resulted in blown veins, severe swelling and additional infection as a result.

***I wanted to bring this to the attention of all participants to remind them to* BE CAREFUL *and* BE AWARE.**

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