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# Managing patients for zoonotic disease in hospitals

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## Summary

Zoonoses involve infections and infestations transmissible from animals to humans. Zoonoses are a major global threat. Exposure to zoonotic pathogens exists in various settings including encroachment on nature; foreign travel; pet keeping; bushmeat consumption; attendance at zoological parks, petting zoos, school 'animal contact experiences', wildlife markets, circuses, and domesticated and exotic animal farms. Under-ascertainment is believed to be common and the frequency of some zoonotic disease appears to be increasing. Zoonoses include direct, indirect and aerosolized transmission. Improved awareness of zoonoses in the hospital environment may be important to the growing need for prevention and control. We reviewed relevant literature for the years 2000 to present and identified a significant need for the promotion of awareness and management of zoonoses in the hospital environment. This article provides a new decision-tree, as well as staff and patient guidance on the prevention and control of zoonoses associated with hospitals.

## DECLARATIONS

### Competing interests

None declared

### Funding

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### Ethical approval

Not applicable

### Guarantor

CW

### Contributorship

All authors contributed equally

### Provenance

This article was submitted by the authors and peer reviewed by Ray Greek

## Introduction

The frequency of some zoonotic disease appears to be increasing, although the overall prevalence of zoonoses in general as well as in the hospital environment is unknown. However, the risk of zoonotic pandemics has been acknowledged as a major global threat to human health.<sup>1</sup> Hospitals are often an early portal for infection cases and must be equipped to promptly and effectively diagnose and control the spread of zoonotic disease. Hospital staff who are not aware of or have not implemented appropriate disease prevention and control measures may incidentally facilitate the spread of zoonotic pathogens.

Under-ascertainment is believed to be common because numerous zoonoses superficially resemble common illnesses such as gastrointestinal, respiratory and dermal disease and thus may go undiagnosed. Monitoring is also highly incomplete.<sup>2</sup> Furthermore, despite increasing governmental and nongovernmental efforts at prevention and control, public adherence to cautionary guidance has not resolved epidemiological occurrence or expansion, and frequency of some zoonotic disease appears to be increasing.<sup>3</sup> For example, in the United States in the 1960s, pet turtle-related salmonellosis was found to be responsible for approximately 14% of all Salmonella infections (approximately 280,000 cases annually) and despite massive public

education aimed at prevention, the epidemic did not abate until the trade and keeping of small turtles was banned in 1975, which resulted in a 77% reduction in disease by the following year.<sup>4</sup> According to region and animal keeping dynamics, reptile-related salmonellosis (RRS) may nowadays be responsible for between 1 and 18% of all human *Salmonella* infections. In the United Kingdom, for example, RRS may account for 1–5% of all salmonellosis, and between 1160 and 6000 cases of disease annually.<sup>5,6</sup>

Around 200 zoonoses are known, of which at least 70 are associated with captive wild animals including exotic pets.<sup>7</sup> Sixty-one percent of human diseases are considered to be of zoonotic origin<sup>8</sup> and 75% of global emerging human disease has a link to wild animals.<sup>9</sup> Exotic pets in particular present a highly diverse and potentially potent reservoir of infection and infestation. Several authors have described the exotic pet trade as a Trojan horse of human disease based on the unsuspecting invitation of pathogens into the home via animals perceived to be harmless.<sup>7</sup> Zoonoses include direct, indirect and aerosolized transmission. Improved awareness of zoonoses in the hospital environment may be important to the growing need for prevention and control.

Hospitals themselves may even unknowingly transfer zoonotic pathogens to patients, as was evidenced during a donor transplantation in 2005. Following organ transplants from a single donor to four patients in Massachusetts and Rhode Island, all four recipients were found to have been infected with lymphocytic choriomeningitis virus (LCMV). This rodent-borne arenavirus had apparently been contracted by the donor from an infected pet hamster.<sup>10</sup> More recently, in the US, a patient died after acquiring rabies following a kidney transplant.<sup>11</sup> Whilst transplant-related zoonoses are relatively rare, new guidelines are in place to reduce transplant associated diseases.<sup>12</sup> RRS has also been acquired via platelet transfusion from a donor who kept a pet snake.<sup>13</sup>

Zoonoses can also be transmitted to hospital personnel, as was the case in Mauritania in 2003, following the admission of a patient who had contracted Crimean-Congo hemorrhagic fever from a goat. This disease was transmitted within the hospital to 15 people and resulted in the infection and death of five hospital workers.<sup>14</sup> A report in 1998 described an outbreak of *Malassezia*

*pachydermatis* involving 15 infants that was introduced into the intensive care nursery on health care workers' hands and which originated from domestic pet dogs, and thence was spread via patient-to-patient transmission.<sup>15</sup>

Certain injuries are capable of resulting in topical, local and systemic infection with a wide variety of zoonotic pathogens, and there are many opportunities for injuries with zoonotic implications to occur.<sup>16,17</sup> Domestic and exotic pets are responsible for a small, but possibly increasing, annual number of injuries, envenomations and stings.<sup>16–19</sup> For example, in the UK, NHS Health Episode Statistics for England indicate that between 2004 and 2010, there were 28,605 full hospital consultation episodes, 28,149 admissions and 59,511 hospital bed days associated with injuries probably related to dogs. During the same period, 760 full hospital consultation episodes, 709 admissions and 2121 hospital bed days were associated with injuries probably related to exotic pets.<sup>17</sup> These data represent a conservative list of possible sources and thus may not include all similar episodes. In Australia, 2001–2002 hospitalization statistics attributed 12,688 episodes to zoonotic and other bacterial diseases.<sup>20</sup> In France and Germany, studies of all admissions for bites and stings from exotic pets at four poisons centres between 1996 and 2006 indicate 404 (mostly snake, fish and invertebrate) envenomation cases.<sup>19</sup> Also, these data do not include primary care consultation episodes. Therefore, thorough wound cleansing and consideration for antimicrobial therapy are important in all incidents.<sup>16,17</sup> The Centers for Disease Control and Prevention's 1985 (CDC's) Study<sup>21</sup> examined efficacy of nosocomial control and reported that hospitals with an epidemiologist, an infection control practitioner for every 250 beds, active surveillance mechanisms, and ongoing control efforts reduced nosocomial infection rates by approximately a third.

The present article presents an expanded protocol and strategy to aid the prevention and control of zoonotic nosocomials as well as providing guidance for dissemination to patients by hospital healthcare workers.

## Methods

Relevant literature was identified through a search of the online databases (MEDLINE,

EMBASE, Google Scholar and the Royal Society of Medicine) using the following terms: 'zoonos', 'hospital', 'nosocomial', 'animal', 'pet', 'zoo', 'circus', 'farm', 'infection', 'infestation', 'review', 'management' and 'pandemic' for the years 2000 to present. Forty-five publications of *prima facie* relevance were identified and reviewed, of which 11 cogent articles and seven reports were identified. Of these publications, six successfully conformed to the essential inclusion criteria of being peer-reviewed as well as referring to hospitals and zoonoses in addition to the authors' own libraries, although none of these publications were systematic reviews involving hospitals.

## Results

Zoonoses prevention and control guidance relevant to hospitals appear to be generally under-represented, although some protocols and strategies have been published.<sup>21-23</sup> Some recommended pre-exposure and post-exposure prophylaxis regimens have been also described in order to reduce the incidence of both public and nosocomial disease, where zoonotic infections might be transmitted in a hospital environment.<sup>2,7,17,21,24,25</sup>

Assessing patients for zoonoses in the general hospital environment reflects regular patient management, with altered emphasis towards dedicated questions and history-taking. Signs and symptoms of gastrointestinal, flu-like, fever, malaise or dermatological nature often indicate possible zoonotic infection. Questions to patients should seek to establish possible direct or indirect exposure to animals or unusual animal products, which may indicate the source of a relevant disease. Figure 1 provides a simple management tree for assessment of patients for possible zoonoses.

### Patient presentation

Patients presenting with signs and symptoms of acute onset, intermittent recurring or persistent disease, as well as those reporting conditions with a history of recurrence or of being difficult to treat should be regarded as red flag indicators. Examples include meningitis, gastrointestinal disorders, influenza-like disorders, dermatitis, fever, haemorrhagic fever and chronic inflammatory signs, for example, atypical arthroses, persistent low-grade fever.

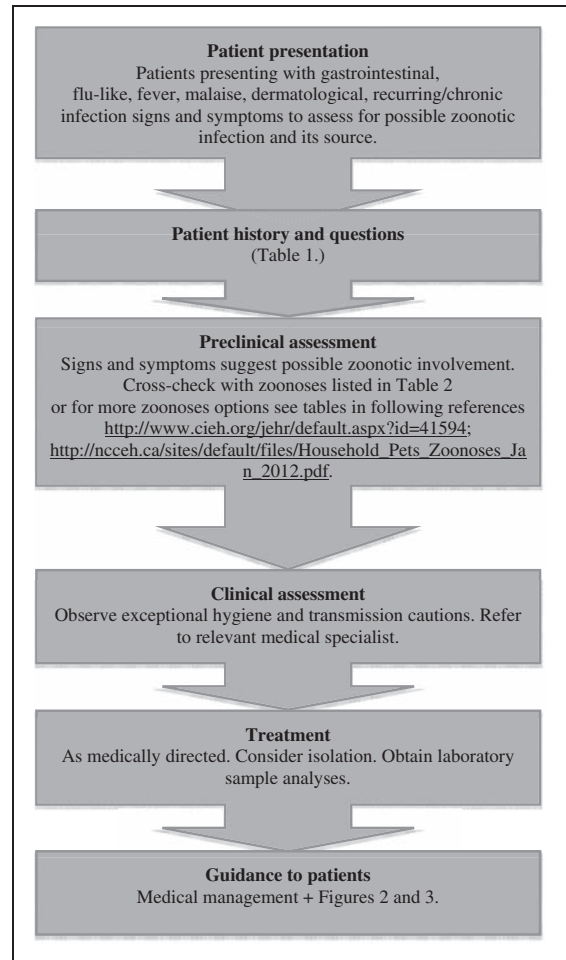


Figure 1. Zoonoses management tree.

### Patient history and questions

Questions directed at patient history are essential to discovering possible zoonoses and their source. Given that many zoonoses are contagious, awareness and careful history-taking may assist to prevent or limit epidemiological outbreaks. Table 1 provides a list of questions dedicated to exploring possible zoonotic disease and their source associations. Positive responses to questions in Table 1 should also be regarded as red flag indicators.

### Preclinical assessment

Patient history, signs and symptoms suggesting possible common zoonotic involvement can be cross-checked with information in Table 2. (Table 2 may also act as a general awareness

**Table 1.**

**Questions to ask patients presenting with gastrointestinal, flu-like, fever, malaise, dermatological signs and symptoms to assess for possible zoonotic infection and its source.**

*Question to patient?*

- a) patient recently consumed exotic foods (e.g. sushi/seafood, turtle meat, bushmeat)
- b) patient recently experienced foreign travel (e.g. fishing trip, eco-tour, adventure)
- c) patient recently visited a foreign hospital
- d) patient recently visited a farm
- e) patient recently visited a zoo or other wildlife centre
- f) patient recently visited a pet shop
- g) patient household possesses any pets (especially exotic species)
- h) patient recently visited a household that possesses pets (especially exotic species)
- i) patient's school recently held animal contact event
- j) patient or others in the household may have recently experienced direct or indirect contact with persons or inanimate material from above categories

chart for staff in a supportive health and safety context.) Patient history, signs and symptoms suggesting possible rare zoonotic involvement can be cross-checked with information in two recent, detailed, and highly accessible sources of both common and rare zoonoses, pathogens and their animal associations.<sup>7,24</sup>

Although domesticated animals, for example dogs and cats, are frequent carriers of zoonotic agents in the home, most veterinarians and doctors are aware of certain common zoonoses (for example, scabies, ringworm, hydatidiosis, toxocariasis, bartonellosis). Therefore, regular medics may quickly recognize many risks and advise accordingly. However, veterinarians encounter exotic pets (which harbour more diverse and novel pathogens) less frequently. Therefore, zoonotic disease may go unrecognized or misdiagnosed due to low familiarity. Relatedly, exotic agents are frequently more persistent and severe than those from domestic animals.<sup>7</sup>

### Clinical assessment

Clinical assessment should wherever possible include laboratory microbial investigation. Many zoonotic pathogens may be highly resistant to typical therapies, and pathogen identification is thus a key component for successful diagnosis and treatment. General staff can successfully manage many zoonoses whereas others require specialist medical knowledge and referral.

### Treatment

Proper diagnosis and treatment are importantly matched with frequent follow-up consultation and also often psychological support is valuable. Presence of parasites, for example, can result in apprehension and serious mental stress, and some rational explanation of the relative normality of host-parasite relationship can be moderately comforting for some patients. Numerous zoonotic episodes may present as acute onset and emergency conditions, and further constitute potential epidemic proportions. Accordingly, important suspected or confirmed cases should be reported to relevant surveillance authorities in the interests of disease prevention and control.<sup>26</sup> Acquired information should include patient age, sex, geographical status, occupation, clinical symptoms, date of onset, exposure to animal (species if known), microbiological and serological data and treatment.<sup>23</sup>

Zoonotic risk is complex, involving both rare and common problems, and ranges from the low probability of severe danger, for which there is no prevention and cure (for example, Herpesvirus-B from some primates), to hazards that are widespread and either self-limiting or potentially serious and with varied treatment success (for example, Salmonella from reptiles), through to moderate threats that are routinely controlled (for example, worms from dogs).<sup>7,21,27</sup>

**Table 2.**  
**Common zoonoses signs and symptoms.**

Zoonosis/condition	Source	Signs and symptoms
Salmonellosis/gastroenteritis	Fish, amphibian, reptile, bird, mammal	Nausea, vomiting, diarrhoea, abdominal cramps and pain, fever, painful joints, meningitis, flu-like
<i>E. coli</i> infection/gastroenteritis	Amphibian, reptile, bird, mammal	Nausea, vomiting, diarrhoea, abdominal cramps and pain, fever, painful joints, meningitis, flu-like
Campylobacteriosis/gastroenteritis	Amphibian, reptile, bird, mammal-primate	Nausea, vomiting, diarrhoea, abdominal cramps and pain, fever, painful joints, meningitis, flu-like
Leptospirosis	Amphibian, reptile, bird, mammal	Flu-like, vomiting, icterus, telangiectasia, uveitis, splenomegaly, meningitis
Psittacosis	Bird, mammal-primate	Flu-like, pneumonia, fever, cough
Vibriosis	Fish, amphibian, reptile, bird	Gastrointestinal, pain, vomiting, fever, otitis
Lyme disease/bartonellosis	Mammal	Flu-like, fever, rash, gastrointestinal
Toxocariasis	Mammal	Eye problems
Giardiasis	Mammal-primate	Gastrointestinal, fever, nausea, fatigue, weight loss
Tuberculosis	Fish, amphibian, reptile, bird, mammal-primate	Respiratory, flu-like, fever, weight loss
Q-fever	Reptile, bird, mammal	Fever, flu-like
Cryptosporidiosis	Fish, amphibian, reptile, bird	Acute gastrointestinal disturbance, nausea, vomiting, pain, fever, flu-like
Macroparasite infestation, e.g. helminths and ectoparasites	Fish, amphibian, reptile, bird, mammal, mammal-primate	Gastrointestinal disturbance, abdominal cramps and pain, weight loss, flu-like
Ringworm	Mammal, mammal-primate	Patchy skin, inflammation, itching
Allergic alveolitis	Bird	Persistent dry cough, chest irritation
Lymphocytic choriomeningitis virus (LCMV)	Mammal	Nausea, vomiting, anorexia, fever, headache, fatigue.

If experiencing these indicators report to a healthcare professional. These are a small sample of relatively common animal-to-human diseases (derived with permission from Warwick *et al.*,<sup>7</sup> <http://www.cieh.org/jehr/default.aspx?id=41594>). Onset of signs and symptoms of an animal-related disease may occur within hours or not for several weeks or months following exposure to an exotic animal. Most cases of diseases are not serious, but it is important to report any suspicion of having an animal-linked disease because treatment may vary from regular illnesses and early access to medical help can alleviate greater problems as well as assist health workers to provide best advice.

### Guidance to hospitals

When patients are admitted for the diagnosis and treatment of suspected serious zoonoses such as haemorrhagic fevers, there is a high risk of a disastrous nosocomial spread of infection. To avoid such outbreaks, it is critical that infection control measures are undertaken. For serious zoonotic diseases that have high person-to-person transmission potential, both pre- and post-exposure prophylaxis regimens have been described by the Centers for Disease Control.<sup>21,27</sup> Pre-exposure regimens may include the vaccination of

hospital staff for diseases such as rabies and monkeypox. Post-exposure regimens may include such measures as patient isolation, protective barrier nursing techniques, safe disposal of materials and body wastes and staff health monitoring.<sup>21,27</sup>

### Guidance to patients

Where some possible zoonotic exposure may be suspected, Figures 2 and 3 provide user-friendly evidence-based guidance on zoonoses prevention

DOMESTIC & EXOTIC PETS

## HYGIENE AND CAUTIONS

**IMPORTANT:** Hygiene measures, such as hand-washing, when performed thoroughly and with correct chemicals, can significantly reduce the amount of germs on your hands but *does not* guarantee protection against becoming sick or remove the possibility of passing germs directly or indirectly to others.

**Advice included here can help to reduce but not eliminate the risk of contracting illness from pets, especially exotic pets.**

Ownership of exotic as pets such as fishes, amphibians, reptiles, birds, and mammals such as raccoons and primates involve special risks to the health of animal keepers and to the health of those around them. *It is not advisable to keep exotic animals as pets.* Many people, however, already have exotic pets, and this most likely causes thousands of cases of human illness annually and occasional deaths.

It is important to note that because exotic pets occupy the home, and that germs are easily spread around surfaces, walls, door-handles, clothes and other items, even thoroughly cleaned hands can quickly become contaminated again by simple contact with any of these items. Pet stores and the people who work there should also be regarded as sources of contamination. Thorough cleaning of exotic pet-related germs from the home may be practically impossible.

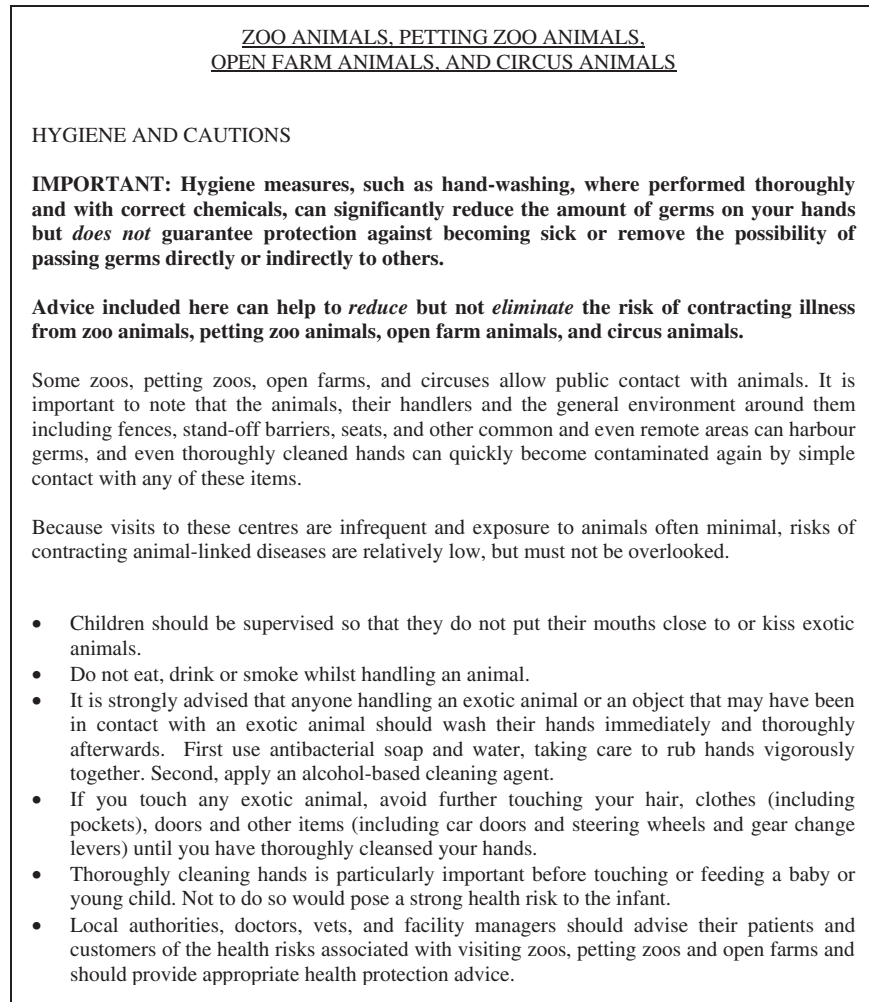
- Children should be supervised so that they do not put their mouths close to or kiss exotic animals.
- Do not eat, drink or smoke whilst handling an exotic animal.
- Always wash your hands thoroughly after touching or handling any exotic animal, their cage or any other equipment.
- Dispose of waste water and droppings from exotic pets down the toilet – and not in the sink or bathtub.
- Always wash your hands immediately and thoroughly after feeding your exotic pet and after handling raw (including frozen or defrosted) mice, rats and chicks.
- Ensure that all surfaces that come into contact with exotic pet animals, (including areas that you may have touched), and raw or defrosting exotic animal food are cleaned thoroughly afterwards.
- Do not use kitchen sinks to bathe exotic pets or to wash their cage or equipment. If you use a bathroom sink or bathtub, it must be cleaned thoroughly with disinfectant afterwards.
- It is strongly advised that anyone handling an exotic animal or an object that may have been in contact with an exotic animal should wash their hands immediately and thoroughly afterwards. First use antibacterial soap and water, taking care to rub hands vigorously together, being careful to clean all areas. Second, apply an alcohol-based cleaning agent.
- If you touch any exotic animal, avoid further touching your hair, clothes (including pockets), doors and other items (including car doors, steering wheels and gear change levers) until you have thoroughly cleansed your hands.
- Thoroughly cleaning hands is particularly important before touching or feeding a baby or young child. Not to do so would pose a strong health risk to the infant.
- Local authorities, doctors, vets facility managers should advise their patients and customers of the health risks associated with having an exotic animal as a family pet and should provide appropriate health protection advice.

**Figure 2.** Avoiding animal-linked disease associated with pets (derived with permission from Warwick *et al.*,<sup>7</sup> <http://www.cieh.org/jehr/default.aspx?id=41594>).

and control, allowing clear information that can be handed to patients by hospital staff. Patients should be advised that animals may be symptomatic or asymptomatic carriers of pathogens, thus the animal's condition may not itself indicate risk of transmission.

## Discussion

The dearth of literature pertaining to zoonoses in the hospital environment, whether regarding patient presentation or nosocomial outbreaks, is unfortunate and probably reflects a historical



**Figure 3.** Avoiding animal-linked disease associated with zoos, petting zoos, open farms, and circuses (derived from Warwick *et al.*,<sup>7</sup> <http://www.cieh.org/jehr/default.aspx?id=41594>).

lack of awareness towards this type of disease and its monitoring. Under-ascertainment of zoonoses is also encountered in the primary care setting, which implies that there is a fundamental deficiency in healthcare management that could result in sick patients failing to receive appropriate medical treatment, failure to recognize pending epidemic outbreaks and incidental promotion of nosocomial disease.

Education of hospital staff at the 'grass-roots' level is probably a major prerequisite of adequate patient treatment as well as the prevention and control of zoonoses. In order for such education to be effective, hospital staff must familiarize themselves with essential exploratory protocols

to identify relevant management areas as well as the red-flag signs and symptoms of patients. Accordingly, we have considerably focused on producing dedicated guidance for awareness that is directed both at the healthcare professional, and at the public who present with suspected zoonoses.

Zoonotic pathogens frequently originate from remote world regions and thus involve opportunities for highly novel pathogens to exploit immunologically naive people. As frequent accommodators of diversely immunocompromised persons, hospitals possess the potential to become epidemic hubs. Improved management of these risks appears to demand a holistic



approach that must include administration, medicine and generalized education.

## Conclusions

Zoonoses are significant and increasingly emerging diseases for which hospital staff should maintain continuous patient- and self-centred awareness. Some zoonoses respond well to conventional treatments whether incidentally or following proper diagnosis. However, some will not respond favourably, whether or not properly diagnosed, and long persist. Accordingly, it is important for general hospital medical staff to inform respective secondary care specialists of zoonotic suspicions to facilitate early investigation, as this may be highly important to outcome. Although not widely considered, zoonoses potentially present a novel and possibly increasing source of nosocomial infection and infestation. For this reason, in cases of suspected serious zoonoses, the risk of nosocomial outbreaks should be managed by hospitals through an established regimen of both pre-exposure and post-exposure infection control measures. In addition, there is a dearth of data regarding prevalence of zoonoses in the hospital environment, and this deficiency may be improved by greater general awareness of the issue by all secondary care staff.

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