

Public Veterinary Medicine: Public Health

A review of published reports regarding zoonotic pathogen infection in veterinarians

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Objective—To identify published reports regarding zoonotic pathogen infection among veterinarians.

Design—Literature review.

Procedures—The PubMed electronic database of medical literature published between 1966 and November 2007 was searched. Clinical case reports and reports of outbreak investigations were also identified through searches of the literature outside of PubMed and searches of references listed in included articles. Reports eligible for inclusion included controlled and uncontrolled studies examining seroprevalence of animal pathogens in veterinarians, serosurveys involving veterinarians, and reports of zoonotic pathogen infections causing clinical illness.

Results—66 relevant articles were identified. This included 44 seroepidemiologic studies (some examined > 1 pathogen), 12 case reports, 3 outbreak investigations, and 7 self-reported surveys (including 4 related to personal protective equipment use). Of the 44 seroepidemiologic studies, 37 (84%) identified an increased risk of zoonotic pathogen infection among veterinarians, and 7 (16%) identified no increased risk or a decreased risk. Surveys also documented that veterinarians often failed to use recommended personal protective equipment.

Conclusions and Clinical Relevance—Our review indicated that veterinarians had an increased risk of infection with a number of zoonotic pathogens. It also suggested that veterinarians may inadvertently serve as biological sentinels for emerging pathogens and could potentially spread zoonotic pathogens to their families, community members, and the animals for which they provide care. Professional and policy measures should be implemented to reduce the risk that veterinarians will become infected with, or transmit, zoonotic pathogens. (*J Am Vet Med Assoc* 2009;234:1271–1278)

It has been estimated that 64% of the more than 1,400 recognized human pathogens are zoonotic,¹ and that 73% of 177 emerging or reemerging pathogens have originated in animals.² Recently, agricultural professionals in routine contact with animals have been shown to have increased risks of contracting various zoonotic infections, with infected individuals often experiencing clinical signs of disease.^{3–9} During a 2003 outbreak of highly pathogenic H7N7 avian influenza virus infection among poultry in the Netherlands, veterinarians had

ABBREVIATIONS

CI	Confidence interval
OR	Odds ratio

the highest or some of the highest attack rates among all those exposed to diseased birds, as evidenced by self-reported influenza-like symptoms, conjunctivitis, and results of a serologic assay.⁸ Five of the 180 (2.8%) veterinarians studied had serologic evidence of infection, and the only individual among the 3,410 persons at risk of H7 virus infection during the outbreak who died was a veterinarian.^{8,10} Similarly, veterinarians and veterinary technicians have recently been reported to have had high morbidity rates during outbreaks of hendra virus and monkeypox virus infection.^{11,12} Each year, more zoonotic pathogens are classified as emerging threats, with recent examples including the mosquito-borne Chikungunya virus¹³; methicillin-resistant *Staphylococcus aureus* in swine¹⁴; *Waddlia chondrophila*,

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a chlamydia-like abortigenic agent in ruminants¹⁵; nipah virus and hendra virus, both naturally found in fruit bats¹⁶; buffalopox virus¹⁷; and *Streptococcus suis*.¹⁸ Clearly, there is a critical need to better understand pathogen transmission from animals to man.¹⁹

In conducting various occupational research studies, we have observed that veterinarians often have evidence of zoonotic influenza virus infection^{4,20,21} and that the risk of infection in veterinarians can exceed the risk for individuals in other occupational groups with extensive exposure to animals.^{4,8,a} These findings have been somewhat counterintuitive because we assumed that given their professional training, veterinarians would have a more comprehensive understanding of measures for preventing zoonotic pathogen transmission, compared with other animal workers. In an attempt to better understand our observations, we conducted a review of the published medical literature regarding zoonotic pathogen infection in veterinarians.

Materials and Methods

To identify published reports of zoonotic pathogen infection in veterinarians, we conducted a review of the PubMed electronic database of medical literature published between 1966 and November 2007. Key words that were used included veterinarians; seroepidemiological studies; zoonoses; medicine, veterinary; animal technicians; and occupational health. Specific inclusion and exclusion criteria were used to identify relevant reports. Reports eligible for inclusion in the present review included controlled and uncontrolled studies examining seroprevalence of animal pathogens in veterinarians, serosurveys involving veterinarians in general or specific subgroups of veterinarians (eg, veterinary surgeons or swine veterinarians), and reports of zoonotic pathogen infections causing clinical illness following occupational contact with an animal. Reports were excluded from the present review if they involved studies in which veterinarians were combined with other professionals into an animal-exposed group without delineating risk by profession (eg, inclusion of veterinarians, meat packers, and farmers in a single exposure group) or if they only involved veterinary support staff or veterinary students. A single individual (WB) screened the titles of all articles identified through the initial PubMed search. For articles pertaining to zoonotic pathogen infection in veterinarians and articles for which the topic was indeterminate, the abstract or full text of the article was obtained and examined to determine whether the article should be included in the review. Articles eligible for inclusion were critically appraised to determine methodologic quality, evidence strength and magnitude, relevance, and completeness, and seroprevalence data were extracted from those articles select-

ed for inclusion. To extend the reach of this review, clinical case reports and reports of outbreak investigations were also identified through searches of the literature outside of PubMed and through searches of references listed in included articles. A second literature search was performed to identify reports of veterinary compliance with safety guidelines, especially use of personal protective equipment. Keywords that were used included veterinarian combined with gloves, respirator use, personal protective equipment, protective clothing, safety devices, and protective devices. Surveys assessing veterinarian compliance were included with self-reported surveys identified through the initial literature search.

Results

Literature review—The comprehensive literature search yielded 563 articles, but 476 of the 563 were excluded following review of the title or abstract (Figure 1). Abstracts or full texts of the remaining 87 articles were obtained for further review, along with abstracts or full texts of an additional 17 articles identified through outside searches or searches of reference lists in other articles.

Of the 104 articles considered for inclusion in the study, 30 were rejected as being irrelevant to the topic and 8 were rejected because of inappropriate sampling, use of combined exposure groups, or a lack of veterinarians in the study cohort. The remaining 66 articles^{4,7,9-12,14,21-78} were considered relevant for the present review. This included 44 seroepidemiologic studies, 12 case reports, 3 outbreak investigations, and 7 self-reported surveys (including 4 self-reported surveys of personal protective equipment use).

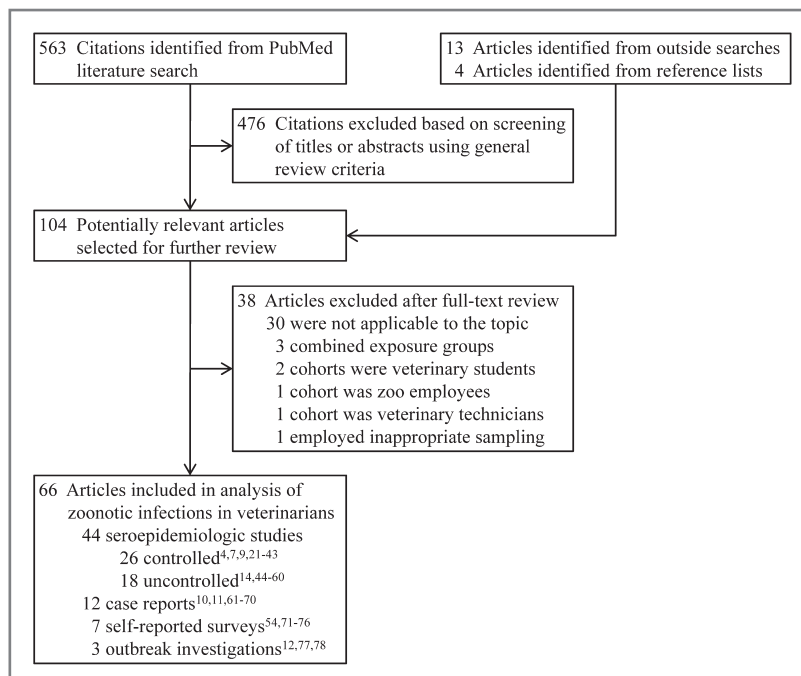


Figure 1—Flowchart of publications identified during a review of the published medical literature regarding zoonotic pathogen infection in veterinarians. Reference 54 appears twice because both a seroepidemiologic study and a self-reported survey were reported in this publication.

Seroprevalence studies—Of the 44 seroepidemiologic studies, 37 (84%) identified an increased risk of zoonotic pathogen infection among veterinarians and 7 (16%) identified no increased risk or a decreased risk. Because some of the studies examined more than 1 pathogen, there were a total of 50 instances when veterinarians were found to have an increased risk of infection with a zoonotic pathogen. In 31 of these 50 (62%) instances, veterinarians had a greater likelihood of having serologic evidence of infection than did controls. For the remaining 19 (38%), a control group was not included.

Seven serosurveys^{22–28} reported a higher seroprevalence of antibodies against *Brucella* spp in veterinarians, compared with controls. A study²² from Turkey found that 13 of 40 (33%) veterinarians who worked in areas in which brucellosis was endemic had antibodies against *Brucella* spp, compared with only 2 of 43 (5%) veterinarians working in areas in which brucellosis was not endemic. Importantly, none of the seropositive veterinarians in that study reported wearing masks while working. In a study²³ from India, the seroprevalence of anti-*Brucella* antibodies among 23 field veterinarians was 17.4%, compared with a seroprevalence of only 4.7% among 298 controls with unknown animal exposures. Researchers in Jordan studied 58 veterinarians and identified 13.8% of them as seropositive, compared with only 0.5% of 600 controls.²⁴ A study in Ohio²⁵ identified a seroprevalence of 12.2% among 392 veterinarians, compared with a seroprevalence of 1.5% among 452 veterinary students. In a study²⁶ from Korea, 4.2% of 51 veterinarians were seropositive for antibodies against *Brucella* spp, whereas none of the 53 individuals in the control group (individuals who performed artificial insemination) were seropositive. In a study²⁷ of the prevalence of *Brucella canis* infection in the United States, investigators classified participants as having had no exposure to dogs (193 newborn infants), an average amount of exposure to dogs (2,026 hospitalized and nonhospitalized patients, hospital employees, and blood donors), or extensive exposure to dogs (73 practicing veterinarians). Seroprevalences among the groups were 5.7%, 67.8%, and 72.6%, respectively. Finally, a Dutch study²⁸ found a significantly ($P = 0.01$) higher seroprevalence of antibodies against *Brucella abortus* among 102 veterinarians (4.5%), compared with 191 pig farmers (0%).

Four serosurveys^{25,29–31} reported a higher seroprevalence of antibodies against *Coxiella burnetii* in veterinarians, compared with controls. A study²⁹ in Nova Scotia found that 17.0% of 65 veterinarians had antibodies against *C. burnetii*, compared with 4.0% of 997 blood donors. Similarly, Japanese researchers³⁰ found a 13.5% seroprevalence among 267 veterinarians, compared with a 3.6% seroprevalence among 2,003 blood donors. In Sweden, 12.9% of 132 veterinarians were seropositive, compared with just 5.6% of 89 military draftees.³¹ A 1964 study²⁵ from Ohio found that the seroprevalence of antibodies against *C. burnetii* was 11.2% in 392 veterinarians but only 6.2% in 452 veterinary students.

Four studies^{4,7,21,32} suggested that zoonotic influenza virus infection was more common in veterinarians

than in controls. This included a US study²¹ involving 42 veterinarians exposed to poultry and 66 controls. In that study, 12.2%, 23.8%, and 14.6% of the veterinarians had serologic evidence of previous infection with avian influenza viruses H5, H6, and H7, respectively, compared with 0%, 0.3%, and 0% of the controls. Compared with controls, veterinarians were substantially more likely to have had evidence of previous infection with avian influenza viruses H5 (OR, 16.7; 95% CI, ≥ 2.1), H6 (OR, 12.2; 95% CI, 2.0 to 138.2), and H7 (OR, 17.7; 95% CI, ≥ 2.3). A US study⁴ involving 65 Iowa veterinarians exposed to swine and 79 controls found that 10.9% and 19.1% of the veterinarians had serologic evidence of previous infection with swine influenza viruses H1N1 and H1N2, respectively, compared with 0% and 1.3% of the controls. All 3 exposure groups examined in this study (farmers, veterinarians, and meat-processing workers) had high antibody titers against swine influenza viruses H1N1 and H1N2, compared with controls, with ORs highest for farmers (ORs, 35.3 [95% CI, 7.7 to 161.8] and 13.8 [95% CI, 5.4 to 35.4], respectively), followed by veterinarians (ORs, 17.8 [95% CI, 3.8 to 82.7] and 9.5 [95% CI, 3.6 to 24.6], respectively) and meat-processing workers (ORs, 6.5 [95% CI, 1.4 to 29.5] and 2.7 [95% CI, 1.1 to 6.7], respectively). A 1981 US study³² reported a 37.5% seroprevalence of antibodies against swine influenza virus H1N1 among 216 Illinois veterinarians, compared with a 4.0% seroprevalence among 225 veterinary students. Olsen et al⁷ found that 1 of 3 veterinarians was seropositive for evidence of previous swine influenza virus H1N1 infection, whereas none of 114 controls were seropositive.

Two studies^{25,33} found evidence that infection with *Chlamydia psittaci* was more common among veterinarians than among controls, although seroprevalence was low in both groups. A Japanese study³³ involving 181 small animal veterinarians and 1,052 control individuals from the general population found that 8.8% of the veterinarians but only 1.7% of the controls were seropositive for antibodies against feline strains of *C. psittaci* and that 5% of the veterinarians but only 3.1% of the controls were positive for antibodies against avian strains of *C. psittaci*. A study²⁵ from Ohio found that 4.8% of 392 veterinarians but only 2.2% of 452 veterinary students had serologic evidence of previous avian *C. psittaci* infection.

Two other studies^{9,34} found evidence that infection with hepatitis E virus was more common among veterinarians than among controls. In a US study⁹ of the prevalence of hepatitis E infection among veterinarians in 8 states, investigators found that 26.4% of 295 swine veterinarians were seropositive for evidence of human hepatitis E infection, compared with 18.3% of 400 blood donors, and that 23.1% of the veterinarians were seropositive for evidence of swine hepatitis E infection, compared with 16.5% of the blood donors. A study³⁴ from the Netherlands found that 11% of 49 swine veterinarians had evidence of previous human hepatitis E infection, compared with only 2.0% of 648 matched controls.

Two controlled, cross-sectional studies^{35,36} found that veterinarians had higher odds of infection with

Bartonella henselae. In a study³⁵ from Poland, 45% of 20 veterinarians, but only 24% of 50 blood donors, were seropositive for antibodies against *B. henselae*, with veterinarians having 2.5 times the odds (95% CI, 1.1 to 3.8) of being seropositive as compared with the odds for controls. A Japanese study³⁶ found that 15.0% of 233 veterinarians were seropositive for antibodies against *B. henselae*, compared with 0.1% of 155 controls.

Finally, individual studies have reported that compared with controls, veterinarians were more likely to be seropositive for antibodies against methicillin-resistant *S. aureus* (5% of 99 Dutch livestock veterinarians vs a 1% national prevalence),³⁸ *Streptococcus suis* type II (6% of 102 Dutch veterinarians vs 1% of 191 pig farmers),²⁹ *Toxocara canis* (27% of 137 Austrian veterinarians vs 2% of 50 controls),³⁹ bovine polyomavirus (71% of 90 English veterinarians vs none of 256 blood donors),⁴⁰ and bovine norovirus (28% of 210 Dutch veterinarians vs 20% of 630 matched controls).⁴¹

The remaining 19 (38%) serosurveys^{14,44-56} did not include control groups for comparisons but did find serologic evidence of zoonotic pathogen infections in veterinarians. Four *Brucella* spp studies⁴⁴⁻⁴⁷ reported veterinarians to be seropositive: 4 of 8 veterinarians⁴⁴ in Lebanon, 4 of 14 veterinarians⁴⁵ in Delhi, 68 of 340 Illinois veterinarians,⁴⁶ and 1 of 22 veterinary personnel in Eritrea.⁴⁷ Specifically for *B. abortus*, a New Zealand study⁴⁸ found 77 of 86 veterinarians to be seropositive (authors combined the results of 3 serologic tests) and a study⁴⁹ in India found 108 of 262 veterinary inspectors to be seropositive. Three uncontrolled studies^{14,50,51} reported methicillin-resistant *S. aureus* infections in veterinarians. In a study¹⁴ from Denmark, 33 of 235 swine veterinarians from 9 countries were seropositive. In Canada, 18 of 125 equine veterinary personnel were positive for antibodies against methicillin-resistant *S. aureus*,⁵⁰ as well as 24 of 345 veterinarians in the United States.⁵¹ An Austrian study⁵² found 13 of 137 veterinarians seropositive for *C. burnetii* antibodies, and a study⁵³ in Turkey found 1 of 13 veterinarians to be seropositive. Two studies found avian *C. psittaci* seropositivity in veterinarians: 42 of 1,301 Illinois veterinarians⁵⁴ and 1 of 57 Slovenian veterinarians.⁵⁵ Uncontrolled studies have also reported seropositivity for antibodies against swine influenza H1N1 (12/137 Austrian veteri-

narians),⁵² equine rhinitis A and B viruses (4 and 5/137 Austrian veterinarians, respectively),⁵⁶ *Toxoplasma gondii* (75/137 Austrian veterinarians),⁵² *Leptospira* spp (2/1,301 Illinois veterinarians),⁵⁴ and borna disease virus (10/138 Finnish veterinarians).⁵⁷

Four controlled studies^{28,41-43} and 3 uncontrolled studies⁵⁸⁻⁶⁰ provided evidence that veterinarians had a decreased risk or did not have an increased risk of infection with zoonotic animal pathogens. In a North American study,⁴¹ none of 50 swine veterinarians or 33 blood donors had evidence of infection with porcine circovirus 1 or 2, consistent with the notion that people are not yet susceptible to this virus. Two studies^{42,43} from India found that none of 20 veterinarians were seropositive for antibodies against *Brucella* spp, compared with 2.5% of 122 controls, and that 13.3% of 30 veterinarians were seropositive for antibodies against *Leptospira* spp, compared with 24% of 50 controls. A Dutch study²⁸ that examined seroprevalence of antibodies against *Leptospira* spp, hantavirus, and lymphocytic choriomeningitis virus found that none of the 102 veterinarians in the study had antibodies against these organisms but that 0.5%, 1.6%, and 2.6%, respectively, of 191 pig farmers did. Uncontrolled studies reported that none of 43 Florida veterinarians had antibodies against *B. canis*,⁵⁹ none of 41 veterinarians in Nigeria had antibodies against *Bacillus anthracis*,⁶⁰ and none of 194 veterinarians attending a feline medicine conference in the United States had antibodies against feline retrovirus.⁶¹

Case reports and outbreak investigations—Twelve case reports^{10,11,61-70} describing symptomatic infections with zoonotic pathogens in veterinarians were identified (Table 1), with most affected veterinarians developing cutaneous lesions following direct contact with infected animals. Three reports^{12,77,78} of investigations following zoonotic disease outbreaks that occurred in US veterinary clinics were also identified. These investigations concerned veterinarians who became ill and tested positive after caring for prairie dogs infected with monkeypox virus,¹² cats infected with multidrug-resistant *Salmonella* Typhimurium,⁷⁷ or chimpanzees infected with hepatitis virus (including a veterinarian's wife who developed hepatitis after coming in contact with her husband's clothing).⁷⁸

Table 1—Published case reports of zoonotic animal pathogen infections in veterinarians.

Reference	Pathogen	Human Illness	No. affected	Exposure	Country
61	<i>Brucella</i> spp	Brucellosis	5	Direct occupational contact with animals	Jordan
62	<i>Brucella</i> spp	Brucellosis	2	Direct occupational contact with animals	India
63	<i>Salmonella</i> spp	Pustular dermatitis	2	Intrauterine examination of cow during stillbirth delivery	The Netherlands
64	<i>Salmonella</i> spp	Folliculitis	1	Intrauterine examination of cow during stillbirth delivery	Canada
65	Bovine papular stomatitis virus	Cutaneous lesions	9	Infected bull requiring an oral feeding tube	United States
66	<i>Sporothrix schenckii</i>	Cutaneous ulcers	1	Direct contact with an infected cat	United States
67	<i>Blastomyces dermatitidis</i>	Blastomycosis	1	Accidental deep IM injection of organisms	United States
68	<i>Listeria monocytogenes</i>	Cutaneous lesions	10	Exposure to aborted bovine fetus	United Kingdom
69	<i>Leptospira interrogans</i>	Leptospirosis	1	Direct contact with livestock	Canada
70	<i>Trichophyton verrucosum</i>	Ringworm lesion	1	Contact with infected cattle	Australia
11	Hendra virus	Cervical lymphadenopathy	1	Performed autopsy on infected horse	Australia
10	Avian influenza virus H7N7	Conjunctivitis or pneumonia	5	Responded to H7N7 outbreak on poultry farm	The Netherlands

Survey research—Seven surveys^{54,71–76} of self-reported disease and use of personal protective equipment were identified. In a 1982 survey⁷¹ of 563 British veterinarians, 64.1% reported having experienced at least 1 zoonosis in the past. In addition, the percentage of veterinarians who reported having had an accident and who also reported having at least 1 zoonotic disease (278/397 [70%]) was significantly higher ($P < 0.001$) than the percentage of veterinarians who had never had an accident but reported at least 1 zoonotic disease (83/166 [50%]). A 2001 survey⁷² of 88 South African veterinarians found that 63.3% reported having had a zoonotic disease and that veterinarians predominately in farm animal practice were more likely (OR, 3.11; 95% CI, 1.04 to 11.23) to have contracted a zoonotic disease than were veterinarians in other fields. A study⁵⁴ of 833 Illinois veterinarians who had experienced an accident reported that 42.7% had also had a zoonotic disease, which was significantly higher ($P < 0.01$) than the percentage of accident-free veterinarians who reported having had a zoonotic disease (113/349 [32.4%]).

A 1999 survey⁷³ of 464 Danish veterinarians found that 88% wore gloves in various contexts but that only 5% wore gloves consistently during animal contact. In a 1996 survey⁷⁴ about self-reported symptoms of respiratory tract disease, 26% of 326 large animal and mixed animal veterinarians in the southern Netherlands reported that they never used respiratory protective devices, 34% reported that they wore them only when present for > 30 minutes in a barn, and only 19% reported that they always wore respiratory protective devices. In another survey,⁷⁵ only 15% of Dutch veterinarians reported using respiratory protective devices when entering a poultry confinement building. Finally, in a study⁷⁶ from Kansas, veterinarians who never or rarely used gloves were more likely to report work-related dermatoses (OR, 4.25; 95% CI, 1.78 to 10.07; $P < 0.001$) than were veterinarians who wore gloves.

Discussion

In our review of the published literature, we found that veterinarians had an increased risk of infection with a number of zoonotic pathogens, including swine and avian influenza A virus, *Brucella* spp, *C burnetii*, avian and feline *C psittaci*, human and swine hepatitis E virus, methicillin-resistant *S aureus*, and *Bartonella* spp. Moreover, we found reports providing serologic evidence that veterinarians could be infected with animal pathogens not widely recognized as zoonotic, including bovine polyomavirus, bovine norovirus, borna disease virus, and equine rhinitis viruses, supporting our suggestion that veterinarians could serve as biological sentinels.⁷⁹ In our review, we also found that veterinary accidents were associated with a higher likelihood of zoonotic disease and that veterinarians were often lax in their use of personal protective equipment.

Our review had a number of limitations. Importantly, only a single individual applied inclusion and exclusion criteria to identified reports, which may have lead to some degree of author bias. The reports we considered were biased toward findings from English-

speaking, developed countries. Internationally, there are major differences in zoonotic pathogen prevalence, the quality of veterinary education, and the availability of resources to protect veterinarians. All of these factors influence the likelihood of disease transmission, incidence of zoonotic infections, and strength of relative risk factors. With regard to the high seroprevalence of antibodies against *Brucella* spp, a wide variety of serologic assays were used in the serosurveys identified in our review, which may have led to differences in seroprevalence, and some studies combined results of multiple assays to calculate an aggregated prevalence. In addition, the high seroprevalence of antibodies against *Brucella* spp in veterinarians may be influenced in developed countries by inadvertent infection with live vaccine strains such as *B abortus* S19 and RB51.^{80,81} Infections have resulted from accidental self-inoculation and accidental contact with the face or eyes, as well as from contact with animals infected with these vaccine strains.^{46,81–84} Because these vaccines are not readily available in developing countries, infections detected among veterinarians in these countries are much more likely to be from endemic *Brucella* strains.

Because emerging infectious diseases first seen in veterinarians could indicate an animal pathogen has gained the ability to spread across species, veterinarians may serve as unprotected biological sentinels for emerging zoonoses. Given the apparent increased risk of zoonotic pathogen infections in veterinarians, professional and public health policy measures should be implemented to protect them. Ensuring proper protection for veterinarians calls for improved equipment and better guidelines and education. In conversations with veterinarians, we have learned that they may neglect wearing protective barriers, such as gowns and gloves, because of discomfort, lack of availability, additional costs, and a belief that there is a low risk of zoonotic infection. Therefore, innovations are needed in the development of personal protective equipment to improve comfort, reduce costs, and increase availability. In some settings, mandating the use of personal protective equipment when in contact with diseased animals may be required. It also seems prudent to provide continuing veterinary education incorporating guidelines such as the National Association of State Public Health Veterinarians' *Compendium of veterinary standard precautions: zoonotic disease prevention in veterinary personnel, 2006*.⁸⁵ This report, recently updated in 2008,⁸⁶ focuses on preventing zoonotic pathogen transmission from animals to veterinary personnel.

Current national policies related to preventing an influenza pandemic often overlook veterinarians or assign them a low priority. This apparent oversight is difficult to understand, as a key risk factor for human infection with swine or avian influenza virus is exposure to diseased pigs or birds,⁸⁷ and occupational exposure studies^{4,5,7,8,21,88} suggest that veterinarians and other swine and poultry workers are being infected with endemic zoonotic influenza viruses. Veterinarians, correspondingly, would be at increased risk of infection with pandemic strains should the virus first amplify in domestic animal herds or flocks and could, in turn, intensify the pandemic within their communities.²⁰

Veterinarians' exposure to endemic animal influenza viruses could likewise play a role in the genesis of novel influenza viruses by serving as an interface for the cross-species sharing of viruses.^{3,6} Therefore, we must comprehensively plan for their protection. National pandemic protection schemes should provide veterinarians priority access to available preventive measures such as personal protective equipment, vaccines, and antiviral medications.

Zoonotic pathogens dominate the National Institute of Allergy and Infectious Diseases' list of category A, B, and C priority pathogens for biodefense.⁸⁹ Veterinarians in the United States are uniquely positioned to first recognize a bioterrorism event in animals and are, consequently, at a higher risk for infection. Yet, not enough has been done to prepare veterinarians in the event of a biological attack with a zoonotic agent. In one study,⁹⁰ for instance, state veterinarians were significantly less likely to have knowledge of bioterrorism incidents within their state or district than were state public health officers. Given that outbreaks can occur simultaneously in animals and humans, communication between the veterinary and public health sectors may be vital in confirming a diagnosis.⁹¹ In a 2004 survey⁹² of 4,144 US veterinarians, when asked which agency they would notify if they observed an unusual infectious disease, most responded that they would notify their state agriculture agency and 28% indicated that they did not know whether their community had a local public health agency. Among 125 Hawaiian veterinarians surveyed in 2004,⁹³ only 12% reported having bioterrorism training and just 16% felt they would be able to effectively respond to a bioterrorism attack. Veterinarians must be properly trained to recognize and correctly respond to bioterrorism events in animals and humans so as to protect themselves and their communities from infection.

Underlining the problem of inadequately protected veterinarians is the underrepresentation of animal health in the public health arena.⁹⁴ Veterinarians comprise only a small fraction of the public health workforce,⁹⁵ and in some states, animal disease surveillance and response remain entirely separate from public health infrastructures.⁹² Recognizing concurrent human and animal outbreaks is crucial for ascertaining the causative zoonotic pathogen and developing subsequent control strategies. Increasingly, the prevention and control of emerging infectious diseases will lie in the hands of those in the veterinary profession positioned at the human-animal nexus. For this reason, agencies must come together and bridge the gap between animal and human health.

As animal husbandry practices evolve from small farms to large agribusinesses, intensified rearing systems will give rise to new niches for pathogens to become endemic in large herds and flocks.^{20,94,96,97} Even with today's biosecurity standards, modern swine producers struggle with swine influenza virus, porcine circovirus, and porcine reproductive and respiratory syndrome virus, demonstrating the complexities of controlling these pathogens.⁹⁸⁻¹⁰⁰ Adding to these struggles are mutations and recombinations that could potentially allow endemic pathogens to cross species

boundaries and infect humans. Because veterinarians have extensive contact with sick animals, we can expect to observe an increase in the number of veterinarians infected with zoonotic agents, especially if inadequate use of personal protective equipment persists.¹⁰¹ For this reason and because veterinarians play a vital role in responding to bioterrorism and foreign animal diseases, we need to better appreciate the roles veterinarians play in protecting our nation.

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