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D. W. Eyre, J. Kenkre, I. C. J. W. Bowler, S. J. McBride

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**Streptococcus equi subspecies zooepidemicus meningitis – a case report and review of the literature**

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2 Eyre DW, Kenkre JS, Bowler ICJW, McBride SJ  
3

4 Infectious Diseases & Medical Microbiology, John Radcliffe Hospital, Oxford Radcliffe Hospitals  
5 NHS Trust, Headington, Oxford OX3 9DU, United Kingdom  
6  
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8 Corresponding Author:

9 Dr David Eyre

10 John Radcliffe Hospital, Oxford Radcliffe Hospitals NHS Trust, Headington, Oxford OX3 9DU,  
11 United Kingdom

12 Email [davideyre@gmail.com](mailto:davideyre@gmail.com)

13 Telephone +44 1865 741166

14 Mobile +44 7739 632430  
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## Abstract

1 A case is described of a 79 year old man, trampled by his horses, who subsequently developed a wound  
2 infection and later meningitis. *Streptococcus equi* subsp. *zooepidemicus* was isolated as the causative  
3 organism.  
4

5 *Streptococcus equi* subsp. *zooepidemicus*, which carries the Lancefield Group C antigen, is an  
6 uncommon human pathogen, but commonly isolated from bacterial infections in animals, particularly  
7 horses. It is most commonly acquired by humans following animal contact.  
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9

10 A review of the literature identified 20 previously described cases of *Streptococcus equi* subsp.  
11 *zooepidemicus* meningitis. Crude mortality following infection was 24 %. All who died were over 70  
12 years old, and ingestion of unpasteurised dairy products was associated with all but one of the fatal  
13 cases. Hearing loss was a frequent complication, occurring in 19%. Only 38% of patients made a  
14 complete recovery. Treatment regimes commonly included benzylpenicillin or a third-generation  
15 cephalosporin, with a mean treatment duration in survivors of 23 days.  
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## Keywords

19 *Streptococcus equi*  
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21 Meningitis  
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23 Horse  
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25 Zoonoses  
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27 Review  
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## Case presentation

1 A 79 year old man presented to his local hospital with confusion and pyrexia one week after being  
2 trampled by horses at the animal sanctuary he managed. During the initial injury, he sustained a large  
3 haematoma over his right knee and a deep occipital scalp laceration, he was found to have no  
4 neurological deficit. The occipital wound was cleaned and sutured, and the patient discharged.

5 One week later, several hours after removal of his scalp wound sutures, he re-presented to his local  
6 hospital confused and drowsy, complaining of a severe occipital headache. He was febrile at 38.7°C  
7 with a pulse of 134/minute in atrial fibrillation. Blood pressure was 111/68, oxygen saturations 98% on  
8 air, capillary blood glucose 5.5mmol/L and his Glasgow Coma Scale (GCS) score was 14/15, although  
9 this rapidly dropped to 10/15. His head wound appeared infected with a malodorous discharge. Cardiac,  
10 respiratory and abdominal examinations were normal. Neurological examination was hindered by the  
11 patient's inability to follow commands, however he was able to move all four limbs and his tone and  
12 reflexes were normal and symmetrical. Blood cultures were obtained.

13 Computed tomography (CT) of the head showed no fracture, bleed, infarct, or features of raised  
14 intracranial pressure. Cerebrospinal fluid (CSF) obtained via lumbar puncture was cloudy, with an  
15 elevated opening pressure of 29cm H<sub>2</sub>O. The CSF white blood cell count was 360×10<sup>6</sup>/L (70%  
16 lymphocytes and 30% neutrophils), protein 4g/dl and glucose 0.2 mmol/l. No organisms were seen on  
17 Gram stain. The patient was treated with intravenous ceftriaxone and aciclovir.

18 The following day the patient was noted to have left-sided neglect, agitation, profound hearing loss and  
19 a GCS of 11/15. He was transferred to the John Radcliffe Hospital, Oxford, for neurological  
20 assessment. On arrival, amoxicillin was added to his treatment regimen to cover the possibility of  
21 Listeriosis. His admission blood cultures became positive, growing Gram positive cocci resembling  
22 streptococci. The streptococcus was identified as Lancefield group C, and further testing undertaken  
23 using API 20 Strep (bioMerieux Vitek Inc. Hazelwood, MI.), identified the isolate as *Streptococcus*  
24 *equi* subsp. *zooepidemicus* (probability >99%). On the basis of this result, aciclovir and amoxicillin  
25 were discontinued.

26 The next day the patient suffered two self terminating tonic-clonic seizures. Phenytoin was prescribed,  
27 and no further seizures occurred. An MRI brain revealed multiple acute right middle cerebral artery  
28 territory infarcts, with normal neck, head and cranial vessels. A small subdural/subarachnoid bleed was  
29 identified. Transthoracic echocardiography was unremarkable. As it was possible that the  
30 subdural/subarachnoid blood seen on MRI had been infected during the patient's bacteraemia, 6 weeks  
31 of therapy with intravenous ceftriaxone was planned. The patient improved rapidly with antibiotic  
32 treatment, with his GCS returning to 15/15 within 3 days and the left-sided inattention resolving  
33 completely.

34 Treatment was unfortunately complicated by severe *Clostridium difficile* infection. This was managed  
35 with enteral vancomycin and intravenous metronidazole, and in an attempt to reduce the risk of relapse,  
36 his meningitis treatment was changed to intravenous benzylpenicillin. The patient continued to recover  
37 well and was discharged after 6 weeks of therapy. However, profound high frequency hearing loss  
38 remained. The horses involved in the original incident remained well throughout, with no features of *S.*  
39 *equi* subsp. *zooepidemicus* infection. Erratic behaviour noted in one of the horses following the original  
40 incident was felt to be related to it being in season.

## Review of the literature

41 *Streptococcus equi* subsp. *zooepidemicus* is an uncommon human pathogen, but commonly isolated  
42 from bacterial infections in animals, particularly horses[1]. It carries the Lancefield Group C antigen,  
43 and is most commonly acquired by humans following animal contact. It shares 80% sequence  
44 homology with *Streptococcus pyogenes*, with many virulence factors in common [2]. Lancefield Group  
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1 C streptococci cause human skin and soft tissue infections and pharyngitis, but bacteraemia is  
2 uncommon [3]. They have also been reported to cause numerous other infections in humans including  
3 lower respiratory tract infection, endocarditis, septic arthritis, peritonitis, aortitis and pericarditis[3,4].  
4 They are a rare cause of meningitis in humans.

5 A literature review revealed only twenty previously reported cases of *S. equi* subsp. *zooepidemicus*  
6 meningitis. The demographics, animal exposure details, treatment and outcome data for published cases  
7 including our case are presented in Table 1[5-21]. The median age of patients was 67 years (range 13-  
8 83). Just over half of patients (12/21, 57%) were male, with 9 cases occurring in females. In contrast to  
9 some reports of other types of invasive Group C streptococcal disease [22], only a minority of patients  
10 (8/21, 38%) had recorded co-morbidities. The majority (13/21, 62%) of reported cases were located in  
11 the United Kingdom/Europe, with the majority of the remaining cases (5/21, 24%), in North America.  
12

13 Contact with animals or ingestion of animal products was noted in all but one of the cases. While horse  
14 contact was most prevalent, contact with cattle and dogs was also reported. The postulated route of  
15 infection varied significantly between cases. Inhalation of the organism was proposed in 10 cases as the  
16 probable route of acquisition, whilst ingestion of unpasteurised dairy products was found to account for  
17 one third (7/21) of cases. Inoculation was the postulated route in 4 cases including the case presented in  
18 this article.  
19

20 Treatment regimes for affected patients included benzylpenicillin (13 patients), and/or a third generation  
21 cephalosporin (12 patients). Treatment duration varied. Amongst patients who survived and for whom  
22 treatment duration was reported, mean treatment duration was 23 days of antibiotics.  
23

24 The crude mortality associated with *S. equi* subsp. *zooepidemicus* meningitis was 24% (5/21), although  
25 one of the patients who died also had a ruptured abdominal aortic aneurysm and it is unclear whether  
26 this related to infection or pre-existing disease. All those who died were over 70 years old, and all but  
27 one of the fatal cases was thought to have acquired their infection by ingesting unpasteurised dairy  
28 products. Other authors have reported rates of mortality with Group C streptococcal bacteraemia of 25-  
29 40%, with the highest rates in the elderly [3,22]. Persistent hearing loss was the most common  
30 complication reported, occurring in 19% (4/21) of patients, although 3 of the 4 patients affected received  
31 aminoglycosides as part of their treatment. Other complications reported included endocarditis,  
32 endophthalmitis, tetraparesis, and aphasia. Only 38% (8/21) of patients made a complete recovery.  
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### 34 **Conclusion**

35 *S. equi* subsp. *zooepidemicus* meningitis is a rare but severe zoonotic infection, usually presenting in  
36 patients who have contact with horses or cattle. It is associated with high mortality and in those who  
37 survive, significant complications, particularly hearing loss. The elderly and those who acquire infection  
38 by ingestion of contaminated unpasteurised dairy products are at greatest risk of death.  
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Demographics				Probable source			Treatment		Outcome	Ref.
Age	Sex	Past Medical History	Location	Animal Contact	Route	Notes	Agents	Duration		
59y	m		Minnesota, USA	Farm animals	Ingestion	Farm hand, drank unpasteurised goat's milk, no unwell animals	Ampicillin, gentamicin, benzylpenicillin	16 days	Positional vertigo, unilateral hearing loss, improved at 2 month follow up	5
66y	m	Nil	Leeds, UK	Dogs	Inhalation	Contact with unwell dogs	Benzylpenicillin, dexamethasone	Not stated	Not stated	6
24y	f	Nil	Manitoba, Canada	Horse	Inhalation	Pet horse	Chloramphenicol, ampicillin, benzylpenicillin	14 days	No neurological sequelae, "more garrulous and gregarious" than her usual self	7
73y	m		West Yorkshire, UK	Cows' Milk	Ingestion	Unpasteurised milk from dairy herd with mastitis	Cefotaxime, benzylpenicillin	Died at 48 hours	Died at 48 hours	8
73y	m	Concurrent leaking aortic aneurysm	West Yorkshire, UK	Cows' Milk	Ingestion	Unpasteurised milk from dairy herd with mastitis	Cefotaxime, benzylpenicillin	Died	Died, ruptured abdominal aortic aneurysm	8
71y	m	Concurrent deep vein thrombosis	West Yorkshire, UK	Cows' Milk	Ingestion	Unpasteurised milk from dairy herd with mastitis	Cefotaxime, benzylpenicillin	6 weeks	Discharged	8
80y	f		West Yorkshire, UK	Cows' Milk	Ingestion	Unpasteurised milk from dairy herd with mastitis	Cefotaxime, benzylpenicillin	Died at day 14	Died at day 14	8
24y	m	Nil	Kentucky, USA	Horses	Inhalation	Employed at horse farm	Benzylpenicillin	14 days	Full recovery	9
33y	m		Créteil, France	Not recorded	Not recorded	Not recorded	Ampicillin, gentamicin	Not recorded	Recovered with mild bilateral deafness	10
67y	f		Bilbao, Spain	Cattle	Inoculation	Boiled milk, exposure to cattle, ear thought portal of entry	Ceftaxime, benzylpenicillin, tobramycin	23 days	Full recovery	11
66y	f	Chronic lymphocytic leukaemia recent chemotherapy	France	Horse	Inoculation	Horse with conjunctivitis, case had conjunctivitis at presentation	Amoxicillin, cefotaxime, fosfomycin	Not recorded	Complicated by unilateral endophthalmitis with associated visual loss	12
74y	m	Nil	Tours, France	Horses	Inhalation	Horse trainer, contact with unwell horses	Ampicillin, gentamicin	15 days	Discharged, no adverse outcome noted	13
13y	f	Asthma, allergic rhinitis	Philadelphia, USA	Horses	Inhalation	Close horse contact, equestrian competition	Cefotaxime, ceftriaxone, vancomycin	14 days	Residual unilateral sided hearing loss, otherwise well	14
49y	f	Nil	Toronto, Canada	Horses, Donkeys	Inoculation / Inhalation	Close contact with 8 horses, and donkey ( <i>Strep. zooepidemicus</i> isolated from 2 horses and donkey), kick to face 2 weeks prior to infection, no break in skin	Cefotaxime, benzylpenicillin	10 days	Discharged after 11 days with diplopia	15
74y	m		Konya, Turkey	Horses	Inhalation	Frequent contact with horses, including one with upper respiratory tract infection	Ceftriaxone	Died at day 7	Died at day 7	16
79y	m	Nil	Bedford Park, Australia	Indirect - Horse manure	Inhalation	Gardener with daily exposure to manure	Benzylpenicillin, vancomycin	6 weeks	Associated endocarditis, good recovery	17
83y	f	Hypertension	Gran Canaria	Indirect - Cheese	Ingestion	Inadequately pasteurized cheese	Beta-lactam	Died	Died	18
41y	m		Stoke-on-Trent, UK	Indirect - Animal manure	Inhalation	Farmer, also contact with animal manure while gardening	Ceftriaxone	14 days	Minimal neurological sequelae	19
30y	f	Cocaine & cannabis use	Salamanca, Spain	Horses	Inhalation	Horse contact	Cefotaxime, vancomycin, ampicillin	4 weeks	Initial tetraparesis, global aphasia, subsequently improved	20
72y	f	Myocardial infarction	Belgrade, Serbia	Indirect - Horses & Cattle	Ingestion	Unpasteurised milk, son close contact with horses	Ampicillin, gentamicin, rifampicin	3 weeks	Good recovery	21
79y	m	Atrial fibrillation, Chronic Obstructive Pulmonary Disease	Swindon, UK	Horses	Inoculation	Owner of animal sanctuary	Ceftriaxone, gentamicin, amoxicillin, benzylpenicillin	6 weeks	Good recovery, high frequency hearing loss	This case

**Table 1, Review of the Literature**

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**Declarations**

The patient described has given his consent for inclusion in this review.

The authors declare that they have no conflict of interest.