New disease

Spacecraft bacterium, *Paenibacillus pasadenensis*, causing wound infection in humansY Flammer Anikpeh,¹ P Keller,² GV Bloemberg,² J Grünenfelder,³ A S Zinkernagel¹¹Division of Infectious Diseases, University Hospital Zurich, Zurich, Switzerland;²Institute of Medical Microbiology, University Zurich, Zurich, Switzerland;³Clinic for Cardiovascular Surgery, University Hospital Zurich, Zurich, Switzerland

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SUMMARY

In a patient with mediastinitis after cardiac surgery *Paenibacillus pasadenensis* was detected in his sternal wound. *Paenibacilli* are gram-positive, aerobic, bacteria related to bacilli. Until recently these organisms were not known to cause human disease. A few cases of human infection caused by another member of this genus, *P alvei*, have been reported. The authors describe the first infection with *P pasadenensis* in humans. *P pasadenensis* was detected by broad-range bacterial 16S rRNA PCR. Treatment consisted of surgical debridement and antibiotics, vancomycin and ciprofloxacin followed by clindamycin and ciprofloxacin, resulting in complete recovery.

BACKGROUND

We consider this case of great interest since it is the first description of an infection due to *Paenibacillus pasadenensis* in humans. This case emphasises the fact that microbes normally found in the environment can cause an infection in a patient. The importance of the broad-range bacterial 16S rRNA PCR as a diagnostic tool is further highlighted, which allows us to identify prokaryotes despite previous antibiotic treatment

CASE PRESENTATION

A 79-year-old man was admitted to our hospital because of acute retrosternal pain followed by a short syncope. Coronary heart disease after myocardial infarction had been diagnosed 16 years earlier. Cardiovascular risk factors were arterial hypertension, smoking and dyslipidaemia for which he received treatment.

An acute coronary syndrome was diagnosed and a percutaneous coronary intervention was performed immediately revealing a long stenosis in the left main artery (90%), a 70–90% stenosis of the left anterior descending, a 70–90% stenosis of the circumflex artery and a 70% stenosis of the right coronary artery. The left ventricular function was impaired and the angiography showed an anterolateral hypokinesia and apical as well as a posterobasal and posterolateral akinesia. Therefore, an immediate bypass operation—off-pump—was done. Due to bleeding complications re-thoracotomy had to be performed. On day 7 after surgery, fever occurred and ventilator-associated pneumonia was suspected. Empirical antibiotic treatment with piperacillin/tazobactam was initiated and changed to amoxicillin according to the resistance profile when catheter-associated bacteraemia with *Enterococcus faecalis* was diagnosed. The catheter had already been removed.

After 2 weeks of treatment the patient was discharged to a rehabilitation clinic.

Five weeks after surgery the patient presented with progressive malaise, elevated inflammation markers and sternal

pain. The clinical investigation showed wound dehiscence and redness of the distal third of the sternotomy wound as well as bone instability. Anaemia (haemoglobin of 8.6 g/dl (13.4–17.0 g/dl)), leucocytosis (white blood cell (WBC)) $11.78 \times 10^3/\mu\text{l}$ ($3.0\text{--}9.6 \times 10^3/\mu\text{l}$) and a C reactive protein (CRP) of 123 mg/l ($<5\text{ mg/l}$) were present. Operative exploration revealed infected tissue, which was removed together with the wire cerclages. Vacuum-assisted closure (VAC) treatment was then carried out. Swabs of the retrosternal area taken during surgery as well as during VAC change were sent to the microbiology laboratory. No bacteria grew from these swabs and, thus, the sternum was stabilised by osteosynthesis 7 days after the initial debridement. The inflammatory markers had declined (WBC $10.45 \times 10^3/\mu\text{l}$ and CRP to 70 mg/l). Fever occurred the next day and empirical antibiotic treatment with amoxicillin/clavulanic acid was started. Despite antibiotics the fever persisted, the WBC increased to $16.09 \times 10^3/\mu\text{l}$ and CRP remained elevated (59 mg/l). A CT scan of the chest showed fluid collection and air inclusions along the entire sternum. Clear fluid discharged from the sternal wound; however, no micro-organism grew again in the blood or in the sternal swabs. Suspecting an abscess, surgery was performed again with extensive lavage of the wound and the osteosynthesis material. Empirical antibiotic treatment was started consisting of vancomycin, gentamicin and rifampicin. Finally, broad-range bacterial 16S rRNA gene PCR followed by sequencing of the amplicon¹ revealed the presence of *P pasadenensis* from the sternal swab. Sequence homology analyses were done using the SmartGene IDNS database and software (SmartGene, Zug, Switzerland). The 443 bp 5'-end 16S RNA gene sequence showed 100% identity to *P pasadenensis* Genbank Accession AY167820. The second highest homology was found for the 16S rRNA sequence of *P humicus* Genbank Accession AM411529 of 95.7% (19 mismatches in 443 bp), which enabled the accurate species assignment of *P pasadenensis* to our sequence (submitted to GenBank under accession number

HM053479). The third most homologous sequence was found for *P kobensis* Genbank Accession AB073363 with of 95.3% (21 mismatches in 443 bp).

INVESTIGATIONS

Several retrosternal swabs for bacterial culture. Broad-range 16S rRNA gene PCR and sequencing of the amplicon.

TREATMENT

According to the standard treatment of *Bacillus* spp. (eg, *B cereus*), antibiotic treatment was adapted to vancomycin intravenously and ciprofloxacin orally for 2 weeks followed by 4 weeks of clindamycin and ciprofloxacin orally.

OUTCOME AND FOLLOW-UP

The patient improved, the wound healed and the inflammation markers returned to normal levels.

DISCUSSION

This patient presented with a secondary mediastinitis after coronary bypass operation and multiple sternal revisions. All the swabs that were taken during the surgeries under empirical antibiotic treatment as well as the blood cultures remained negative. However, broad-range 16S rRNA gene PCR revealed *P pasadenensis*, which we believe is the causative pathogen of this secondary mediastinitis. Immediate clinical response after starting an adequate antibiotic treatment and decline of inflammation markers further underlined this.

P pasadenensis is a spore-forming gram-positive, mesophilic, heterotrophic rod, which was first isolated and identified as a novel species in the genus *Paenibacillus* by the Jet Propulsion Laboratory Spacecraft Assembly Facility (JPL-SAF) in December 2000 on a clean entrance floor in one of the spacecraft facilities.² The name refers to the city of Pasadena where the JPL-SAF is located. There are more than 100 species identified in the genus *Paenibacillus*. Relatively few have been found to cause human disease. The most common *Paenibacillus* spp. in human infections is *P alvei*. In the literature, six infections (two of them meningitis) with *P alvei* have been described.^{3–8} Another eight case reports describe bacteraemia due to the *Paenibacillus* spp., such as *P polymyxa*, *P popilliae*, *P sanguinis*, *P massiliensis*, *P timonensis* and *P thiaminolyticus*.^{9–13}

Paenibacillus spp. are ubiquitous and found in the environment. If the skin, our primary defence against bacteria is disturbed, such as in this patient who had undergone multiple sternal revisions, infections by pathogens that normally occur in the environment become more likely. This is underlined by other case reports describing bacteraemia due to *Paenibacillus* spp.^{8–13}

Some members of the *Paenibacilli* were originally classified as bacilli but then reclassified as *Paenibacillus* genus. Because of the genetic similarity to *Bacillus* spp. we decided to choose the treatment of *P pasadenensis* according to the standard treatment of *Bacillus* spp. (eg, *B cereus*) in the absence of sensitivity testing. Most *Bacillus* spp.

isolates are susceptible to vancomycin, clindamycin, fluoroquinolones, aminoglycosides, carbapenems and, variably, penicillins and cephalosporins.¹⁴ Because of the severity of the infection we choose a combination of vancomycin intravenously and ciprofloxacin orally. After 2 weeks we switched vancomycin to clindamycin orally for an additional 4 weeks. The patient has recovered completely and is doing well.

Learning points

- ▶ *P pasadenensis*, so far recognised as an environmental microbe, can cause infection in humans.
- ▶ Bacterial broad-range 16S rRNA gene PCR and sequencing are important diagnostic tools and can be the only way for detection of the causative bacteria especially if the patient is under empirical antibiotic treatment.
- ▶ Treatment with vancomycin, clindamycin and ciprofloxacin—according to standard treatment for *Bacillus* spp—showed a successful outcome for infection with *P pasadenensis*.

Competing interests None.

Patient consent Obtained.

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