CLINICAL CASE REPORT

Ignatzschineria indica bloodstream infection associated with maggot infestation of a wound in a patient from Canada

Thomas Fear MD, FRCPC[1,2], Quinn Richert MD[1], Jasmine Levesque[3], Andrew Walkty MD, FRCPC[1,2,4], Yoav Keynan MD, PhD[1,2]

We describe a case of *Ignatzschineria indica* bacteremia in a patient with maggot infestation of a necrotic left leg wound. *Ignatzschineria* spp are an infrequent cause of infection in patients with wound myiasis. We review 16 cases described in published literature. Microbiologists and clinicians should be aware of uncommon bacteria, including *Ignatzschineria* spp, that may cause infection in patients with maggot-infested wounds such that these organisms are appropriately worked up and treated when found in clinical specimens.

KEY WORDS: *Ignatzschineria indica*, myiasis, sepsis, wound infection

Les auteurs décrivent un cas de bactériémie à *Ignatzschineria indica* chez un patient présentant une infestation de larves dans une plaie nécrotique de la jambe gauche. Les espèces d'*Ignatzschineria* sont une cause peu courante d'infection chez les patients présentant une myiase des plaies. Ils analysent 16 cas décrits dans des publications. Les microbiologistes et les cliniciens doivent connaître les bactéries rares, y compris les espèces à *Ignatzschineria*, susceptibles d'être responsables d'une infection chez les patients ayant une plaie infestée par des larves, afin que ces organismes fassent l'objet de bilans appropriés et soient traités lorsqu'ils sont présents dans des échantillons cliniques.

MOTS-CLÉS : *Ignatzschineria indica*, infection des plaies, myiase, sepsis

[1]*Department of Internal Medicine, Max Rady College of Medicine, University of Manitoba, Winnipeg, Manitoba, Canada;* [2]*Department of Medical Microbiology & Infectious Diseases, Max Rady College of Medicine, University of Manitoba, Winnipeg, Manitoba, Canada;* [3]*Department of Surgery, Max Rady College of Medicine, University of Manitoba, Winnipeg, Manitoba, Canada;* [4]*Shared Health, Winnipeg, Manitoba, Canada*

Correspondence: Thomas Fear, Max Rady College of Medicine, University of Manitoba, 807K John Buhler Research Centre, 727 McDermot Avenue, Winnipeg, Manitoba R3E 3P5, Canada. Telephone: 204-869-1485. Fax: 204-789-3988. E-mail: thofear@gmail.com

CASE PRESENTATION

A 60-year-old male presented to a tertiary care hospital emergency department in Winnipeg (Manitoba, Canada) during the summer with hypothermia and a reduced level of consciousness. The patient was homeless. Bystanders found him lying on the ground and not moving. He was noted to be difficult to rouse. Emergency medical services were called, and the patient was brought to the hospital. He had no known chronic medical conditions and was not taking any regularly prescribed medications.

Upon arrival at the emergency department, the patient was unable to provide a coherent history. On examination, his Glasgow Coma Scale score was 14, and he was hypothermic with a temperature nadir of 34°C. He was in atrial fibrillation with a heart rate of 170 beats per minute and his blood pressure was 124/86 mm Hg. His peripheral oxygen saturation was 100% on 10 litres of oxygen provided by face mask. He was observed to have a large gangrenous wound on his left leg; scrotal swelling with associated cellulitis and purulent discharge was also present, but there was no necrotic tissue in this area. The left leg was grossly infested with maggots (Figure 1). He was able to move his feet and legs, and peripheral pulses were palpable. The patient had a grade 2/6 systolic murmur at the cardiac base that did not radiate.

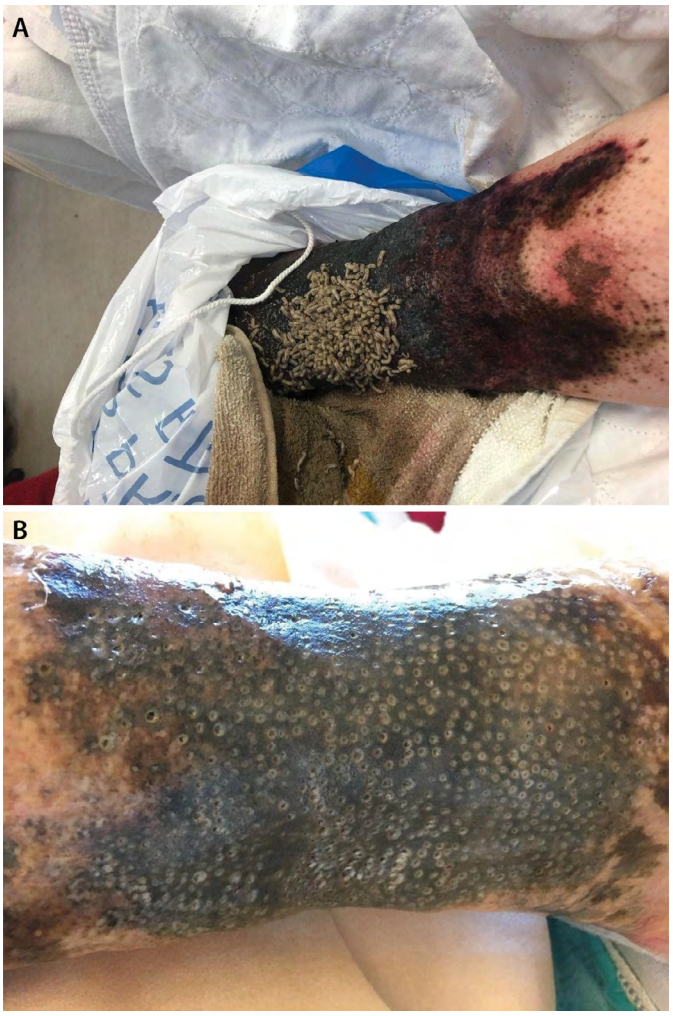

Figure 1: Necrotic left leg wound pre-debridement: (a) with visible maggots, and (b) post-debridement

Laboratory investigations were significant for a peripheral leukocytosis of 19.8 × 10^9/L (normal 4.5–11.0 × 10^9/L) with a neutrophil predominance (79.4% of the total leukocyte count). The patient had a serum blood glucose of 42.6 mmol/L (normal 4.0–11.0 mm/L), a creatinine of 440 µmol/L (normal 44–106 µmol/L), and a creatine kinase of 2,241 U/L (normal 52–175 U/L). A venous blood gas demonstrated a pH of 7.31 (normal 7.30–7.40), and lactate of 10.6 mmol/L (normal 0.55–2.2 mmol/L). Plain radiographs of the tibia, fibula, and left foot showed gas present in the soft tissues but no signs of osteomyelitis. A computed tomography (CT) scan of the abdomen and pelvis revealed an inguinal hernia, but no pelvic or scrotal abscess.

A central line was inserted in the right internal jugular (IJ) vein, and the patient was volume resuscitated with intravenous lactated Ringer's solution; warming was achieved with an external forced-air warming system. His hyperglycemia was corrected with insulin. Blood cultures were drawn from the central line (one aerobic bottle and one anaerobic bottle) and a peripheral site (one aerobic bottle), and the patient was started on therapy with intravenous piperacillin–tazobactam and vancomycin. The orthopedic service was consulted for surgical management of the left leg. Irrigation and debridement were undertaken, but the surgeons were unable to remove all maggots beneath the layers of necrotic skin. Petroleum jelly was applied thickly over the left leg in an attempt to suffocate the remaining maggots. The urology service was involved, and they did not feel that debridement of the scrotum was required for management of the genital infection. The patient's hemodynamic status and blood work abnormalities rapidly corrected with empiric antimicrobial therapy and fluid resuscitation; he remained afebrile, and on day 2 of his presentation, he was admitted to a general internal medicine ward.

The aerobic blood culture bottle collected from a peripheral site became positive following 32 hours of incubation on a BacT/ALERT® 3D blood culture instrument (bioMérieux, Marcy-Létoile, France). A Gram stain revealed gram-negative rods (Figure 2A). The organism subsequently grew on a subculture of the bottle to a blood agar plate (Figure 2B). The pathogen was identified by matrix-assisted laser desorption/ionization time-of-flight (MALDI-TOF) mass spectrometry (Bruker MALDI Biotyper System using Compass 4.1.70 software and the MBT 7854 MSP library [last updated April 2018], Bruker Daltonics Ltd., East Milton, ON) as *Ignatzschineria indica*, with an identification score of 2.19. The identity of the organism was confirmed by polymerase chain reaction (PCR) amplification and sequencing of an 800-bp fragment of the 16S rRNA gene using universal primers 8FPL (5′-AGTTTGATCCTGGCTCAG-3′) and 806R (5′-GGACTAC CAGGGTATCTAAT-3′). The sequence data were submitted to Genbank and assigned accession number MT117227. Antimicrobial susceptibility testing was performed by broth microdilution as described by the Clinical and Laboratory Standards Institute (CLSI), using an in-house prepared broth microdilution panel (1). Antimicrobial minimum inhibitory concentrations (MICs) were interpreted using the CLSI non-*Enterobacteriaceae* breakpoints (2). The isolate was susceptible to ceftazidime (MIC = 2 µg/mL), ciprofloxacin (MIC = 0.12 µg/mL), gentamicin (MIC = 0.5 µg/mL), meropenem (0.12 µg/mL), piperacillin–tazobactam (MIC = 8 µg/mL), and trimethoprim–sulfamethoxazole (MIC = 0.25 µg/mL).

Wound swabs obtained from the patient's left leg grew *Morganella morganii* and methicillin-susceptible *Staphylococcus aureus*. *Proteus mirabilis* was recovered from a wound swab obtained from the patient's scrotum. Repeat blood cultures collected on the fourth day of admission were negative. The right IJ central line was removed. No further debridement of

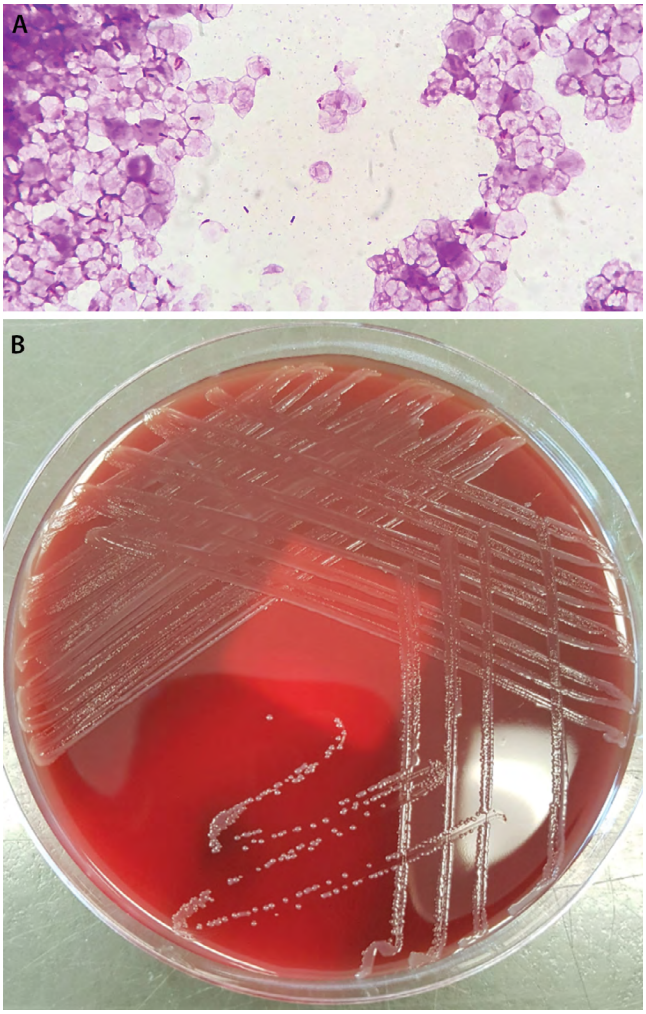

Figure 2: *Ignatzschineria indica* seen on Gram stain: (a) from a blood culture bottle, and (b) growing on a sheep blood agar plate

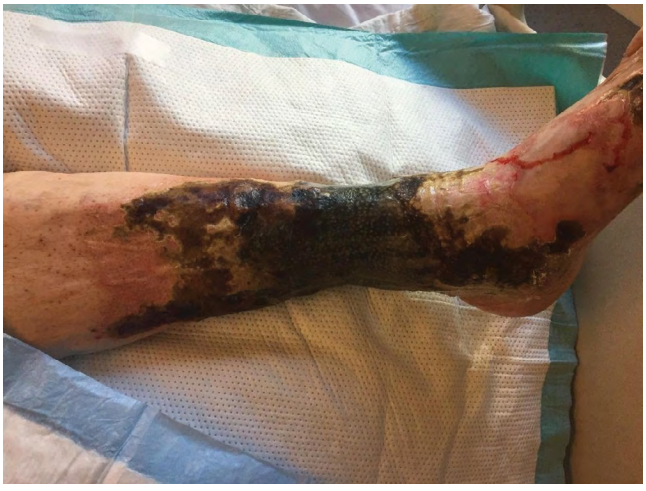

Figure 3: Clinical appearance of the left leg on day 13 of treatment

the left leg was required. The clinical appearance of the left leg at day 13 is presented in Figure 3. The patient was found to have an elevated hemoglobin $A1_c$ of 8.9%, in keeping with undiagnosed diabetes mellitus. On account of the murmur associated with his bacteremia, a transthoracic echocardiogram was performed, and this was normal. The patient was treated with 10 days of intravenous piperacillin–tazobactam and remained afebrile. He completed treatment with an additional 2 weeks of oral amoxicillin–clavulanate, which was recommended because of the severity of this infection, the patient's underlying diabetes, and incomplete surgical source control.

DISCUSSION

In 2001, Toth et al published a description of a gram-negative rod that was isolated from the larvae of the *Wohlfahrtia magnifica* fly (3). The organism was named *Schineria larvae*, in honour of Ignatz Rudolph Schiner, who described the *Wohlfahrtia magnifica* fly. The genus name *Schineria* was subsequently discovered to be illegitimate, and in 2007 it changed to *Ignatzschineria* (4). Bacteria belonging to this genus are found in the class Gammaproteobacteria (5). There are currently four species in the genus *Ignatzschineria*; *I. larvae*, *I. indica*, *I. ureiclastica*, and *I. cameli*. *I. indica* and *I. ureiclastica* received species designation in 2011, while *I. cameli* was more recently described in 2018 (5,6). *Ignatzschineria* spp are aerobic gram-negative rods. They are oxidase-positive, catalase-positive, non-motile, and non-spore forming (5). Colonies of *I. indica* are reported as being non-pigmented, convex, and translucent (5). Specific virulence factors among *Ignatzschineria* spp clinical isolates that may contribute to pathogenicity have not been well defined.

Ignatzschineria spp have been associated with bloodstream infections in patients with wound myiasis (7–11). The case presented here highlights this connection and is, to our knowledge, the second such case described in Canada (12). A summary of previously reported cases describing infection with *Ignatzschineria* spp is listed in Table 1. No cases have been reported in patients undergoing maggot therapy for wound debridement.

Most clinical cases from Europe have described infection due to the species *I. larvae* and *I. ureiclastica* (9–11,13). In contrast, *I. indica* is the only species that has been reported in cases from the United States and Canada (8,12,14,15). All four *Ignatzschineria* spp have been isolated from the gut contents or larvae of flesh flies (Diptera: Sarcophagidae), but it remains unclear which fly larvae are predominantly associated with *Ignatzschineria* infections in humans (3,5). In the majority of clinical case reports describing *Ignatzschineria* associated myiasis, no attempt was made to identify maggots found in

Table 1: Summary of previously published cases of *Ignatzschineria* infection

Year*, geography	Case description	*Ignatzschineria* species (source)	Antimicrobial susceptibility (MIC, µg/mL)	Co-pathogens and site of isolation	Ref.
2005, Montpellier, Hérault, France	39 M "Trench foot" infested with maggots	*I. larvae* (blood)	Susceptible to β-lactams, AGs, FQs, TETs, ERY, RIF, CST. Resistant to NAL and FOF	Wound: *Proteus mirabilis*, *Providentia stuartii*, group G *Streptococcus*, *Streptococcus* spp, and *Enterococcus* spp	(9)
2006, Romans-sur-Isère, Drôme, France	76 M with chronic cutaneous ulcers of both legs infested with maggots	*I. larvae* (blood)	Susceptible to β-lactams, AGs, CHL, SXT, FQs, CST	Blood and wound: *Staphylococcus aureus*	(13)
2013, Tours, Indre-et-Loire, France	69 M with necrotic shoulder lesion and maggot infestation around genitals	*I. ureiclastica* (blood)	Susceptible to all β-lactams, AGs, FQs, CST, SXT. Resistant to FOF	Blood: *Enterococcus faecalis*, *Enterobacter cloacae*, *Providencia stuartii*, *Corynebacterium* spp	(11)
2014, Louisville Kentucky, US	64 M with a leg ulcer, infested with maggots	*I. indica* (blood); [*Phaenicia sericata*-Blowfly]	Not available	None	(8)
2014, Rapid City, South Dakota, USA, Regional Hospital	67 M with a foot ulcer and osteomyelitis infested with maggots	*I. indica* (blood)	Susceptible AMK (8), GEN (2), TOB (2), CAZ (8), FEP (4), ATM (8), CIP (≤0.12), LVX (≤0.25), TIM (≤4/2), and MEM (≤0.25). Intermediate to TZP (34/4)†	Blood: *Streptococcus pyogenes*	(8)
2014, Dallas, Texas, US	26 M with decubitus ulcer, nephrostomy tubes, urethrocutaneous fistulas	*I. indica* (urine)	Susceptible to ATM, CRO, FEP, GEN, MEM, SXT, TOB. Intermediate susceptibility to CIP	Urine: *Escherichia coli*, *Proteus mirabilis*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, *Providencia stuartii*	(8)
2016, Sittard-Geleen, Limburg, Netherlands	71 M with foot ulcer infested with maggots	*Ignatzschineria* spp (blood)	Susceptible to AMC (0.25), AMX (0.047), and CIP (0.064). β-lactamase test (oxoid) was positive "suggestive of an inducible β-lactamase"†	Wound: *Providencia stuartii*	(10)

Year*, geography	Case description	*Ignatzschineria* species (source)	Antimicrobial susceptibility (MIC, µg/mL)	Co-pathogens and site of isolation	Ref.
2016, Philadelphia, Pennsylvania, US	76 F with necrotic axillary lesion and abscess	*I. indica* (breast abscess)	Susceptible to AMK (≤2), TOB (≤1), CIP (≤0.5), LVX (≤1), ATM (≤4), CAZ (≤1), IPM (≤1), MEM (≤1), SXT (≤2/38)†	Abscess: *Proteus penneri* and *Providencia stuartii*	(14)
2017, Mississippi, US	46 M with decubitus ulcers	*I. indica* (blood)	Susceptible to AMK, ATM, FEP, CAZ, CIP, GEN, LVX, MEM, TZP, TOB	Blood: *Streptococcus gallolyticus*, *Streptococcus anginosus* Wound: *Proteus mirabilis*, *Escherichia coli* and diphtheroids	(15)
2017, Buenos Aires, Argentina	72 M with a chronic tibial ulcer with maggot infestation	*I. indica* (blood)	Not available	None	(17)
2018, Indianapolis, Indiana, US	37 M with leg ulcer infested with maggots	*I. indica* (blood); *Lucilia sericata* (green bottle fly)	Not available	Blood: *Providencia stuartii*, *Wohlfahrtiimonas chitiniclastica.*	(7)
2019, Asturias, Spain	44 M with foot and shin ulcers infested with larvae	*I. indica* (blood)	Susceptible to AMP (≤2), AMC (≤2), CTX (≤1), CIP (≤0.25), GEN (≤1), IPM (≤0.25), SXT (1/19)	Wound: *Alcaligenes faecalis* and *Proteus hauseri.*	(18)
2019, Ottawa, Ontario, Canada	Elderly patient, foot ulcer covered with maggots and cellulitis	*I. indica* (blood)	Susceptible to ATM (<8), AMK (<8), CRO (<1), CAZ (2), CIP (<0.5), GEN (<2), IMP (<2), MEM (<1), SXT (<0.5/9.5), TOB (<4), TZP (<16/4)	None	(12)
2019, Hamburg, Germany	57 M with bilateral foot ulcers infested with maggots	*I. ureaclastica* (blood)	Susceptible to AMP (0.125), CRO (0.032), CIP (0.016), MEM (0.032), TZP (0.19)†	None	(19)
2019, Winnipeg, Manitoba, Canada	60 M with leg ulcer and scrotal ulcers infested with maggots	*I. indica* (blood)	Susceptible to CAZ, CIP, GEN, MEM, TZP, SXT†	Wound: *Morganella morganii*, *Staphylococcus aureus*, and *Proteus mirabilis*	–
2020, Rennes, France	71 M with foot ulcer infested with maggots	*I. larvae* (blood)	Susceptible to all β-lactams, AGs, FQs, SXT; resistant to FOF		(20)

(*Continued*)

Year*, geography	Case description	*Ignatzschineria* species (source)	Antimicrobial susceptibility (MIC, µg/mL)	Co-pathogens and site of isolation	Ref.
2020, Harrisburg, Pennsylvania, US	82 M with bilateral foot ulcers infested with maggots	*I. indica* (blood)	Susceptible to ATM (<4), FEP (<8), CAZ (8), GEN (<2), IMP (<1), LVX (<2), TZP (<16), TOB (<4), SXT (<2/38), intermediate to TET (8)	Blood: *Staphylococcus aureus*, *Wohlfahrtiimonas chitiniclastica*	(21)

** When the year and geographic details of a case were not described, the authors' details and publication year are listed.*
† Reference in which methods of antimicrobial sensitivity testing and source of breakpoints were described.
AGs = aminoglycosides; AMC = amoxicillin/clavulanic acid; AMK = amikacin; AMP = ampicillin; AMX = amoxicillin; ATM = aztreonam; CAZ = ceftazidime; CIP = ciprofloxacin; CHL = chloramphenicol; CRO = ceftriaxone; CST = colistin; CTX = cefotaxime; ERY = erythromycin; FEP = cefepime; FQs = fluoroquinolones; FOF = vosfomycin; GEN = gentamicin; IMP = imipenem; LVX = levofloxacin; MEM = meropenem; NAL = nalidixic acid; RIF = rifampin; SXT = trimethoprim–sulfamethoxazole; TETs = tetracyclines; TIM = ticarcillin–clavulanic acid; TOB = tobramycin; TZP = piperacillin–tazobactam

the patients' wounds. In two case reports from the United States, *Ignatzschineria* infection occurred in association with myiasis due to larvae of the green bottle fly *Lucilia (Phenicia) sericata* (Diptera: Calliphoridae) (7,8). In the case described here, the maggots were not submitted to an entomologist for identification. However, *Lucilia sericata* is commonly found throughout southern Canada, and it is possible that the larvae of this fly may also have been involved in our patient's infection (16). The main role for identification of fly larvae in a case such as the one presented here would be to better define which species are predominantly associated with infection due to *Ignatzschineria* spp.

Identification of *Ignatzschineria* spp in the clinical microbiology laboratory can be difficult. Commercial phenotypic identification systems may misidentify or fail to identify bacteria belonging to this genus (8–10,13,17,18). Bacteria that have been misidentified as *Ignatzschineria* spp include *Acinetobacter lwoffii* (VITEK 2 Combo, ID-GN card, bioMérieux), *Acinetobacter lwoffii*/*Moraxella* spp (VITEK 2, bioMérieux), *Acinetobacter* spp (VITEK 2, bioMérieux), *Alcaligenes faecalis* (RapidID NF Plus, Remel), *Oligella ureolytica* (VITEK 2 ID-GNB, bioMérieux), *Oligella urethralis* (API20 NE, bioMérieux), and *Psychrobacter phenylpyruvicus* (API20 NE, bioMérieux) (8–10,13,18). In most cases of *Ignatzschineria* infection reported in the literature, organism identification has been made by molecular methods (most often 16S rDNA amplification and sequencing) (8–11,13,17). Interestingly, MALDI-TOF has also failed to identify *Ignatzschineria* spp in two published clinical cases (10,17). In one of these cases, identification failed on a Bruker MALDI-TOF instrument (17). We speculate that this may be related to the use of an earlier version of the database. The authors of this case did not indicate which version of the database they used (17). In the second case, identification failed on a VITEK MS (bioMérieux) instrument (10). The bioMérieux VITEK MS V3.2 Knowledge Base database does not currently include *Ignatzschineria* spp. In the current report, we obtained an excellent organism identification with MALDI-TOF. There are two other cases published in 2019 in which *Ignatzschineria indica* was successfully identified using a Bruker Daltonics MALDI-TOF instrument (12,18).

Only limited data are available on the antimicrobial susceptibility profile of *Ignatzschineria* spp. In the published case reports of *Ignatzschineria* infection, various methods have been used for susceptibility testing, including disk diffusion, testing on an automated instrument (VITEK2), and ETEST (bioMérieux) (7,9,10). In some case reports, no details were provided on the method used for susceptibility testing, or susceptibility testing was not performed (7,8,11,13,15,17). The breakpoints used for interpretation of susceptibility data were also not always clearly indicated, although CLSI breakpoints for non-*Enterobacteriaceae* have been applied in at least one case as we elected to do here (8). Despite these limitations, *Ignatzschineria* spp clinical isolates have generally been found to be susceptible to aminoglycosides, fluoroquinolones, and trimethoprim–sulfamethoxazole (8–10,13–15,18). Many of the reported isolates have also tested susceptible to various β-lactams (Table 1), but resistance to third-generation cephalosporins, piperacillin–tazobactam, and carbapenems has been described (12). The optimal treatment for clinical cases of *Ignatzschineria* infection remains undefined.

In summary, we describe a case of *Ignatzschineria* spp bloodstream infection associated with wound myiasis. This report illustrates the potential utility of MALDI-TOF in the identification of *Ignatzschineria* spp, although this may depend on the instrument and database being used. Microbiologists and clinicians should be aware of uncommon bacteria, including *Ignatzschineria* spp, that may cause infection in patients

with maggot-infested wounds such that these organisms are appropriately worked up and treated when found in clinical specimens.

CONTRIBUTORS: Conceptualization, TF, QR, JL, AW, YK; Data Curation, TF, AW; Methodology, TF; Writing – Original Draft, TF, AW; Writing – Review & Editing, TF, QR, JL, AW, YK; Supervision, AW, YK; Project Administration, AW, YK.

FUNDING: No funding was received for this work.

DISCLOSURES: The authors have nothing to disclose.

INFORMED CONSENT: Informed consent was obtained from the patients.

PEER REVIEW: This manuscript has been peer reviewed.

ANIMAL STUDIES: N/A.

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