# *Morganella morganii* Infections in a General Tertiary Hospital

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## Abstract

**Background:** *Morganella morganii* is a commensal Gram-negative bacillus of the intestinal tract of humans and other mammals and reptiles. Few reports exist in the literature regarding infections caused by this organism.
**Methods:** A retrospective study at the 650-bed University Hospital of Heraklion, Crete, Greece was performed during a 4-year period (2001–2004) to identify and analyze infections caused by *M. morganii*.
**Results:** Twenty-four patients had *M. morganii* isolated from clinical specimens during the study period. Thirteen patients (54%) suffered from skin and soft tissue infections, five from pyelonephritis, three from female genital tract infections, one from pneumonia, one from gangrenous appendicitis, and one from tonsillitis. *M. morganii* was a constituent of polymicrobial infections in 14 patients (58%). The patients received various antibiotics, i.e., six patients received ciprofloxacin, four piperacillin/tazobactam, two amoxicillin/clavulanic acid, one ticarcillin/clavulanic acid, one ceftriaxone, one imipenem, and one cefuroxime monotherapy, whereas the remaining eight received antibiotic combinations. Two (both debilitated) of 24 patients (8%) died, despite antibiotic treatment.
**Conclusion:** Skin and soft tissue infection was the commonest type of infection due to *M. morganii* in our series. *M. morganii* is commonly a part of polymicrobial infections and can rarely cause fatalities in debilitated patients.


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## Introduction

*Morganella morganii* is a Gram-negative bacillus, which belongs to the tribe *Proteae* of the family *Enterobacteriaceae* and has two subspecies, *M. morganii* and *M. sibonii*. It is found in the environment and in the intestinal tracts of humans, mammals, and reptiles as part of the normal flora. Despite its wide distribution, it is an uncommon cause of infections in humans [1].

*M. morganii* was initially identified in the late 1930s as a cause of urinary tract infections and since then a small number of reports of infections due to this pathogen have been published. *M. morganii* is most often encountered in postoperative patients and is mainly associated with urinary tract infections [2], bacteremia/sepsis both in children and adults [3, 4], skin and soft tissue infections [5–7], meningitis [8], ecthyma [9], chorioamnionitis [10], septic arthritis [11, 12], and endophthalmitis [13, 14].

*M. morganii* is considered a rare pathogen in humans. However, one should take into account the difficulties in identification of the microbe, which could be responsible for the underestimation of the number of infections due to this organism. For example, commercial laboratories isolate fewer bacterial species from urine samples, especially of uncommon pathogens, including *M. morganii*, compared to research laboratories [15]. Therefore, case series of *M. morganii* infections offer useful data regarding the clinical settings, the characteristics of patients afflicted and the clinical outcome. In the present study, a series of patients who developed various forms of infections due to *M. morganii* is reported.

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**Authors' Contributions:** M.E. Falagas wrote the manuscript and supervised the data analysis. P.K. Kavvadia and E. Mantadakis made a major revision of the manuscript. P. Kofteridis and I.A. Bliziotis determined independently the type and clinical outcome of the infections. D.P. Kofteridis and E. Saloustros collected the clinical data. S. Maraki collected and reviewed all the microbiological data. G. Samonis had the original idea, provided advice and gave final approval of the submitted manuscript. All authors read and approved the final manuscript.

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## Methods

### Study Design – Patient Population

The Microbiology laboratory records of patients that were hospitalized at the 650-bed University Hospital of Heraklion, Crete, Greece, during a 4-year period (January 2001–December 2004) were retrospectively searched in order to identify patients in whom *M. morganii* was isolated from clinical specimens. Then, the following data from the medical records of these patients were extracted: age, sex, underlying medical conditions, prior invasive procedures, symptoms, signs, findings from laboratory and imaging tests, and medications received before and after the isolation of *M. morganii.* Additional microbiological information that was collected included data for other isolated organisms as well as *in vitro* susceptibilities of all isolated organisms.

### Microbiological Studies

The identification of the pathogens was performed by standard microbiological methods and the API 20E system (bioMérieux, Marcy L' Etoile, France). Susceptibility to antimicrobial agents was determined by the disk diffusion method recommended by the Clinical and Laboratory Standards Institute [16].

### Definitions of Infections and Outcomes

Infections were defined based on the guidelines from the Center for Disease Control and Prevention [17]. Soft tissue infection was defined by the presence of an organism in a culture from tissue/drainage of the affected site, or by at least two symptoms/signs (localized pain/tenderness, redness, swelling, or heat) and at least one positive diagnostic test, such as positive blood culture, or positive antigen test, or diagnostic single antibody titer (IgM) or four-fold increase in paired sera (IgG) for a pathogen [17]. Decubitus ulcer was defined by at least two symptoms/signs (tenderness, redness, or swelling of the ulcer edges) and growth of microorganisms from cultures of tissue specimens or from blood cultures [17].

Possible outcomes of infections were defined as "cure" or "failure". Cure was defined as complete resolution of all symptoms and signs of infection and discharge from the hospital; failure was defined as persistence or worsening of symptoms and/or signs of infection. The type and clinical outcome of the infection was independently determined by two reviewers-authors (DPK, IAB).

## Results

### Studied Patients

During the 4-year study period, 24 patients had *M. morganii* isolated from clinical specimens. In Table 1, we present total demographic and clinical data and in Table 2 we present in detail clinical and microbiological characteristics of each patient. Eight patients (29%) had comorbidities such as diabetes, neoplasia, or chronic renal failure, while none was HIV positive or immunosuppressed due to chemotherapy, splenectomy, or liver disease. Two patients (8%) had central venous catheters, whereas eight (33%) had a urinary catheter. At the time of presentation, ten patients (42%) had developed stage I systemic inflammatory response syndrome (SIRS). Two patients (8%) were infected during the postoperative period, but not in the surgical wound area (patients 11 and 13, Table 2). Only in one (4%) of our patients infection was associated with a previous surgical procedure (patient number 6, Table 2).

Table 1
**Characteristics of patients with *Morganella morganii* infections (n = 24).**

| | n (%) or mean ± standard deviation |
|---|---|
| Demographic characteristics: | |
| Age (years) | 57.5[a] |
| Male | 11 (46%) |
| Comorbidity: | |
| Neoplasm | 2 (8.4%) |
| Diabetes mellitus | 6 (25%) |
| Chronic renal failure | 2 (8.3%) |
| Potential risk factors: | |
| Surgery | 2 (8.3%) |
| Intensive care unit hospitalization | 3 (12.5%) |
| Central venous catheter | 2 (8.3%) |
| Clinical signs and symptoms: | |
| Temperature | 37.5°C ± 1.3°C |
| SIRS | 10 (41.6%) |
| Type of infection: | |
| Polymicrobial infections | 14 (58.3%) |
| Outcomes: | |
| Days of hospitalization | 19.4 ± 8.5 |
| Deaths | 2 (8.3%) |

[a] Range: 4 months to 97 years old; 4 children and 20 adults; SIRS: systemic inflammatory response syndrome

### Types of Infections

Approximately half of our patients, from whom *M. morganii* was isolated from clinical specimens, had skin and soft tissue infections. More specifically, 13 patients (54%) suffered from skin and soft tissue infections, including eight cases of cellulitis, two cases with infectious gangrene of the foot, and three with decubitus ulcers (patients 1–8, 9–10, and 11–13, respectively, Table 2). In all cases, the pathogen was isolated from tissue cultures or fluid specimens obtained from the affected area except for one patient with decubitus ulcer in whom *M. morganii* was isolated also from blood. Of note, in 9 out of 13 patients (69%) with skin and soft tissue infections more than one organism was isolated from the clinical specimens obtained, and thus the infections were considered polymicrobial (Table 2). Apart from the skin and soft tissue infections, *M. morganii* caused pyelonephritis in five patients, three of whom were children younger than 4 years of age, and the remaining two were elderly adults who had urinary catheters. In three out of these five patients the infections were considered polymicrobial, since *Klebsiella pneumoniae*, *Enterococcus faecalis*, and *Pseudomonas aeruginosa*, respectively, were isolated together with *M. morganii* from urine specimens. Only one patient in this series suffered from pneumonia due to *M. morganii* and *E. faecalis*, diagnosed while hospitalized in the ICU due to septic shock. *M. morganii* was isolated in a blood culture taken from this patient. Three more patients were found to have female genital tract infections. In one of them, the infection was considered polymicrobial, since *E. coli* was also isolated from the genital secretions. Another patient was diagnosed to have gangrenous appen-

Table 2
**Clinical and microbiological characteristics of the studied patients.**

| Patient number | Sex/age | Medical history | Cause of admission | Specimen from which *Morganella* was isolated | Other pathogens isolated | Antibiotic treatment administered | Duration of antibiotic therapy in days (empiric + etiologic therapy) | Outcome of infection |
|---|---|---|---|---|---|---|---|---|
| 1 | F/65 | Obesity | Skin ulcers in inguinal region, cellulitis | Pus culture | None | Amoxicillin/clavulanic acid changed to piperacillin/tazobactam | 14 | Cure |
| 2 | F/79 | Diabetes mellitus type 2, hypertension, coronary heart disease | Septic shock, skin ulcer in the frontal tibial region, cellulitis | Pus culture | None | Piperacillin/tazobactam | 3 | Septic shock – death |
| 3 | F/72 | Diabetes mellitus type 2, osteoporosis | Rash, cellulitis | Pus culture from skin infection | None | Amoxicillin/clavulanic acid changed to ciprofloxacin | 12 | Cure |
| 4 | M/77 | Multiple myeloma, chronic renal failure | Skin ulcer, cellulitis | Pus culture | *Staphylococcus aureus, Escherichia coli, Candida albicans* | Ticarcillin/clavulanic acid | 14 | Cure |
| 5 | M/73 | Chronic osteomyelitis | Fever, skin ulcer, cellulitis | Pus culture | None | Piperacillin/tazobactam | 16 | Cure |
| 6 | M/0.3 | Congenital megacolon | Surgery for closure of colostomy, cellulitis of the area around the colostomy | Pus culture from skin in the vicinity of colostomy | *Enterococcus faecalis* | Cefotaxime and metronidazole | 13 | Cure |
| 7 | F/68 | Osteoporosis, hypertension, bullous pemphigoid | Uterine infection abdominal wall cellulitis | Culture of uteral ulcer | *Enterobacter cloacae, Citrobacter koseri* | Cefuroxime | 14 | Cure |
| 8 | F/82 | Diabetes mellitus type 2, anemia, Parkinson's disease, dementia | Hypoglycemia, fever, diabetic ulcer, cellulitis | Pus culture | *Staphylococcus aureus, Enterococcus faecalis* | Piperacillin/tazobactam and teicoplanin | 14 | Cure |
| 9 | F/74 | Diabetes mellitus type 2, hypertension, diabetic ulcer with critical ischemia of the limb | Diabetic ulcer – gangrene, cellulitis, required femoral-popliteal bypass operation, ICU hospitalization | Pus culture | *Streptococcus agalacticae* | Piperacillin/tazobactam | 36 | Cure |
| 10 | M/82 | Head and neck cancer, chronic obstructive pulmonary disease, atherosclerosis | Gangrene/admission for amputation, cellulitis | Pus culture | *Serratia marcescens, Klebsiella pneumoniae, Enterococcus faecalis* | Ciprofloxacin and vancomycin | 14 | Cure |

*(continued next page)*

Table 2 (Continued)

| Patient number | Sex/age | Medical history | Cause of admission | Specimen from which *Morganella* was isolated | Other pathogens isolated | Antibiotic treatment administered | Duration of antibiotic therapy in days (empiric + etiologic therapy) | Outcome of infection |
|---|---|---|---|---|---|---|---|---|
| 11 | F/97 | Depression, bedridden for 3 months due to femoral head fracture | Decubitus ulcer, cellulitis | Pus culture | *Citrobacter freundii, Candida albicans* | Ciprofloxacin | 14 | Cure |
| 12 | F/85 | Hypertension, cerebrovascular disease, bedridden for 10 months, hypothyroidism | Fever, decubitus ulcer, cellulitis | Pus culture | *Escherichia coli* | Amoxicillin/clavulanic acid changed to ceftriaxone and clindamycin | 16 | Septic shock – death |
| 13 | M/52 | Hypertension, cerebral hemorrhage, neurosurgical procedure, ICU hospitalization | Fever in ICU, decubitus ulcer, cellulitis | Pus and blood culture | *Pseudomonas aeruginosa, Enterococcus faecalis* | Imipenem | 22 | Cure |
| 14 | M/78 | Hypertension, prostatic hyperplasia | Fever | Urine culture | None | Ciprofloxacin | 14 | Cure |
| 15 | F/67 | Hypertension, history of cerebral hemorrhage | Fever, pyelonephritis | Urine culture | *Klebsiella pneumoniae* | Amoxicillin/clavulanic acid | 14 | Cure |
| 16 | M/0.3 | Aortic valve stenosis | Fever, pyelonephritis | Urine culture | None | Amoxicillin/clavulanic acid | 14 | Cure |
| 17 | F/1 year | Ureterocele | Fever, pyelonephritis | Urine culture | *Pseudomonas aeruginosa* | Cefuroxime, then added ciprofloxacin | 14 | Cure |
| 18 | M/1 year | – | Fever, pyelonephritis | Urine culture | *Enterococcus faecalis* | Ceftriaxone | 14 | Cure |
| 19 | F/54 | Diabetes mellitus type 2, hypertension, hypothyroidism, uteral fibromyomas | Fever, vaginitis | Vaginal culture | *Escherichia coli* | Ciprofloxacin | 12 | Cure |
| 20 | F/78 | Hypertension | Fever | Vaginal culture | None | Ciprofloxacin | 12 | Cure |
| 21 | F/65 | Diabetes mellitus type 2, hypertension, chronic renal failure, history of ischemic brain stroke | Fever, vaginitis, tibial rash | Vaginal culture | None | Ciprofloxacin | 10 | Cure |
| 22 | M/28 | – | Pneumonia, septic shock, ICU hospitalization | Blood culture (CVC) | *Enterococcus faecalis* | Piperacillin/tazobactam, then added teicoplanin and ciprofloxacin | 16 | Cure |
| 23 | M/33 | Nephrolithiasis, peptic ulcer | Appendicitis | Culture of peritoneal fluid | None | Ceftriaxone, metronidazole, and amoxicillin | 12 | Cure |
| 24 | M/69 | Hypertension | Fever, acute pharyngitis, erysipelas of the right tibia | Throat culture | None | Clindamycin, then added ceftriaxone | 10 | Cure |

dicitis; cultures from specimens of peritoneal fluid as well as the surgical specimen grew only *M. morganii*. Finally, *M. morganii* was the only microbe isolated from a throat culture of a patient with exudative tonsillitis.

### Susceptibility of the Isolates-Empirical Treatment

Results of the susceptibility testing of *M. morganii* isolates are shown in Table 3. No *M. morganii* isolate was resistant to imipenem, whereas 1/24 (4%) was resistant to amikacin, 1/17 (6%) to netilmicin, 2/24 (8%) to ciprofloxacin, ceftazidime, ceftriaxone and cefepime, 2/23 (9%) to aztreonam and ceftazidime, 3/24 (13%) to trimethoprim/sulfamethoxazole and ticarcillin, 16/23 (70%) to cefuroxime and 23/24 (96%) to amoxicillin/clavulanic acid (Table 3). The empirical antibiotic treatment prior to the isolation of *M. morganii* was considered to be inappropriate in eight patients (33%), based on the *in vitro* susceptibility that became available later. In these patients, appropriate antibiotic changes were performed, with the exception of two cases of urinary tract infections that responded well to amoxicillin/clavulanic acid monotherapy despite *in vitro* resistance of *M. morganii* to this agent (cases 15 and 16 in Table 2).

### Definitive Antibiotic Treatment

The prescribed antibiotic treatment varied and in some cases combinations of antibiotics were used, mainly because many infections were polymicrobial (Table 2). Six patients received ciprofloxacin, four piperacillin/tazobactam, two amoxicillin/clavulanic acid, one ticarcillin/clavulanic acid, one ceftriaxone, one imipenem, and one cefuroxime monotherapy, whereas the remaining eight received antibiotic combinations.

### Outcomes

Response to antibiotic treatment was good in 22 patients (92%), since they were cured from the infection and discharged home. However, some of the patients developed infection-related complications that necessitated prolonged treatment. More specifically, the patient with pneumonia was transferred to the ICU in septic shock. In addition, one patient with soft tissue infection and underlying chronic

Table 3
**Results of the in vitro susceptibility testing of *M. morganii* isolates against various antibiotics (S = susceptible, R = resistant).**

| Patient number | Trimethoprim/sulfamethoxazole | Ciprofloxacin | Amoxicillin/clavulanic acid | Ticarcillin[a] | Cefuroxime | Ceftriaxone[b] | Imipenem | Aztreonam | Amikacin | Netilmicin | Colistin | Nitrofurantoin |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | S | S | R | S | R | S | S | S | S | – | R | R |
| 2 | S | S | R | S | R | S | S | S | S | – | R | R |
| 3 | S | S | R | S | R | S | S | S | S | S | – | R |
| 4 | S | S | R | S | R | S | S | S | S | S | – | – |
| 5 | R | S | R | S | S | S | S | S | S | S | – | R |
| 6 | S | S | R | S | R | S | S | S | S | S | R | R |
| 7 | S | S | R | S | S | S | S | S | S | R | – | R |
| 8 | R | R | R | S | R | S | S | S | S | | R | R |
| 9 | S | S | R | S | R | S | S | S | S | S | R | R |
| 10 | S | S | R | S | R | S | S | S | S | S | – | R |
| 11 | S | S | R | S | S | S | S | S | R | S | R | R |
| 12 | S | S | R | S | R | S | S | S | S | S | R | R |
| 13 | R | R | R | R | R | R | S | R | S | S | R | S |
| 14 | S | S | R | S | S | S | S | S | S | S | R | – |
| 15 | S | S | R | S | R | S | S | S | S | S | R | S |
| 16 | S | S | R | S | R | S | S | – | S | – | R | R |
| 17 | S | S | R | S | R | S | S | S | S | – | – | – |
| 18 | S | S | R | S | – | S | S | S | S | – | – | R |
| 19 | S | S | R | S | S | S | S | S | S | S | R | R |
| 20 | S | S | R | R | S | S | S | S | S | S | R | R |
| 21 | S | S | R | S | S | S | S | S | S | S | R | R |
| 22 | S | S | R | R | R | R | S | R | S | – | R | R |
| 23 | S | S | R | S | R | S | S | S | S | S | R | R |
| 24 | S | S | S | S | R | S | S | S | S | S | R | R |

[a] Susceptibility results were identical for piperacillin; [b] susceptibility results were identical for ceftazidime (except for patient number 9 in whom ceftazidime was not tested) and cefepime

osteomyelitis developed diffuse intravascular coagulation during antibiotic therapy (case number 5, Table 2). A third patient with soft tissue-diabetic foot infection had to be operated due to concurrent limb ischemia. He underwent a femoral-popliteal bypass, and while the infection was still active, he developed acute renal failure necessitating ICU admission. Finally, a patient with cellulitis, who was infected while hospitalized in the ICU due to cerebral haemorrhage, developed septic shock (case number 13, Table 2). In all four patients these complications were treated successfully and their infections were cured.

In two debilitated patients the infections failed to respond to therapy. The first patient was a 79-year-old female with pretibial cellulitis developed on the area of a non-traumatic skin lesion (case number 2, Table 2). The patient had history of diabetes and coronary artery disease that was treated conservatively. She was admitted in septic shock and *M. morganii* was isolated from blood cultures. Despite appropriate therapy with piperacillin/tazobactam, an agent in which the isolated pathogen was sensitive *in vitro*, the patient died within 48 h. The second patient was an 85-year-old female, who was hemiparetic and bedridden after a stroke that had occurred 10 months earlier (case number 12, Table 2). The patient suffered from infection of a decubitus ulcer in the sacrococcygeal area, which was clinically manifested and left untreated for a week prior to hospital admission. Initial empiric antibiotic therapy was amoxicillin/clavulanic acid for 4 days. After the isolation of *M. morganii* resistant to the empiric therapy (together with *E. coli*) from the ulcer, treatment was changed to ceftriaxone and clindamycin. However, the infection was unresponsive to treatment and the patient steadily deteriorated and died 16 days after hospital admission.

## Discussion

The main finding of our study is that a considerable proportion of our patients with M. morganii isolated from clinical specimens had skin and soft tissue infections. In addition, about 50% of the M. morganii infections were polymicrobial. Our results regarding the sites and severity of infections caused by M. morganii are generally in accordance with the results from previous studies. In a cluster epidemic of M. morganii infections that occurred over a 3-month period, it was reported that 61% of these infections were postoperative wound infections and the rest were urinary tract infections [7]. Similarly, 5 out of 71 patients in a cardiac surgery unit developed septicemia due to M. morganii. Two of the patients with Morganella septicemia in that series died due to the infection [18]. In another series of 19 episodes of M. morganii bacteremia over a 5.5-year period, 11 occurred in surgical patients and 7 of these were postoperative wound infection [6]. In that series the investigators concluded that M. morganii bacteremia may be an indicator of an environment conducive for an outbreak of nosocomial infection. It is noteworthy that, although 54% of our patients also suffered from skin and soft tissue infections due to M. morganii, only in one (4%) of all patients infection was associated with a previous surgical procedure (patient number 6, Table 2), although even in that case it cannot be characterized as a typical surgical wound infection.

In the largest reported series of *M. morganii* bacteremias, the infection occurred more frequently in the hospital, and in patients with biliary and hepatic diseases, especially those requiring biliary drainage, while the infection-related mortality was 15% [3]. In our series mortality was 8% while the infection was not related to hepatic abnormalities.

An interesting finding of our study is that the majority of *M. morganii* infections were polymicrobial (58%). It is of note that *M. morganii* has been considered a relatively innocent isolate and its role in the pathogenesis of polymicrobial infections remains unclear. No comparisons exist between infections caused by specific pathogens alone and polymicrobial infections of the same pathogens in conjunction with *M. morganii*. The site of infection plays a major role regarding the frequency of polymicrobial infections. For example, *Kim* et al. [3] found that 27% of bacteremias caused by Proteae were polymicrobial, although they did not report any specific data for *M. morganii*. In addition, *Williams* et al. [18] reported that two out of three postoperative soft tissue infections caused by *M. morganii* were polymicrobial, and *Tucci* and *Isenberg* [7] reported a polymicrobial infection in 1 out of 11 patients during an epidemic of various forms of *M. morganii* infections. Similarly, in our series 9 of 13 skin and soft tissue infections were polymicrobial, whereas the same phenomenon was less common (5/11) among the rest of the infections.

The antimicrobial susceptibility of our *M. morganii* isolates did not differ substantially from those previously reported [3]. The microbe is known to have intrinsic resistance to oxacillin, ampicillin, amoxicillin, most of the first and second generation cephalosporins, macrolides, lincosamides, glycopeptides, fosfomycin, fusidic acid and colistin [7, 19]. It is naturally sensitive to aztreonam, aminoglycosides, antipseudomonal penicillins, third and fourth generation cephalosporins, carbapenems, quinolones, trimethoprim/sulfamethoxazole and chloramphenicol [19]. M. *morganii* develops resistance to multiple classes of antibiotics with various mechanisms, including production of inducible extended spectrum beta-lactamases [19–21].

Our study has some limitations. First of all, we were unable to perform analysis of the risk factors leading to poor outcomes after *M. morganii* infection due to the very small number of patients with poor outcome. Moreover, the study carries the inherent limitations of any retrospective analysis. Finally, due to its retrospective design, this study cannot define the exact role of *M. morganii* in the cases of isolation of multiple potential pathogens. A clear distinction between the actual pathogens and colonizers could not be made. *M. morganii* may not have been necessarily a pathogen, especially in skin and soft tissue

infections such as decubiti ulcers or diabetic foot ulcers. In these infections there are inherent uncertainties about the pathogenic role of an organism isolated from fluid obtained from the affected area, particularly when several species are cultured from the same source.

## Conclusion

The present series indicates that *M. morganii* is a microbe responsible for skin, soft tissue, and urogenital tract infections. It has good overall prognosis, although fatal outcome may occur in debilitated patients. Moreover, *M. morganii* is commonly isolated in polymicrobial infections, especially when affecting the skin and soft tissues.

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