Serratia

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Background: Serratia are opportunistic gram-negative bacteria classified in the tribe Klebsielleae and the large family Enterobacteriaceae.
*Serratia marcescens* is the only pathogenic species of *Serratia*, except for rare reports of disease resulting from infection with *Serratia plymuthica, Serratia liquefaciens, Serratia rubidaea, and Serratia odorifera*.

Some strains of *S marcescens* are capable of producing a pigment called prodigiosin, which ranges in color from dark red to pale pink, depending on the age of the colonies. *S marcescens* has a predilection for growth on starchy foodstuffs, where the pigmented colonies are easily mistaken for drops of blood.

In 1819, Bartolomeo Bizio, a pharmacist from Padua, Italy, discovered and named *S marcescens* when he identified the bacterium as the cause of a miraculous bloody discoloration in a cornmeal mush called polenta. Bizio named *Serratia* in honor of an Italian physicist named Serrati, who invented the steamboat, and Bizio chose *marcescens* from the Latin word for decaying because the bloody pigment was found to deteriorate quickly.

Since 1906, physicians have used *S marcescens* as a biological marker for studying the transmission of microorganisms, because until the 1950s, this bacterium generally was considered a harmless saprophyte. Only since the 1960s has *S marcescens* been recognized as an opportunistic human pathogen.

**Pathophysiology:** In the hospital, *Serratia* tends to colonize the respiratory and urinary tracts of adults, rather than the gastrointestinal tract.

*Serratia* causes about 2% of nosocomial infections of the bloodstream, lower respiratory tract, urinary tract, surgical wounds, and skin and soft tissues of adult patients. Outbreaks of *S marcescens* meningitis, wound infections, and arthritis have occurred in pediatric wards.

*Serratia* has caused endocarditis and osteomyelitis in people addicted to heroin.

Cases of arthritis resulting from *Serratia* infection are reported in outpatients who have received intraarticular injections.

**Frequency:**

- **In the US:** *Serratia* species cause 1.4% of nosocomial bloodstream infections.
- **Internationally**: The prevalence of *Serratia* in nosocomial infections is diminishing, but these bacteria still are able to cause hospital outbreaks, especially in intensive care units.

**Mortality/Morbidity:**

- Crude mortality for nosocomial bloodstream infection with *Serratia* is 26%.
- Mortality is very high in patients with meningitis and endocarditis caused by *Serratia* infection.

**Age**: Outbreaks occur in neonates and infants. In adults, most cases are isolated, but occasional nosocomial outbreaks occur.

**History:**

- Patients with *Serratia* sepsis may present with fever, chills, shock, and respiratory distress.
- Urinary tract infection
  - Approximately 30-50% of patients are asymptomatic. When symptoms are present, patients may have fever, frequent urination, dysuria, pyuria, or pain upon urination.
  - In 90% of cases, patients have a history of recent surgery or instrumentation of the urinary tract.
  - Important risk factors include diabetes mellitus, urinary tract obstruction, and renal failure.
- Respiratory tract infection
  - These patients usually are colonized with *Serratia* after instrumentation (eg, ventilation, bronchoscopy), especially those patients with chronic obstructive pulmonary disease.
Patients may have pneumonia, but this development is rare. If pneumonia develops, patients may have fever, chills, productive cough (sometimes with pseudohemoptysis), hypotension, dyspnea, or chest pain.

- Meningitis or cerebral abscess
  - Meningitis or cerebral abscesses resulting from *Serratia* infection may develop in premature children and neonates with prior sepsis or in patients who have experienced head trauma, neurosurgery, or lumbar puncture.
  - The symptoms are those of gram-negative meningitis (eg, headache, fever, vomiting, stupor, coma).

- Patients with intraabdominal infections resulting from *Serratia* infection may present with biliary drainage, hepatic abscess, pancreatic abscess, and peritoneal exudate.

- Patients with *Serratia* infection may have osteomyelitis or arthritis, which can be hematogenous in people addicted to intravenous drugs or may be caused exogenously by surgery, open trauma, or intraarticular injection.

- Patients with endocarditis resulting from *Serratia* infection may present with fever, petechiae, and, occasionally, embolic complications (eg, stroke, arterial emboli).

- Patients with *Serratia*-related ocular infections will have keratitis or endophthalmitis.

- Patients with soft tissue infections resulting from *Serratia* may have surgical scars, cellulitis, phlebitis, or skin infections.

- Patients with *Serratia*-related otitis media have earaches, hearing loss, and ear discharge.

- Bacterial parotitis associated with *Serratia* infection is very rare.

**Physical:**
• Pink hypopyon in the absence of hyphema may suggest *S marcescens* endophthalmitis.

**Causes:**

- **Sepsis**
  - Risk factors include hospitalization, with intravenous, intraperitoneal, or urinary catheters, or prior instrumentation of the respiratory tract.
  - Other factors include cardiac valve replacement and the use of contaminated intravenous infusions or transfusions.

- **Urinary tract infection**
  - In 90% of cases, patients have a history of recent surgery or instrumentation of the urinary tract.
  - Important risk factors are diabetes mellitus, urinary tract obstruction, and renal failure.

- **Respiratory tract colonization appears after instrumentation (eg, ventilation, bronchoscopy), especially in patients with chronic obstructive pulmonary disease.**

- **Meningitis or cerebral abscess may result from *Serratia* infection in premature children and neonates with prior sepsis or in patients who have experienced head trauma, neurosurgery, or lumbar puncture.**

- **Osteomyelitis or arthritis can be hematogenous in people addicted to intravenous drugs or can be caused exogenously by surgery, open trauma, or intraarticular injection.**

- **Ocular infections**
  - *Serratia* infection frequently causes nonulcerating bacterial keratitis, which is associated with soft and rigid contact lens wear.
  - Endophthalmitis usually occurs after eye
surgery.

- Bacterial parotitis can appear in individuals with prior sialectasia.

**DIFFERENTIALS**

Enterobacter Infections
Escherichia Coli Infections
Klebsiella Infections
Meningitis
Pneumonia, Bacterial
Proteus Infections
Providencia Infections
Sepsis, Bacterial

**WORKUP**

Lab Studies:

- Complete blood count with differential
  - Leukocytosis with neutrophilia
  - Leukopenia (rare)
  - Presence of more than 10% immature neutrophils (ie, bands)
  - Possible anemia
- Serum biochemistry for glucose, urea, and creatinine
- Bacterial cultures and antibiograms
  - Blood
  - Urine
  - Samples of abscesses or effusions
  - Catheters suspected of being contaminated
- Liquid soaps or disinfectants suspected of being contaminated
- IV fluids suspected of being contaminated

- Cerebrospinal fluid
  - Polynuclear pleocytosis
  - High protein
  - Low glucose

**Imaging Studies:**

- Perform chest radiography if pneumonia is suspected or in the presence of respiratory distress.

- Abdominal ultrasonography or computed tomography (CT) scans will rule out obstructive hydronephrosis or intraabdominal abscesses (eg, hepatic, pancreatic, other).

- Transthoracic or transesophageal echocardiography may reveal valvular vegetations and valvular or paravalvular regurgitation.

- Perform a spinal CT scan or MRI if spondylitis is suspected.

**Procedures:**

- Lumbar puncture should be performed in all patients with suspected meningitis. If signs of increased intracranial pressure are present (focal neurologic abnormalities, seizure, or altered mental status), obtain a head CT scan prior to the puncture to exclude cerebral abscess or mass lesion.

**Medical Care:** Antibiotic therapy is the primary treatment for most patients. Home therapy is an option for patients who are clinically stable.

**Surgical Care:** Purulent collections (abscesses) may require drainage.

**Consultations:**

- Consult a cardiac surgeon if considering valve replacement in patients with infective endocarditis.

- In a possible nosocomial outbreak, strain typing may assist the
S marcescens is naturally resistant to ampicillin, macrolides, and first-generation cephalosporins. Therapy for Serratia infections would include an antipseudomonal beta-lactam plus an aminoglycoside. Most strains are susceptible to amikacin, but reports indicate increasing resistance to gentamicin and tobramycin. Quinolones also are highly active against most strains. Definitive therapy should be based on the results of susceptibility testing because multiresistant strains are common.

Drug Category: Antibiotics -- Empiric antimicrobial therapy should cover all likely pathogens in the context of the clinical setting.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Adult Dose</td>
<td>15 mg/kg/d IV q24h or in a single dose; use adjusted dosing weight, IBW + 0.4 (ABW-IBW), for calculation if actual body weight exceeds IBW by more than 30%</td>
</tr>
<tr>
<td>Pediatric Dose</td>
<td>Administer as in adults</td>
</tr>
<tr>
<td>Contraindications</td>
<td>Documented hypersensitivity</td>
</tr>
<tr>
<td>Interactions</td>
<td>Coadministration with other aminoglycosides, penicillins, cephalosporins, and amphotericin B increases nephrotoxicity; enhances effects of neuromuscular blocking agents; causes respiratory depression; irreversible hearing loss may occur with coadministration of</td>
</tr>
<tr>
<td>Drug Name</td>
<td>Aztreonam (Azactam) -- Usually synergistic with amikacin. Use both in combination, pending results of susceptibility testing. A monobactam that inhibits cell wall synthesis during bacterial growth. Active against gram-negative bacilli.</td>
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<tr>
<td>Adult Dose</td>
<td>1-2 g IV q6-8h</td>
</tr>
<tr>
<td>Pediatric Dose</td>
<td>90-120 mg/kg/d IV/IM divided q6-8h</td>
</tr>
<tr>
<td>Contraindications</td>
<td>Documented hypersensitivity</td>
</tr>
<tr>
<td>Interactions</td>
<td>Tetracyclines may reduce effects</td>
</tr>
<tr>
<td>Pregnancy</td>
<td>B - Usually safe but benefits must outweigh the risks.</td>
</tr>
<tr>
<td>Precautions</td>
<td>Adjust dose in renal insufficiency</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Drug Name</th>
<th>Meropenem (Merrem IV) -- Preferred therapy for <em>Serratia</em> meningitis. Bactericidal broad-spectrum carbapenem antibiotic that inhibits cell wall synthesis. Effective against most gram-positive and gram-negative bacteria. Has increased activity against gram-negative bacteria and slightly decreased activity against staphylococci and streptococci compared to imipenem.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult Dose</td>
<td>1000 mg IV q8h</td>
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<tr>
<td>Pediatric Dose</td>
<td>40 mg/kg IV q8h</td>
</tr>
<tr>
<td>Contraindications</td>
<td>Documented hypersensitivity</td>
</tr>
<tr>
<td>Interactions</td>
<td>Probenecid may inhibit renal excretion of meropenem, increasing meropenem levels</td>
</tr>
<tr>
<td>Pregnancy</td>
<td>B - Usually safe but benefits must outweigh the risks.</td>
</tr>
<tr>
<td>Precautions</td>
<td>Adjust dosage in patients with renal insufficiency; pseudomembranous</td>
</tr>
<tr>
<td>Drug Name</td>
<td>Imipenem-cilastatin (Primaxin) -- Comparable in activity to meropenem.</td>
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</tr>
<tr>
<td>Adult Dose</td>
<td>Base initial dose on severity of infection and administer in equally divided doses; dose may range from 500-1000 mg IV q6h; not to exceed 4 g/d</td>
</tr>
<tr>
<td>Pediatric Dose</td>
<td>&lt;12 years: Not established; 15-25 mg/kg/dose IV q6h suggested for &gt;3 months</td>
</tr>
<tr>
<td>Contraindications</td>
<td>Documented hypersensitivity</td>
</tr>
<tr>
<td>Interactions</td>
<td>Nephrotoxicity increased with aminoglycoside; coadministration with cyclosporine may increase CNS adverse effects of both agents; coadministration with ganciclovir may result in generalized seizures</td>
</tr>
<tr>
<td>Pregnancy</td>
<td>C - Safety for use during pregnancy has not been established.</td>
</tr>
<tr>
<td>Precautions</td>
<td>Risk of inducing seizures or cerebral toxicity with 1-g doses; adjust dose in renal insufficiency; avoid use in children &lt;12 y</td>
</tr>
<tr>
<td>Drug Name</td>
<td>Ciprofloxacin (Cipro) -- Greatest anti- \textit{P} \textit{aeruginosa} activity among the quinolones. May be particularly useful for isolates resistant to the aminoglycosides.</td>
</tr>
<tr>
<td>Adult Dose</td>
<td>400 mg IV q12h</td>
</tr>
<tr>
<td>Pediatric Dose</td>
<td>&lt;18 years: Not recommended</td>
</tr>
<tr>
<td>Contraindications</td>
<td>Documented hypersensitivity</td>
</tr>
<tr>
<td>Interactions</td>
<td>Antacids, iron salts, and zinc salts may reduce serum levels; administer antacids 2-4 h before or after taking fluoroquinolones; cimetidine may interfere with metabolism of fluoroquinolones; levofloxacin reduces</td>
</tr>
</tbody>
</table>
therapeutic effects of phenytoin; probenecid may increase levofoxacin serum concentrations; may increase toxicity of theophylline, caffeine, cyclosporine, and digoxin (monitor digoxin levels); may increase effects of anticoagulants (monitor PT)

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<tr>
<td>Precautions</td>
<td>In prolonged therapy, perform periodic evaluations of organ system functions (eg, renal, hepatic, hematopoietic); adjust dose in renal function impairment; superinfections may occur with prolonged or repeated antibiotic therapy</td>
</tr>
</tbody>
</table>

### Further Inpatient Care:

- Remove or change catheters suspected of being contaminated.

### Deterrence/Prevention:

- Reject possibly contaminated IV fluids.
- Avoid using soaps or disinfectants that may be contaminated.
- Use disposable ECG leads.
- Emphasize standard precautions. Hospital employees should wash their hands before and after contact with patients. The most frequent mechanism of transmission in nosocomial outbreaks is through soiled hands.
- IV lines should be removed as soon as possible.

### Prognosis:

- The mortality rate for severe infection (bacteremia) is 26%. For those who survive, the prognosis for complete recovery is good.
- Patients with *S marcescens* endophthalmitis have a poor prognosis for maintaining vision.
Special Concerns:

- If bacterial disease is suspected in a patient who is severely immunocompromised and infected with HIV, consider the diagnosis of *Serratia* infection.

- Risk factors for severe infections with *Serratia* include old age, previous antibiotic treatment, and chronic or debilitating diseases.

**BIBLIOGRAPHY**

• Sehdev PS, Donnenberg MS: Arcanum: The 19th-century Italian pharmacist pictured here was the first to characterize what are now known to be bacteria of the genus Serratia. Clin Infect Dis 1999 Oct; 29(4): 770, 925[Medline].
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