Melioidosis, an infectious disease caused by the bacterial species *Burkholderia pseudomallei*, is associated with severe symptoms and high death rates (1). Although considered an emerging disease, melioidosis has little formal public health recognition (2). Researchers initially documented cases in Brazil in 2003 (3). As of 2018, Ceará, a coastal state in northeastern Brazil, has the highest incidence in South America; however, sporadic cases have been reported in other states (4). Although the disease predominantly affects adults with associated risk factors (1), the growing incidence of severe melioidosis among children and adolescents in Ceará highlights the need for clinical and epidemiologic investigations.

The Study

We analyzed all cases of melioidosis in persons <18 years of age documented by the Ceará State Health Department during January 2005–May 2019. This state declared melioidosis a notifiable disease in 2005 (5), although the literature records cases from early 1989 (6). We also searched for cases in the SciELO and PubMed databases using the terms “melioidosis” AND “Brazil” OR “children” published during March 2003–May 2019. We also searched the annals of Brazilian Congresses of Pediatric Infectiology from 2003–2018. In total, we identified 16 cases in the health department database (1 case was excluded because of an alternative diagnosis) and 5 in the literature (3,6). All cases were either suspected or confirmed (Table 1) (5,7).

We investigated cases using data from patient records and, when possible, from interviews with the patients and their relatives. We analyzed data on age, sex, time of symptom onset, geographic location, occupational or recreational activity involving water or soil during the 2 weeks before symptom onset, underlying conditions, signs and symptoms, laboratory and radiographic findings, clinical evolution, treatment, and clinical outcome. We used the Fisher exact test to assess the correlation between appropriate treatment using carbapenem or ceftazidime during the intensive phase of melioidosis (8) and survival. The study protocol was previously approved by the research ethics committees of the University of Fortaleza (Fortaleza, Brazil) (approval no. 3,094,492) and Albert Sabin Children’s Hospital (Fortaleza) (approval no. 3,194,070).

We identified 10 confirmed (including 5 before 2005: 4 in 2003, and 1 identified retrospectively in 1989) (3,6), and 10 suspected cases of melioidosis among children and adolescents. The 10 confirmed cases in persons <18 years of age account for 23.2% of the 43 confirmed cases of melioidosis in the state of Ceará as of May 2019. This proportion is substantially greater than the 5%–15% usually reported for children (9).

Most (9/20; 45%) patients were 10–17 years of age. The median age was 11 years for patients with confirmed cases and 9 years for those with suspected cases. For comparison, childhood melioidosis is most prevalent in children <5 years of age in Malaysia (10) and in children >10 years of age in Australia (11).

As in previous studies (2,12), most (13/20; 65%) patients in this sample were male. Illnesses occurred most frequently during the rainy season (i.e., February–May), accounting for 65% (13/20) of all cases and 70% (7/10) of confirmed cases. This trend resembles the results of a study in Australia (11) and reinforces
the association between heavy rainfalls and exposure to *B. pseudomallei*. Most (19/20; 95%) patients had environmental exposure during the 14 days before symptom onset (Table 2). Outdoor recreational behavior is common among children in Brazil, especially in the tropics. For example, when intense warm showers interrupt the extended droughts of northeastern Brazil, children often bathe and play in waterfalls, rivers, and dams. This might partially account for the high prevalence of melioidosis among children, especially older children and boys, in this region.

The most frequent clinical manifestations were sepsis (18/20; 90%), pneumonia (18/20; 90%), and septic shock (17/20; 85%) (Table 2). Among confirmed cases, 90% (9/10) of patients had sepsis and pneumonia and 80% (8/10) had septic shock. Among suspected cases, 90% (9/10) of patients had pneumonia, sepsis, and septic shock. Studies in Malaysia have reported similar figures (10); however, the main manifestations among children are skin lesions in Australia and infectious parotitis in Cambodia (13,14). Although the methods used by these studies differ, they suggest that children in Ceará might have more severe clinical manifestations of melioidosis.

Two patients had meningitis, accounting for 20% (2/10) of confirmed cases and 10% (2/20) of total cases; however, a study in Australia observed neumeliodosis in 3% of pediatric patients (15). These findings might indicate either a greater proportion of neurologic involvement or substantial underreporting of less severe manifestations among children with melioidosis in Brazil.

In total, 45% (9/20) of patients died: 60% (6/10) of patients with confirmed cases and 30% (3/10) of those with suspected cases. Childhood melioidosis is associated with a death rate of 35% globally (9), although in Australia the rate is reported to be 7% (13). In Cambodia, 16.4% of patients die, including up to 71% of patients with bacteremia (14). Our findings, which include high prevalence of sepsis and septic shock, 2 cases of severe neurologic involvement, and high death rates, warrant further investigation.

We found that appropriate, timely treatment for melioidosis (8) was significantly associated with survival among 20 patients (p<0.01). Thus, physicians should consider empirical treatment for suspected melioidosis in patients in areas to which the disease is endemic, especially if the initial treatment was unsuccessful. We did not find a significant association between proper treatment and survival among patients with confirmed (p = 0.08) and suspected cases (p = 0.07) of melioidosis, possibly because of small sample size.

**Conclusion**

We describe a high prevalence, death rate, and severity of childhood melioidosis in Brazil. The high death rate and clinical severity might be partially explained by underreporting of mild cases, but the frequent environmental exposures of children in this region warrant further research. These findings emphasize the need for melioidosis awareness among healthcare providers and laboratory professionals. Physicians should consider melioidosis as a differential diagnosis; improved awareness might reduce underreporting and optimize the quality of epidemiologic data. Physicians also should consider empirical treatment in patients who have clinical manifestations compatible with the disease and whose prognosis is compromised by clinical severity.

**About the Author**

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### Table 2. Clinical and epidemiologic characteristics of children with melioidosis, Brazil, 1989–2019*

| Pt | Age, y/sex | City                    | Rainy season† | Potential exposures‡ | Pneumonia | Sepsis | Septic shock | Diagnostic results | Timely treatment# | Outcome (time to death) |
|----|------------|-------------------------|---------------|----------------------|-----------|--------|--------------|-------------------|-------------------|------------------------|
| 1  | 0.25/M     | Fortaleza               | No            | Mother lived in rural area during pregnancy§ | No        | No     | No           | 
|    |            |                         |               |                      |           |        |              | Pseudomonas pseudomallei in cerebrospinal fluid | Yes               | Survived               |
| 2  | 15/M       | Tejuçuoca               | Yes           | Swim in river        | Yes       | Yes    | Yes          | No test, met clinical epidemiologic criteria | No                | Death (40 h)           |
| 3  | 14/F       | Tejuçuoca               | Yes           | Swim in river        | Yes       | Yes    | Yes          | Burkhholderia pseudomallei | No                | Death (90 h)           |
| 4  | 10/M       | Tejuçuoca               | Yes           | Swim in river        | Yes       | Yes    | Yes          | B. pseudomallei | No                | Death (6 d)            |
| 5  | 12/F       | Tejuçuoca               | Yes           | Swim in river        | Yes       | Yes    | Yes          | B. pseudomallei | Yes               | Survived               |
| 6  | 17/M       | Fortaleza               | Yes           | Bathed in river/waterfall | Yes       | Yes    | Yes          | B. pseudomallei | Yes               | Death (10 d)           |
| 7  | 3/M        | São João do Jaguaribe   | Yes           | Swim in river        | Yes       | Yes    | Yes          | B. pseudomallei | Yes               | Death (28 d)           |
| 8  | 13/F       | Itu                     | No            | Bathed in waterfalls | Yes       | Yes    | Yes          | B. pseudomallei | No                | Death (10 d)           |
| 9  | 3/F        | Granja                  | Yes           | Swim in river, bathed in waterfalls | Yes       | Yes    | No           | No test, met clinical epidemiologic criteria | Yes               | Survived               |
| 10 | 6/M        | Fortaleza               | No            | Swim in river, bathed in waterfalls | Yes       | Yes    | Yes          | B. pseudomallei in bronchoalveolar lavage, met clinical epidemiologic criteria | Yes               | Survived               |
| 11 | 6/M        | Limoeiro do Norte       | No            | Swim in river, bathed in waterfalls, fished, drank contaminated water | No        | No     | No           | Negative          | Yes               | Survived               |
| 12 | 9/F        | Pacatuba                | No            | Swim in river, bathed in waterfalls | Yes       | Yes    | Yes          | Negative          | Yes               | Death (5 d)            |
| 13 | 13/M       | Guaiúba                 | No            | Swim in river, bathed in waterfalls, fished | Yes       | Yes    | Yes          | B. cepacea in oropharyngeal swab sample | Yes               | Survived               |
| 14 | 1/F        | Fortaleza               | No            | Swim in untreated pool | Yes       | Yes    | Yes          | Negative          | Yes               | Survived               |
| 15 | 6/M        | Canindé                 | Yes           | Swim in river/dams, fished | Yes       | Yes    | Yes          | Negative          | No                | Death (8 d)            |
| 16 | 3/M        | Fortaleza               | Yes           | Swim in lake/ played with soil | Yes       | Yes    | Yes          | Negative          | Yes               | Survived               |
| 17 | 9/F        | Canindé                 | Yes           | Swim in river/dams, fished | Yes       | Yes    | Yes          | Negative          | Yes               | Survived               |
| 18 | 11/M       | Orós                    | Yes           | Swim in river, fished | Yes       | Yes    | Yes          | Negative          | Yes               | Survived               |
| 19 | 14/M       | Trairi                  | Yes           | Swim in river/dams, fished | Yes       | Yes    | Yes          | No                | Death (4 d)         |                       |
| 20 | 9/M        | Trairi                  | Yes           | Swim in river/dams, fished | Yes       | Yes    | Yes          | Negative          | Yes               | Survived               |

*Cases 1–10 were confirmed according to diagnostic criteria (5,7); cases 11–20 were suspected. Pt, patient.
†Rainy season in Ceará, Brazil is February–May.
‡During 14 d before symptom onset.
§From symptom onset.
¶From symptom onset.
§‡Potential vertical transmission.
#As defined in (8).
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