Article type : Tropical Medicine Rounds

Title: Cutaneous melioidosis: a review of the literature

Running head: Cutaneous melioidosis

Manuscript word count: 2947

Manuscript table count: 3. **Supplementary tables:** 3.

Article type: Tropical Medicine Rounds

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Funding and conflicts of interest:

The authors have no conflicts of interest to disclose.

The work was done without funding.

This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1111/ijd.14167

Key words: infectious diseases of the skin. Bacterial. Tropical disease.

Abstract:

Background: Melioidosis is mainly observed in South-East Asia, where *Burkholderia pseudomallei* is endemic. Cutaneous melioidosis (CM) has rarely been described and in contrast to systemic forms, there are no therapeutic recommendations to guide management.

Methods: We reviewed the literature published before January 2018, evaluating: dermatological presentation, natural history, diagnostic methods, and treatment options. We also distinguish between (1) primary and secondary CM in which the infection first started in the skin or came from an extra-cutaneous localization respectively and (2) chronic CM when duration exceeded two months. The recommended treatment for systemic forms included ceftazidime or meropenem, followed by oral maintenance therapy with cotrimoxazole or amoxicillin - clavulanic acid.

Results: Forty-three cases were published in 38 articles. Twenty-nine patients (67.4%) were travelers, including 13 (44.8%) returning from Thailand. Thirty-eight patients (88%) had primary CM, including nine (29.9%) with chronic infection. All cases of secondary CM first presented with acute infection. The median incubation time was three weeks. The most common presentation was cutaneous abscesses (58%). The recommended treatment was administrated in 62.7% cases while 37.2% for maintenance therapy. Sixteen patients (37.2%) underwent surgery. Death was reported in less than 5%.

Conclusion: CM should be considered in travelers returning from or residents of endemic countries, particularly Thailand presenting with cutaneous abscesses, cellulitis or ulcerations. Surgery may be necessary in a substantial proportion of patients and follow-up of at least one year is essential. Therapeutic recommendations need to be established.

Introduction:

Melioidosis is caused by *Burkholderia pseudomallei*, a Gram-negative, motile, aerobic bacillus that is found in soil and water. Infection occurs following inhalation or

inoculation of through skin following contact with contaminated soil or water. Melioidosis is known to be endemic in 48 tropical countries in South-East Asia, Middle East, Africa, Latin America, Caribbean and Pacific Islands. However 34 other countries are probably affected, including the far north of Australia (1).

Melioidosis has a wide spectrum of clinical presentations ranging from mild subclinical infection to septicemia, pneumonia and meningoencephalitis associated with a high mortality. The clinical presentation can follow an acute course with disseminated infection although chronic infection is not infrequent. Cutaneous melioidosis (CM) accounts for approximately 10 to 20% of infections. In contrast to systemic infection, there are no therapeutic recommendations for the management of CM.

In two large cohort studies from Australia, CM accounted for 58 cases (12%), and 42 cases (16.6%) respectively (2,3). In the first report, 42 cases of CM were identified out of a total of 252 individuals with melioidosis. Of the cases with CM, 32 were diagnosed with skin abscesses, and 10 with soft tissue abscesses while primary and secondary forms CM were not distinguished (3). In the larger series 58 cases of CM were identified in 486 individuals with melioidosis. In this study, all the patients presented with primary infection, and 22 (38%) had a chronic form without precise description (2).

For non-endemic countries, two reviews identified 72 and 82 imported cases of melioidosis in travelers, including nine (15%) and 23 (28%) patients with CM, respectively (4,5). The increasing number of travelers returning from endemic countries especially from Thailand provides an explanation as to why imported cases of CM are now more frequently diagnosed in Western countries (6).

The aim of this review is to evaluate the dermatological presentation, natural history, diagnosis, and discuss the treatment options for CM.

Material and methods:

We reviewed the medical literature from 1970 to January 2018 with Pubmed, indexed for MEDLINE using the following combination of MeSH terms: (Melioidosis OR *Burkholderia pseudomallei* OR Cutaneous Melioidosis). Case reports of CM, series, and reviews with full texts or abstracts available in English, French, German, Dutch and Japanese language were included. Several cases were added by cross-referencing, using references cited in the case reports and reviews. Cases of systemic melioidosis were excluded except when they were associated with secondary CM. For the purpose of this

review only adult cases were selected in order to have a homogeneous population. In contrast to adults, parotid infection has been reported to occur in 25% of childhood infections in Thailand (7) and neurological disease occurs in as many as 38% of cases in Australia (8). Furthermore, in contrast to adults, the importance of host risk factors in children remains undetermined (9).

The following variables were evaluated: gender, age, travel status (for imported cases), country of exposure, incubation period (time from potential exposure to symptoms onset in imported cases), history (time from symptoms onset to consultation), time to diagnosis (time from first consultation to diagnosis), predisposing factors, clinical presentation (cutaneous presentation and associated signs), diagnostic techniques, initial treatment, maintenance treatment, treatment duration, duration of follow-up, and outcome (recovery, relapse or death). Chronic CM was defined by a duration of infection of over two months (2). CM was defined as primary when the cutaneous infection was the initial presentation whereas CM was defined as secondary when cutaneous infection was considered as a septic focus arising from an extracutaneous infected organ. Regarding bacterial diagnosis we distinguished cultures from cutaneous or non-cutaneous samples (including blood), and the methods used for identification (phenotypic, spectrometric, molecular and serology).

We distinguished returning travelers (seen in non-endemic countries) from residents (seen in endemic countries). We also defined if the treatment was appropriate or not with reference to the therapeutic recommendations established for systemic melioidosis: initial phase from 10 days to 4 weeks depending on the clinical form, with ceftazidime or meropenem, followed by a minimum of 12 weeks of oral maintenance therapy with cotrimoxazole or amoxicillin - clavulanic acid (10,11,12). We defined an adequate follow-up period as at least one year from treatment and resolution of infection.

Data analyses were performed using Excel (Version 14.7.0).

Results:

Thirty-eight studies (35 cases reports, 3 cases series) were published between 1970 and 2018. Overall, 43 patients were reported with CM. The epidemiological and clinical characteristics are detailed in Table 1. The diagnostic procedures and treatments are detailed in Table 2.

Of the 43 patients, 29 (67.4 %) were travelers, and 14 were residents. The mean age was 45.6 years (+/-18.15), and 72% were men. The 29 travelers had returned from four different continents with travelers crossing into more than one country. Thirty-eight trips were from Asia (88.4%), 4 from America and Caribbean (9.3%), 4 from Africa (9.3%), and one from Oceania (2.3%). Thailand was the most commonly visited country with 14 cases (48.3%) (Table 1). For resident cases the most frequent endemic country was China (35,7%).

Among the 43 patients, 22 (51.1%) were found with at least one predisposing factor, mainly diabetes (18 patients, 41.8%).

Twenty-one patients (48.8 %) had only cutaneous lesions, all primary CM, whereas the remaining 22 patients had CM associated with other sites of infection. In total, primary CM was diagnosed in 38 patients including 13 (34.2 %) having an associated bacteremia. Lung infection was the most commonly observed extra-cutaneous site, occurring in 10 patients (26.3%) (Table 2).

The cutaneous presentation was similar in travelers and residents, with abscesses in 25 (58.1%), cellulitis in 11 (25.5%) and skin ulceration in nine (20.9%) patients. Some patients presented with two clinical forms, i.e. abscess and cellulitis. Four patients (9.3%) presented with lymphadenopathy and 23 (53.4%) had fever. Among the 38 patients with primary CM, 57.8% had abscesses, 23.6% had cellulitis and 23.6% had skin ulceration whereas three had multiple cutaneous sites of infection. The more common sites of infection included legs and feet in 16 patients (43.2%), head and neck in 8 patients (21.6%), arms and hands in 7 patients (18.9%), trunk in 4 patients (10.8%) and disseminated infection in 2 patients (5.4%). For one patient, a specific site of infection was not specified. Among the 5 patients with secondary CM, 3 had abscesses (60%), one had inflammatory leg swelling (20%) and one had disseminated pustulosis (20%). All secondary CM presented with acute form.

The nine patients with chronic CM presented with skin ulceration (55.5%), abscesses (44.4%) and / or cellulitis (33.3%). Only one of patient had associated lymphadenopathy (6) and the only patient who presented with fever had multiple skin abscesses. The patients with acute CM presented with abscesses (55.8%), cellulitis (11.7%), skin ulceration (11.7%), inflammatory leg swelling (5.8%) or pustulosis (5.8%).

In the 29 travelers the median incubation time (time between return and onset of CM) was three weeks (+/- 154.8 months)(Table 2), whereas the mean incubation time was three years as the only possible exposure was traced to the second world war (62 years previously) in one patient (13).

The median and mean time duration of the disease were 15 days (+/-3.9) and 2.26 months respectively with no differences between travelers and residents. The mean time to diagnosis reported in the literature was 0.69 months (+/-0,74) overall, and 0.72 (+/-0.78), and 0.52 (+/-0.47) months in residents and travelers, respectively (Table 2).

The diagnosis relied exclusively on culture in 20 patients (46.5%) and molecular diagnostics in 12 (27.9). All diagnoses were made with samples from the cutaneous lesions: 17 from aspirates of abscesses (53.1%), 5 from skin biopsies (15.6%) and 10 from swabs (31.2%). Blood cultures were positive in 15 (34.8 %) patients. The sample came from an extra-cutaneous site in 6 patients (13.9 %) (Table 3).

The different treatments and outcomes are summarized in Table 3. Regarding the initial intravenous therapy, 27 patients (62.7 %) were treated with recommended antibiotics (10,12,14). Inappropriate initial therapies included a duration of treatment of less than 10 days in one patient, use of inappropriate antibiotic in four patients and eight (61.5 %) with both. Maintenance therapy followed recommended antibiotics in 16 (37.2 %) patients. Among those given inappropriate maintenance therapies, three patients (13 %) were treated less than 12 weeks, eight (34.7%) were treated with an inappropriate antibiotic, and 12 (52.1 %) had both. Sixteen patients (37.2 %) underwent surgery at least once. Most of patients who underwent surgery presented with acute (81.2%) and primary (93.7%) CM and were more frequently diagnosed with skin abscesses (62.5%) (Table 3).

Among the 37 patients with adequate follow-up after treatment, thirty-four patients (70%) had fully recovered. Two patients died (4.6 %), both being travelers with primary CM complicated with secondary bacteremia. One of these travelers died following a ruptured abdominal aorta and was found to have histological evidence of acute inflammation and periaortic abscess formation (15). The second patient died of pulmonary empyema and pneumonia caused by *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* (16). One patient relapsed after 18 months (2.3 %). The mean

duration of follow up was 10.3 months (+/-9.28) but follow-up information was only specified for 18 patients.

Discussion:

Melioidosis is a severe bacterial infection causing significant morbidity and mortality. CM can have different presentations including acute cellulitis to chronic abscesses. This heterogeneity often leads to misdiagnosis (17) and delay the introduction of curative treatment.

Paradoxically there are more cases reported in travelers seen in non-endemic countries than in autochthonous populations living in endemic countries. Indeed of the 43 cases of CM, 29 (67.4 %) were in returning travelers. Thailand is the most commonly visited country by travelers diagnosed with CM, which is not surprising as this country has the highest incidence with an increasing number of melioidosis cases diagnosed in Thailand from 1997 to 2006 (18). Similarly, in a review of the literature of 72 cases of travelers presenting with imported melioidosis (not only cutaneous forms), 46% had returned from Thailand (4). However other cases, among travelers or inhabitants, show that CM can also be acquired in other tropical countries including the Caribbean: Guadeloupe (19), Aruba (20) and Jamaica (21) (Supplementary table 1).

We found very few cases in children and a noted that the predominant number of cases occurred in males, in line with other reviews focusing on travelers (4,5). Indeed in these reviews, men outnumbered women by a factor of three. The predominance of cases in males has also been reported in series of melioidosis from in endemic countries (22).

The classical predisposing factors (i.e., diabetes, nephropathy, chronic liver disease, chronic lung disease, thalassemia and alcoholism) were identified in half of our cases. Of note HIV infection is not considered as a classical predisposing factor for melioidosis (22). Only one case of primary CM has been reported in an HIV infected patient. Nonetheless in this report the duration of infection was 3 months despite some degree of immunosuppression (6).

The incubation period is impossible to evaluate precisely in endemic countries where patients may be exposed daily. In the 29 returning travelers, the median incubation time was three weeks and the mean incubation time was 1.8 months, excluding the patient in whom the only possible exposure was traced to the second world war (13).

The time to diagnosis was prolonged with chronic infection in 20.9% of the 43 cases (vs 23,6% of the primary forms of CM), and a maximum duration of 2 months in 4 patients (6,13,23). This shows the difficulty of considering a rare tropical infection even when returning from a tropical country and also illustrates that the course of the infection may be chronic even though melioidosis is better known to be rapidly lethal in its systemic forms. In tropical Australia primary CM has been associated with a chronic duration compared to non-cutaneous melioidosis (OR, 6.35; 95% CI, 3.38–11.93) (2). Abscesses are the most common dermatological presentation in CM (58.1%) and primary CM (57.8%) whereas skin ulceration is more common in chronic infection (55.5%). Fever was found in 53.4% of CM but in only one of the nine patients with chronic CM. This highlights the difficulty in considering a diagnosis of CM in the case of chronic skin ulceration. However, the diagnosis of CM is made easier when samples are systematically taken for culture from any skin infection.

In the laboratory, *B. pseudomallei* grows easily on most agar media at 37°C. Ashdown's selective medium is commonly used to culture the bacterium and colonies develop a characteristic appearance resembling cornflower heads and take up crystal-violet dye from the medium (24). The antibiotic susceptibility pattern is characteristic of this Gram-negative bacillus, especially in a context of recent travel in an endemic country (22). Indeed, *B. pseudomallei* is typically susceptible to ureidopenicillins, amoxicillin-clavulanic acid, third-generation cephalosporins, chloramphenicol, cyclines, cotrimoxazole and carbapenems. On the other hand, it is naturally resistant to other penicillins, first- and second-generation cephalosporins, macrolides, rifamycins and aminoglycosides. Molecular analysis can confirm culture diagnosis. Serological tests can exclude melioidosis or lend support to the diagnosis in areas with low prevalence of infection. They are of little use in endemic areas where a high proportion of the population is seropositive (24).

Of note, laboratory handling and storage require Level 3 biosafety measures. Therefore, for safety reasons and to facilitate the identification of the bacteria, laboratories should be informed before receiving specimens from patients suspected to have melioidosis. *B. pseudomallei* is also considered as a potential bioterrorism agent because of its high potential for infection following inhalation or skin contact with the organism, and its associated high mortality rate. The role of exotoxins released by *B. pseudomallei* is unresolved (24).

The therapeutic recommendations for melioidosis have been highlighted in many instances (10,11,12,14,25). None of these distinguishes the treatment of CM from that of systemic forms. The treatment of systemic forms consists of two phases: the initial phase from 10 days to 4 weeks, depending on the clinical form, with ceftazidime or meropenem, followed by a minimum of 12 weeks of oral maintenance therapy with cotrimoxazole or amoxicillin - clavulanic acid. Surgery is required in more than one third of the cases (Table 3). Surgery appears to be effective and is usually recommended in cases of skin abscesses (24). However, there is no study comparing antibiotics alone versus added surgery.

The management of CM remains controversial as illustrated in our review, which shows the diversity of the treatment approaches. A minimum duration of 2 weeks for the initial phase, and 90 days for the eradication phase has been suggested for skin abscesses in one melioidosis guideline from Darwin, Australia (14). The same authors highlight that only 25% of treating physicians follow the guideline-specified minimum initial phase duration (14). In the case of a single isolated CM lesion, some authors suggest shortening the duration of initial phase to approximately one week (26,24). In one study 9 indigenous cases of primary CM were treated with only oral antibiotics and without apparent failure but the cutaneous presentation was not detailed and the duration of follow-up was not specified (2). Single oral treatment with a single oral agent together with surgery has proven to be effective in some cases (6).

Systemic forms of melioidosis are severe with mortality rates of up to 40% (1), a mean relapse rate of 10% (reaching 30% when antibiotic therapy is limited to 8 weeks), and a median time to relapse of 21 weeks in Thailand (22). In contrast the mortality of cutaneous infection is low with only two reported deaths (less than 5%) (14,27). Persistent positive *B. pseudomallei* blood cultures at the end of the first and/or second week after hospitalization for melioidosis have been demonstrated to be a strong factor associated with mortality (28). Of note initial bacteremia was found in 37% of the patients with CM but this is not a prognostic factor for CM. A prolonged duration of follow-up is required because even after appropriate antibiotic therapy, relapses may occur and be associated with antibiotic resistance (29,30).

The only means of preventing CM in travelers visiting endemic countries is to avoid contact with land and stagnant water mostly during rainy seasons, to wear shoes and abundantly clean skin sores with water and soap. Of note *B. pseudomallei*

contamination occurs mainly via percutaneous inoculation, inhalation, aspiration and ingestion (31). Flooding remains a major risk factor for infection, especially in the case of a pre-existing skin wound. There is no vaccine to date, especially since immunization does not seem to protect against a new infection (22). Post-exposure antibiotic prophylaxis cotrimoxazole or amoxicillin - clavulanic acid can be prescribed but has only been used in the setting of laboratory exposure (32).

One of the most significant limitations of our study is related to literature. Published cases of CM are probably those associated with the most severe course, the most atypical presentation and more likely in travelers than in residents. Also, it was sometimes difficult to distinguish primary from secondary CM as illustrated by the high percentage (37%) of primary CM associated with positive blood cultures. This explains why we have not just focused on primary CM. A few variables have not been evaluated in some cases, such as follow-up, which is not provided in more than half of the cases.

Conclusion:

Cutaneous melioidosis is a rare infection that presents as non-specific abscess or ulceration, especially in endemic countries or in travelers returning from Thailand, and in case of diabetes. The diagnosis can be easily confirmed by systematically culturing pus from any cutaneous lesion. Intravenous antibiotic therapy with ceftazidime or meropenem is recommended for at least 10 days, and then oral treatment adapted to the susceptibility pattern should be administered for eight weeks. Surgery should be systematically considered in case of abscess. However long-term efficacy remains to be evaluated, and long term follow up is required.

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Table 1: Epidemiological characteristics in the 43 cases of cutaneous melioidosis

Characteristics	Travelers	Residents	Total
Number of cases: n (%)	29 (67.4)	14 (32.5)	43
Percentage of men	68.9	78.5	72.0
Mean age (standard deviation)	47.58 (+/-17.1)	41.5 (+/-20.1)	45.60 (+/-18.1)
Main predisposing factors: n (%)			
- Diabetes mellitus	11 (37.9)	7 (50)	18 (41.8)
- Chronic liver disease	2 (6.9)	1 (7.1)	3 (6.9)
- Alcoholism	2 (6.9)	1 (7.1)	3 (6.9)
- Chronic lung disease	2 (6.9)	0	2 (4.6)
- Nephropathy	1 (3.4)	0	1 (2.3)
- Immunosuppression	1 (3.4)	0	1 (2.3)
Areas of exposure [a]: n (%)			
- Thailand	14 (48.3)	0	14 (32.6)
- China	2 (6.9)	5 (35.7)	7 (16.3)
- Other South-Eastern Asian countries	7 (24.1)	4 (28.6)	11 (25.6)
- Sub-Indian continent	3 (10.3)	1 (7.1)	4 (9.3)
- Other Asian countries	2 (6.9)	0	2 (4.6)
- Australia	0	0	0
- Oceania	1 (3.5)	0	1 (2.3)
- Africa:	3 (10.3)	1 (7.1)	4 (9.3)
- Ivory Coast	1 (3.5)	0	1 (2.3)
- Gambia	1 (3.5)	0	1 (2.3)
- Nigeria	1 (3.5)	0	1 (2.3)
- Sierra Leone	0	1 (7.1)	1 (2.3)
- America and Caribbean	4 (13.8)	0	4 (9.3)
- Honduras	1 (3.5)	0	1 (2.3)
- Aruba	1 (3.5)	0	1 (2.3)
- Guadeloupe	1 (3.5)	0	1 (2.3)
- Jamaica	1 (3.5)	0	1 (2.3)

Total of 43 patients

Time in months

NA: not available

a. Some travelers visited several countries during their trip

Table 2: Clinical presentation in the 43 cases of cutaneous melioidosis

Characteristics	Travelers	Residents	Total
Primary cutaneous forms: n (%)	26 (89.6)	12 (85.7)	38 (88.3)
Cutaneous isolated forms: n (%)	15 (51.7)	6 (42.8)	21 (48.8)
Chronic presentation in primary cutaneous forms: n(%)	4 (15.4)	5 (41.6)	9 (23.7)
Secondary extra-dermatological localizations in the primary cutaneous forms: n (%) a			
- Pulmonary	7 (29.9)	3 (25)	10 (26.3)
- Osteoarticular	2 (7.6)	1 (8.3)	3 (7.8)
- Splenic	2 (7.6)	1 (8.3)	3 (7.8)
- ENT	3 (11.5)	0	3 (7.8)
- Uro-genital	1 (3.8)	1 (8.3)	2 (5.2)
- Muscular	1 (3.8)	0	1 (2.6)
- Hepatic	0	1 (8.3)	1 (2.6)
- Neuro-meningeal	1 (3.8)	0	1 (2.6)
- Ophthalmologic	1 (3.8)	0	1 (2.6)
- Digestive	1 (3.8)	0	1 (2.6)
Primary extra-dermatological localizations in the secondary cutaneous forms: n (%) b			
- Pulmonary	3 (100)	2 (100)	5 (100)
- Splenic	1 (33.3)	0	1 (20)
- Neuro-meningeal	1 (33.3)	0	1 (20)
- Digestive	1 (33.3)	0	1 (20)
Bacteremia in primary cutaneous forms: n (%)	10 (38.4)	2 (16.6)	15 (37.2)
Median incubation period (standard deviation) c	0.6 (+/- 154.8)	NA	0.6 (+/- 154.8)
Median time of evolution (standard deviation) d	0.3 (+/- 4.4)	3 (+/-2.3)	0.6 (+/-3.9)

Time in months

NA: not available

a. Total of 38 primary CM. Secondary cutaneous melioidosis were excluded. Some patients had multiple secondary extra-dermatological localizations.

b. Total of 5 secondary CM. Some patients had multiple primary extra-dermatological localizations.

c. Documented in 27 patients (62.79%)

d. Documented in 30 patients (69.77%)

Table 3: Diagnostic methods and treatments in the 43 cases of cutaneous melioidosis

Characteristics	Travelers	Residents	Total
B. pseudomallei diagnostic methods: n(%) a			
- Culture exclusively	10 (34.4)	10 (71.4)	20 (46.5)
- Culture + molecular assays	10 (34.4)	2 (14.2)	12 (27.9)
- Serology	0	0	0
- Extra-dermatological positive culture or molecular assays	4 (13.7)	2 (14.2)	6 (13.9)
- Blood culture associated	10 (34.4)	5 (35.7)	15 (34.8)
Treatment: n (%)			
- Appropriate initial treatment b	22 (75.8)	5 (35.7)	27 (62.7)
- Inappropriate initial treatment c	6 (20.6)	7 (50)	13 (30.2)
- Appropriate antibiotic maintenance treatment d	14 (48.2)	2 (14.2)	16 (37.2)
- Inappropriate antibiotic maintenance treatment e	13 (44.8)	10 (71.4)	23 (53.4)
Surgery: n (%)	12 (41.3)	4 (26.6)	16 (37.2)
- Acute CM	10 (83.3)	3 (75)	13 (81.2)
- Primary CM	11 (91.7)	4 (100)	15 (93.7)
- Abscesses	9 (75)	1 (25)	10 (62.5)
- Ulceration	1 (8.3)	2 (50)	3 (18.7)
- Cellulitis	2 16.7)	1 (25)	3 (18.7)
Outcome: n (%) f			
- Recovery	22 (75.8)	12 (85.7)	34 (70.0)
- Relapse	1 (3.4)	0	1 (2.3)
- Death	2 (6.8)	0	2 (4.6)
Median follow-up (standard deviation) g	12 (+/-6.8)	3.5 (+/-13.6)	10 (+/-9.3)

Time in months

NA: not available

a. Documented in 43 patients and including first the cutaneous samples. Blood culture was usually associated to a dermatological or extra-dermatological positive sample.

b. Documented in 40 patients (93.02%) including 8 patients (20%) treated with ceftazidime. 9 (22.5%) with carbapenem. 1 (2.5%) with both antibiotic. On the basis of MERTH study.
c. Including 1 patient (7.69%) treated less than 10 days. 4 (30.77%) treated with an inappropriate antibiotic and 8 (61.54%) with both issues.
d. Documented in 39 patients (90.69%) all treated with Cotrimoxazole more than 12 weeks. On the basis of MERTH study.
e. Including 3 patients (13.04%) treated less than 12 weeks. 8 (34.78%) treated with an inappropriate antibiotic and 12 (52.17%) with both issues.
f. Documented in 37 patients (86.05%)
g. Documented in 18 patients (41.86)

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Title:
Cutaneous melioidosis: a review of the literature

Date:
2019-02-01

Citation:
Fertitta, L., Monsel, G., Torresi, J. & Caumes, E. (2019). Cutaneous melioidosis: a review of the literature. INTERNATIONAL JOURNAL OF DERMATOLOGY, 58 (2), pp.221-227. https://doi.org/10.1111/ijd.14167.

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