Original Article

Epidemiology of Cellulitis at a University-Based Tertiary Care Hospital in Thailand

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Background: Cellulitis is a common infection at our center. Broad-spectrum antibiotic or antibiotic combination is often prescribed for most adult patients with cellulitis. A contributing factor to the high prevalence of broad-spectrum antibiotic or antibiotic combination for cellulitis is the lack of data specific to the epidemiology and microbiology of cellulitis in Thai patients.

Objective: To determine the characteristics of patients with cellulitis, the prevalence of causative bacteria and their antibiotic susceptibility, antibiotic treatment, and clinical outcomes of cellulitis in adult patients at Siriraj Hospital.

Materials and Methods: The retrospective study included patients aged 18 years and older with a diagnosis of cellulitis who received medical care at Siriraj Hospital between June and December 2016. Collected data included demographic information, underlying conditions, type(s) of infection, location(s) of cellulitis, clinical features of cellulitis, culture and antibiotic susceptibility results, antibiotic prescriptions, and clinical outcomes of cellulitis.

Results: Of the 970 adult cellulitis patients included, 20.6% were hospitalized and 79.4% were outpatients. The mean age of patients was 60.6±18.5 years, 75.4% had at least one underlying illness, and 55% were females. Eighty-six percent of patients had community-acquired infection. Amoxicillin-clavulanate, dicloxacillin, ceftriaxone plus clindamycin, and ceftriaxone alone were the most commonly prescribed antibiotics. Ninety-seven percent of patients had a favorable clinical outcome. The overall mortality rate was 2.0%, and the cellulitis-related mortality rate was 0.3%. Hospitalized patients had a significantly lower proportion of favorable clinical outcome than ambulatory patients. The most commonly isolated bacteria (73.7%) were Gram-positive bacteria (beta-hemolytic streptococci or *Staphylococcus aureus*). Antibiotic combination therapy was significantly more prevalent among hospitalized patients. Patients who received antibiotic combination had a significantly less favorable outcome than those who received monotherapy.

Conclusion: Seventy-seven percent of adult patients with cellulitis at Siriraj Hospital received broad-spectrum antibiotic or antibiotic combination despite the most commonly isolated bacteria being beta-hemolytic streptococci and methicillin-susceptible *S. aureus* (MSSA), both of which are normally treatable with a simple narrow-spectrum antibiotic. Mortality and complication rates in cellulitis were very low. Appropriate antibiotic treatment of cellulitis at Siriraj Hospital should be encouraged.

Keywords: Thailand, Epidemiology, Cellulitis, Bacteria, Antibiotic

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Cellulitis is an acute spreading infection involving the dermis and subcutaneous tissues that is characterized by tenderness, swelling, redness, and warmth at the affected area[1]. Cellulitis is one of the most common infections among both hospitalized patients and ambulatory patients, with more than 1,500 cases identified each year at Siriraj Hospital, Thailand's largest national tertiary referral center. Cellulitis ranges in severity from mild to severe, up to and including life-threatening manifestations. The estimated hospitalization rate in cellulitis is approximately 7%, with a mortality rate that ranges from less than 1.0% to 2.5%[2]. Appropriate antibiotic treatment is essential for treatment of cellulitis to prevent associated morbidity and mortality[3,4].

Many studies over the past decade demonstrated that most patients with cellulitis receive inappropriate broad-spectrum antibiotic or antibiotic combination that contains activity against Gram-positive bacteria, Gram-negative bacteria, and/or anaerobes[5]. Published

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studies and guidelines describe beta-hemolytic streptococci and *Staphylococcus aureus* as the most common causative bacteria in cellulitis[4,6,7] The prevalence of Gram-negative bacteria in cellulitis is very low[2,5,7]. Two recent randomized controlled trials that investigated the value of antibiotic combination therapy in cellulitis found that no additional clinical benefits were realized from combination therapy[8,9]. Moreover, inappropriate overuse of antibiotics is associated with increased risk of adverse drug events, increased cost of treatment, and the development of antimicrobial resistance.

It was observed that broad-spectrum antibiotic or antibiotic combination was given to more than 50% of patients with cellulitis at Siriraj Hospital despite the recommendation of international practice guidelines for treatment of cellulitis that broad-spectrum antibiotic or antibiotic combination be given only to patients with high-risk features of having uncommon causative agents or severe illnesses[6]. One of the reasons that may explain this inappropriate use of antibiotics may be the lack of data specific to the epidemiology and microbiology of cellulitis in Thai patients. The current practice guidelines for treatment of cellulitis were developed based on and for patients in Western countries with a high prevalence of community-acquired methicillin-resistant *S. aureus* (CA-MRSA)[6,10]. Since CA-MRSA is extremely rare in Thai communities[11,12], these clinical practice guidelines may not be suitably generalizable to Thai population.

Accordingly, the aim of the present study was to determine the characteristics of patients with cellulitis, the prevalence of causative bacteria, and their antibiotic susceptibility, antibiotic treatment, and clinical outcomes of cellulitis in adult patients at Siriraj Hospital.

Materials and Methods

The protocol for the retrospective study was approved by the Institutional Review Board of the Faculty of Medicine Siriraj Hospital, Mahidol University (COA no.125/2560). The present study was conducted at Siriraj Hospital, which is a 2,300-bed university-based tertiary care hospital that is located in Bangkok, Thailand. Patients aged 18 years or older with a diagnosis of cellulitis according to the International Statistical Classification of Diseases and Related Health Problems, Tenth revision (ICD-10) codes L03.0 to L03.9 who received medical care at Siriraj Hospital between June and December 2016 were included. Patients with non-bacterial cellulitis or who had unavailable or insufficient medical record data were excluded.

Data collected from patient medical records included demographic information, underlying conditions, type(s) of infection, location(s) of cellulitis, other clinical features of cellulitis [fever, body temperature 38°C or higher, and hypotension (systolic blood pressure of less than 90 mmHg)], culture and antibiotic susceptibility results from clinical specimens, antibiotic prescriptions, and clinical outcomes of cellulitis. Broad-spectrum antibiotic was defined as antibiotic that is effective against a wide range of Gram-positive bacteria, Gram-negative bacteria, and/or anaerobes[5]. Community-acquired infection (CAI) was defined as infection in ambulatory patient or hospitalized patient within two days who has no healthcare-associated conditions (i.e., prior hospitalization within three months, prior use of antibiotic within 90 days, resident of long-term care facility, and/or undergoing chronic hemodialysis). Hospital-acquired infection (HAI) was defined as infection in ambulatory patient with healthcare-associated conditions (as described in the preceding sentence) or in hospitalized patient admitted longer than two days at Siriraj Hospital or at other hospitals prior to admission to Siriraj Hospital.

Statistical analysis

The prevalence of the appropriate use of antibiotic treatment in cellulitis was estimated to be 30.0±3.0%. Using a type I error (two-sided) of 5%, a minimum sample size of 897 patients was calculated. Data are presented as number and percentage, mean ± standard deviation, or median. Fisher's exact test or Chi-square test was used to compare categorical variables, and t-test was employed to compare quantitative variables. All statistical analyses were performed using Microsoft Excel version 2010 (Microsoft Corporation, Redmond, WA, USA). A p-value of 0.05 or lower was considered statistically significant.

Results

Of the 970 adult cellulitis patients enrolled in the present study, 200 (20.6%) were hospitalized and received inpatient care, and 770 (79.4%) were ambulatory patients that received outpatient care. The mean age of patients was 60.6±18.5 years (range 18 to 98), 75.4% had at least one underlying illness, and 55% were females. Eighty-six percent of patients had CAI. Sixteen percent of patients presented with fever documented by physical examination, and 2.1% had hypotension. The common locations of cellulitis were

Table 1. Antibiotic regimens for treatment of cellulitis in study patients

Antibiotic regimens for treatment of cellulitis in all patients	Number of patients n (%)
Intravenous or oral antibiotics	(n = 970)
Amoxicillin-clavulanate	286 (29.5)
Dicloxacillin	222 (22.9)
Ceftriaxone plus clindamycin	124 (12.8)
Ceftriaxone	96 (9.9)
Clindamycin	41 (4.2)
Cephalexin	36 (3.7)
Cefazolin	28 (2.9)
Levofloxacin	27 (2.8)
Piperacillin-tazobactam	26 (2.7)
2nd and 3rd-generation cephalosporins	25 (2.6)
Ciprofloxacin plus clindamycin	21 (2.2)
Cefdinir plus clindamycin	20 (2.1)
Meropenem plus vancomycin	18 (1.9)
Meropenem	16 (1.6)
Ciprofloxacin	14 (1.4)
Cloxacillin	10 (1.0)
Dicloxacillin plus clindamycin	8 (0.8)
Vancomycin	6 (0.6)
Ciprofloxacin plus metronidazole	4 (0.4)
Piperacillin-tazobactam plus vancomycin	4 (0.4)
Amoxicillin	3 (0.3)
Cefazolin plus clindamycin	3 (0.3)
Others*	51 (5.3)
Antibiotic regimens for treatment of cellulitis in hospitalized patients	
Intravenous antibiotics	(n = 200)
Ceftriaxone plus clindamycin	72 (36.0)
Ceftriaxone	18 (9.0)
Meropenem plus vancomycin	18 (9.0)
Amoxicillin-clavulanate	17 (8.5)
Piperacillin-tazobactam	16 (8.0)
Cefazolin	16 (8.0)
Cloxacillin	10 (5.0)
Ciprofloxacin plus clindamycin	6 (3.0)
Meropenem	6 (3.0)
Vancomycin	6 (3.0)
Piperacillin-tazobactam plus vancomycin	4 (2.0)
Cefazolin plus clindamycin	3 (1.5)
Others**	8 (4.0)
Oral step-down antibiotics	(n = 121)
Amoxicillin-clavulanate	39 (32.2)
Dicloxacillin	20 (16.5)
Levofloxacin	11 (9.1)
Cephalexin	10 (8.3)
Cefdinir plus clindamycin	10 (8.3)
2nd and 3rd-generation cephalosporins	9 (7.4)
Clindamycin	7 (5.8)
Ciprofloxacin plus clindamycin	5 (4.1)
Ciprofloxacin plus metronidazole	4 (3.3)
Amoxicillin	3 (2.5)
Cephalexin plus clindamycin	2 (1.7)
Fusidic acid plus rifampicin	1 (0.8)
Antibiotic regimens for treatment of cellulitis in ambulatory patients	
Intravenous or oral antibiotics	(n = 770)
Amoxicillin-clavulanate	230 (29.9)
Dicloxacillin	202 (26.2)
Ceftriaxone	78 (10.1)
Ceftriaxone plus clindamycin	52 (6.8)
Clindamycin	34 (4.4)
Cephalexin	26 (3.4)
Levofloxacin	16 (2.1)
2nd and 3rd-generation cephalosporins	16 (2.1)
Ciprofloxacin	14 (1.8)
Cefazolin	12 (1.6)
Cefdinir plus clindamycin	10 (1.3)
Ciprofloxacin plus clindamycin	10 (1.3)
Dicloxacillin plus clindamycin	8 (1.0)
Others***	62 (8.0)

* Ampicillin-sulbactam, cefuroxime, roxithromycin, clarithromycin, moxifloxacin, metronidazole, fusidic acid, fusidic plus rifampicin, trimethoprim-sulfamethoxazole, ertapenem, imipenem, and fosfomycin

** Ampicillin-sulbactam, cefuroxime, ertapenem, imipenem, and fosfomycin

*** Roxithromycin, clarithromycin, moxifloxacin, metronidazole, fusidic acid, trimethoprim-sulfamethoxazole, piperacillin-tazobactam, and carbapenems

leg (53.0%), foot (20.5%), and arm (11.9%). All 970 patients received antibiotic treatment for cellulitis, as shown in Table 1. Amoxicillin-clavulanate, dicloxacillin, ceftriaxone plus clindamycin, and ceftriaxone alone were the most commonly prescribed antibiotics. Ninety-seven percent of patients had a favorable clinical outcome. Subsequent complications of cellulitis, including necrotizing fasciitis and osteomyelitis, were found in only four patients (0.4%). The overall mortality rate was 2.0%, and the cellulitis-

Table 2. Demographic and clinical characteristics compared between hospitalized patients and ambulatory patients with cellulitis

Characteristics	Hospitalized patients (n = 200) n (%)	Ambulatory patients (n = 770) n (%)	p-value
Sex: female	97 (48.5)	438 (56.9)	0.03
Age (years)			
Mean±SD	62.7±18.0	60.0±18.7	0.07
Median	65.0	61.0	
Clinical presentation			
Fever	119 (59.5)	38 (4.9)	<0.001
Hypotension	20 (10.0)	0 (0.0)	<0.001
Location of cellulitis			
Leg	132 (66.0)	382 (49.6)	<0.001
Foot	19 (9.5)	180 (23.4)	<0.001
Arm	23 (11.5)	92 (11.9)	0.86
Hand	5 (2.5)	36 (4.7)	0.17
Head & neck	10 (5.0)	38 (4.9)	0.97
Trunk	11 (5.5)	42 (5.5)	0.98
Type of infection			
Community-acquired infection	148 (74.0)	712 (92.5)	<0.001
Hospital-acquired infection	52 (26.0)	58 (7.5)	<0.001
Comorbidities			
Overall comorbidities	179 (89.5)	552 (71.7)	<0.001
Diabetes mellitus	59 (29.5)	178 (23.1)	0.06
Chronic kidney disease	48 (24.0)	58 (7.5)	<0.001
Malignancy	41 (20.5)	106 (13.8)	0.02
Heart disease	39 (19.5)	105 (13.5)	0.04
Skin disease	22 (11.0)	28 (3.6)	<0.001
Rheumatic disease	20 (10.0)	44 (5.7)	0.03
Immunocompromised status	20 (10.0)	56 (7.8)	0.20
Lung disease	19 (9.5)	22 (2.9)	<0.001
Liver disease	10 (5.0)	12 (1.6)	0.004
Vascular disorder*	10 (5.0)	116 (15.1)	<0.001
Duration of hospitalization (days)			
Mean±SD	15.8±23.5	-	-
Median	8.5	-	-
Clinical outcomes			
Cure	180 (90.0)	702 (97.5)**	<0.001
Cellulitis-related mortality	3 (1.5)	-	-

SD=standard deviation

* Vascular disorder was defined as chronic venous insufficiency, deep vein thrombosis, lymphedema, or peripheral vascular disease

** Fifty patients were excluded due to a lack of clinical outcome data

A p-value <0.05 indicates statistical significance

related mortality rate was 0.3%.

Demographic and clinical characteristics compared between hospitalized patients and ambulatory patients with cellulitis are shown in Table 2. Patients with fever, hypotension, leg cellulitis, presence of comorbidities, and HAI were more likely to be hospitalized; whereas, patients with foot cellulitis, CAI, and vascular disorders were more likely to be treated as outpatients. Hospitalized patients had a median length of hospital stay of 8.5 days (range 1 to 228 days), and a lower proportion of favorable clinical outcome than ambulatory patients (90.0%

Table 3. Bacteria isolated from patients with cellulitis at Siriraj Hospital

Isolated bacteria	Number of patients (n = 61) n (%)
Beta-hemolytic streptococci	19 (31.1)
MSSA	19 (31.1)
MSSA and beta-hemolytic streptococci	5 (8.2)
MRSA*	2 (3.3)
Pseudomonas aeruginosa	7 (11.5)
Escherichia coli	3 (4.9)
Klebsiella pneumoniae	2 (3.3)
Acinetobacter baumannii	1 (1.6)
Salmonella spp.	1 (1.6)
Mixed bacteria	2 (3.3)

MSSA=methicillin-susceptible *Staphylococcus aureus*; MRSA =methicillin-resistant *S. aureus*

* MRSA isolates from 2 hospitalized patients with acute myeloid leukemia

versus 97.5%; p<0.001).

From the 970 included patients with cellulitis, 331 clinical specimens, including 251 blood specimens and 80 pus/swab specimens, were sent to the microbiology laboratory at our center for bacterial culture. The overall positive culture rate for bacteria was 18.4%, the positive blood culture rate for bacteria was 8.4%, and the positive pus/swab culture rate for bacteria was 50.0%. Comparisons between patients with positive cultures for bacteria and patients with negative cultures for bacteria revealed that hypotension (11.5% versus 3.0%, p=0.01) and underlying hematologic malignancy (34.4% versus 4.2%, p<0.001) were significantly higher than in the patients with positive cultures for bacteria. Bacteria were isolated from 61 patients (6.3%), as shown in Table 3. The most commonly isolated bacteria (73.7%) were Gram-positive bacteria (i.e., beta-hemolytic streptococci or *S. aureus*). All isolated streptococci were susceptible to penicillin. Most isolated *S. aureus* were methicillin-susceptible strains. Two isolates of MRSA were recovered from two hospitalized patients with acute myeloid leukemia, and both developed hospital-acquired cellulitis during their hospitalization. Gram-negative bacteria (i.e., Enterobacteriaceae, *Pseudomonas aeruginosa*, *Acinetobacter baumannii*, and mixed bacteria) were found in 26.7% of patients. Among the isolated Gram-negative bacteria, 62.5% were community-acquired isolates, whereas six isolates (37.5%; 3 *Escherichia coli*, 1 *Klebsiella pneumoniae*, 1 *P. aeruginosa*, and 1 *A. baumannii*) were recovered from patients with HAI. Most of the isolated Enterobacteriaceae were susceptible to common antibiotics, including amoxicillin-clavulanate, cefuroxime, cefoxitin, ceftriaxone, cefotaxime, ceftazidime, cefepime, ciprofloxacin, trimethoprim-sulfamethoxazole, gentamicin, and amikacin. One isolate of ceftriaxone-resistant *E. coli* was found in a hospitalized patient with hepatocellular carcinoma who had hospital-acquired cellulitis. All isolated *P. aeruginosa* and *A. baumannii* were susceptible to ceftazidime, cefepime, ciprofloxacin, piperacillin/tazobactam, imipenem, and meropenem. Most of those isolates (75.0%) were cultured from ambulatory patients with CAI, while the remaining two isolates (25.0%; 1 *P. aeruginosa* and 1 *A. baumannii*) were found in hospitalized patients with HAI. Isolated uncommon bacteria, including Gram-negative bacteria, mixed bacteria, and MRSA, were recovered significantly more often in patients with HAI, neutropenia, and bite wound, as shown in Table 4.

Among the 21 patients with positive blood cultures for bacteria, the isolated bacteria were beta-hemolytic streptococci (38.1%), *S. aureus* (19.0%; three methicillin-susceptible *S. aureus* [MSSA] and one MRSA), *E. coli* (14.3%; two ceftriaxone-susceptible isolates, and one ceftriaxone-resistant isolate), *P. aeruginosa* (9.5%), *K. pneumoniae* (9.5%), *A. baumannii* (4.8%), and *Salmonella* spp. (4.8%). Comparisons between patients with positive blood cultures for bacteria and patients with negative blood cultures for bacteria demonstrated that hypotension (23.8% versus 3.1%, p<0.001) and underlying hematologic malignancy (52.4% versus 4.4%, p<0.001) were significantly higher than in the patients with positive blood cultures for bacteria. Moreover, prevalence of fever was not significant difference between patients with positive blood cultures for bacteria and patients with negative blood cultures for bacteria.

Antibiotic regimens for treatment of cellulitis in hospitalized patients are shown in Table 1. All hospitalized patients were initially treated with parenteral antibiotics. The most commonly prescribed parenteral antibiotics were ceftriaxone-clindamycin combination (36.0%), ceftriaxone (9.0%), meropenem-vancomycin combination (9.0%), amoxicillin-clavulanate (8.5%), and piperacillin-tazobactam (8.0%). Forty percent of hospitalized patients received clindamycin combination therapy for initial treatment. Monotherapy with parenteral anti-Gram-positive antibiotics (i.e., cefazolin or cloxacillin) was prescribed in 13.0% of patients.

Table 4. Factors associated with common and uncommon isolated bacteria

Characteristics	Common bacteria* (n = 43) n (%)	Uncommon bacteria** (n = 18) n (%)	p-value
Sex: male	27 (62.8)	10 (55.6)	0.60
Age (years)			
Mean±SD	60.2±15.3	61.3±13.2	0.79
Clinical presentation			
Fever	17 (39.5)	7 (38.5)	0.96
Hypotension	8 (18.6)	3 (16.7)	0.86
Location of cellulitis			
Leg	30 (69.8)	10 (55.6)	0.29
Type of infection			
Community-acquired infection	39 (90.7)	10 (55.6)	0.001
Hospital-acquired infection	4 (9.3)	8 (44.4)	0.001
Hospitalized patients	32 (74.4)	11 (61.1)	0.30
Ambulatory patients	11 (25.6)	7 (38.9)	0.30
Neutropenia***	0 (0.0)	4 (22.2)	0.001
Bite wound	0 (0.0)	2 (11.1)	0.03
Comorbidities			
Overall comorbidities	35 (81.4)	17 (94.4)	0.19
Clinical outcome			
Cure	39 (90.7)	15 (83.3)	0.41
Cellulitis-related mortality	1 (2.3)	1 (5.6)	0.52

SD=standard deviation

* Common bacteria included beta-hemolytic streptococci, methicillin-susceptible *S. aureus* (MSSA), or both

** Uncommon bacteria included Gram-negative bacteria, mixed bacteria, and methicillin-resistant *S. aureus* (MRSA)

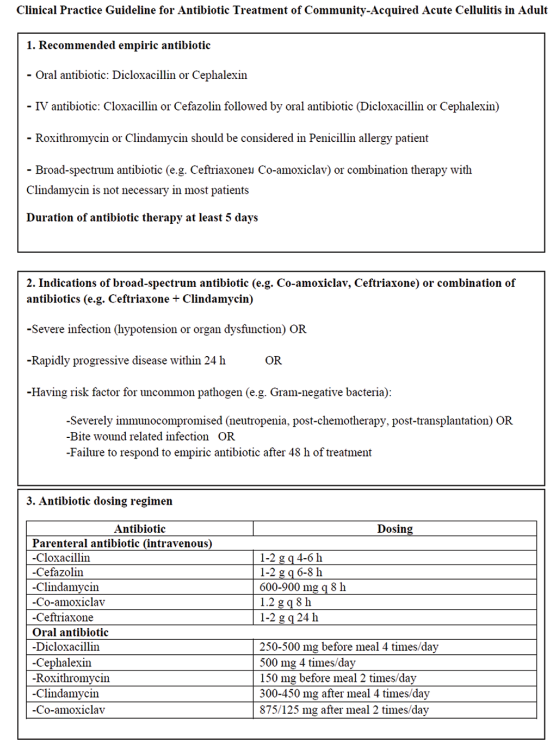
*** Neutropenia defined as absolute neutrophil count ≤500 cells/mm^3

A p-value <0.05 indicates statistical significance

Step-down oral antibiotic was ordered in 60.5% of hospitalized patients when their clinical conditions improved after parenteral antibiotic therapy. However, the other 39.5% of the hospitalized group did not receive step-down treatment. Among the 79 patients with no step-down therapy, 36.7% did not have appropriate oral step-down regimen, 30.4% required additional parenteral antibiotics due to slow clinical response or unfavorable outcome, and 32.9% did not receive step-down treatment even when their clinical conditions improved. Amoxicillin-clavulanate (32.2%), dicloxacillin (16.5%), levofloxacin (9.1%), and cephalexin (8.3%) were the most commonly prescribed oral antibiotics for step-down treatment.

Antibiotic regimens for treatment of cellulitis in ambulatory patients are also shown in Table 1. The most common antibiotics given to ambulatory patients were amoxicillin-clavulanate (29.9%), dicloxacillin (26.2%), ceftriaxone (10.1%), ceftriaxone-clindamycin combination (6.8%), clindamycin (4.4%), and cephalexin (3.4%). Monotherapy with oral anti-Gram-positive antibiotics (i.e., dicloxacillin or cephalexin) was prescribed in 29.6% of patients. Ten percent of ambulatory patients received clindamycin combination therapy.

Comparison between patients who received antibiotic monotherapy (i.e., cloxacillin, dicloxacillin, cefazolin, cephalexin, or clindamycin) and those who received combination therapy (i.e., ceftriaxone plus clindamycin) for treatment of cellulitis showed that 1) community-acquired cellulitis was significantly more common in the antibiotic monotherapy group and presence of fever, hypotension, leg cellulitis, and comorbidities was significantly more common among those who received antibiotic combination therapy, 2) antibiotic combination therapy was significantly more prevalent among hospitalized patients (58.1%) than ambulatory patients (8.5%) ($p<0.001$), 3) the types of isolated bacteria were comparable between the patients who received antibiotic monotherapy and those who received antibiotic combination, and 4) patients who received antibiotic monotherapy had



Clinical Practice Guideline for Antibiotic Treatment of Community-Acquired Acute Cellulitis in Adult

1. Recommended empiric antibiotic

- Oral antibiotic: Dicloxacillin or Cephalexin
- IV antibiotic: Cloxacillin or Cefazolin followed by oral antibiotic (Dicloxacillin or Cephalexin)
- Roxithromycin or Clindamycin should be considered in Penicillin allergy patient
- Broad-spectrum antibiotic (e.g. Ceftriaxoneและ Co-amoxiclav) or combination therapy with Clindamycin is not necessary in most patients

Duration of antibiotic therapy at least 5 days

2. Indications of broad-spectrum antibiotic (e.g. Co-amoxiclav, Ceftriaxone) or combination of antibiotics (e.g. Ceftriaxone + Clindamycin)

-Severe infection (hypotension or organ dysfunction) OR

-Rapidly progressive disease within 24 h OR

-Having risk factor for uncommon pathogen (e.g. Gram-negative bacteria):

-Severely immunocompromised (neutropenia, post-chemotherapy, post-transplantation) OR
-Bite wound related infection OR
-Failure to respond to empiric antibiotic after 48 h of treatment

3. Antibiotic dosing regimen

Antibiotic	Dosing
Parenteral antibiotic (intravenous)	
-Cloxacillin	1-2 g q 4-6 h
-Cefazolin	1-2 g q 6-8 h
-Clindamycin	600-900 mg q 8 h
-Co-amoxiclav	1.2 g q 8 h
-Ceftriaxone	1-2 g q 24 h
Oral antibiotic	
-Dicloxacillin	250-500 mg before meal 4 times/day
-Cephalexin	500 mg 4 times/day
-Roxithromycin	150 mg before meal 2 times/day
-Clindamycin	300-450 mg after meal 4 times/day
-Co-amoxiclav	875/125 mg after meal 2 times/day

Figure 1. Clinical practice guideline for antibiotic treatment of community-acquired cellulitis in adults at Siriraj Hospital.

a significantly more favorable outcome than those who received antibiotic combination (cure rate 99.0% versus 92.7%, p<0.001).

Discussion

Empiric antibiotic therapy is usually prescribed in patients with cellulitis, because identification of the causative agent in this condition is uncommon, and the yield for recovery of the pathogen is low[3,4,7]. Although the use of empiric broad-spectrum antibiotic in cellulitis is a common practice at many centers[5], the routine use of broad-spectrum antibiotic is not recommended by several practice guidelines for treatment of cellulitis. The existing practice guidelines recommend that empiric antibiotic treatment should cover the most commonly involved Gram-positive cocci. Broad-spectrum antibiotic or antibiotic combination should be considered according to specific risk factors, including severity of illness, history of exposure to factors associated with the development of cellulitis, response to prior treatment, and patient immune status[6,7,13].

The present study revealed the following important observations: 1) cellulitis is a common infection at Siriraj Hospital, with the identification of more than 1,500 new cases (hospitalized or ambulatory patients) per year; 2) the causative bacteria were identified in only 6.3% of cellulitis patients who received medical care at our center; 3) the most commonly isolated bacteria were beta-hemolytic streptococci and MSSA; 4) no CA-MRSA was isolated; 5) inappropriate antibiotic treatment was common relative to the use of broad-spectrum antibiotic (58.5%) and clindamycin in combination with other antibiotics (18.4%), even though clindamycin combined with other antibiotics confers no additional benefit[8]; 6) step-down treatment to oral antibiotic was not ordered in 13.0% of patients who initially received parenteral antibiotics; and 7) cellulitis-related complication and mortality rates were very low. Those findings and observations suggest that at least 80% of cellulitis patients in the present study did not require broad-spectrum antibiotic or antibiotic combination based on the types of bacteria isolated and the recommendations for antibiotic treatment in patients with cellulitis that are outlined in current international practice guidelines[6,7].

The present study has some mentionable limitations. First, the diagnosis of cellulitis relied on ICD-10 codes, so some diagnostic errors may have occurred. Second, the number of isolated organisms from patients with cellulitis was relatively small, and clinical specimens were sent for culture in less than 50% of study patients. Thus, the true prevalence of causative bacteria may be underestimated, and the type of bacteria may not reflect the causative bacteria in all patients. Third, the present study was conducted retrospectively in a single university-based tertiary care hospital, so the study results may not be generalized to all levels of hospitals in Thailand.

According to the most study patients have community-acquired cellulitis, the clinical practice guideline proposed in the present study (Figure 1) for antibiotic treatment in adult patients with community-acquired cellulitis at Siriraj Hospital was developed based on data from the present study. This guideline will be implemented at Siriraj Hospital in 2018. Data from patients with community-acquired cellulitis after the implementation of this guideline will be prospectively collected and analyzed. If the intended objective of this guideline is met, a decrease in the prevalence of broad-spectrum antibiotic and antibiotic combination use in cellulitis patients will be significantly decreased.

Conclusion

Cellulitis is a common infection at Siriraj

Hospital. Seventy-seven percent of adult patients with cellulitis at Siriraj Hospital received broad-spectrum antibiotic or antibiotic combination despite the most commonly isolated bacteria being beta-hemolytic streptococci and MSSA, both of which are normally treatable with a simple narrow-spectrum antibiotic. Mortality and complication rates in cellulitis were very low. Appropriate antibiotic treatment of cellulitis at Siriraj Hospital should be encouraged.

What is already known on this topic?

Cellulitis is a common infection but the epidemiology and microbiology data of cellulitis among Thai patients are still limited.

What this study adds?

Most Thai patients with cellulitis receive inappropriate broad-spectrum antibiotic or antibiotic combination despite that the mortality and complication rates in cellulitis are low. Appropriate antibiotic treatment of cellulitis should be promoted.

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Conflicts of interest

The authors declare no conflict of interest.

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