

# Cellulitis Recurrence Score: A tool for predicting recurrence of lower limb cellulitis

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**Background:** Cellulitis is the most common skin and soft tissue infection and is associated with frequent recurrences.

**Objectives:** An objective of our study was to identify factors for recurrence in patients who present with a first episode of lower-limb cellulitis. A secondary aim was to formulate a score based on observed clinical risk factors that might predict recurrence within a year.

**Methods:** Dermatology referral forms and national computerized records were reviewed from 2003 to 2012. Demographics, coexistent dermatoses, local factors, and comorbidities were reviewed.

**Results:** A total of 102 (45.3%) of 225 patients had recurrence. Multivariate analysis showed that lymphedema ( $P < .0005$ ), chronic venous insufficiency ( $P < .0005$ ), peripheral vascular disease ( $P = .002$ ), and deep vein thrombosis ( $P = .008$ ) predicted for recurrence. The Cellulitis Recurrence Score (CRS) was constructed based on these factors.  $CRS \geq 2$  was associated with a positive predictive value of 83.6% and negative predictive value of 67.5%. Model performance was good (Hosmer-Lemeshow statistic,  $P = .753$ ).

**Limitations:** This is a retrospective study limited to an inpatient cohort.

**Conclusion:** Lymphedema, chronic venous insufficiency, peripheral vascular disease, and deep vein thrombosis were risk factors. CRS is reliable for predicting recurrence, and early interventions should be considered in patients with  $CRS \geq 2$ . (J Am Acad Dermatol <http://dx.doi.org/10.1016/j.jaad.2014.08.043>.)

**Key words:** cellulitis; erysipelas; recurrence; lymphedema; chronic venous insufficiency; stasis dermatitis; peripheral vascular disease; deep vein thrombosis.

Cellulitis is an acute, pyogenic inflammation of the dermis and subcutaneous tissue,<sup>1</sup> with an incidence of 16.4 to 24.6 per 1000 person-years.<sup>2</sup> Cellulitis accounts for 14% of visits to the emergency department and contributes up to 7% of hospital admissions in the United States.<sup>3,4</sup> Cellulitis contributes to an average length-of-stay of 6 days and a hospital bill of at least \$13,000 US dollars per admission.<sup>5</sup> The all-cause mortality rate for patients admitted for cellulitis is 7.2%.<sup>6</sup> Microbiologic analyses from blood cultures, aspirates, and skin biopsies isolate various groups of Streptococci in 75% to 90% of cases.<sup>7</sup>

#### Abbreviations used:

CRS: Cellulitis Recurrence Score  
CVI: Chronic venous insufficiency  
DVT: Deep vein thrombosis

Recurrence is common, occurring at 8% to 20% per year.<sup>8,9</sup> Cellulitis contributes to postcellulitic edema, setting up a vicious cycle, which further predisposes subjects to recurrent cellulitis.<sup>10</sup> Measures such as the administration of prophylactic antibiotics<sup>11</sup> and reduction of modifiable risk factors

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Funding sources: None.

Conflicts of interest: None declared.

Accepted for publication August 26, 2014.

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Published online October 16, 2014.

0190-9622/\$36.00

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<http://dx.doi.org/10.1016/j.jaad.2014.08.043>

have shown promise in reducing the rate of recurrence. We seek to identify factors for recurrence in patients presenting with their first episode of lower limb cellulitis and propose a validated scoring system predictive of the risk of recurrence.

## METHODS

The study was conducted based on subjects referred to the inpatient dermatology consult service at our 1500-bed tertiary hospital. This study was reviewed and approved by the ethical review board of our institution (Protocol: 2012/1003/E).

Inclusion criteria were patients with lower extremity cellulitis at or below the level of the buttocks, aged 18 years and older and with the diagnosis of cellulitis made by a consultant dermatologist (TT, SMP, HYL). Subjects with necrotizing fasciitis or with a secondarily infected dermatologic process such as folliculitis, septic bursitis with overlying cellulitis, septic arthritis with surrounding cellulitis, carbuncles, and furuncles were excluded.

Inpatient consultation and national computerized medical records were retrospectively reviewed for the period of March 2003 to March 2012 by an independent doctor (ET) to ensure that the clinical features were in concordance with cellulitis.

A case of recurrence was defined as a second episode of cellulitis occurring in the same limb within 1 year of the first episode, with documented clearance of cellulitis between the 2 episodes. This definition was either by (1) follow-up documentation of clearance in the medical records, (2) the absence of any further hospital inpatient and outpatient consultations for the same episode, (3) absence of documentation of failure of therapy after the initial episode, and (4) absence of prescription of further courses of antibiotics within 2 months of the initial episode. Data on demographics, the presence of coexistent dermatoses, local factors predisposing to cellulitis, comorbidities, and laboratory investigations were analyzed.

Chronic venous insufficiency (CVI) referred to the presence of at least 2 of the following: sclerotic skin, varicose veins, pigmented purpuric dermatoses, or the detection of venous insufficiency on Doppler studies. Lymphedema was defined as a chronic, progressive swelling of the affected limb for more

than 3 months' duration, consistent with at least stage II of the grading of the International Society of Lymphology.<sup>12</sup> Chronic kidney disease was taken as a glomerular filtration rate of less than 60 mL/min/1.73m<sup>2</sup> for at least 3 months, which corresponds to stage 3 on the Kidney Disease Outcomes Quality Initiative Chronic Kidney Disease classification. Liver

cirrhosis was defined by the presence of fibrosis detected on imaging. A body mass index of  $\geq 25\text{kg/m}^2$  was considered obese.

Statistical analysis was performed using R version 3.01 (R Foundation for Statistical Computing, Vienna, Austria). Statistical significance was set at  $P < .05$  for all testing. For univariate analyses, differences between the 2 groups were assessed using the  $\chi^2$  test for association for categorical variables and 2-sample Student  $t$  test or Mann-Whitney U for contin-

uous variables. The multivariate model for prediction of recurrent cellulitis was constructed by considering all factors emerging as significant (at significance level of  $P < .05$ ) in the univariate analysis, using backward stepwise variable selection with entry and exit criteria of  $P < .01$  and  $P > .05$ , respectively.

Scores were constructed by converting into integers the regression coefficients of independently predictive factors in the multivariate logistic regression model. Presence of any independent risk factor was awarded the corresponding integer score. A total score, named Cellulitis Recurrence Score (CRS), was calculated by summing up the scores for each independent variable.

The bootstrap technique (resampling without replacement from original dataset) with 200 resamples was used to generate the c-statistics for assessing discrimination and the bias-corrected calibration curve for assessing calibration. The c-statistics and calibration curves were measures of the performance of the prediction tool.<sup>13</sup> A c-statistic between 0.7 and 0.9 is an indicator of fair to good discrimination, and a calibration curve close to the ideal  $y = x$  line is an indicator of good calibration .

## CAPSULE SUMMARY

- Recurrence of lower limb cellulitis is common.
- Clinical factors that predict recurrences are lymphedema, venous insufficiency, deep vein thrombosis, and peripheral vascular diseases.
- Cellulitis Recurrence Score is a scoring system based on presence or absence of lymphedema, venous insufficiency, deep vein thrombosis, and peripheral vascular disease. It is useful for predicting recurrence in lower limb cellulitis.

## RESULTS

During the study period, 225 patients were referred to the dermatology inpatient consultation service with cellulitis. Table 1 summarizes their baseline characteristics.

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