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Can progression of odontogenic infections to cervical necrotizing soft tissue infections be predicted?☆

K. Zemplenyi[1], B. Lopez[2], M. Sardesai[3], J. K. Dillon[1]
[1]Department of Oral and Maxillofacial Surgery, University of Washington, Seattle, WA, USA; [2]School of Dentistry, University of Washington, Seattle, WA, USA; [3]Department of Otolaryngology Head and Neck Surgery, University of Washington, Seattle, WA, USA

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Abstract. The progression of odontogenic infections to necrotizing soft tissue infections (NSTIs) is unknown. The Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) score is used to predict risk of NSTI. This study aimed to (1) estimate the frequency at which odontogenic infections progress to NSTIs, (2) measure the value of LRINEC in predicting progression to NSTI, and (3) estimate the charges associated with managing NSTIs. This retrospective cohort study enrolled all subjects admitted for the management of odontogenic infections from 2001 to 2013. The primary predictor was the LRINEC score. The primary outcome was NSTI. The secondary outcome was billing charges. Descriptive and bivariate statistical analyses were performed, with significance set at a P-value of <0.05. Of 479 odontogenic infections, (1.0%) progressed to NSTI. The mean LRINEC for NSTI was 5.8 and for odontogenic infection was 3.4 ($P = 0.043$). LRINEC parameters for the prediction of NSTIs had 60% sensitivity, 68.4% specificity, 20% positive predictive value, and 92.9% negative predictive value. The mean charge for NSTI was $319,337 and for odontogenic infections was $19,291 ($P = 0.051$). One percent of odontogenic infections progressed to NSTIs. The LRINEC score was not able to identify all NSTIs. NSTIs are 16 times more costly.

Key words: LRINEC; necrotizing soft tissue infections; odontogenic infections.

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Necrotizing soft tissue infections (NSTIs) and descending necrotizing mediastinitis are rare but rapidly progressive, usually polymicrobial, infections with high limb and life mortality. Mortality rates of between 30% and 50% have been reported for descending necrotizing mediastinitis.[1] With advancements made in the medical field, other sources have reported a slight decrease in the mortality rate to 20–40%.[2] Early diagnosis and aggressive treatment is critical to limit the associated morbidity and mortality.

The progression of odontogenic infections to NSTIs is well described, but the frequency of this progression

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and predictive factors are unclear.[3] To better discriminate patients with NSTIs from those with other soft tissue infections, Wong et al. proposed the Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) score[4] . The LRINEC score is a numeric score that ranges from 0 to 13 and is computed using six laboratory indices: C-reactive protein (CRP), white blood cell (WBC) count, haemoglobin (Hb), sodium, creatinine, and blood glucose. Individual point values are summed to give the total LRINEC score (Table 1). With this system, a score ≤5 indicates <50% risk of NSTI, a score of 6–7 indicates 50–75% risk of NSTI, and a score ≥8 indicates a >75% risk of NSTI.

In the original study, which used patient records from two tertiary hospitals over a 5-year period, all patients diagnosed with necrotizing fasciitis were compared with a random cohort of patients diagnosed with cellulitis or abscess. The aetiology and location of the infections was not recorded.[4] Thus, it is unclear whether this diagnostic tool is useful in the early identification of NSTI in its progression from odontogenic infection. It was hypothesized that the LRINEC score would be positively associated with the risk of NSTI in subjects with odontogenic infection. The specific aims of this study were (1) to estimate the frequency at which odontogenic infection progresses to NSTI in an inpatient cohort, (2) to measure the value of the LRINEC score in predicting this progression, and (3) to estimate the inpatient costs associated with managing patients with NSTIs.

Table 1. Laboratory Risk Indicator of Necrotizing Fasciitis (LRINEC).

Laboratory parameter, units	LRINEC score
CRP, mg/l	
<150	0
≥150	4
Total WBC count $\times 10^9$/l	
<15	0
15–25	1
>25	2
Hb, g/dl	
>13.5	0
11–13.5	1
<11	2
Sodium, mmol/l	
≥135	0
<135	2
Creatinine, mg/dl	
≤1.6	0
>1.6	2
Glucose, mg/dl	
≤180	0
>180	1

CRP, C-reactive protein; WBC, white blood cell; Hb, haemoglobin.

Materials and methods

Study design/sample

After obtaining institutional review board approval, the investigators implemented a retrospective cohort study and enrolled a sample derived from the population of subjects who presented to a medical center for the evaluation and management of odontogenic infections between January 1, 2001 and December 31, 2013. To be included in the study sample, the subjects had to have one of the following discharge diagnoses, according to the International Classification of Diseases, Ninth Revision (ICD-9 codes): cellulitis (528.3), cellulitis and abscess of face/neck (682, 682.1), mediastinitis (519.2), neck swelling/mass (784.2), dental caries (521.09), and necrotizing fasciitis (728.86). Alternatively they could have a Current Procedural Terminology (CPT) code for debridement (11,040–11,044, 41,000–41,008, 41,015–41,018, 42,725, 97,597), intraoral/extraoral incision and drainage (21,501), sternal debridement (21,627), open treatment of sternum fracture with or without skeletal fixation (21,825), thoracoscopy (32,651–32,652), creation of pericardial window (33,025), mediastinotomy with exploration (39,000, 39,010), removal of devitalized tissue from wound(s) (97,602), and negative pressure therapy (97,605). A computer search of the electronic medical records was used to identify potential subjects for inclusion. Exclusion criteria were patient age <18 years, any non-odontogenic infection, and patient not pursuing treatment or for whom data were not complete.

Variables

The primary predictor variable was the LRINEC score. The LRINEC score was computed using the parameters described by Wong et al. using admission laboratory values for CRP, WBC count, Hb, sodium, creatinine, and blood glucose.[4] For each patient, the LRINEC score was calculated as the sum of these six laboratory values as per Table 1.

The primary outcome variable was whether or not the patient developed a NSTI and/or descending necrotizing mediastinitis. This was determined by searching for ICD codes 728.86 (necrotizing fasciitis) and 519.2 (mediastinitis), respectively. These diagnoses were confirmed clinically, operatively, and by biopsy of necrotic tissue. The secondary outcome variable was the total dollar amount billed to each subject derived from billing data. The data were collected in a Microsoft Excel spreadsheet (Microsoft, Redmond, WA, USA).

The other study variables were grouped into the following sets: demographic data, patient history, values on admission, presentation, evaluation, treatment, and outcome. The demographic variables were age (years), race (Caucasian, African American, or other), and sex (male or female). Weight (kg), height (cm), and body mass index (BMI, kg/m^2) were also recorded. The patient history variables were history of diabetes (insulin-dependent and non-insulin-dependent), history of dental disease, and other medical/social history (cardiac disease, liver disease, hypertension, chronic obstructive pulmonary disease, asthma, HIV/AIDS, cancer, psychiatric disorder, tobacco use, intravenous drug use, alcohol abuse, and homelessness).

Age was determined by subtracting the date of birth in the demographic information from the date of admission. Sex and race were gathered from the patient demographic information. Weight, height, and BMI were collected from the nursing notes recorded on the day of admission. Medical and social histories were determined from the emergency department notes. Any history of dental disease specifically was determined from the emergency department notes or preoperative notes indicating decay of one or more teeth on admission.

The values recorded on admission were temperature (°C), CRP (mg/l), total WBC count ($\times 10^9$/l), Hb (g/dl), sodium (mmol/l), creatinine (mg/dl), and blood glucose (mg/dl). Temperature on admission was that recorded in the emergency department notes. Admission laboratory data for CRP, WBC, Hb, sodium, creatinine, and blood glucose were obtained from the laboratory results section of the patient's chart.

The presentation variables were the presence of a draining wound (neck or oral), indication of gas on initial imaging, and whether there was airway compromise. Information on the use of imaging was obtained from the radiology section of the patient's chart, and the assessment of gas on imaging was obtained from the radiology report and a review of the imaging. Airway compromise was determined by 'airway involvement' or 'airway deviation' on the radiology report. The evaluation variables were the number and type of imaging modalities