Correlation Between Routine Microbiology Results at Definitive Closure and Wound Infection in Type III Tibia Fractures: Results from a Multicenter, Prospective Cohort Study

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Purpose: Infection remains the most common and significant complication following high-energy fractures. However, we are currently unable to assess the relationship of a subsequent deep infection to the patient's bioburden profile at the time of wound closure and are unable to determine the efficacy / impact of the patient's antibiotic treatment during the hospitalization to the late infection pathogen. The goal of this analysis is to examine the correlation between routine microbiology results at the time of soft-tissue closure with subsequent wound infection.

Methods: Participants (N = 509) with open Gustilo Type III tibia fractures or traumatic amputation were recruited across 33 Level I trauma centers and followed for 6 months following definitive soft-tissue closure. Debrided tissues and swabs collected at the time of the soft-tissue closure were sent for routine microbiology at a central laboratory. Subsequent infections were diagnosed following CDC (Centers for Disease Control and Prevention) criteria, and microbiology results provided by the local hospital laboratories following standard of care procedures. Participants were 71% male, 63% white, 81% polytraumatized, and had a mean age of 39.2 years. Bivariate analyses and multivariate regression techniques were used to examine the relationship between routine microbiology results at baseline and subsequent infection. Bivariate analyses were conducted for 452 participants with baseline microbiology data and regression analyses were performed for 426 records with complete data for outcomes and all covariates.

Results: The overall infection rate was 13.2% (56 of 426). Among 347 participants with negative microbiology results at baseline, the 6-month infection rate was 11.2% (39 of 347). Among 105 participants with positive routine microbiology results at baseline, the infection rate was 19.1% (20 of 105). After adjusting for confounders (polytraumatized, traumatic amputation, smoking status, and wound contamination), participants with positive baseline microbiology results were twice as likely to come back with an infection (odds ratio [OR]: 1.92; 95% confidence interval [CI]: 1.06, 3.50; P = 0.032). Both the presence of surface and imbedded wound contamination noted at the initial debridement (as defined by the Orthopaedic Fracture Classification) were also predictive of infection (ORs of 2.13 and 2.41, respectively; P <0.05 for both). Overall, the percent of positive baseline routine microbiology species matching the species identified at the subsequent infection was 26.9%. The three most common species identified at soft-tissue closure were Enterobacter cloacae, Enterococcus species, and Serratia marcescens, with 3/7, 2/6, and 2/6 returning with subsequent infection with that particular species, respectively. However, by far the most common follow-up infectious species was Staphylococcus aureus, which comprised 30% of infectious species identified (roughly equally split between MRSA [methicillin-resistant S. aureus] and MSSA [methicillin-sensitive S. aureus]), but was only observed in 3 baseline microbiology results, none of which matched to subsequent infections. Interestingly, among participants with

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positive microbiology results at baseline, S. aureus was not a top five species in infected follow-up microbiology results. Instead, Enterobacter species was the most commonly observed, comprising 22% of infectious species identified among participants with positive routine microbiology results at baseline.

Conclusion: Overall, we document a moderate correlation between bioburden (as measured by routine microbiology) at the time of soft-tissue closure and subsequent infection. However, the relationship between pathogens at these time points was weak, with the most common infectious pathogen, S. aureus, being nearly absent in baseline routine microbiology results. This could be related to the perioperative antibiotic selection and short-term suppression, or high biofilm production. The results highlight the limitation of routine microbiology results, and suggest further advancement in this area will require the use of more advanced tools for baseline microbial bioburden identification. Identification of bacteria responsible for late infections is a critical next step to assess the potential of novel local and/or systemic antibiotic strategies.