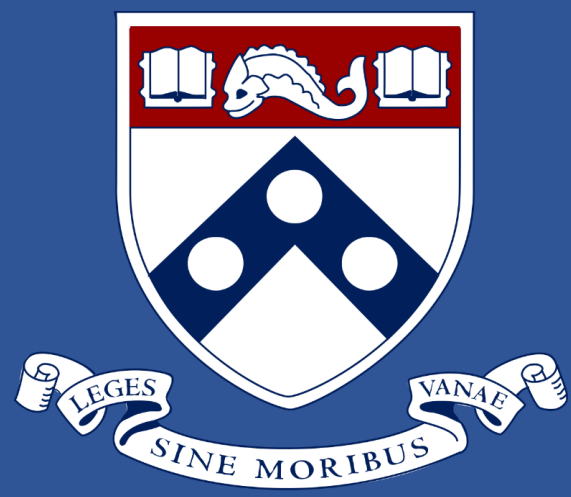


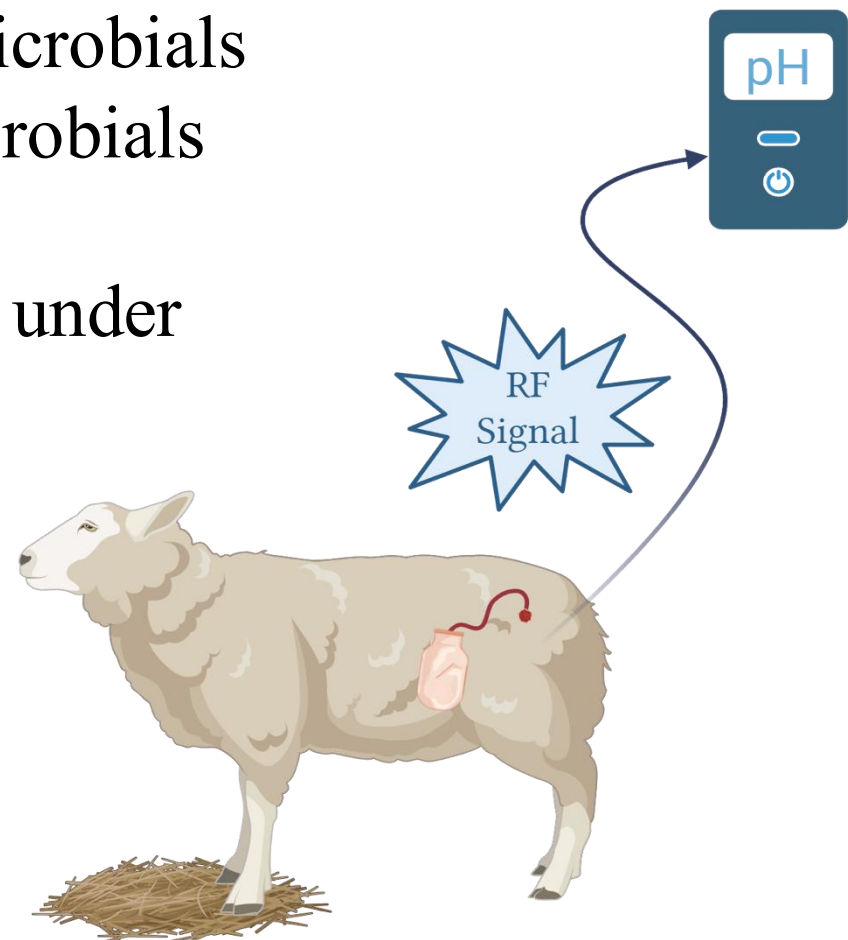


Real-Time pH Monitoring in a Large Animal Model of the Peri-Prosthetic Wound Environment



Introduction

- Previous Assumptions Negatively Impacting Treatment:**
 - periprosthetic joint infection (PJI) wound environment is assumed to be acidic
 - Drives preferential use of β -lactam antimicrobials — a class that loses stability and efficacy outside a narrow pH range.
- Continuous pH Monitoring:**
 - continuous indwelling wireless pH capsule
 - J-P drains
 - 4 experimental cohorts
 - Aseptic +/- Local Antimicrobials
 - Septic +/- Local Antimicrobials
- Goal:** characterize pH dynamics under aseptic and septic conditions, with and without local antibiotics.



Methods and Materials

First, a single hip from four adult female mixed-breed sheep was operated on and evaluated. A wireless pH Capsule Reflux Monitoring System and a J-P drain were sutured in place next to the open coxofemoral joint for continuous pH monitoring and fluid collection. The ndwelling capsule began recording pH data at time zero. The J-P drain was sampled at wound closure (time zero) and every 6-12 hours for 96 hours, as fluid output allowed, then immediately analyzed for pH using a calibrated digital pH meter. Venous blood pH was also recorded. Then, six sheep were enrolled, with a 4-week washout period between surgeries on the left and right hips, respectively. In the 1st hip surgery, sheep underwent a coxofemoral arthrotomy without inoculation prior to a 96 hour data collection period, followed by a 4-week medication washout period. Then the procedure was repeated on the opposite hip, which was inoculated with 3 ml of *Staphylococcus aureus* ATCC 25923 (1×10^5 CFU/mL in PBS) via the JP drain after closure. Three of the six sheep received 250 mg Ceftriaxone Sodium locally via the J-P drain every 24 hours for 96 hours, 24 hours after inoculation. Human samples: 99 human synovial fluid samples were collected during outpatient office visits and at the time of surgery for both index and revision arthroplasty and were analyzed for pH using pH paper. Infection status was unknown for this sampling. Normality tests and homogeneity of variance tests were performed on the data. A simple linear regression model was used to evaluate the relationships among pH, time, infection status, and antimicrobial treatment. Comparisons across time points for parameters such as infection status, antimicrobial treatment, and wound/synovial fluid pH were conducted using repeated-measures analysis of variance, with significance level of $P < 0.05$.

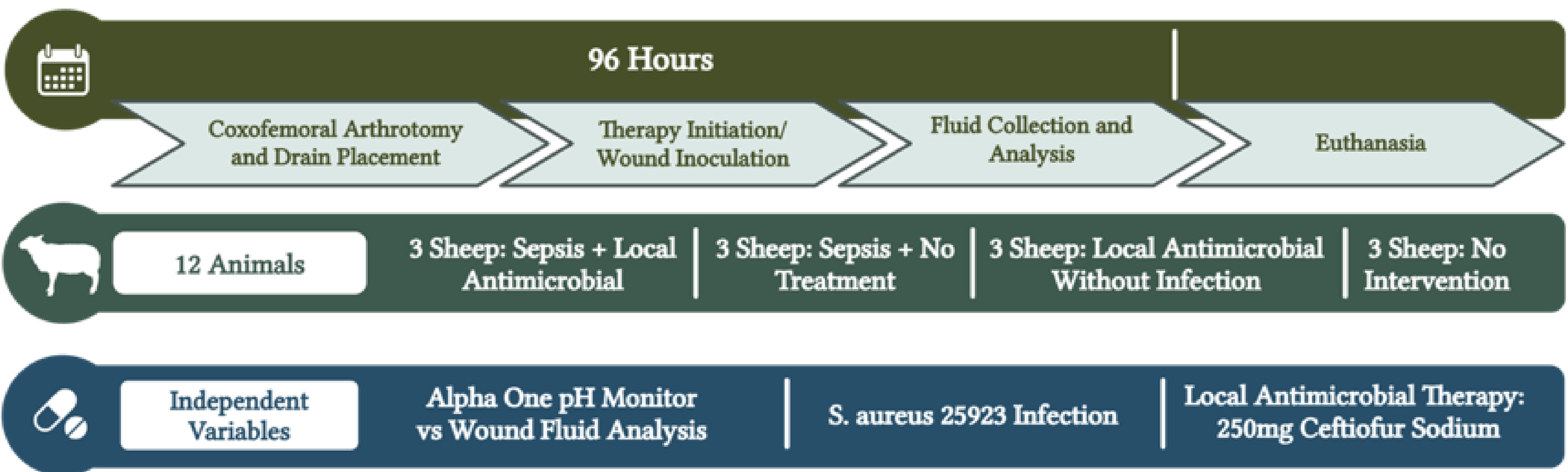
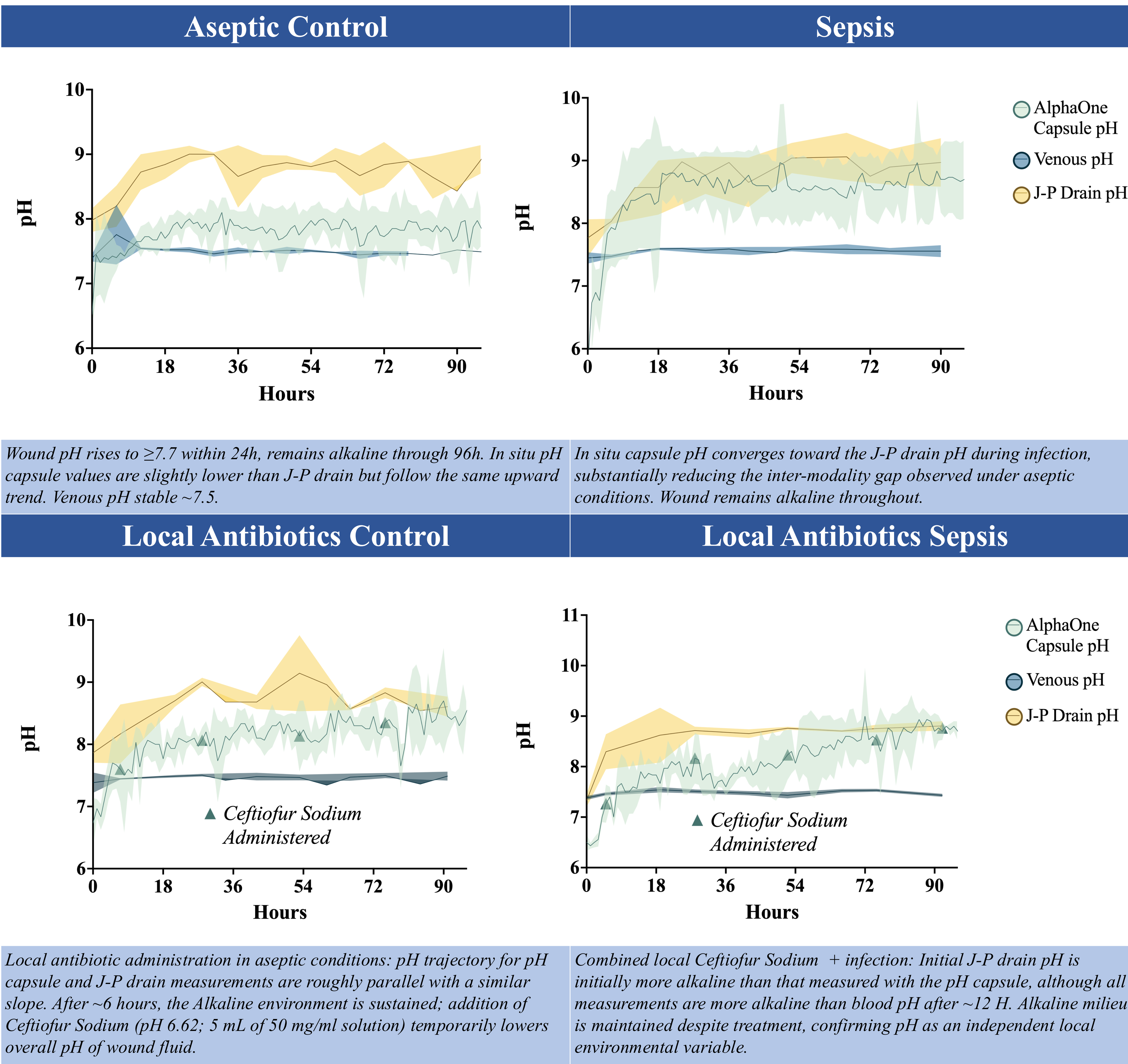


Figure 1 (below): pH over a 96 period for 4 cohorts: Aseptic control, Sepsis (inoculated with 3mL *S. aureus*), Local Antibiotics Control (250mg Ceftriaxone Sodium administered by J-P drain every 24 hours), and Local Antibiotics Sepsis



Results

All animals completed the study. The AlphaONE System produced continuous pH readings for 96 hours. The starting pH ranged from pH 6.3 to pH 7.8. Across all cohorts, postoperative wound fluid pH was consistently alkaline (≥ 7.7 after 24h). The venous pH was stable at ~ 7.5 . Infection effect: In situ pH closely converged with J-P drain pH in septic cohorts but less so in aseptic cohorts, suggesting infection reduces wound fluid compartment gradients. In human wound fluid/synovial samples, the mean pH, independent of underlying pathology, was alkaline, centered at pH 7.9. The correlation between changes in pH and wound fluid status over time and across treatment groups (infected, non-infected, +/-antimicrobial treatment) was not statistically significant.

Discussion

The environment created in the postoperative period differs from that of the native joint, posing a unique set of environmental stressors for opportunistic pathogens. One reason septic joints and/or PJI are notoriously hard to treat may be the decreased effectiveness of antimicrobials in the alkaline local environment, suggesting that pH should be considered when developing a clinical diagnostic or treatment plan for septic joints and/or infected arthroplasty patients. While the early postoperative period may represent a "golden window" of transient acidity supporting β -lactam efficacy, pH rises to ≥ 7.7 within 24 hours, diminishing that activity. Aminoglycosides, which retain efficacy across a broader pH range, warrant greater consideration for sustained local PJI treatment, and these findings support pH-informed antibiotic selection. Our findings may guide the exploration of mechanistic, diagnostic, and therapeutic questions addressing septic joints, PJI, and joint cross-talk.

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