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# A Survey of Orthopedic Surgical Management of Pressure Ulcer–Related Pelvic Osteomyelitis

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Pressure-ulcer related pelvic osteomyelitis is managed with little high-quality evidence. We undertook an international survey of orthopedic surgical management, covering diagnostic parameters, multidisciplinary input, and surgical approaches (indications, timing, wound closure, and adjunctive therapies). This identified areas of consensus and disagreement, representing a starting point for future discussion and research.

**Keywords.** decubitus ulcer; pelvic osteomyelitis; pressure ulcer; sacral osteomyelitis.

Pressure-ulcer related pelvic osteomyelitis (POM) is a challenging condition associated with high morbidity and mortality rates [1, 2]. Management often involves prolonged and complicated antimicrobial therapy [1, 2]. Surgical management is difficult owing to anatomic constraints of the pelvis, associated patient comorbid conditions, and the risk of recurrence [1, 2]. It remains a relatively under-researched condition.

Wong and colleagues [3] systematically reviewed available data from observational studies and reported several important observations: (1) neither exposed bone nor magnetic resonance (MR) imaging findings are synonymous with histologically confirmed osteomyelitis and (2) antimicrobial therapy may not be beneficial if surgical wound closure will not be

attempted. Kaka and colleagues [4] surveyed 558 infectious diseases (ID) physicians in North America, identifying heterogeneous approaches to diagnosis and medical management of POM; about 10% of their respondents identified the role, timing and type of surgery as key knowledge gaps.

Recognizing that surgical management is a challenging and uncertain area and considering the frequent interface between orthopedic surgeons and infection specialists in such cases, we undertook a survey of orthopedic surgical management of this disease to complement the work by Kaka and colleagues [4]. Our findings were presented in part at the 2022 meeting of The European Bone and Joint Infection Society [5].

## METHODS

An 18-question multiple-choice questionnaire was designed initially by 3 of the authors (C. D. R., S. T. J. T., and R. K. S.). Through iterative feedback from remaining authors, the final version was agreed. POM was defined as “a clinical/radiological diagnosis of osteomyelitis involving the ischium, sacrum, coccyx, pubic ramus or proximal femur underlying and considered to be related to a pressure (decubitus) ulcer.” Likert-type scale responses were used for questions with graded responses (eg, never/fewer than half of patients/around half of patients/more than half of patients/every patient). On 23 February 2021, the online survey (Google Forms; Alphabet) was sent to members of the Musculoskeletal Infection Society, the European Bone and Joint Infection Society, and the European Society of Clinical Microbiology and Infectious Diseases Study Group for Implant-Associated Infections. No incentive for participation was provided. Two follow-up electronic reminders were sent at 2-week intervals. The survey closed on 13 July 2021. Statistical analyses were performed using GraphPad Prism software, version 9.5.0 (GraphPad Software).

## RESULTS

In total, 41 orthopedic surgeons completed the questionnaire (Table 1). Respondents were mostly from Europe (n = 18) and the United States (n = 10). Most (29 of 41) had between 5 and 24 years of experience in practice. The number of patients with POM treated in the last year varied from none to ≥10. Most respondents worked in tertiary or academic hospitals.

Concerning diagnosis, a high priority was attached to bone sample microbiological and histological findings (Figure 1A). A very low priority was attached to culture-positive superficial swab samples ( $P < .001$  compared with culture-positive bone biopsy). Palpable bone was also considered a high priority for diagnosis, but more so in the absence of periosteal covering ( $P = .006$  compared with palpable bone with periosteal covering).

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**Table 1. Respondent Characteristics**

Characteristic	Respondents, No.
Time practicing orthopedic surgery, y	
<5	5
5–14	13
15–24	16
≥25	7
No. of patients with POM treated in past year	
None	8
1–5	13
6–10	8
≥10	11
Missing	1
Geographic location	
Europe (excluding the UK)	18
USA	10
UK	4
Other	9
Type of hospital	
Outside the USA	
Tertiary	26
Secondary	2
Private	2
USA	
Academic	8
City/county	2

Abbreviation: POM, pelvic osteomyelitis.

Receipt of multidisciplinary input was high overall (Figure 1B), especially from plastic surgery during the index procedure (n = 31; more than half of cases or always) and tissue viability nursing/wound care (n = 29; more than half of cases or always). Input from occupational therapy was lower (n = 26; in half of cases or fewer).

When identifying patients likely to benefit from surgical intervention (Figure 1C), source control for sepsis (most influential parameter in 24 of 41) had the greatest influence, followed by abscess/collection and then wound closure. Concerning the timing of surgery when it was determined surgical intervention was to be undertaken (Figure 1D), most respondents favored operating after control of acute infection and after physiological or psychological optimization. There was variation in what was considered the minimal extent of surgical debridement. Most respondents considered this to be marginal bone debridement (dissection to bleeding bone; 28 of 41). However, similar numbers considered the significantly different options of soft-tissue debridement (6 of 41) and wide local bone debridement (clearance of >5 mm beyond extent of infection; 5 of 41) to be the minimum. One respondent answered with intralesional bone debridement. Urinary and fecal diversion procedures and implanted antimicrobials were used infrequently (Figure 1E). The most favored wound closure technique was local or regional primary tissue transfer, rather than free flaps, but there was substantial variability in responses (Figure 1F).

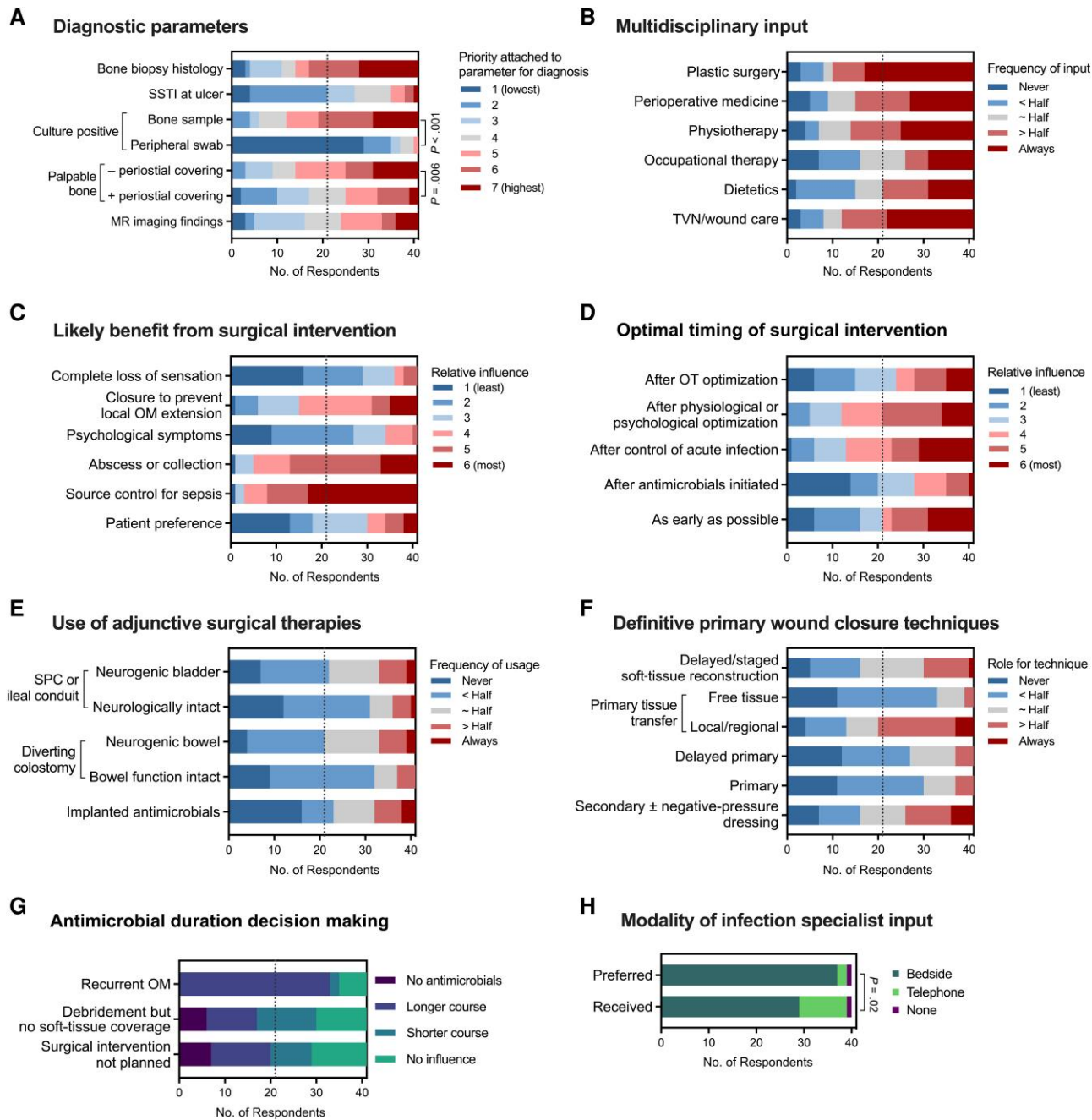
Regarding decision making about duration of antimicrobial therapy (Figure 1G), there was agreement that recurrent osteomyelitis was an indication for a longer antimicrobial course. However, there was no clear agreement on the appropriate duration if soft-tissue coverage could not be achieved after debridement or if no debridement was planned (with almost equal numbers favoring “longer” and “shorter” durations). Infection specialist input was received by 34 of 41 respondents in all cases, 2 of 41 in more than half, 3 of 41 in fewer than half, and 1 of 41 never. The majority of respondents received this input as a bedside consultation, and this modality was preferred to telephone advice ( $P = .02$ ; Figure 1H).

Respondents had variable experience of treating POM in the preceding year, so we stratified responses based on this (Supplementary Figure 1) and compared responses specifically between those who had and those had not treated patients with POM in the preceding year (Supplementary Table 1). Respondents with more experience attached less priority to MR imaging findings and local findings of soft-tissue infection and more to palpable bone lacking periosteal covering. Such respondents were also less likely to favor surgical intervention as early as possible (instead favoring intervention after antimicrobials, optimization, and control of acute infection). Compared with respondents who had treated no patients in the preceding year (n = 8), those who had treated patients in the last year (n = 32) favored primary wound closure with local or regional tissue transfer (19 of 32 vs 1 of 8, respectively, responded that there was a role for the technique more than half of cases or always;  $P = .04$ ).

## DISCUSSION

Several consistent opinions among surveyed orthopedic surgeons were identified. Preferred diagnostic approaches are bone sample microbiological and histological findings and palpation of bone lacking a periosteal covering. Multidisciplinary team input is frequently used, especially plastic surgery and tissue viability/wound care nurse specialists, and the benefits of this approach have been reported elsewhere [6, 7]. Source control of sepsis, drainage of abscess/collection, and obtaining wound closure are the most influential indications for surgery. Advantages of wound closure include meeting the patient’s objective and to prevent recurrent infections or malignant change [2, 8]. Timing of surgery was preferred, following control of acute infection and physiological or psychological optimization. Bedside input from an infection specialist was considered desirable and usually received.

Regarding diagnosis, compared with the survey of ID physicians [4], we found that a similarly low priority was attached to culture-positive superficial wound swab samples and a high priority to bone sample culture and histopathology results. A systematic review has found that a positive culture result



**Figure 1.** Questionnaire responses. *A*, Responses to “What relative degree of priority do you attach to the following parameters when diagnosing pressure-ulcer related pelvic osteomyelitis?” Comparisons were made using Mann-Whitney test. *B*, Responses to “How often do you receive input from the following specialties in the management of patients with pressure ulcer-related pelvic osteomyelitis?” and “How often do you obtain surgical input from a plastic surgeon during the index procedure?” *C*, Responses to “Rank the relative influence of each variable on identifying which patients are likely to benefit from surgical intervention” (respondents could assign the same rank to multiple variables). *D*, Responses to “Rank the relative influence of each variable on the optimal timing of surgical intervention” (respondents could assign the same rank to multiple variables). *E*, Responses to “How often do you use the following adjunctive surgical therapies?” *F*, Responses to “Select whether there is a role for the following primary definitive surgical wound management techniques.” *G*, Responses to “What antimicrobial approach would you use in the following scenarios?” (“Longer” was defined as >2 weeks, and “shorter” as ≤2 weeks.) *H*, Responses to “Which modality of infection specialist input do you most commonly receive?” and “Which modality of infection specialist input would you prefer to receive?” Responses were compared using Fisher exact test (for telephone vs bedside). Vertical dotted line represents mark  $n = 21$  on the x-axis. The denominator is  $n = 41$  responses for all panels, except *H*, where  $n = 40$ . Abbreviations: MR, magnetic resonance; OM, osteomyelitis; OT, occupational therapy; SPC, suprapubic catheter; SSTI, skin and soft-tissue infection; TVN, tissue viability nursing.

from a bone sample is sensitive for diagnosis of POM when compared with histopathology (76%–100% sensitivity), but lacks specificity (8%–67%), possibly reflecting contamination during sampling [9], a concern with radiologically guided sampling. It is particularly difficult to obtain uncontaminated bone samples in POM with large open ulcers. ID physicians considered palpable bone at the ulcer base or positive probe to bone test to be strongly indicative, whereas surgeons attached greater priority to palpable bone specifically lacking periosteal covering. There was disagreement on the utility of MR imaging. Although MR imaging was ranked as the first test to choose by 24% of ID physicians, in our survey MR imaging findings received a median score of 4 (interquartile range 3–5, on a scale of 1 [lowest priority] to 7 [highest]). MR imaging is known to have poor specificity (22%) for identifying histologically confirmed POM owing to the confounding effect of bone remodeling [10].

Multiple questions arose from the responses regarding management strategies. Occupational therapy and dietetic colleagues may be underused in the multidisciplinary approach to management. Adjunctive surgical therapies are used infrequently but could be beneficial in selected cases. This may be because of concerns that temporary fecal diversion may be difficult to reverse and patients may find it difficult to regain bowel control. However, such diversion may be useful in patients with fecal incontinence. Although local or regional soft-tissue transfer was the preferred method of wound closure, there was a wide range of responses, which differed by the respondent's experience.

Data support a shorter postoperative antimicrobial course (5–7 days) if flap coverage has been achieved and indicate no benefit from antimicrobial treatment if coverage is not to be attempted [3, 11]. However, there was substantial heterogeneity regarding the impact of surgical intervention on antimicrobial duration in our survey (Figure 1G). In the survey of ID physicians by Kaka and colleagues [4], duration of antimicrobial therapy was stratified by extent of debridement (full vs no [or partial] debridement), but wound closure was not specified. Responses to this question indicated that some ID physicians recommend a longer antimicrobial course if no or partial debridement is undertaken rather than full debridement, despite data indicating lack of benefit in this scenario [3]. Combined with our survey findings, this indicates an opportunity to improve stewardship practices when debridement and wound closure are not to be undertaken. Orthopedic surgeons are likely to follow guidance from infection specialists regarding treatment duration, so it is noteworthy that in another area of orthopedic infection (fracture-related infection), antimicrobial regimens in one series were reported to follow published guidelines in only 25% of cases [12].

A significant limitation of this work is the number of respondents. Although this likely reflects the limited interest in the condition from a surgical perspective, it also indicates a risk of selection bias. This is a complex disease, and a pragmatic

survey cannot capture the multitude of factors that will influence decision making about surgical management. We did not stratify by cause of pressure ulceration (eg, spinal cord injury or multiple sclerosis) or extent of sensory loss. Future work could be to seek the opinions of other surgical specialists who manage this condition, such as plastic surgeons.

In summary, this international survey of orthopedic surgical management of POM has identified areas of consensus and disagreement, both among orthopedic respondents and compared with an earlier survey of ID physicians. This represents a starting point for future discussion about management approaches and for formulating clinical trial questions to ultimately inform guidelines for management.

### Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

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### References

- Russell CD, Tsang SJ, Simpson AHRW, Sutherland RK. Outcomes, microbiology and antimicrobial usage in pressure ulcer-related pelvic osteomyelitis: messages for clinical practice. *J Bone Jt Infect* 2020; 5:67–75.
- Dudareva M, Ferguson J, Riley N, Stubbs D, Atkins B, McNally M. Osteomyelitis of the pelvic bones: a multidisciplinary approach to treatment. *J Bone Jt Infect* 2017; 2:184–93.
- Wong D, Holtom P, Spellberg B. Osteomyelitis complicating sacral pressure ulcers: whether or not to treat with antibiotic therapy. *Clin Infect Dis* 2019; 68:338–42.
- Kaka AS, Beekmann SE, Gravely A, Filice GA, Polgreen PM, Johnson JR. Diagnosis and management of osteomyelitis associated with stage 4 pressure ulcers: report of a query to the Emerging Infections Network of the Infectious Diseases Society of America. *Open Forum Infect Dis* 2019; 6:ofz406.
- Russell CD, Tsang SJ, Dudareva M, et al. Pressure ulcer-related pelvic osteomyelitis: survey of orthopaedic management. *Orthop Proc* 2022; 104-B(suppl 10):76–76.
- Ferguson J, Alexander M, Bruce S, O'Connell M, Beecroft S, McNally M. A retrospective cohort study comparing clinical outcomes and healthcare resource utilisation in patients undergoing surgery for osteomyelitis in England: a case for reorganising orthopaedic infection services. *J Bone Jt Infect* 2021; 6:151–63.
- Vasoo S, Chan M, Sendi P, Barbari E. The value of ortho-ID teams in treating bone and joint infections. *J Bone Jt Infect* 2019; 4:295–9.
- Corrigan RA, Barlow G, Hartley C, McNally M. Squamous cell carcinoma complicating chronic osteomyelitis: a systematic review and case series. *Surgeon* 2022; 20:e322–37.
- Chicco M, Singh P, Beitverda Y, Williams G, Hirji H, Rao GG. Diagnosing pelvic osteomyelitis in patients with pressure ulcers: a systematic review comparing bone histology with alternative diagnostic modalities. *J Bone Joint Infect* 2020; 6:21–32.
- Brunel AS, Lamy B, Cyteval C, et al. Diagnosing pelvic osteomyelitis beneath pressure ulcers in spinal cord injured patients: a prospective study. *Clin Microbiol Infect* 2016; 22:267.e1–e8.
- Dinh A, D'Anglejan E, Leliepvre H, et al. Short antibiotic treatment duration for osteomyelitis complicating pressure ulcers: a quasi-experimental study. *Open Forum Infect Dis* 2023; 10:ofad088.
- Corrigan R, Slieden J, Rentenaar RJ, et al. The effect of guideline-based antimicrobial therapy on the outcome of fracture-related infections (EAT FRI study). *J Infect* 2023; 86:227–32.