

Reducing PICC Placement in Pediatric Osteomyelitis: A Diamond in the Deimplementation Rough?

Jessica J. Truelove, DO,^{a,b} Samantha A. House, DO, MPH^{a,b}

Acute osteomyelitis is a common condition among children and is associated with intensive health care resource use.¹ The practice of treating pediatric osteomyelitis with long-term intravenous antibiotic therapy, typically achieved through placement of a peripherally inserted central catheter (PICC), has been questioned in recent years. In multiple comparative effectiveness studies, researchers have failed to identify differences in patient outcomes when comparing prolonged intravenous therapy to oral antimicrobial therapy while at the same time bringing to light the harms associated with peripherally inserted central catheter lines.^{2–7} Although the available evidence supports a practice shift away from long-term parenteral therapy, less is known about the extent to which this evidence is influencing actual population-based trends.

In this month's *Hospital Pediatrics*, Shaikh et al⁸ identify important changes in pediatric osteomyelitis care over the last decade. The authors used the National Inpatient Sample database, a publicly available, all-payer database approximating a large sample of discharges from US hospitals, to derive weighted national estimates of health care use patterns for acute osteomyelitis from 2007 to 2016. They identified a rising proportion of osteomyelitis hospitalizations over this time period, from 42.9 to 81.5 per 100 000 hospitalizations, presumably related to increasingly sensitive diagnostic modalities, such as MRI. This increase in incidence coincided with a sharp decline in PICC placement rates in osteomyelitis patients, from 58.8% to 5.9%. Multivariate analysis failed to reveal any significant change in length of stay (LOS) or inflation-adjusted hospital cost over the study period, although PICC placement was associated with both increased LOS and cost. The work by Shaikh et al⁸ contributes important information around what appears to have been a paradigm shift occurring in pediatric osteomyelitis care.⁸

A pause for reflection is warranted with the findings of this study. A nearly 10-fold reduction in PICC placement for osteomyelitis over less than a decade should be viewed as a tremendous success. Although Shaikh et al⁸ are the first to assess this trend in a population-based sample, recent literature confirms these findings in other cohorts. Fenster et al, using the Pediatric Health Information System database, identified a decrease in the percentage of patients with osteomyelitis treated with postdischarge intravenous antibiotics from 61% in 2000 to 22% in 2018.⁹ Yi et al identified a decrease in PICC rates for children with osteomyelitis and septic arthritis from 56% in 2009–2012 to 26% in 2012–2015 at 2 large, freestanding children's hospitals.⁷ The lower rates of PICC placement at the conclusion of the study period in the National Inpatient Sample data, as

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Address correspondence to Jessica J. Truelove, DO, Dartmouth-Hitchcock Medical Center, One Medical Center Dr, Lebanon, NH 03756.

E-mail: drjtruelove@gmail.com

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^aDepartment of Pediatrics, Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire; and ^bGeisel School of Medicine, Dartmouth College, Hanover, New Hampshire

compared with those observed in freestanding children's hospitals, may be related to differential acuity between these samples, although further investigation into the drivers of these differences may be informative. Nonetheless, with a rising incidence of osteomyelitis diagnoses and cited rates of PICC complications in this population ranging from 15% to 41%,^{2,5} this practice change has the potential to prevent thousands of children from experiencing unnecessary harm. For pediatric osteomyelitis, the tides have turned quickly: but why?

Deimplementation, or the elimination of low-value care practices, has garnered increasing attention in recent years because the prevalence of low-value care and its associated harms have become more apparent.¹⁰ Deimplementation is typically challenged by both intrinsic elements of the health care system and cognitive barriers that decrease provider comfort with relinquishing established practices.^{10,11} In many published frameworks, researchers have synthesized available literature to offer proposed facilitators for successful deimplementation.^{11–14} Interestingly, some of these key strategies are notably absent in the story of PICC reduction for osteomyelitis. Although a highly structured approach, incorporating elements from implementation science, is generally perceived as necessary for successful deimplementation,^{13,15} there are relatively few published quality reports in which initiatives aiming to increase early transition to oral antibiotics for osteomyelitis are described,^{16–21} particularly as compared with the volume of published quality improvement work in which other common inpatient pediatric conditions are targeted. High-level evidence, and specifically the existence of clinical practice guidelines, is a factor commonly cited as being critical to successful deimplementation.^{11–14} Yet pediatric osteomyelitis lacks a society-sponsored clinical practice guideline. Furthermore, the preponderance of available literature to support early transition to oral antibiotics is derived from retrospective data,^{3–5} with only a

small amount of prospective data to support the efficacy of the practice.^{22–24}

With key elements for successful deimplementation lacking, we are left to consider what drove the rapid reduction in PICC use noted in this study. One possible explanation is the overt harm associated with PICC placement, which has been previously identified as an important facilitator of practice discontinuation.^{10,11} Ruebner et al found that 41% of patients with osteomyelitis receiving >2 weeks of intravenous antibiotic therapy developed a catheter-associated complication, with 26% of patients developing concerns for line-related infection.² Researchers have corroborated these findings in subsequent studies, which have consistently revealed higher rates of treatment complications, emergency department visits, and readmissions among children with musculoskeletal infections who receive a PICC line, as compared with those receiving early transition to oral therapy.^{3,5,7} The direct harm children are exposed to from PICC placement appears to exceed the visible harm associated with many low-value pediatric services; perhaps PICC placement in osteomyelitis is a scenario for which available evidence of harm is persuasive enough to overcome resistance to deimplementation of well-established practices.

Although obvious harm may be an intuitive driver of this impressive decline, there are other aspects of osteomyelitis care that may make this condition particularly amenable to deimplementation efforts. The inpatient setting may offer time and opportunity to have meaningful conversations about treatment options, benefits, and harms discrepant from that in some clinical spaces. Lack of time is frequently cited as a barrier to deimplementation^{13,14}; this may be disproportionately problematic in settings with high turnover. The field of pediatric hospital medicine has a clear focus on high-value care; the rapid growth observed in our field^{25,26} and increased involvement in the care of this patient population, across both community and children's hospitals, may also have an important impact. Unique characteristics of

particular diseases, patient groups, providers, and clinical care settings have all been related to deimplementation success,^{13,14} but their specific role in the reduction of PICC placement for children with osteomyelitis remains speculative.

Despite the reduction in PICC use, and the association between PICC placement and both increased hospital LOS and cost, Shaikh et al⁸ found no significant changes in these outcome measures over time. The authors speculate that current LOS may be justified for this diagnosis, acknowledging time needed for workup, culture results, and monitoring for therapeutic response. The LOS at the end of this study period is 4.3 days, which is lower than most published estimates and certainly reflects long-term decreases.^{1,2,5,19} There may still be room to move the needle on LOS, however. In a recent study, Cotter et al used the Pediatric Health Information System database to identify opportunities for earlier transition to enteral antibiotic therapy across conditions. "Opportunity days," defined as those during which patients received parenteral antibiotics and at least 1 enteral nonantibiotic medication (supporting the ability to tolerate oral medications), accounted for 69% of osteomyelitis patient days.²⁷ Although clinical improvement and down-trending inflammatory markers typically guide the transition to oral antibiotics, approaches to this process remain variable.^{5,9,27} Continued assessment of the optimal duration of intravenous therapy may identify opportunities to further reduce LOS. Given that the cost of bed occupancy composes a majority of total hospitalization cost,²⁸ this is the most feasible route toward achieving cost reduction associated with the inpatient episode. With overall hospitalization costs rising rapidly in the United States, cost stability for osteomyelitis hospitalizations may be perceived as positive.²⁹

The data provided by Shaikh et al⁸ may help us pose broader questions around pediatric deimplementation efforts. Further investigation of physician experiences with transition to oral antibiotics for children with osteomyelitis, particularly through a

qualitative lens, may elucidate important facilitators of this unique success that could inform deimplementation efforts across conditions. The marked reduction in PICC placement should be celebrated but not met with complacency; current data continue to reveal wide variation in care patterns and opportunities for care improvement among children with osteomyelitis.^{9,27} The rapid practice change observed in this study emphasizes the importance of longitudinal measurement of low-value services on a population basis. Regular measurement is needed to establish improvement targets and prioritize deimplementation initiatives. Finally, the results of this study bring to light the importance of a focus on patient harm as we approach low-value care practices, which may prove more powerful than focusing on cost.

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