The appropriateness of X-ray referrals of osteomyelitis and its timely management with antibiotics: a service evaluation

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Key words

- Antibiotic therapy
- Appropriate referral
- Osteomyelitis
- Podiatry service evaluation
- X-ray

Article points

1 Prevalence of prescribing bone penetrating antibiotics when osteomyelitis is suspected is low

2. Education and training with respect to the signs and symptoms of osteomyelitis is required within the podiatry profession

3. The formulation of firm guidance is required to standardise care and improve outcomes.

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Background: Osteomyelitis is a frequent occurrence in the high-risk foot, which if not detected early and managed appropriately, can lead to severe complications for patients. Alongside the clinical signs and symptoms of infection, X-rays are the most commonly used tool to confirm diagnosis in practice. Aim: A service evaluation was conducted to ascertain whether clinicians are safely and appropriately referring patients for X-ray with suspected osteomyelitis, and whether suitable management is instigated at the point of clinical diagnosis. Method: X-ray cards that questioned the presence of osteomyelitis, requested between the period of April 2020 to April 2021, were reviewed within a community podiatry service in the NHS. Results: A total of 40 X-ray request cards were analysed, with 5% (*n*=2) providing no clinical detail to rationalise referral, 45% (*n*=18) outlining one reason, and 50% (*n*=20) detailing more than one clinical detail to justify referral. The most common clinical finding to support referral was the presence of a chronic wound (*n*=21, 53%). A total of 12 (30%) were confirmed to have osteomyelitis, a positive probe-to-bone test being found to be the most indicative rationale (*n*=7, 64%). Only 10% (*n*=4) had commenced bone-penetrating antibiotics at the time of referral. Conclusion: Education and the development of guidance for clinicians within the community podiatry service is required to advance knowledge when assessing wounds for the presence of osteomyelitis and to promote timely instigation of antibiotics. This is necessary to improve the appropriateness and detail of X-ray referral requests to champion patient safety and enhance patient outcomes.

Osteomyelitis is common in patients with conditions that predispose the foot to ulceration, in particular, diabetes mellitus where infection affects an estimated 60% of foot ulcers (Geerlings and Hoepleman, 1999; Giurato et al, 2017; Lew and Waldvogel, 2004; Mandell et al, 2018; Berbudi et al, 2020). Infection in the high-risk foot can have catastrophic consequences routinely leading to delayed healing, extensive use of antibiotics, hospitalisation, amputation and increased risk of premature death (Rajbhandari et al, 2001; Lavery et al, 2007; Boffeli, 2015; Dinh et al, 2016; Mutluoglu et al, 2017; Mandell et al, 2018). Prompt and accurate diagnosis of osteomyelitis is imperative to initiate intervention more efficiently, enhance healing rates and prevent deterioration. This can prove challenging in clinical practice due the lack of consensus and evidence around a strict criterion to help inform diagnosis.

This difficulty is exacerbated in the high-risk foot as clinical signs of infection are often dampened due to the underlying pathophysiology, subduing the usual inflammatory response (Jeffcoate and Lipsky, 2004; Lavery et al, 2007). It is important clinicians are, therefore, aware that infection may present in more subtle ways when assessing for the presence of osteomyelitis (Lozano et al, 2010). The International

Wound Infection Institute (IWII) (2016) has outlined these subtle features to help guide clinicians with respect to signs and symptoms of infection. Although these indicate subtle signs of infection, they are not specific to determine osteomyelitis.

The probe-to-bone test (PTB) has been identified as a determined diagnostic clinical indicator of osteomyelitis, whereby a sterile metal probe is inserted into the wound to establish contact with bone (Rajbhandari et al, 2001; Jeffcoate and Lipsky, 2004; Lavery et al, 2007; Hartemann-Heurtier and Senneville, 2008; Lozano et al, 2010; Sánchez et al, 2010; Mutluoglu et al, 2017; IWGDF, 2019). The research evidence is conflicting with respect to the efficacy of the PTB test in its ability to accurately diagnose osteomyelitis (Jeffcoate and Lipsky, 2004; Lavery et al, 2007; IWGDF, 2019).

Despite the opportunity for potential error, it has been deemed a useful indicator in combination with other clinical features and is a low-cost and uncomplicated skill to learn (Lavery et al, 2007). A 'sausage toe' is another clinical sign of osteomyelitis which includes: swelling, erythema, destruction of the normal contour (Rajbhandari et al, 2001; Dinh et al, 2006; Hartemann-Heurtier and Senneville, 2008; Mutluoglu et al, 2017). The appearance of a sausage toe alone cannot be used exclusively to make a definitive diagnosis of osteomyelitis due to the limited evidence available investigating the sensitivity and specificity to predict diagnosis (Rajbhandari et al, 2001).

The clinical signs and symptoms of infection, independently, do not hold much gravity in the high-risk foot, however, as a collective are more persuasive to predict diagnosis and should prompt a high index of suspicion for osteomyelitis. Clinicians should only refer patients for X-ray in the presence of clinical signs and symptoms of osteomyelitis, in which instance, bone-penetrating antibiotics should be instigated at the point of suspicion. The clinical presentation of infection should prompt early prescribing of antibiotic therapy to manage the bioburden and prevent deterioration (Hartemann-Heurtier and Senneville, 2008). Research has found that osteomyelitis in the high-risk foot is proceeded by infected soft tissue foot ulceration, whereby antibiotic therapy should be implemented as per national guidance (Hartmann-Heurtier and Senneville, 2008; NICE, 2019).

In order to champion patient safety, efficacy of referral and appropriately manage resources, this service evaluation aims to investigate the rationale of which clinicians are writing on X-ray cards when suspicious of osteomyelitis. The evaluation also intends to appraise whether bone-penetrating antibiotics were instigated at the time of X-ray request and aims to propose a suitable criteria for requesting X-ray when clinically

indicated for osteomyelitis (Rajbhandari et al, 2001; Lozano et al, 2010). A study by Santana et al (2020) appraising patterns of expenditure across 14 healthcare locales in the NHS, reported that 7% of total NHS expenditure was spent on diagnostics and therapeutics, which included radiology and X-ray.

Method

A service evaluation was carried out in a community podiatry service within the NHS, reviewing all X-ray request forms between April 2020 and April 2021. Ethical approval was sought and gained from the Research and Development (R&D) department of the NHS Trust where the service was conducted. This community podiatry service is commissioned to manage patients with a high-risk foot and the X-rays can be requested by all qualified podiatrists working within the high-risk team who have completed IR(ME)R training.

Since there is no standardised criteria for what clinical details should be included on an X-ray card, the service evaluation strove to establish current practice and measure this in comparison to the various suggested clinical signs of osteomyelitis in the high-risk foot, which were identified in the literature review.

Each X-ray requested within the allocated period (April 2020 to April 2021) was evaluated. X-ray request cards were eligible for inclusion in the evaluation if osteomyelitis, or clinical signs, were noted on the form within the community podiatry service between April 2020 and April 2021. X-ray request cards were not considered for inclusion if they met any of the following criteria: if the preferred diagnosis was not osteomyelitis (such as, Charcot neuroarthropathy and fracture), requests prior to April 2020, and requests whereby the patient failed to attend the X-ray examination.

Data collected were analysed descriptively using SPSS IBM (Statistical Package for the Social Sciences).

Results

A total of 60 X-ray requests were forwarded to radiology during the period of the April 1, 2020 to April 1, 2021, of which 40 X-ray request were eligible for inclusion. Twenty (33%) patients were excluded from the evaluation for not meeting the criteria, 10 were suspicious of Charcot neuroarthropathy, three fracture and seven patients failed to attend for X-ray.

Primary outcome

The primary outcome of the service evaluation was to assess the appropriateness of the X-ray request. Of the 40 X-ray request cards analysed, 5% (*n*=2) provided no clinical detail to rationalise referral, 45% (*n*=18) outlined one reason, while 50% (*n*=20) provided more than one clinical detail to justify referral.

The rationale for referral to X-ray were based on the clinical presentation of the wound. The most common clinical finding to support referral was the presence of a chronic wound (*n*=21, 53%), followed by swelling (*n*=12, 30%), PTB (*n*=11, 28%) and erythema (*n*=11, 28%), indicated in *Table 1*.

Table 1: Summary of the reasons provided for X-ray requested with suspected osteomyelitis.

Rationale	Frequency (%)
Wound probed to bone	11 (27.5)
Chronic wound	21 (52.5)
Presence of infection	5 (12.5)
Sausage toe	3 (7.5)
Hypergranulation	2 (5)
Pus	1 (2.5)
Swelling	12 (30)
Erythema	11(27.5)
Increased temperature	4 (10)
Pain experienced	1 (2.5)

Of the 40 referral requests, 30% (*n*=12) were confirmed to have osteomyelitis, with 70% (*n*=28) of the X-ray findings reporting no radiological signs of osteomyelitis present. The most favoured clinical details outlined on the request forms that was confirmed on X-ray was those that reported the ability to PTB with 64% (*n*=7) of the 11 confirmed as osteomyelitis following X-ray, indicated in *Table 2*. Of the 12 that were confirmed by X-ray to have osteomyelitis, the two other most frequently reported clinical signs and symptoms on X-ray request were chronic wound (*n*=5, 42%) and swelling (*n*=5, 42%) 58% (*n*=7).

Secondary outcome

The secondary outcome was to determine whether practitioners commenced antibiotic therapy at the point of referral for X-ray in patients with suspected osteomyelitis. Only 10% (*n*=4) of the 40 cases reviewed requested patients to commence a bone penetrating antibiotic. Of these four, 100% of the

Table 2: Summary of the number of those confirmed with osteomyelitis and the clinical rationale against the total overall percentage confirmed on X-ray.

Clinical detail	Number outlined on x-ray request form (%)	Osteomyelitis confirmed on x-ray report with each clinical detail (%)	Total percentage confirmed on x-ray of all request forms (%)
Wound probed to bone	11 (27.5)	7 (64)	58
Chronic wound	21 (52.5)	5 (24)	42
Presence of infection	5 (12.5)	0 (0)	0
Sausage toe	3 (7.5)	1 (33)	8
Hypergranulation	2 (5)	0 (0)	0
Pus	1 (2.5)	1 (100)	8
Swelling	12 (30)	5 (42)	42
Erythema	11 (27.5)	3 (27)	25
Increased temperature	4 (10)	2 (50)	17
Pain experienced	1 (2.5)	0 (0)	0

referral requests outlined a positive PTB test on the form.

Upon reviewing the X-ray reports, a further eight (20%) of the 40 patients were supplied with antibiotic therapy, which was in line with the total number of positive osteomyelitis diagnosis on X-ray. There was a delay in these eight patients receiving antibiotic therapy of between 5 days to 1 month. In addition, two (25%) of these eight patients did not receive a bone penetrating antibiotic regimen and instead were supplied with empirical therapy of flucloxacillin 500 mg, four times a day, for 7 days.

Discussion

An important finding from the service evaluation was the wide disparity in clinical details outlined on the X-ray request forms and subsequent rationale for referral. Of the 40 requests, 5% (n=2) provided no details other than stating the presence of a wound, while 50% (n=20) identifying more than one clinical detail. It is necessary that the referrer provides a strong rationale and builds a detailed clinical picture for the radiographer as this will help to guide their diagnosis. Abnormal alterations of bone on X-ray are not exclusively married to osteomyelitis but other pathologies, such as fracture and Charcot neuroarthropathy, which can be attributed to changes on the radiological image making it difficult to differentiate with a vague clinical picture (Lee et al, 2016). This emphasises the need for clinical updates regarding the presentation and management of osteomyelitis for staff.

Of the 40 X-ray requests by the community podiatry service on suspicion of osteomyelitis, 30% (n=12) returned with radiological signs of bone infection. There are a number of plausible explanations for this: patients are being sent for X-ray on suspicion of osteomyelitis when the clinical signs are not present or patients are being sent for X-ray in the first 2 weeks of infection when radiographic findings have not yet developed (Lee et al, 2016).

The existing literature emphasises the link between the PTB test and osteomyelitis (Rajbhandari et al, 2001; Jeffcoate and Lipsky, 2004; Lavery et al, 2007; Lozano et al, 2010; Mutluoglu et al, 2017). The service evaluation highlighted that as few as 11 (27.5%) of the total 40 X-ray requests included detailed a positive PTB on the request form. It could be suggested that there is a general lack of knowledge surrounding the clinical signs of osteomyelitis and that perhaps clinicians are over requesting X-rays as a safety net, conceivably to act with a high index of suspicion or to protect themselves against litigation (Ho, 2010).

Alternatively, the podiatrists may be obtaining a negative PTB result during clinical assessment but not documenting this finding on the X-ray request card. This raises questions as to the

rationale for referring for X-ray on suspicion of osteomyelitis if no positive PTB was found. While research questions the high predictability of a positive test confirming osteomyelitis diagnosis, strong evidence supports that a negative PTB has a higher predictive value in ruling out osteomyelitis presence (Dinh et al, 2008). It could be argued that the podiatrists may be referring for X-ray unnecessarily if no positive PTB is established. Of the 11 X-ray request forms which stated a positive PTB test, seven (64%) returned radiographic signs of osteomyelitis.

The data gathered in this service evaluation reported that, of the 40 X-ray cards studied, 10% (*n*=4) of the cases were prescribed bone penetrating antibiotics concomitantly with the X-ray request. In the four instances that bone penetrating antibiotics were requested concurrently with X-ray request, 100% reported a positive PTB test. Delay in the prescription of bone penetrating antibiotics at the time of clinical assessment, when osteomyelitis is suspected by the clinician, interrupts the management of bone infection leading to worse outcomes for the patient and increased risk of amputation (Hartemann-Heurtier and Senneville, 2008). The data derived from this service evaluation could suggest that clinicians are overly reliant on X-ray results and not confident in their own diagnostic skills with respect to the clinical signs and symptoms of osteomyelitis. This is evident in this data whereby a further eight (20%) were prescribed bone-penetrating antibiotics following receipt of an X-ray report detailing radiographic signs of osteomyelitis.

Another issue with the delay in prescribing bone penetrating antibiotics is the interval in radiographic changes on X-ray. Radiographic signs of osteomyelitis, such as periosteal reaction, elevation of the periosteum and radiolucency are often absent in the first 2 weeks of bone infection and radiographic images may appear conventional (Fritz and McDonald, 2008; Lee et al, 2016). Unlike X-ray, Magnetic resonance imaging (MRI) has a very high sensitivity and specificity for osteomyelitis, which shows signs of bone infection early, such as bone marrow oedema. It is, however, expensive and often inaccessible in a community setting, such as that in this service evaluation (Sax et al, 2020).

To obtain an MRI scan, patients must be referred to a consultant-led clinic, often in a hospital setting, which takes time and again can delay effective treatment if solely relied upon for diagnosis. It may be another 2 weeks post-initial X-ray that a clinician requests a repeat film in which time, opportunity to successfully manage the infection is dwindling. This issue has been evidenced in the findings of this service evaluation whereby the eight patients who were prescribed bone-penetrating antibiotics following radiographic changes on X-ray, experienced prescribing delays of between 5 days to 1 month post-X-ray request by the podiatrist. If clinicians are relying on radiographic findings, in order to make a diagnosis of osteomyelitis and guide their decision of whether to instigate bone penetrating antibiotics, then if infection is present, it may progress and be more challenging to treat (Hartemann-Heurtier and Senneville, 2008). This has raised the necessity of conducting further training and clinical updates for staff within the community service team to reinforce the clinical signs of osteomyelitis and its potential complications if not managed promptly.

A strength of the study was that an entire year of X-ray request forms were investigated within the service (*n*=40), which provided a wealth of data. Conversely, it could be suggested that, due to the COVID-19 pandemic, podiatry referrals to X-ray were fewer than would be expected for a number of reasons, including: reduced clinical capacity and reluctance of patients to attend hospital settings for fear of being exposed to COVID-19.

A limitation of the study is the author's involvement in the requesting of X-ray cards, within the service which has been evaluated. Recognising the risk of bias at an early stage in the design of the project allowed for mitigation of this risk. Data were only amassed and evaluated from the exact text transcribed on the X-ray card and radiology report, not from the author's recall or what the author thought they had remembered. Risk of bias was low as the

author was interested in true findings, which would be used to influence future practice and improve patient care, refining the credibility of the evaluation. The author is also bound by the HCPC standards of conduct, performance and ethics and that of the NHS constitution with respect to integrity, openness and honesty, therefore, it would be a breach of duty to falsify or infringe findings (Health & Care Professions Council, 2018).

Conclusion

The evaluation raised the necessity of training and guideline development for clinicians within the community podiatry service, to advance knowledge and skills when assessing wounds for the presence of osteomyelitis and guide more effective X-ray referral requests to champion patient safety. Reinforcing the need to instigate early antibiotic intervention in patients where clinical infection is present is important to improve outcomes for these high-risk patients. ■

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