

## Management of open lower limb injuries in South West England and Wales

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### ABSTRACT

**INTRODUCTION** The joint British Association of Plastic, Reconstructive and Aesthetic Surgeons/British Orthopaedic Association standards define best practice management in open diaphyseal fractures of the lower limb. The aim of our study was to review the regional approach and experience in South West England and Wales. A further objective was to evaluate service provision with regard to the standards' key recommendations.

**METHODS** A prospective audit was undertaken of open diaphyseal fracture patients. Compliance with published standards within all orthoplastic services in South West England and Wales was assessed, and facilities were evaluated.

**RESULTS** A total of 86 patients were managed between October 2012 and March 2013. This was a 56% increase from 2008. Over half (56%) presented directly to the orthoplastic services with all patients undergoing debridement within 24 hours. Two-thirds (66%) of procedures were in daylight hours excluding those requiring immediate surgical intervention. Adherence to correct antibiotic therapy was 88% at admission, 50% at primary surgery and 62% at definitive surgery. Almost two-thirds (60%) of primary procedures were performed with combined senior orthoplastic teams, with 81% achieving definitive soft tissue coverage and fixation within seven days. Compliance improved in units with larger patient caseloads and where there was an early combined approach during daylight hours.

**CONCLUSIONS** Increased open lower limb fracture workload was demonstrated across South West England and Wales, probably owing to centralisation of trauma services. An improvement in early transfer of this patient group to orthoplastic facilities has allowed all patients to be assessed and debrided within the recommended timeframe. Standards were most likely to be met in those centres seeing higher numbers of injuries and when there was a daylight hours procedure by combined orthoplastic teams.

### KEYWORDS

Lower limb – Fracture – Open – Management

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Open fractures of the lower limb remain a challenge and cause significant morbidity. Guidance on the management of this patient group, as endorsed jointly by the British Association of Plastic, Reconstructive and Aesthetic Surgeons (BAPRAS) and the British Orthopaedic Association (BOA), is now in its third incarnation.<sup>1</sup> It summarises an evidence-based approach to the optimal management pathway including all aspects of patient care from initial assessment through to reconstruction and includes key recommendations for composition of the multidisciplinary team within the specialist centres managing these patients.

Furthermore, the updated version published in 2009 moved from what were 'guidelines' in 2001 to the current 'standards'.<sup>1</sup> This change in nomenclature has significance as previous guidelines described a method for advising best management whereas a standard is an agreed level of attainment that we should be meeting. Although seemingly a small modification, the implications of a standard can involve a significant change in the duty of care expected.

Standards set for the initial management dictate correct transfer of appropriate patients to trauma centres, and define best practice for primary wound care, provision of antibiotic prophylaxis and identification of those requiring immediate surgical intervention. Initial care should include removal of only gross wound contamination, co-amoxiclav antibiotic prophylaxis, and moist saline gauze and film dressing application.<sup>1</sup> Indications for immediate surgical intervention include one or more of the following: vascular compromise, compartment syndrome, marine or agricultural contamination and when an open diaphyseal fracture is part of a multiply injured patient.

When no indication for immediate surgical intervention is present, soft tissue and bone excision should be performed by senior plastic and orthopaedic surgeons working together on scheduled trauma operating lists within normal working hours within 24 hours of injury.<sup>1</sup> Standards for perioperative antibiotic prophylaxis at primary procedure dictates a single dose of gentamicin 1.5mg/kg in

addition to co-amoxiclav prophylaxis. The standards define a 'best evidence' approach to intermediate dressing when not performing immediate wound coverage and can be either a vacuum foam dressing or an antibiotic bead pouch.

With little evidence for the 'five-day rule', the standard for definitive coverage alongside skeletal fixation was set at within the first seven days from injury.<sup>1</sup> Additional prescription of antibiotics along with co-amoxiclav at the time of definitive skeletal fixation should be both gentamicin 1.5mg/kg and either vancomycin or teicoplanin.

Key factors in the management of open diaphyseal injuries include the experience and facilities available to the medical services. The published literature suggests the ideal of low infection and high bone union rates in complex lower limb trauma patients can be best met in 'specialist centres'.<sup>1-3</sup> Furthermore, in the specialist centres, there should be an appropriate and experienced multidisciplinary team, there should be sufficient and dedicated facilities, and the centres should receive a sufficient case volume. Fifteen requirements are summarised in the standards and are needed as constituent parts to a specialist centre.<sup>1</sup> These requirements cover areas including the surgical team, facilities and service provision, the extended multidisciplinary team and case volume/audit.

The South West England and Wales area is a large geographical region served by 6 plastic surgery units with a collective catchment of over 9.2 million people.<sup>4</sup> Our study aimed to assess this supraregional area's compliance with the published standards (including immediate, early and late management) and to evaluate service provision with regard to the key recommendations of the standards.

## Methods

This multicentre prospective study was conducted including all open tibial diaphyseal fractures admitted to Bristol (Frenchay Hospital), Exeter (Royal Devon and Exeter Hospital), Plymouth (Derriford Hospital), Portsmouth (Queen Alexandra Hospital), Salisbury (Salisbury District Hospital) and Swansea (Morrison Hospital). All patients were included for a six-month period from October 2012 to March 2013. Patients admitted during this period but not discharged by 31 March 2013 were included while open tibial intra-articular fractures (eg plateau, pilon or malleolar) were excluded. Data were entered prospectively using an agreed proforma and focused on three phases of acute care: initial management, intermediate care (primary surgical management) and definitive surgical management. The study was undertaken by the plastic surgery teams in their respective units.

After completion of the audit period, a questionnaire survey was conducted of all six units to assess service provision against the key recommendations published in the 2009 BAPRAS/BOA standards.<sup>1</sup> The questionnaire was sent to each unit with completion requested by the lead consultant plastic surgeon for lower limb trauma. The wording of the statements in the survey was unchanged from that documented in the standards. The survey was answered based on a 'best fit' response. The responses were: 1 = never; 2 = almost never; 3 = sometimes; 4 = almost always; and 5 = always.

## Results

A total of 86 open diaphyseal fracture patients were managed by the 6 plastic surgery units in the 6-month study period. In 56% of cases, the patient presented directly to the emergency department at the specialist hospital. The range between units (RBU) was 25–100%.

### Initial management

The standards necessitate identification of appropriate patients for referral based on fracture pattern and soft tissue injury.<sup>1</sup> All patients seen initially outside of the 6 units (44% of the patient group) were transferred appropriately and within 24 hours.

As part of initial management, wound care standards are detailed in the BAPRAS/BOA document.<sup>1</sup> Where no dressing was documented, non-compliance was assumed. Thirty per cent compliance was achieved (RBU: 0–85%).

Correct antibiotic prophylaxis was prescribed and administered in 88% of cases (RBU: 69–100%).

Immediate surgical intervention was indicated and performed in 34% of cases (30 patients). All 30 patients were admitted directly to the orthopaedic units. Indications were sometimes multiple but included 16% with vascular compromise, 12% with compartment syndrome, 5% with marine or agricultural contamination and 15% as part of management of a multiply injured patient.

### Intermediate management/primary surgery

In our patient group, eight patients had single stage debridement, skeletal fixation and soft tissue coverage. All primary procedures (either debridement or single stage fixation and soft tissue coverage) were completed within 24 hours. Excluding the 'immediate intervention' group, 66% of cases (RBU: 0–100%) were undertaken during daylight hours (taken as between 8am and 5pm). Correct antibiotics were prescribed in a mean of 50% of cases (RBU: 50–100%).

When examining the surgical teams involved with the primary procedure, the orthopaedic teams included a senior surgeon (ST8 or above) in 98% of cases (RBU: 92–100%). When looking at the plastic surgery team, the mean was 55% (RBU: 0–100%). Correct primary wound dressings were used in 75% of cases (RBU: 40–100%).

### Definitive wound management

In the study group, 81% (RBU: 38–100%) had definitive fixation and soft tissue cover within seven days of injury. Correct antibiotic prophylaxis was prescribed in 62% of cases (RBU: 23–100%).

### Service questionnaire

The questionnaire response rate was 100% from the six units. The survey can be broken down into four general areas: surgical team, service provision, multidisciplinary team and audit/case volume. The full results are available in Table 1.

Surgical team: Regarding the expected requirements of the surgical team in a specialist centre, all units responded

**Table 1** Survey results from the six units on specialist centre requirements

	Never	Almost never	Sometimes	Almost always	Always
Multidisciplinary team				4	2
Primary surgical management at specialist centre				4	2
Orthopaedic consultant with special expertise in trauma			2	1	3
Plastic surgery consultant with expertise in vascular reconstruction				4	2
Microbiologist with musculoskeletal expertise	1	1	2	2	
Emergency imaging including interventional radiology		1	1	2	2
Artificial limb team access		1		1	4
Physical and psychosocial rehabilitation			1	1	4
Facilities for simultaneous debridement			1	2	3
Combined orthopaedic rounds	2	1	2	1	
Combined surgical planning in <i>all</i> cases		1	1	3	1
Dedicated combined theatre sessions	3		1	1	1
Ongoing audit		1	1	1	3
≥30 cases per annum	2			1	3
Appropriate ICU facilities available				1	5

ICU = intensive care unit

that a team including orthopaedic and plastic surgeons with appropriate experience was almost always available (4/6 units) or always available (2/6 units). In terms of the orthopaedic surgical experience, 2/6 units responded that an orthopaedic team with a special interest in trauma was only sometimes available to their unit. Consultant plastic surgeons with an interest in vascular reconstruction were available either almost always (4/6 units) or always (2/6 units).

**Service provision:** Facilities for simultaneous debridement by orthopaedic and plastic surgical teams were always available in only 3/6 units but almost always available in 2/6 units. Most units did not always attain combined surgical planning although 4/6 units felt this almost always happened. The availability of dedicated combined theatre sessions was never available in half of the units. Most units (4/6 units) had good access (always or almost always) to a 24-hour interventional radiology service with 5 units having good access to an artificial limb team.

**Multidisciplinary team:** Provision of an appropriate multidisciplinary team across the units was mixed with good access to appropriate intensive care facilities, physiotherapists and psychosocial rehabilitation. No unit reported that orthopaedic and multidisciplinary ward rounds were always available. The availability of specialist microbiological expertise was also mixed with 2/6 units never or almost never having access.

**Case load/audit:** Only half of all units always participate in ongoing audit of their open lower limb patients with the same proportion having ≥30 cases annually.

## Discussion

The increase in patients seen at orthopaedic centres is most likely attributable to a change in referral pathway with early involvement of the specialist centres. The 44% of patients who presented initially to non-orthopaedic units were all referred and admitted to specialist centres within 24 hours. This is a significant improvement from previously published rates.<sup>4,5</sup> One limitation of this study was that data could only be collected on patients referred to the centres.

Despite clear guidance towards simple, cheap and readily available dressings, a significant variation was seen across the region with only 30% of primary dressings managed correctly. The majority of non-compliance was due to application of povidone-iodine impregnated alternatives or non-documentation. Subset analysis showed minimal difference in primary dressings regardless of unit caseload. Potential failure points for primary dressings may lie outside of orthopaedic departments and at the point of first patient contact.

Intermediate dressings showed less variation and greater median compliance than that for primary dressings. Difficulties in acquiring a negative pressure dressing system were reported in less than 5% of cases. Subset analysis when senior orthopaedic teams were involved did highlight a difference. The median compliance rate for intermediate dressings improved from 66% to 86%. An improvement from 80% to 90% was also seen with daylight hours operating.

A high level of compliance was demonstrated with antibiotic prophylaxis. Non-compliance was commonly due to

use of alternative antibiotics. Procedural antibiotic prophylaxis was less well achieved with only half (51%) of the patients receiving correct prophylaxis at primary debridement and 62% at definitive fixation. The question and controversies of antibiotic prophylaxis are well covered in the standards, and the limitations of available evidence is acknowledged.<sup>1</sup>

Subset analysis showed some improvement with units reporting higher case loads. Antibiotics use prior to debridement improved from a mean of 50% to 57% and from 62% to 82% prior to definitive fixation. Results also improved when combined orthopaedic teams were involved, with antibiotic prophylaxis prior to debridement improving from a median of 50% to 76%. An audit in one South West unit presented in 2013 demonstrates how a significant improvement in antibiotic compliance in open diaphyseal fracture patients

can be made through simple, inexpensive educational methods and the use of ward-based posters (Fig 1).<sup>9</sup>

A joint orthopaedic approach with senior surgeons occurred at definitive fixation and coverage in 100% of cases. However, at primary assessment and debridement, only 55% of cases had early involvement of a senior orthopaedic team. This shows little improvement from a similar study reporting less than 40% plastic surgery involvement at the primary procedure in 2008<sup>4</sup> and a comparable study published in 2005 showing only 62%.<sup>5</sup> Although some variation was seen within the six units, early plastic surgery involvement seems to be persistently low. Compliance when senior orthopaedic teams are involved at the primary procedure and during daylight hours demonstrates improvement in all later outcome measures.

Intermediate wound dressings compliance was 94% and definitive surgical management within seven days was in

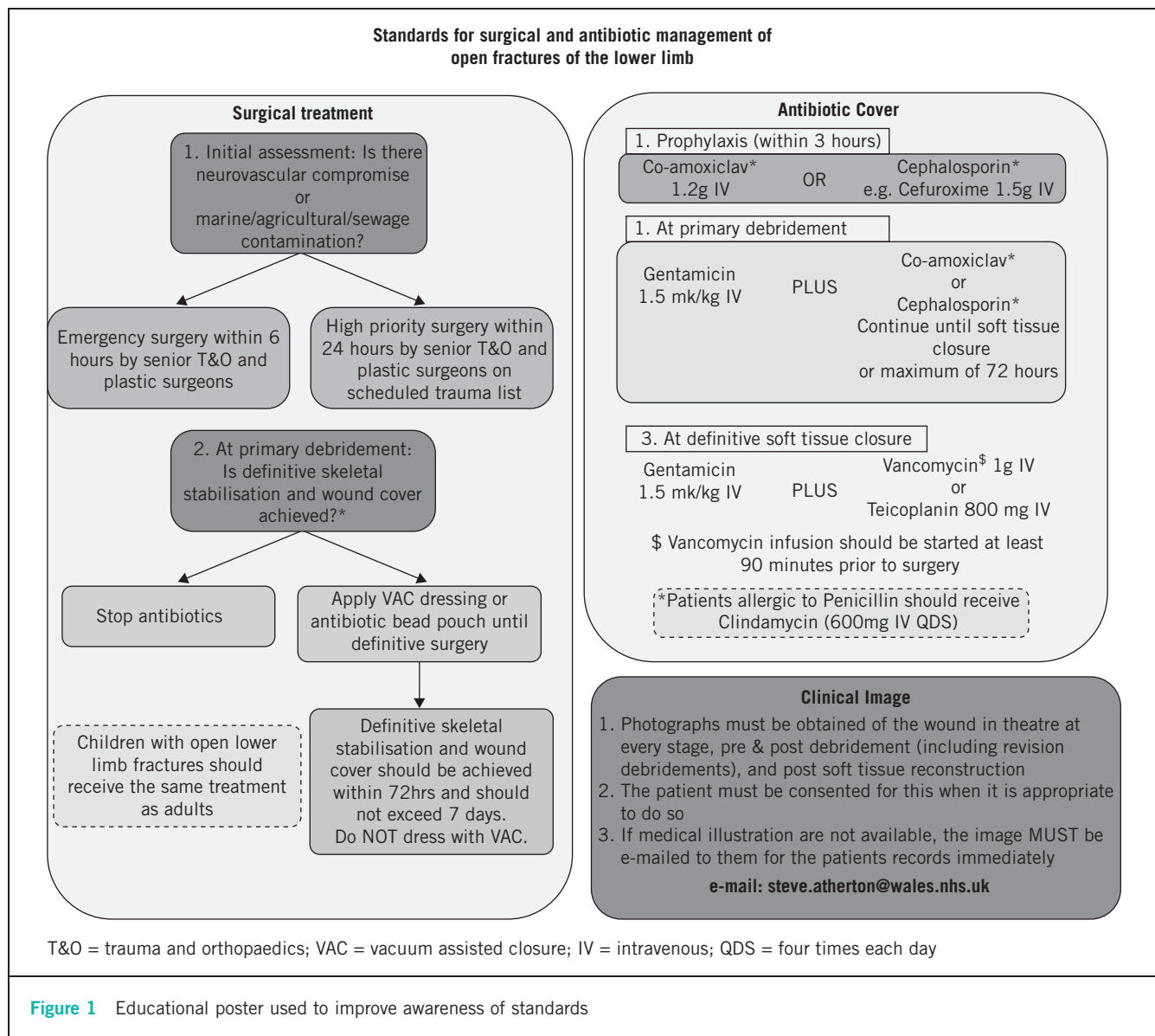


Figure 1 Educational poster used to improve awareness of standards

91% of cases. When senior orthopaedic teams were not involved at the outset and out of daylight hours, compliance dropped to 64% for dressing and 48% for definitive fixation and coverage.

The published literature has previously demonstrated a less than 60% awareness of joint guidelines at consultant level.<sup>8</sup> Furthermore, with all patients being received within 24 hours, low rates of early combined care do not reflect emergency department identification, delays with inter-hospital transfer or a 'have a go' approach from non-orthopaedic units, as demonstrated in other studies.<sup>4,5</sup>

The responses provided to the questionnaire demonstrate that only 5/6 units always have an orthopaedic team with expertise in trauma and only 4/6 units always have a plastic surgery team with appropriate microvascular experience. Four of the six units reported that dedicated combined orthopaedic theatre time was only sometimes or never available. However, the two units who always or almost always had dedicated and combined theatres did not show any significant difference with compliance on early combined orthopaedic operating, out-of-hours operating or time to definitive soft tissue cover. It was encouraging that all six units reported good access to appropriate intensive care facilities, physiotherapy and psychological services. Furthermore, five units almost always or always had access to an artificial limb appliance team.

## Conclusions

Open tibial diaphyseal injuries represent an increasing workload in the orthopaedic units of South West England and Wales. There is appropriate and early admission or transfer of these patients to specialist services, and early surgical debridement is performed within the 24-hour standard. Compliance with early wound dressings, antibiotic prophylaxis and operating in daylight hours is higher in units with a greater caseload as well as when joint senior

orthopaedic involvement is initiated at primary debridement. However, combined early involvement remains far from what is expected. Open lower limb diaphyseal fracture patients require a combined approach by dedicated orthopaedic teams in appropriately resourced units receiving adequate throughput in order to provide best management.

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