The construction and implementation of a clinical decision-making algorithm reduces the cost of adult fracture clinic visits by up to £104,800 per year: a quality improvement study

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ABSTRACT

INTRODUCTION Inappropriate referrals to the new patient fracture clinic unnecessarily consume hospital resources and many hospitals lack clear guidelines as to what should be referred. Many of these injuries can be definitively managed by the emergency department. Our aim was to construct and disseminate a clinical decision-making algorithm to reduce the frequency of inappropriate referrals to fracture clinics at our institution, to improve the management of patients with minor injuries and save the hospital and the patient the cost of unnecessary visits.

MATERIALS AND METHODS Data were prospectively collected for all new fracture clinic referrals over two separate 1-week cycles with cohorts of 94 and 74 patients, respectively. After the first cycle, the referral algorithm was disseminated both electronically (intranet) and orally (presentations to emergency department staff). The results of this intervention were examined in the second cycle, which took place 6 months after the first cycle.

RESULTS The introduction of this algorithm significantly reduced inappropriate referrals by almost 20% ($P = 0.0445$).

DISCUSSION This simple intervention highlighted a potential annual cost saving of up to £104,000. We advocate the use of this concise algorithm in improving the efficiency of the referral system to fracture clinics.

KEYWORDS

Fracture clinic – Referral algorithm – Cost effectiveness

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Introduction

In the UK, the management of minor trauma in an orthopaedic consultant-led fracture clinic is now ubiquitous and has proven to reduce cost, reduce inpatient bed-days and improve clinical outcomes.¹ The entry of a patient into fracture clinic remains primarily via the emergency department, with a minority also being referred from general practitioners and other hospital specialties. This ‘open-door’ policy of referral to fracture clinic risks expending valuable NHS resources and inconveniencing patients, with potentially unnecessary hospital visits for conditions that can be treated definitely at the first visit to primary care or can safely be discharged with advice and no routine follow up.

Cost-efficiency of service utilisation in the NHS is becoming increasingly important with growing demand and tighter budgets. Glasgow Royal Infirmary identified the opportunity to improve their fracture clinic referral system by using a ‘virtual fracture clinic’ model, in which a referral protocol was used by emergency care providers to make decisions on minor orthopaedic trauma patients.² Over the 5-year period,

they demonstrated a 15% reduction in fracture clinic attendances, institutional saving of £212,705 and a 12% relative reduction in staffing cost (in comparison to national figures).²

Similarly, Leicester Royal Infirmary remodelled their management of minor trauma referral through a consultant-led ‘rapid review process’, in which all trauma-related musculoskeletal x-rays are reviewed, with a brief clinical summary, by a consultant orthopaedic surgeon within 24 hours of the patient attending at the emergency department.³ They were then referred or recalled accordingly. Over a 4-week period, they demonstrated that 28 unnecessary fracture clinic appointments were prevented. This is clearly a significant improvement in cost and time efficiency for both patient and department. This may indicate a need for more senior decision making in the emergency department to enable efficient referral but may also highlight a lack of concise referral criteria to fracture clinics.

The aim of this study was to allow more cost and time efficient resource use within the fracture clinic and to minimise the financial and time inconvenience to patients in attending

fracture clinic appointments which would not alter management or outcome.

Patients and Methods

We conducted a prospective observational study of the adult new-patient fracture clinic service at a teaching hospital. After gaining local research and audit committee approval, two 5-day (Monday to Friday) data-collection cycles were compared 6 months apart. Each cycle had five consultant-led new-patient fracture clinics.

We developed a referral algorithm for common musculoskeletal injuries encountered in the emergency department, with suggested management strategies and whether or not it was appropriate for them to be referred for fracture clinic follow-up. This guideline was created in conjunction with the emergency department physicians, using both evidence-based practice and the clinical experience of the senior members of both departments to create a final document for use (Table 1, Fig 1).

The primary outcome measures of the study were to determine whether all new-patient fracture clinic referrals were compliant with our referral algorithm and whether dissemination and presentation of these guidelines to the respective clinicians would improve the referral pattern to these clinics.

Data were collected from the emergency department electronic information system (EDIS, (Emergency Department Information Solution, iSOFT plc) and from the dictated letters from the fracture clinics using a standardised pro forma which included:

- > date of emergency department attendance;
- > referrer grade;
- > Diagnosis made in emergency department: yes or no (if yes, was it appropriate?);
- > Date of fracture clinic attendance;
- > Diagnosis in fracture clinic;
- > Further management from fracture clinic;
- > Clinical outcome.

Hand injuries and paediatric fractures were excluded as they are both managed by their respective independent specialist clinics.

These data were compared with our referral algorithm by two independent reviewers (PL & DR). If the referral did not follow the protocol, it was deemed an inappropriate referral.

After the first cycle, the data were analysed and presented at the local quality improvement multidisciplinary team meeting. The algorithm was discussed and amended in response to this discussion. Distribution of the referral algorithm to the emergency department was carried out by placing the referral pathway on the intranet, as well as presenting it to both the department and orthopaedic clinical staff at their respective divisional meetings. At this time we advised the emergency department team on the standard protocol for referral of chronic non-traumatic injuries to elective clinics.

The second cycle was held 6 months later, to allow enough time for dissemination and integration of the algorithm in to the ED daily practice.

Descriptive statistics were reported as actual values and percentages. Pre- and post-intervention categorical data were analysed using contingency table analysis and Fisher's exact test. Statistical significance was defined as a *P*-value of less than 0.05. All statistical analyses were performed using GraphPad Prism version 6.0a (GraphPad Software Inc., USA).

Results

The total number of patients attending the fracture clinic in cycles 1 and 2 was 94 and 74, respectively. The number of appropriate referrals in cycles 1 and 2 were 58/94 and 57/74, respectively. This represents a significant reduction in inappropriate referrals (36/94 and 17/74, respectively) from 38% to 22% ($P = 0.0445$).

Inappropriate referrals were divided into acute traumatic conditions and chronic non-traumatic conditions. The acute traumatic conditions were subdivided in to categories, as shown in Table 2. Subgroup analysis of the acute traumatic referrals showed a reduction in absolute number in each category other than simple phalangeal fractures. There was no statistically significant reduction in acute traumatic referrals. However, this may be a result of the small sample size. There was a statically significant reduction in number of chronic non-traumatic conditions referred ($P = 0.027$).

Cost analysis

The total cohort over both cycles numbered 168 patients, averaging 84 patients per week. There was a reduction in inappropriate referrals from 38% to 22%. At our institution, the total cost to the department for a new-patient fracture clinic appointment was £150. With a reduction of inappropriate referrals of 16%, we estimated a cost saving of £2,016 per week; an estimated annual cost saving of up to £104,800. The authors acknowledge that the realistic cost saving will likely be lower, as staffing levels are not linearly related the number of patients seen at each individual clinic. However, if a significant reduction in referrals persists, it may offer the opportunity for reallocation or reduction in staffing to achieve greater cost efficiency.

Discussion

There is no doubt that consultant-led fracture clinics are a vital part of trauma management in the UK. They are also a busy, high-turnover system; with the Leicester Royal Infirmary, UK, recently stating that the average duration of a clinic appointment is only 11 minutes.³ Inefficiency in the service through unnecessary attendances is therefore a waste of both department time and resources, and patient's time and clinical experience.⁴

Up to 50% of emergency department attendances are related to musculoskeletal pain or trauma.⁵ The majority of

Table 1 Acute musculoskeletal conditions that do not require routine referral to fracture clinic

Injury	Suggested pathway	Patients who must be referred
Shoulder dislocation after reduction if comfortable, neurovascularly intact and there is no associated fracture	Reduce shoulder; provide broad arm sling or polysling for up to 1 week then self-mobilise. Refer to acute soft tissue shoulder clinic for further assessment at around 10 days post injury.	<ul style="list-style-type: none"> > Any associated fracture (glenoid or proximal humerus) > Any patient with neurological deficit that persists after reduction. > Any patient where adequacy of reduction is unclear.
Shoulder – acromioclavicular joint injury with no (grade 1) or slight (grade 2) displacement	Provide analgesia and broad arm sling or polysling for up to 1 week, then advise to mobilise shoulder after that.	<ul style="list-style-type: none"> > Any injury with $\geq 100\%$ displacement of the lateral end of the clavicle. > Any injury where the skin is tented or possibly compromised (refer to on-call team). > Any injury with associated fracture of the lateral end of the clavicle. > All sternoclavicular dislocations.
Shoulder – fracture midshaft of clavicle with minimal displacement	Provide broad arm sling or polysling for up to 1 week then advise to mobilise shoulder as pain allows. Refer for outpatient physiotherapy review at 10 days. Physiotherapist to refer into fracture clinic if persistent pain that might indicate delayed union.	<ul style="list-style-type: none"> > All clavicle fractures with displacement or comminution. > All fractures of the lateral end of the clavicle. > If there is tenting of the overlying skin. > Any other associated fracture around the shoulder girdle (eg neck of scapula). > Any neurovascular injury.
Elbow – completely undisplaced or suspected radial head fracture (not visible on x-rays but diagnosed on basis of anterior fat pad sign)	Early active mobilisation, refer for outpatient physiotherapy review at 10 days post-injury to check for range of extension/supination. Physiotherapist to refer into fracture clinic if any problems.	<ul style="list-style-type: none"> > Any displacement of radial head fracture. > If the elbow has been dislocated > Any medial bruising/swelling/tenderness (? medial ligament injury). > Any associated fracture (coronoid process, capitellum). > Any wrist pain (? distal radioulnar joint injury).
Knee – isolated grade 1 medial collateral ligament sprain (ie pain but no laxity)	Provide long-leg elasticated tubular support and crutches. Encourage early active movement and weight bearing as tolerated and refer for outpatient physiotherapy review at 10 days to check knee range of movement. Physiotherapist to refer into fracture clinic if concerns.	<ul style="list-style-type: none"> > Any patient with any laxity of medial collateral ligament (grade 2 or 3 injury). > Any patient with a significant effusion or haemarthrosis (? associated intra-articular injury). > Any patient with avulsion fracture on x-ray.
Ankle – severe lateral ligament sprain with or without associated avulsion fracture from tip of distal fibula	See separate ankle injury pathway.	<ul style="list-style-type: none"> > Any malleolar fracture that is more than a small avulsion fracture. > Any other associated fracture (medial talus, proximal fibula, fifth metatarsal base). > If the ankle has been dislocated requiring manipulation – apply backslab. > Any patient with diabetes with neuropathy.
Foot – lesser toe fractures	Manipulate if necessary under ring block anaesthesia, apply buddy strapping. Discharge with advice and analgesia. Maintain buddy strapping for 3 weeks.	<ul style="list-style-type: none"> > Any toe where there is clinical deformity that persists after manipulation and buddy strapping. > Any open lesser-toe fracture (to on-call team). > Any patient with diabetes with neuropathy.
Foot – big toe crush injury with tuft fracture of terminal phalanx (often with subungual bleeding or nail avulsion)	Remove nail if partly avulsed, clean and dress nail bed, prescribe oral antibiotics. Refer to practice nurse for regular dressings.	<ul style="list-style-type: none"> > Any patient with exposed bone. > Any patient with diabetes. > Delayed presentation with established infection.
Chronic non-traumatic injuries – to be referred via general practitioner to appropriate elective orthopaedic clinic.

these patients will be seen by junior doctors, some with little experience in assessing traumatised patients. McLauchlan

et al. demonstrated that senior house officers (SHOs) were significantly poorer at evaluating the plain radiographs than

Table 2 Subdivision of acute traumatic inappropriate referrals for subgroup analysis.

Diagnosis	Cycle		P-value
	2	2	
Soft-tissue injury (other than ankle)	7	4	0.552
Ankle sprain	6	2	0.294
Uncategorised (grade 1 acromioclavicular joint injury, healed metatarsal fracture, resolving haematoma, intersection syndrome, chronic painful total shoulder replacement)	6	4	0.754
Fibula tip avulsion (Weber A)	4	2	0.688
Simple phalangeal fractures (closed, no dislocation or displacement)	3	4	0.707

their registrar and consultant colleagues: with SHOs only correctly identifying abnormalities 32% of the time, as compared with 80% for their seniors.⁶ This clearly indicates a potential problem in correctly diagnosing and hence correctly referring patients to fracture clinics.

To address this problem, we presented our findings to the emergency department team at the divisional meeting, made the protocol easily accessible on the hospital intranet site and provided laminated protocols that were displayed in key clinical areas in the department. We proposed the introduction of this protocol into the induction pack for new doctors. Furthermore, we recommended a teaching session to focus specifically on minor trauma for emergency department junior doctors. We also presented the appropriate route of referral for chronic non-traumatic conditions through the elective clinic system, which proved highly effective.

A study of the quality of distal radius fracture manipulation and application of plaster casts carried out by SHOs in the local regional trauma centre showed a significant improvement in outcome after a dedicated teaching session provided by a senior orthopaedic surgeon.⁷ Identification of problem areas such as this should be a focus for training hospitals, as teaching sessions such as this are easy interventions and have significant potential benefit to patient's outcomes and departmental efficiency.

This study identified a number of key minor trauma injuries that are commonly referred to fracture clinic in which there is considerable evidence to support conservative management without further referral to orthopaedic services. The most common include ankle sprains/soft tissue injuries, stable Weber A ankle fractures and simple phalangeal fractures.

Stable soft tissue ankle injuries and 'stable' ankle fractures are common, accounting for 40–75% of ankle trauma.⁸ They are not only a problem medically but also socioeconomically through time lost owing to immobility or reduced function. The spectrum of management strategies is vast and often leads to confusion. Recent evidence from the Royal Dutch Society of Physical Therapy suggests that the rigorous use of a concise, evidence-based clinical guideline in assessing and managing soft-tissue ankle injuries improves quality

of care and efficiency of service usage.⁹ Moreover, Jain et al.⁸ advocate a protocol-style approach to ankle injuries and showed a significant reduction in cost of managing soft-tissue and stable ankle fractures in functional bracing instead of plaster cast, through the reduced risk of displacement and hence less frequent need for repeated clinical and radiographic assessment. Martin et al.¹⁰ showed no requirement for further intervention in their cohort of 53 patients using this approach and found significant cost savings. These data were used in the development of our referral algorithm with the addition of an ankle injury flowchart (Table 1, Fig 1).

Both hand and foot phalangeal fractures are commonly referred to fracture clinics. Hand fractures were not investigated in our study because our institution has a dedicated hand unit, into which all hand trauma is referred. Lower-limb phalangeal fractures are commonly treated non-operatively with good clinical outcome and without deformity. Eves et al. found that, over a 12-month period, 11% of referrals were for toe phalangeal fractures.¹¹ Of the 707 patient cohort examined, only two patients with simple, closed phalangeal fractures required surgical intervention. The authors estimated that not referring undisplaced and stable toe fractures to the fracture clinic would result in a 52% reduction in toe fracture attendances.¹¹ This study highlights the ability of a robust, evidence-based referral protocol to improve the efficiency of fracture clinics.

Using this intervention, our study showed an estimated cost saving of up to £2,016 per week (at a cost of £150 per appointment). This is comparable with a 2011 study from the Glasgow Royal Infirmary, which found that each new consultant-led fracture clinic appointment cost £91.77.¹² Additionally, using the data from Beiri et al.,⁵ a 16% reduction in referrals would lead to an estimated time saving of up to 2.46 hours per week; or 128 hours per year.

The effective construction of any clinical guideline or algorithm is not a unilateral process. In our case, it required a multidisciplinary approach to understand the resources and 'road blocks' encountered in emergency departments that lead to unnecessary fracture clinic appointments.¹⁵

A multidisciplinary approach is also necessary for liaison with services in the community. We identified unnecessary referrals to fracture clinics for chronic, non-traumatic

conditions such as osteoarthritis, adhesive capsulitis of the shoulder and chronic pain following arthroplasty. These should be managed through the standard outpatient referral system from primary care providers. Our subgroup analysis showed a statistically significant reduction in this type of referral, suggesting that our approach is effective. This is a potential avenue for further study by engaging the general practitioner community to streamline referral to elective orthopaedic services, thereby relieving the burden on fracture clinics further.

Leicester Royal Infirmary showed an improvement in their service using a 'virtual' fracture clinic model.⁵ This study shows that virtual fracture clinics are not the only way to improve the service. Moreover, simple interventions such as this protocol and educational sessions can significantly improve service use without incurring large costs or major system overhaul.

Conclusion

Rigorous use of evidence-based referral strategies in orthopaedic services is increasingly important as demand and volume grows. We found in this study that our referral algorithm, coupled with the supporting teaching sessions with the emergency department, were effective in reducing the burden of inappropriate referrals to fracture clinic. It highlights the ability of simple educational interventions to significantly improve service use and cost efficiency. This led to a projected possible cost saving of £104,800 per annum.

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