

Review began 05/24/2023

Review ended 06/29/2023

Published 07/03/2023

© Copyright 2023

Menyah et al. This is an open access article distributed under the terms of the Creative Commons Attribution License CC-BY 4.0., which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Assessing Referrals to a Trauma and Orthopaedic Department: Evaluation of a Traffic Light System for Virtual Fracture Clinic in the Emergency Department and Urgent Care

Effie Menyah¹, Sean M. Garcia¹, Ann McCormack¹, Babajide Taiwo¹, Mohamed Aly^{2, 1}, Walid Kamel¹, Baljinder S. Dhinsa¹

1. Trauma and Orthopaedics, William Harvey Hospital, Ashford, GBR 2. Orthopaedics, Alexandria University, Alexandria, EGY

Corresponding author: Sean M. Garcia, sean.garcia@nhs.net

Abstract

Background

The Trauma and Orthopaedic (T&O) on-call service receives referrals from the emergency department (ED), general practice (GP) and urgent treatment centres (UTCs) and requests for inpatient reviews. The virtual fracture clinic (VFC) pathway allows ED and UTC clinicians to assess, discharge and refer when necessary. For VFC, the on-call orthopaedic consultant reviews the cases the next working day and makes an appropriate plan. This pathway consists of a traffic light system, in which practitioners can either safely discharge with written advice (green), refer to the VFC (yellow) or refer to the on-call team (red).

Method

The aim of this study was to assess how the VFC pathway was being utilised. All referrals to the T&O on-call team over three weeks were evaluated retrospectively. The following referrals were excluded: fractured femur, head injury, trauma calls and back pain pathway. The following data were collected: patient details, diagnosis, referral source, reason for referral, plan, double booking with VFC and appropriateness.

Results

A total of 191 referrals were analysed. Most referrals are from the ED (51%) and UTC (23%). Of the referrals, 39% were deemed to be inappropriate. Of the inappropriate referrals, 35% should have been referred directly to the VFC rather than the on-call team. A significant minority (7%) of inappropriate referrals were referred to the on-call team and VFC.

Conclusion

Education and collaboration are required with the ED and UTC to ensure the proper use of the VFC pathway. Immediate radiograph reporting may also be beneficial.

Categories: Emergency Medicine, Orthopedics, Trauma

Keywords: emergency medicine and trauma, orthopaedic referrals, urgent treatment center, minor injury unit, virtual fracture clinic

Introduction

Musculoskeletal complaints are common presentations to the emergency department (ED). They range from low-severity strains to high-severity trauma [1,2]. High volumes of presentations to the ED are known to result in overcrowding and delays to care [3,4]. The utilisation of urgent treatment centre (UTC) services, specifically minor injuries units (MIUs), can reduce this burden [5] by managing and discharging, where appropriate, less severe musculoskeletal complaints.

At our institution, the Trauma and Orthopaedic (T&O) on-call service receives referrals from the ED, general practice (GP) and urgent treatment centres (UTCs) and requests for inpatient reviews. Patients seen in the UTC and ED with musculoskeletal complaints have their management streamlined via a virtual fracture clinic (VFC) emergency management pathway. Virtual fracture clinics are well established in the United Kingdom with multiple studies confirming reasonable patient satisfaction [6,7], good clinical outcomes, overall improved efficiency of trauma services, cost savings [6,8], safety [9], reduced unplanned ED re-attendances [10] and invaluable time for the T&O service to focus on more complex cases [11].

Our Trust's VFC pathway consists of a traffic light system of musculoskeletal diagnoses, from which practitioners can safely discharge with written advice (green), refer to the VFC (yellow) or refer to the on-

How to cite this article

Menyah E, Garcia S M, McCormack A, et al. (July 03, 2023) Assessing Referrals to a Trauma and Orthopaedic Department: Evaluation of a Traffic Light System for Virtual Fracture Clinic in the Emergency Department and Urgent Care. Cureus 15(7): e41316. DOI 10.7759/cureus.41316

call team (red) if warranted. Our current pathway version is the latest iteration that includes more diagnoses compared to previous iterations. The virtual fracture clinic pathway allows ED and UTC clinicians to assess, manage and discharge or refer to the T&O on-call service when necessary. For VFC, the healthcare practitioner reviewing the patient is responsible for making the referral electronically using the Trust's electronic medical records (EMRs). The practitioner provides their history, examination findings and management plan performed. The on-call orthopaedic consultant will review the cases with X-rays the next working day and make an appropriate plan in keeping with the British Orthopaedic Association (BOA) Standards for Trauma for fracture clinic services [12]. Should a patient in VFC require an early investigation or intervention such as a CT scan or surgery, this will be arranged through VFC, and a face-to-face appointment is made if necessary. Patients are informed via telephone and a letter in the post with the outcome, and this is added to their EMR for clinical documentation purposes. Patients reviewed by the on-call team/consultant are never referred to VFC as this will duplicate or result in differing consultant decisions and plans. Face-to-face fracture clinic appointments are made for such patients if necessary.

An example of a typical patient's pathway could be as follows. A patient comes into the ED with a displaced distal radius fracture. The patient is triaged and seen by the ED where fracture reduction is attempted and put into a back slab with repeat X-rays as per the yellow pathway. The patient is referred to VFC and reviewed by the on-call orthopaedic consultant virtually the following day. On review, the consultant notes this is an intra-articular volar displaced fracture and decides on surgical management. The patient is added to the trauma board and informed of the plan.

Our study aimed to evaluate the appropriateness of referrals received by the T&O on-call team in relation to the VFC Matrix and determine if the pathway was being used correctly.

Materials And Methods

All referrals to the T&O on-call team over three weeks were assessed retrospectively. This included referrals from the ED, UTC, general practitioners and inpatient wards. To assess the use of the VFC Matrix, data was collected from the departmental Trauma Drive, a system used to record each referral to the T&O team and manage trauma theatre lists.

All referrals during this period from the green and yellow pathways were included (Figures 1, 2).

SAFE FOR DISCHARGE with DISCHARGE LEAFLET - NB- IF PATIENT IS REFERRED TO VFC, CLEARLY STATE CLINICAL REASON FOR REFERRAL		
DIAGNOSIS	INITIAL TREATMENT	IMPORTANT POINTS AND DOCUMENTATION REQUIRED
# Clavicle Child	Collar and Cuff	Safeguarding Completed
# Head / Neck of Radius/ Undisplaced / Minimally Displaced	Collar and Cuff	
# 5 th Metacarpal Neck	Neighbour Strapping	? Rotational deformity
Mallet Finger - Non Bony	Mallet Splint	
Crush # Terminal Phalanx Closed	Neighbouring Strapping	? Trephine then becomes open #
Ankle Sprain	Crutches, RICE	Discharge - Reassurance given - No Leaflet
5 th Metatarsal Base #	Walking Boot	
Lesser toe Phalanx #	Neighbour Strapping	
Torus 'Buckle' #	Futura Splint	
Pubic Rami #	Analgesia and Walking aid	Refer to Hot Floor Discharge Team/ Medics if unable to cope

FIGURE 1: Virtual Fracture Clinic Emergency Fracture Management Matrix: Green Pathway

Adapted from East Kent Hospitals University Foundation Trust Virtual Fracture Clinic Matrix for management of specific fractures, with permission. Designed by Jenni Finlay (Trauma Nurse Practitioner, Trauma and Orthopaedics Department, William Harvey Hospital, East Kent Hospitals University Foundation Trust).

**REFER TO VIRTUAL #Clinic – All referrals MUST have an X-RAY.
CALL TEAM.*****

*****READ MATRIX BEFORE CONTACTING THE ON-**

	DIAGNOSIS	INITIAL TREATMENT	IMPORTANT POINTS AND DOCUMENTATION REQUIRED
UPPER LIMB	# Clavicle Adults	Polysling	
	# Neck of Humerus	Collar & Cuff	
	# Shaft of Humerus	Humeral brace or double loop collar & cuff if not avail	
	Dislocated Shoulder	Polysling after reduction	Physio ? 1 st time or recurrent
	Acromioclavicular Joint Injury	Polysling	
	Dislocated Elbow	Reduce, above elbow then re-x-ray	If unable to reduce refer to Orthopaedic On Call
	Supracondylar # Humerus (child) Undisplaced	Above elbow back slab	Must have true lateral x-ray to check if angulated
	# Head / Neck of Radius Undisplaced / Marginal # / Comminuted	Collar & Cuff	
	# Olecranon Undisplaced Extensor Mechanism Intact Against Gravity	Polysling	
	Child with Undisplaced/Minimally Displaced Distal Greenstick #	Below Elbow Back slab	
HAND	Adult undisplaced/Minimally Displaced Distal Radius #	Below Elbow Backslap	
	Distal Radius # with No Functional Demands eg. Dementia, Paralyzed Limb Patients	Below Elbow Backslap	Record details of functional ability.
	Distal Radius # Displaced	Reduce First and Apply POP Back slab	Check x-ray after POP applied
	Child with Positive fat pad sign distal humerus no Definite # seen	Collar & Cuff	
	Scaphoid #	Below elbow Back slab	SCAPHOID VIEWS PLEASE
	? Scaphoid #	Futura Splint	SCAPHOID VIEWS PLEASE
	# Base / Shaft 1 st Metacarpal	Futura Splint with Thumb extension	
	# Metacarpal Shaft / Base Undisplaced	Futura Splint with neighbour strapping	? Rotational deformity
	Undisplaced Proximal / Middle Phalangeal finger #	Neighbour Strapping	
	Volar Plate # of Fingers	Neighbour Strapping/ Gutter Cast	
LOWER LIMB	Dislocation MCP / IP joint	Reduce and Neighbour Strap	
	Crush # Terminal Phalanx Open	Wound washout +/- nail bed repair	Antibiotics to be given
	Mallet Finger - Bony	Mallet Splint	
	# Patella Undisplaced (NB Normal variant of bipartite or tripartite)	Cricknet Pad Splint & Walking Aid	
	Undisplaced # Shaft of Fibula with no ankle involvement	Crutches weight bear as pain allows - no plaster	Record ankle examination
	# Tarsal Bone Undisplaced	Walking Boot	
	Single # Metatarsal 2-5	Heel bearing post op shoe	
	Great Toe Phalanx #	Heel bearing post op shoe/ neighbour strap	Do not use Elastoplast toe Spica
	Weber B and Weber A # / # Lateral Malleolus with no Talar Shift	Walking Boot	Record presence or absence of medial bruising and tenderness
	Calcaneal # Extra Articular	Walking Boot	

FIGURE 2: Virtual Fracture Clinic Emergency Fracture Management Matrix: Yellow Pathway

Adapted from East Kent Hospitals University Foundation Trust Virtual Fracture Clinic Matrix for management of specific fractures, with permission. Designed by Jenni Finlay (Trauma Nurse Practitioner, Trauma and Orthopaedics Department, William Harvey Hospital, East Kent Hospitals University Foundation Trust).

Referrals for fractured femur, head injury, trauma calls, open fractures, complex wounds and the back pain pathway were excluded, as the T&O on-call team always reviews these patients under the red pathway of the VFC traffic light matrix (Figure 3).

REFER TO ORTHO ON CALL TEAM – URGENTLY

All fractures below that are discussed with the On-call team will be made a fracture clinic follow up appointment – DO NOT BOOK INTO VFC!

	DIAGNOSIS	INITIAL TREATMENT	IMPORTANT POINTS AND DOCUMENTATION REQUIRED
UPPER LIMB	Dislocated Shoulder (irreducible) or # Dislocation	Polysling after reduction	Spontaneous / Post Trauma
	Supracondylar # Humerous (Child) Displaced	Above elbow backslab as comfortable	? Pulses
	# Olecranon Displaced	Polysling	Whether extensor mechanism intact against gravity
	Displaced Forearm, #Monteggia #Dislocation, Galeazzi #Dislocation	Above elbow back slab	
	Isolated Ulna Shaft # Displaced	Above elbow back slab	
	Distal radius # with high energy, open #, neurologist deficit, # off ended, volar displacement.	Back slab	Volar angulated fractures need a volar slab
HAND	Child displaced /angulated distal radius fracture	Backslab	
	Bennett's # (Intra-Articular Base 1 st Metacarpal)	Thumb Spica/Spencer Splint	Do not use elastoplast thumb spica
	# Metacarpal Shaft/ Base Displaced. Rotational Deformity	Neighbour strapping	
FOOT AND ANKLE	Displaced/Rotated Proximal/Middle Phalangeal Finger #	Neighbour strapping	
	Displaced/ Unstable Ankle # (Weber C or Bi-malleolar)	Reduce, back slab then post pop x-ray	
	Calcaneal # Intra Articular	Below knee back slab	
	# Tarsal Bone Displaced	Walking boot	
	Multiple metatarsal # / Crushed foot ? Lisfranc	Below knee back slab	? compartment syndrome
LOWER LIMB	Tendo Achilles Rupture (Squeeze test)	Equinus cast/Black boot with wedge	Follow Tendo Achilles Pathway
	# Pelvis	Treat hypovolemic? pelvic splint	
	# Neck of Femur	Follow #NOF Pathway	Analgesia Fascia Iliaca Block
	# Femur Shaft	Treat hypovolaemia - cross match	Traction? Analgesia? Nerve Block
	# Patella Displaced, Intercondylar Tibial Avulsion #, Tibial Plateau - undisplaced and displaced.	Cricknet Pad splint	Record ability to straight leg raise
	# Tibial Shaft - Closed, Undisplaced	Above knee back slab	? Compartment syndrome
	# Tibial Shaft Displaced (Intra - Articular Distal Tibia)	Above knee backslab	? Compartment syndrome

FIGURE 3: Virtual Fracture Clinic Emergency Fracture Management Matrix: Red Pathway

Adapted from East Kent Hospitals University Foundation Trust Virtual Fracture Clinic Matrix for management of specific fractures, with permission. Designed by Jenni Finlay (Trauma Nurse Practitioner, Trauma and Orthopaedics Department, William Harvey Hospital, East Kent Hospitals University Foundation Trust).

The following data were collected for each referral that met the inclusion criteria: patient hospital number, diagnosis, referral source, reason for referral, plan, double booking with VFC and appropriateness, which was determined based on the VFC traffic light matrix (Figures 1, 2) and assessed by two reviewers independently. Appropriateness was defined as whether the pathway was followed for any given injury.

Results

A total of 191 referrals to the Trauma and Orthopaedic Department were analysed. Most referrals were from the ED (51%) and UTC (23%) located within the hospital (Figure 4).

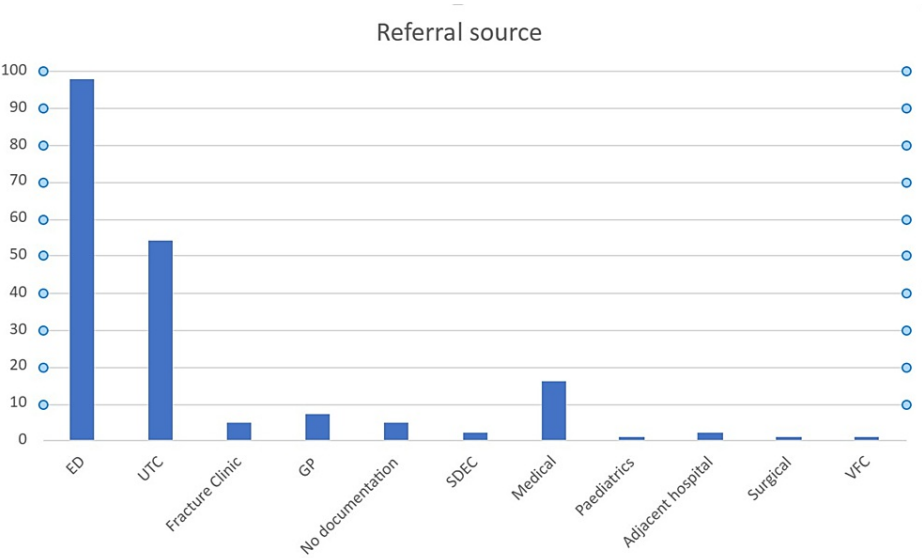
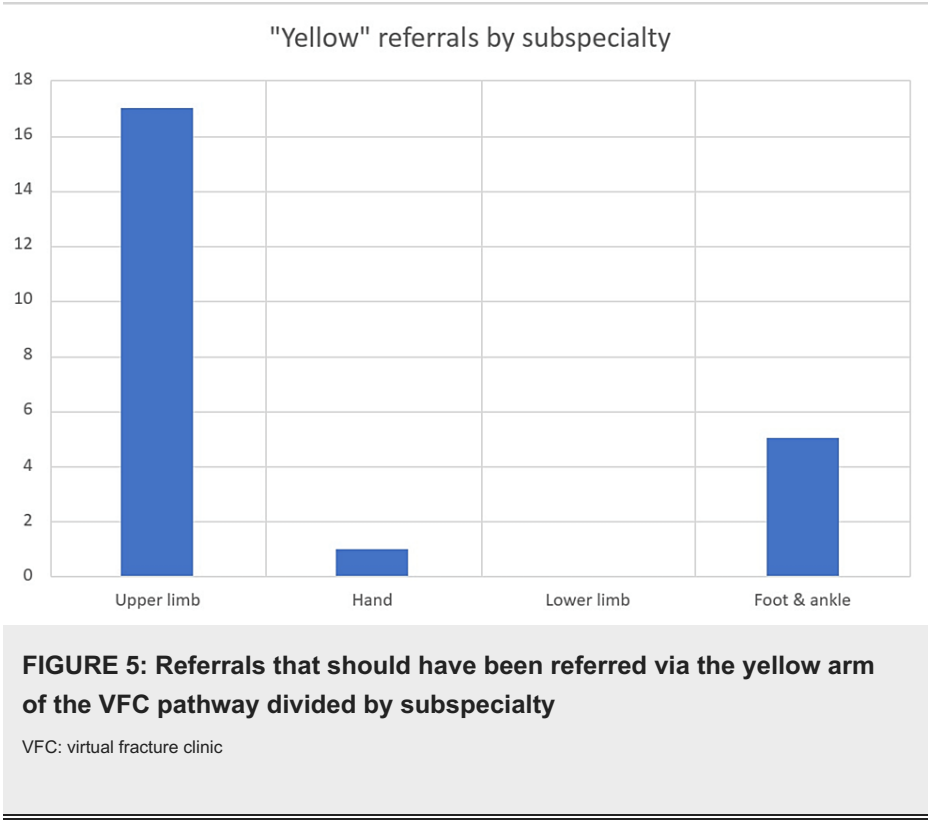


FIGURE 4: Sources of referrals

ED: emergency department, UTC: urgent treatment centre, GP: general practice, SDEC: same-day emergency care, VFC: virtual fracture clinic

Of all patients referred who met the inclusion criteria, 27% went on to have surgical management. In addition, 30% were discharged with advice, and 35% were discharged with outpatient follow-up in a fracture clinic. Of the patients, 7% referred in line with the inclusion criteria were admitted. However, this does not reflect most T&O admissions at our institution, as patients with a fractured femur, head injury or admission via trauma calls were excluded.

Of the referrals, 39% were deemed to be inappropriate, and 35% of those deemed to be inappropriate referrals should have been referred to the VFC following the yellow arm of the pathway. Of those referrals, 50% were from the UTC, while 38% were from the ED. Of those, the majority were for upper limb referrals (Figure 5); 69% were from the UTC and 80% from the ED. Of the patients that were referred acutely who should have been on the green pathway, 86% were referred by the UTC, and 71% were sprains involving the lower limb. All patients referred that should have been on the green pathway did not have their radiographs reported at the time. The average time for a radiology report for those patients was seven days. No untoward events were identified. The average time to a report for the yellow box patients was two days with 29% being reported within 24 hours.



In addition, 7% were referred to the on-call team and VFC, duplicating review as these patients would have been discussed in the morning trauma meeting with the on-call consultant and reviewed by the consultant allocated to the VFC.

Discussion

An established acute musculoskeletal pathway through MIU can reduce ED attendance, decrease wait times and ultimately improve patient satisfaction [13]. Despite a well-established VFC pathway, there were many referrals that could have been managed according to our Trust's protocol, which were referred to the T&O on-call team. Most referrals were within the yellow section of the traffic light system, with a smaller number in the green section (for discharge and written advice). The remaining referrals were deemed to be more appropriately managed by other services, such as general practice, emergency medicine, vascular, medical and surgical teams.

With uninitiated junior staff or trainees, referrals can often be to ask whether a patient should be referred to the virtual fracture clinic or to interpret radiographs and make a diagnosis when a report is unavailable. It is also important to remember that oftentimes, urgent treatment centres are staffed by emergency nurse practitioners (ENPs). This is not to say that nurse-led minor injuries units (MIUs) are inferior as there are multiple examples in the literature to suggest otherwise [14-16] but that there may be uncertainty in radiograph interpretation and hesitancy to discharge across both junior doctors and ENPs for fear of missing an important diagnosis.

It is known that errors in radiograph interpretation can occur in both the ED and UTC [17] and are more likely to occur in paediatric cases and the more junior the healthcare practitioner is. Evidence suggests that emergency nurse practitioners were at least as good as senior house officer (SHO)-level doctors at interpreting MIU skeletal radiographs [18,19]. There is evidence to suggest that junior doctors' accuracy in the interpretation of trauma radiographs is lower when compared to registrar or consultant counterparts [20,21]. Tachakra et al. (2002) [22] were able to demonstrate that emergency medicine consultants were at least as good as consultant radiologists at interpreting minor injury unit skeletal radiographs by contrast. Snaith et al. (2014) [23] found no significant discrepancy between emergency nurse practitioners and other medical staff for radiograph interpretation but noted a significant reduction in patient recalls and radiograph misinterpretation if radiographs are reported immediately by a reporting radiographer.

Two randomized controlled trials found ENPs to be at least equal to junior doctors and in some ways better in a minor injury unit setting including patient satisfaction, health education and clinical documentation [24,25]. It is reasonable to assume that some referrals, although managed via the VFC protocol, are referred for a second opinion when uncertainty exists or there is not yet a radiology report, to ensure optimal patient safety and the best patient outcome.

Concerning radiograph interpretation and discharges, Howard and Craib (2022) [26] looked at radiographer-led discharges once no fractures were identified. This strategy reduces waiting times and negates the need for an unsure practitioner to chase a radiology report or seek an orthopaedic opinion in a patient with a minor soft tissue injury. Instead, the patient would be discharged with appropriate advice following a pre-determined pathway.

There are also examples of advanced physiotherapist practitioner (APP)-led MIUs [27,28] that have done comparably well against emergency nurse practitioners when it comes to patient satisfaction and performance. The cost and clinical effectiveness of such strategies are yet to be determined within the literature, but for musculoskeletal complaints, the use of advanced physiotherapist practitioners (APPs) seems viable.

The other possible explanation for inappropriate referrals is admittedly an ambiguous referral matrix. The authors admit that the yellow box places the decision-making power in the hands of the ED doctor/UTC practitioner as it requires them to identify the injury as safe for discharge and follow-up in the VFC. A simplified system incorporating the yellow box into the green box may not mitigate this problem as the decision still falls onto the ED/UTC practitioner for those specific diagnoses. An alternative would be for the acute on-call team to take up the "yellow" cases, which are currently posing a challenge; however, this negates the benefits of the VFC pathway. The inclusion of Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) classification in the matrix may help specify injuries but could also complicate the matrix and increase calls to the on-call team for clarification on which fracture subtype a particular injury is. While such classifications could be implemented into the matrix, this would require considerable educational efforts regarding various fracture classification subtypes directed toward the ED and UTC who do not typically use these systems.

Research has repeatedly shown that medical image interpretation among juniors is lacking and educational drives through e-learning and formal structured courses delivered by radiologists should be explored by all trainees as opposed to only on-the-job training [29]. Across the hierarchy of ENPs on the other hand, according to the Urgent and Emergency Care Emergency Practitioner Framework, all emergency practitioners including trainees would have been required to at least attend an interpretation of images course followed by ongoing continuing professional development (CPD) needs [30].

There are courses available aimed specifically at junior doctors and as refreshers for minor injury unit ENPs and GPs for radiograph interpretation. Based on our work, upper limb fractures need the most work, and CPD should be explored in this regard. Frequent, repetitive education, CPD and inter-departmental collaboration are the most viable options in the authors' opinion moving forward. Our department has initiated an education and awareness drive, redistributing posters of the VFC matrix and taking a personal non-confrontational approach to educating those unaware of it with the help of our trauma nurse practitioner. The matrix is always open to revision and improvement, and perhaps, more feedback from the practitioners who use it is required to point out areas that need clarification or are too complex. A website has also since been developed that is pending approval for trust use for ease of access to the VFC Matrix and to use as an educational e-learning tool. Immediate radiograph reporting may also be helpful and can reduce patient waiting times.

Conclusions

No referral system is perfect, and expecting a complete absence of human error is unreasonable. However, ensuring an efficient and safe referral pathway means that overall patient care is improved. The authors believe that collaboration between UTC, T&O and ED with educational efforts and feedback can help broaden knowledge, improve awareness of our VFC pathway and improve patient care. This can be aided through the digitalization of the VFC Matrix for ease of access.

Additional Information

Disclosures

Human subjects: Consent was obtained or waived by all participants in this study. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Acknowledgements

Effie Menyah and Sean Garcia should be considered as co-first authors.

References

1. Gaieski DF, Mehta S, Hollander JE, Shofer F, Bernstein J: Low-severity musculoskeletal complaints evaluated in the emergency department. *Clin Orthop Relat Res*. 2008, 466:1987-95. [10.1007/s11999-008-0277-5](https://doi.org/10.1007/s11999-008-0277-5)
2. Cantu RV, Bell JE, Padula WV, Nahikian KR, Pober DM: How do emergency department physicians rate their orthopaedic on-call coverage?. *J Orthop Trauma*. 2012, 26:54-6. [10.1097/BOT.0b013e31821d7a81](https://doi.org/10.1097/BOT.0b013e31821d7a81)
3. Wennman I, Wittholt M, Carlström E, Carlsson T, Khorram-Manesh A: Urgent care centre in Sweden-the integration of teams and perceived effects. *Int J Health Plann Manage*. 2019, 34:1205-16. [10.1002/hpm.2790](https://doi.org/10.1002/hpm.2790)
4. Coster JE, Turner JK, Bradbury D, Cantrell A: Why do people choose emergency and urgent care services? A rapid review utilizing a systematic literature search and narrative synthesis. *Acad Emerg Med*. 2017, 24:1137-49. [10.1111/acem.13220](https://doi.org/10.1111/acem.13220)
5. The Health Foundation: Emergency hospital admissions in England: which may be avoidable and how? . (2018). Accessed: October 23, 2022: https://www.health.org.uk/sites/default/files/Briefing_Emergency%2520admissions_web_final.pdf.
6. Murphy EP, Fenelon C, Murphy RP, O'Sullivan MD, Pomeroy E, Sheehan E, Moore DP: Are virtual fracture clinics during the COVID-19 pandemic a potential alternative for delivering fracture care? A systematic review. *Clin Orthop Relat Res*. 2020, 478:2610-21. [10.1097/CORR.0000000000001388](https://doi.org/10.1097/CORR.0000000000001388)
7. Thelwall C: A service evaluation after 4 year's use of the virtual fracture clinic model by a district general hospital in the south west of England. *Int J Orthop Trauma Nurs*. 2021, 41:100798. [10.1016/j.ijotn.2020.100798](https://doi.org/10.1016/j.ijotn.2020.100798)
8. Khan SA, Asokan A, Handford C, Logan P, Moores T: How useful are virtual fracture clinics?: a systematic review. *Bone Jt Open*. 2020, 1:683-90. [10.1302/2633-1462.111.BJO-2020-0107.R1](https://doi.org/10.1302/2633-1462.111.BJO-2020-0107.R1)
9. Cavka B, Cross E, Montvida O, Plunkett G, Oppy A, Bucknill A, Treseder T: Retrospective cohort study evaluating the efficacy and safety of an orthopaedic consultant-led virtual fracture clinic in an Australian level 1 trauma centre. *ANZ J Surg*. 2021, 91:1441-6. [10.1111/ans.16574](https://doi.org/10.1111/ans.16574)
10. Vardy J, Jenkins PJ, Clark K, et al.: Effect of a redesigned fracture management pathway and 'virtual' fracture clinic on ED performance. *BMJ Open*. 2014, 4:e005282. [10.1136/bmjopen-2014-005282](https://doi.org/10.1136/bmjopen-2014-005282)
11. Bhattacharyya R, Jayaram PR, Holliday R, Jenkins P, Anthony I, Rymaszewski L: The virtual fracture clinic: reducing unnecessary review of clavicle fractures. *Injury*. 2017, 48:720-3. [10.1016/j.injury.2017.01.041](https://doi.org/10.1016/j.injury.2017.01.041)
12. BOAST: Fracture clinic services . (2022). Accessed: October 23, 2022: <https://www.boa.ac.uk/static/7ded8f00-987e-42d5-a389e739b1e03b47/ec9d4564-4fa7-4d08-aef4efc3cede7d53/fracture%20clini....>
13. Tammes P, Morris RW, Brangan E, et al.: Exploring the relationship between general practice characteristics and attendance at walk-in centres, minor injuries units and emergency departments in England 2009/10-2012/2013: a longitudinal study. *BMC Health Serv Res*. 2017, 17:546. [10.1186/s12913-017-2483-x](https://doi.org/10.1186/s12913-017-2483-x)
14. Mabrook AF, Dale B: Can nurse practitioners offer a quality service? An evaluation of a year's work of a nurse led minor injury unit. *J Accid Emerg Med*. 1998, 15:266-8. [10.1136/emj.15.4.266](https://doi.org/10.1136/emj.15.4.266)
15. Heaney D, Paxton F: Evaluation of a nurse-led minor injuries unit . *Nurs Stand*. 1997, 12:35-8. [10.7748/ns1997.10.12.4.35.c2484](https://doi.org/10.7748/ns1997.10.12.4.35.c2484)
16. Smith J, Balogun-Ojuri B, Chessier T: Minor injury units: are they a safe alternative for emergency treatment of orthopaedic minor injuries?. *Emerg Med J*. 2012, 29:15. [10.1136/emmermed-2012-201246.18](https://doi.org/10.1136/emmermed-2012-201246.18)
17. Wilson C: X-ray misinterpretation in urgent care: where does it occur, why does it occur, and does it matter?. *N Z Med J*. 2022, 135:49-65.
18. Freij RM, Duffy T, Hackett D, Cunningham D, Fothergill J: Radiographic interpretation by nurse practitioners in a minor injuries unit. *J Accid Emerg Med*. 1996, 13:41-3. [10.1136/emj.13.1.41](https://doi.org/10.1136/emj.13.1.41)
19. Meek S, Kendall J, Porter J, Freij R: Can accident and emergency nurse practitioners interpret radiographs? A multicentre study. *J Accid Emerg Med*. 1998, 15:105-7. [10.1136/emj.15.2.105](https://doi.org/10.1136/emj.15.2.105)
20. McLauchlan CA, Jones K, Guly HR: Interpretation of trauma radiographs by junior doctors in accident and emergency departments: a cause for concern?. *J Accid Emerg Med*. 1997, 14:295-8. [10.1136/emj.14.5.295](https://doi.org/10.1136/emj.14.5.295)
21. Liu YM, O'Hagan S, Holdt FC, Lahri S, Pitcher RD: After-hour trauma-radiograph interpretation in the emergency centre of a district hospital. *Afr J Emerg Med*. 2022, 12:199-207. [10.1016/j.afjem.2022.04.001](https://doi.org/10.1016/j.afjem.2022.04.001)
22. Tachakra S, Mukherjee P, Smith C, Dutton D: Are accident and emergency consultants as accurate as consultant radiologists in interpreting plain skeletal radiographs taken at a minor injury unit?. *Eur J Emerg Med*. 2002, 9:131-4. [10.1097/00063110-200206000-00006](https://doi.org/10.1097/00063110-200206000-00006)
23. Snaith B, Hardy M: Emergency department image interpretation accuracy: the influence of immediate reporting by radiology. *Int Emerg Nurs*. 2014, 22:63-8. [10.1016/j.ienj.2013.04.004](https://doi.org/10.1016/j.ienj.2013.04.004)
24. Sakr M, Angus J, Perrin J, Nixon C, Nicholl J, Wardrope J: Care of minor injuries by emergency nurse practitioners or junior doctors: a randomised controlled trial. *Lancet*. 1999, 354:1321-6. [10.1016/s0140-6736\(99\)02447-2](https://doi.org/10.1016/s0140-6736(99)02447-2)
25. Cooper MA, Lindsay GM, Kinn S, Swann IJ: Evaluating emergency nurse practitioner services: a randomized controlled trial. *J Adv Nurs*. 2002, 40:721-30. [10.1046/j.1365-2648.2002.02431.x](https://doi.org/10.1046/j.1365-2648.2002.02431.x)
26. Howard ML, Craib J: Radiographer-led discharge in a minor injuries unit . *J Med Imaging Radiat Sci*. 2018, 49:S9. [10.1016/j.jmir.2018.06.031](https://doi.org/10.1016/j.jmir.2018.06.031)
27. McDonough A, Troedel M, Dawson T, Jeavons K, Marsden L: A physiotherapy led minor injuries unit during the covid pandemic. *Physiotherapy*. 2022, 114:E125. [10.1016/j.physio.2021.12.078](https://doi.org/10.1016/j.physio.2021.12.078)
28. McDonough A, Lennox A, Angus M, Coumbarides A: An analysis of the utility, effectiveness and scope of advanced physiotherapy practitioners in an urgent treatment centre pilot. *Physiotherapy*. 2022, 115:61-5. [10.1016/j.physio.2021.12.005](https://doi.org/10.1016/j.physio.2021.12.005)
29. Ayesa SL, Katelaris AG, Brennan PC, Grieve SM: Medical imaging education opportunities for junior doctors and non-radiologist clinicians: a review. *J Med Imaging Radiat Oncol*. 2021, 65:710-8. [10.1111/1754-9485.13266](https://doi.org/10.1111/1754-9485.13266)
30. Urgent and Emergency Care: Emergency Practitioner Framework . (2023). Accessed: March 23, 2023: <https://www.hee.nhs.uk/sites/default/files/documents/HEE%20Urgent%20and%20Emergency%20Care%20>

