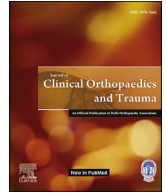




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Foot and ankle trauma management during the COVID-19 pandemic: Experiences from a major trauma unit

Rohi Shah*, Abdul Ahad, Murtuza Faizi, Jitendra Mangwani

Trauma & Orthopaedic Department, University Hospitals of Leicester NHS Trust, Leicester Royal Infirmary, Infirmary Square, Leicester, LE1 5WW, United Kingdom

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ABSTRACT

The COVID-19 pandemic has resulted in a paradigm shift in clinical practice, particularly in ways in which healthcare is accessed by patients and delivered by healthcare practitioners. Many of these changes have been serially modified in adaptation to growing service demands and department provision capacity. We evaluated the impact of the pandemic on the foot and ankle service at our trauma unit, assessing whether these adaptations to practice were justifiable, successful and sustainable for the future. This was a single-centre, retrospective cohort study analysing the patient care pathway from admission to discharge, for two pre-defined timeframes: Phase 0 (pre-lockdown phase) and Phase 1 (lockdown phase). Patients were split into stable and unstable injuries depending on their fracture pattern. The follow-up modality and duration were evaluated. Trauma throughput for the equivalent timeframe in 2019 was also analysed for comparison. There were 106 unstable fractures and 100 stable fractures in 2020. 78 interventional procedures were performed on 72 patients with unstable fractures in Phase-1. Close contact casting was performed on 13 patients at presentation in the ED. Selective patients underwent partial fixation in theatre, which still provided adequate stability. 35% of patients with a stable fracture were discharged directly from the ED with written advice from a review letter. The treatment modality in selective patients, particularly the vulnerable should be carefully assessed. Interventions performed at presentation often negate the need for admission. Partial fixation reduces intraoperative time and surgical insult. Integrating telemedicine into the care pathway, particularly for stable ankle fractures reduces the need for physician-patient contact and eases follow-up burden. Many of our recommended changes are easily replicated in other clinical settings. Should these adaptations demonstrate long-term sustainability, it is likely they will remain incorporated into future clinical practice.

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1. Background

The COVID-19 pandemic has resulted in a paradigm shift in clinical practice in many areas, with ensuing adaptations in the ways in which healthcare is accessed by patients and delivered by healthcare practitioners (HCP). Many of these changes have been serially modified to allow adaptation to growing service demands as well as department provision capacity. If successfully established, healthcare provision may never need to revert to the pre-

pandemic period.

Significant variation within subspecialty fracture management exists, with the foot and ankle being no exception. There are many clinical scenarios where controversies exist between non-surgical and surgical management. Often, the long-term clinico-radiological outcomes between the treatment modalities are equivocal. In these situations, an informed decision should be made primarily with the patient's wishes and guided by surgeon's experience.

To adhere to Government guidelines and mitigate the effects of the COVID-19 pandemic, we anticipated a shift towards more conservative measures within our hospital for all subspecialty trauma. In an attempt to reduce the number of inpatient admissions and the number of follow-up appointment requiring patients to physically return to hospital, the foot and ankle trauma care pathways within our hospital were reviewed and subsequently modified at the start of the lockdown period. The revised guidelines

Abbreviations: HCP, Healthcare Practitioners; ED, Emergency Department; F/u, Follow Up; CCC, Close Contact Casting.

* Corresponding author.

E-mail addresses: rohi.shah@nhs.net (R. Shah), aahad1@nhs.net (A. Ahad), murtuza.faizi@uhl-tr.nhs.uk (M. Faizi), Jitendra.Mangwani@uhl-tr.nhs.uk (J. Mangwani).

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advised clinicians to increase the number of interventions and minor procedures performed at presentation in the Emergency Department (ED), when safe and feasible, and lowering the threshold for ‘acceptance’ in equivocal cases. We anticipated that these measures would result in an overall reduction in all operative trauma cases. Advice for subsequent follow-up (f/u) plans, irrespective of the initial treatment being surgical or non-surgical were also adjusted, staggered or converted to telemedicine where feasible, in a bid to reduce patient-clinician physical contact at follow-up.

The main aim of this project was to evaluate the impact of the COVID-19 pandemic specifically on the *foot and ankle trauma service* at the University Hospitals of Leicester NHS Trust, assessing the variation in trauma throughput, injury pattern and finally follow-up duration and modality. Based on these outcomes, we assessed whether adaptations to clinical practice were justifiable, successful and sustainable for the future.

2. Methods

This was a single-centre, retrospective cohort study of all patients who presented to our department with foot and ankle trauma. The time frame for data collection was split in line with National guidelines i.e., from January 01, 2020 to March 22, 2020 (pre-lockdown phase) and from 22/03/20 to 31/05/20 (lockdown phase) spanning 70 days (Table 1). Due to the Leicestershire region being in a higher risk area, local restrictions were in place for an extended period of time for an extra 54 days. Trauma throughput for the equivalent timeframe in 2019 was analysed.

Data was obtained from the business intelligence department of our NHS trust based on patient coding at presentation and during their inpatient stay. This was further cross matched with the inpatient Orthopaedic database, theatre schedulers and Operating Room Management Information System (ORMIS). The data was subsequently cleaned for errors and duplication and analysed using Wizard® Statistical & Analysis Software. Only patients with foot and ankle trauma were included in the analysis. The patient pathway was analysed from presentation to the ED up to final discharge from f/u from clinic. At presentation, patients were split into two pathways based on radiographic parameters: stable injuries who were seen and treated in the ED and unstable injuries who required subsequent inpatient care. Assessment of the medial column integrity (i.e. the deltoid ligament) was of key importance when considering the stability of isolated lateral malleolus fractures and was further evaluated using weight-bearing x-rays. Fractures were classified using the AO classification system, derived from an expansion of the Danis-Weber classification scheme.^{1,2} Data was collected on age, gender and comorbidities. Further data was obtained on the type of injury and mechanism of injury (indoor vs. outdoor). Most patients were COVID swabbed at presentation to ED or within 24 h of admission. Operative data was obtained using our theatre reporting system (ORMIS). We determined the duration and pattern of f/u, including the time taken to the first f/u and the type of consultation (telephone vs. physical) utilised at each f/u appointment up to discharge.

Any modifications to clinical practice that occurred as a direct consequence of the lockdown phase that were not present in the

Table 1
Variation in phase by dates.

Phase	Description	Dates	Days
Phase 0	Pre-Lockdown	1st January - 22nd March	81
Phase 1	Lockdown	23rd March - 31st May	70

pre-lockdown phase were analysed. Determining whether an intervention is ‘successful’ is usually subjective to the clinician with limited objective markers. We decided that if an intervention facilitated early discharge or reduced what would have otherwise been an inpatient admission, without compromising patient outcomes, it would be deemed successful. Additionally, if altering the type and duration of a f/u appointment reduced patient-clinician contact during the COVID era then it would also be considered successful.

3. Results

206 patients were reviewed between January 01, 2020 to July 24, 2020, encompassing Phase 0 and Phase 1. There were 106 patients with unstable fractures and 100 patients with stable fracture patterns presenting to the foot and ankle service. 114 procedures were performed on 106 patients with the unstable fractures. Over the equivalent time frame in 2019, there were a total of 130 procedures performed on 121 patients with unstable fractures. Table 2 highlights the variation in patient demographics from the pre-lockdown and lockdown phase for *unstable* ankle fractures in 2020 and the equivalent timeframe in 2019. In 2020, 78 procedures were performed on 72 patients during Phase 1, spanning 70 days. 36 procedures were performed on 34 patients during Phase 0.

3.1. Patient demographics

The mean age of male patients was significantly lower (37 yrs; Range: 4–65 yrs) compared to the pre-lockdown phase (56 yrs; Range 11–91 yrs), whereas a slightly older cohort of female patients were operated upon during lockdown phase (57 yrs; Range: 4–92 years). We also noted an uneven sex distribution, with 2.4x more female patients (n = 51) compared to male patients (n = 21). There was only 1 patient who tested positive for COVID-19 on PCR swab tests. In the equivalent Phases in 2019, there were more surgical procedures performed in Phase 0 (n = 61), but interestingly fewer procedures in Phase 1 (69 procedures (2019) vs. 78 procedures (2020)). For comparative purposes, Table 3 highlights patient demographics for stable foot and ankle fractures during the lockdown phase. The overall number of patients presenting to the department was 100, with a lower mean age (34 yrs; Range: 4–90 yrs).

3.2. Trauma variation

Fig. 1 highlights the variation in trauma using the AO Classification scheme, which is based on the location of the fracture lines and on the degree of comminution.

For stable ankle fractures during the lockdown phase, isolated Weber A (28%) and Weber B (29%) fractures made up the majority of the acute throughput to the specialty (Fig. 2). Avulsion fractures were treated conservatively, accounting for 26% of acute presentations. Treatment for stable foot and ankle fractures during the lockdown phase consisted of either a walker boot (73 patients), Cast immobilisation (21 patients) or a self-removable soft wrap (5 patients). 1 patient was discharged with just verbal advice.

In 2020, for the 72 patients with unstable fractures in Phase 1, 71 patients underwent some form of intervention either in the acute setting in the Emergency Department (ED) or formally in a theatre setting under anaesthesia. 1 patient declined any form of intervention. 21 patients were sent home with non-weight bearing (NWB) advice, analgesia and high elevation and advised to return for on their pre-planned surgery date. 8 patients were admitted under the medical team for optimization prior to surgery. The remaining 43 patients were admitted directly under the Orthopaedic team for expedited surgery. 20 patients underwent close

Table 2
Patient demographics for unstable fractures managed surgically.

Patient Demographics	Phase 0	Phase 1	Phase 0	Phase 1
	Unstable Fractures		Unstable Fractures	
	2020		2019	
Patients	81 days N = 34	70 days N = 72	81 days N = 56	70 days N = 65
Paediatric (<18 yrs)	N = 3	N = 3	N = 1	N = 4
Adult	N = 31	N = 69	N = 55	N = 61
No of procedures	N = 36	N = 78	N = 60	N = 69
Sex Distribution	M: 20 F: 14	M: 21 F: 51	M: 32 F: 24	M: 25 F: 40
Age Distribution	M: 56 (Range: 11–91 yrs) F: 51 (Range: 14–84 yrs)	M: 37 (Range: 4–65 yrs) F: 57 (Range: 4–92 yrs)	M: 50 (Range: 12–82 yrs) F: 50 (Range: 5–86 yrs)	M: 53.4 (Range: 7–79 yrs) F: 49.5 (Range: 1–85 yrs)
COVID Positive	–	1 patient	–	–
Mortality Rates	1 patient (3%)	3 patients (4%)	–	–

Table 3
Patient demographics for stable foot and ankle fractures during the lockdown phase.

Patient Demographics	Phase 1
	Stable Fractures
	2020
Patients	70 days N = 100
Paediatric (<18 yrs)	N = 12
Adult	N = 88
No of interventions	N = 100
Age Distribution	Mean: 34 yrs (Range: 4–90 yrs)
COVID Positive	–
Mortality Rates	1 patient (1%)

contact casting (CCC) as the primary treatment modality. 13 CCC were performed at presentation in the ED (under fluoroscopy guidance) with the remaining 7 cases being performed in theatre under anaesthesia. Of those performed in ED, 2 were medically unwell at presentation (hence the decision to perform CCC). A further 2 patients progressed to surgical stabilisation with fixation

at a later stage due to displacement of the fracture. The remaining 9 patients (69%) were followed up in clinic as out-patients and successfully discharged without requiring operative intervention.

3.3. Follow-up pathway variation

Of the 100 stable ankle fractures, 86% were discharged home directly from the ED. Two were admitted under the Orthopaedic team (requiring operative intervention due to a non-foot & ankle fracture related problem) whilst 12 patients were admitted under the medical teams for social reasons prior to discharge. Every patient who presents acutely has their case reviewed the following day by the on-call team. Subsequently, a dictated letter is sent out to the patient within 48 h highlighting injury details and the subsequent management/follow-up plan. Of the 100 patients with stable fractures, 35 patients (avulsion/Weber A fractures) were discharged with written advice from a review letter without needing another planned consult. Subsequent follow up appointments were either triaged to be physical attendance (face to face) or telephone consultation. By 6 weeks, 79% of patients had been discharged from subsequent follow-up, with only 21 patients

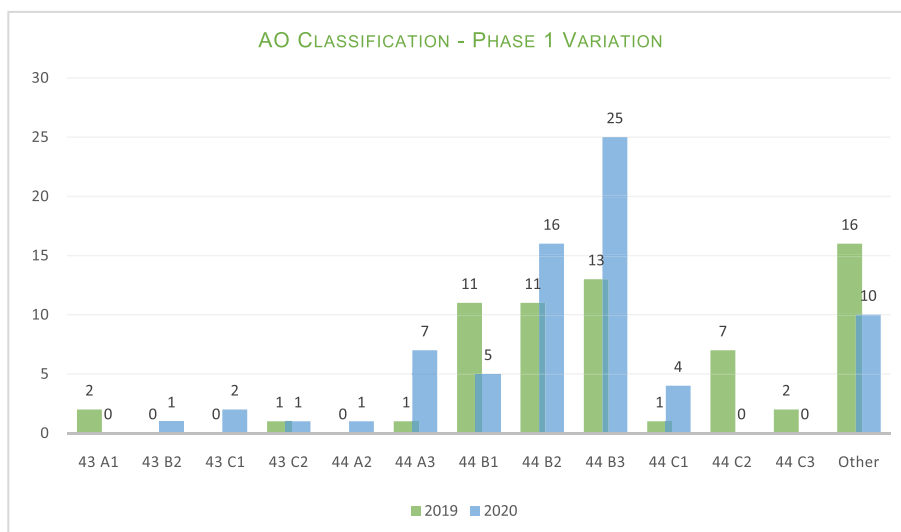


Fig. 1. Trauma variation in Phase 1 between 2019 and 2020 (unstable fractures).

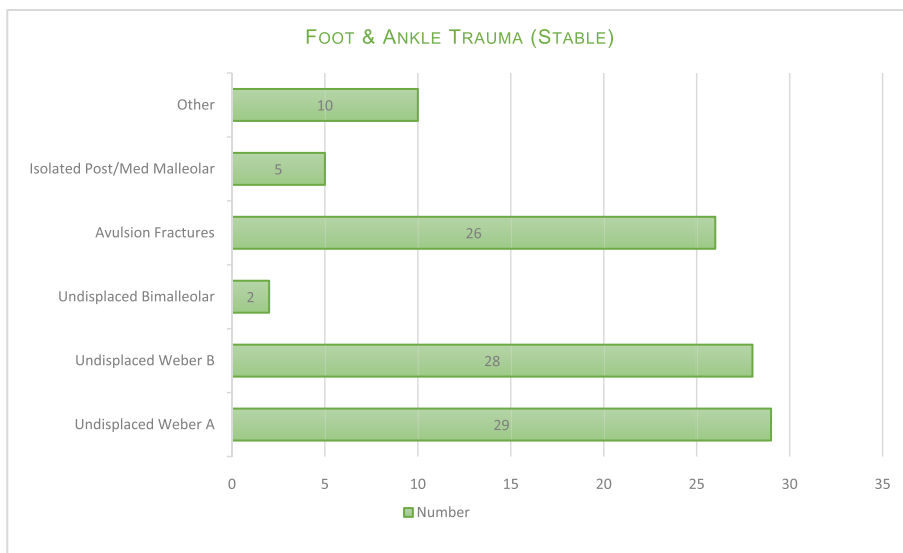


Fig. 2. Trauma variation in 2020 Phase 1 for stable fractures.

requiring a follow up appointment.

Fig. 3 highlights the variation in the 1st follow-up timeline that occurred which enabled minimal physical contact between physicians and patients. Standard postoperative management usually involves relatively frequent follow-up at 1–2 weeks for wound check and check x-rays to ensure no displacement of the fixation. Further follow-ups are usually done at the 6-week mark to assess for signs fracture healing. Based on the same principle of limiting physician-patient contact during the lockdown phase, the timeframe utilised for the 1st postoperative follow up was also analysed. Fig. 4 highlights this post-operative timeline for all unstable ankle fractures who were followed up (68 patients; 3 mortalities, 1 DNA).

4. Discussion

Preventative measures are the current strategy to limit the spread of COVID-19.³ These are often multifactorial, with key aspects involving isolation of infected patients and prevention strategies to ensure safety by mitigating the spread of the virus in HCP

and non-infected patients alike. The World Health Organization⁴ have issued technical guidance which includes frequent hand washing, avoiding close contact with patients with acute respiratory infections, departmental application of strict hygiene measures for the prevention and control of infections and avoidance of public gatherings. From our departmental perspective, multiple changes occurred to the patient pathway from presentation to discharge. These pathways were modified as the available evidence on COVID-19 evolved.

In line with transforming practices occurring in multiple trusts across the UK,⁵ the trauma service was shifted to the elective hospital due to cessation of majority of elective operating. Understandably, there were logistical issues with staff expertise and equipment availability associated with moving an entire trauma service. These improved as the lockdown progressed. A 'lift-and-shift' approach was adopted, with patients being transferred straight from the ED to a ward in the trauma-converted elective hospital. Patients were isolated in a side-room on a ward until their COVID status was cleared. Due to initial delays of obtaining a

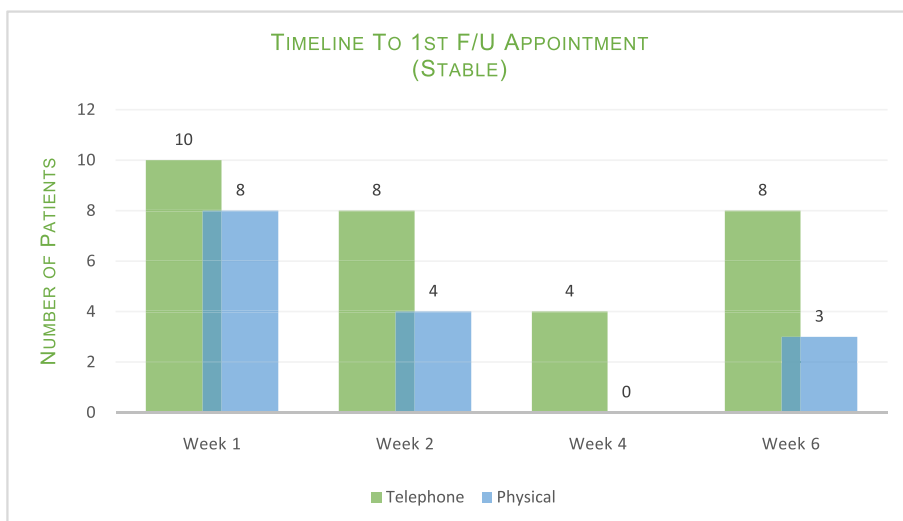


Fig. 3. First f/u timeline for stable ankle fractures.

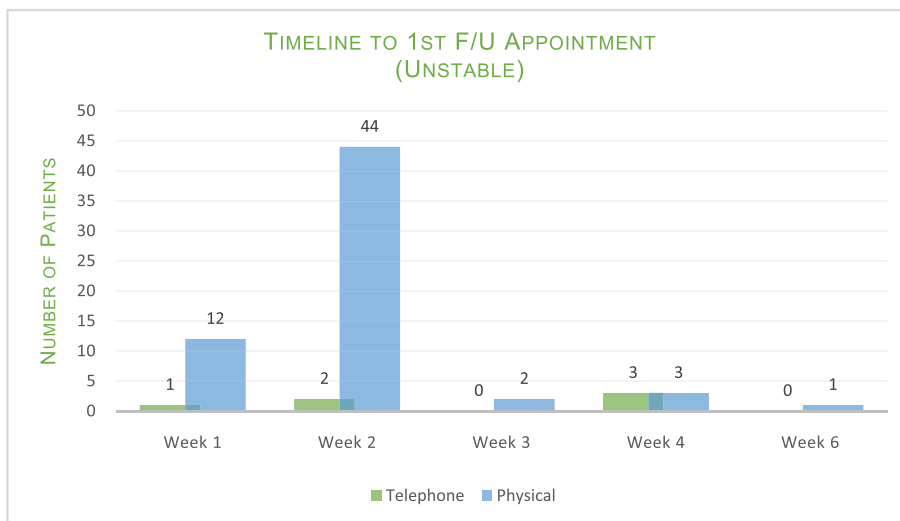


Fig. 4. First f/u timeline for post-operative unstable ankle fractures.

patient’s COVID status, a clinical decision was made to proceed with surgery undertaking full precautions pre- and intraoperatively. This measure was undertaken to mitigate surgical delay which would have a knock-on effect. This also allowed timely discharge and eased the surgical burden of accumulation cases for the hospital. Postoperatively, patients were actively encouraged to mobilise with the help of regular physiotherapy to allow early discharge from hospital, minimising risk to both the patient and the HCP.

Whilst we anticipated a net reduction in surgical intervention for foot and ankle trauma during the lockdown Phase 1, the number of unstable fractures was in fact marginally higher over the same time frame from net figures from 2019 (69 procedures (2019) vs. 78 procedures (2020)). Majority of the unstable injuries sustained were indoors (72% indoors vs 38% outdoors). Many cases underwent manipulation under fluoroscopy guidance in the first instance, without the need for formal anaesthesia. We are fortunate to have 24-h availability of the Mobile C-arm X-ray image intensifier in the ED to be able to offer this intervention to patients. Most of these cases were performed using Pentrox® (Methoxyflurane) which provided adequate analgesic effect for manipulation to occur. Fig. 5 depicts pre-reduction radiographs of a 75 year-old patient with a trimalleolar fracture dislocation (5a & 5b). Following closed reduction, CCC was applied (5c & 5d). She subsequently required no surgical intervention with imaging at final follow-up showing fracture union. The decision to perform CCC was multifactorial, with prior identification of ‘high-risk’ patients based on the patient’s age, functional status, comorbidities and suitability for anaesthesia. 13 out of 20 patients (65%) who were deemed suitable for CCC based on these criteria, underwent its application within the ED. Nine of these patients required no further intervention up to discharge.

Certain fractures may be amenable to partial fixation i.e. fixation of one anatomical aspect of a multi-component fracture, whilst still providing adequate stability and early mobilization. This would reduce the overall operative time in theatre, surgical insult to the body as well as post-operative complications. Of the patients operated in Phase 1, 5 patients underwent partial fixation. There were no post-operative complications of note in this cohort of patients. Discharge from follow-up varied, ranging from 6 weeks to 6 months from their primary procedures. Figs. 6 and 7 depict intra-operative images of a 55-year-old multimorbid patient, presenting with a tri-malleolar fracture. A clinical decision was made to



Fig. 5. (a): Pre-reduction antero-posterior (AP) X-ray of a trimalleolar ankle fracture. (b): Pre-reduction lateral X-ray (for the same patient). (c): AP X-ray following closed reduction and application of close contact casting (CCC). (d): Lateral X-ray following closed reduction and application of CCC.

perform isolated medial malleolar fixation followed by application of close contact casting. There were no post-operative complications. X-rays at 6 weeks (Figs. 8 and 9) depicted a uniting fracture. The patient was subsequently discharged from f/u following a telephone consultation at 12 weeks. Whilst this is a single case example, the principle behind the decision to perform a unilateral fixation with additional CCC is undoubtedly applicable to other



Fig. 6. Intraoperative antero-posterior radiograph following isolated medial malleolar fixation for a tri-malleolar fracture.



Fig. 8. Antero-posterior radiographs 6-weeks post-operatively.



Fig. 7. Intraoperative lateral radiograph following isolated medial malleolar fixation for a tri-malleolar fracture.



Fig. 9. Lateral radiographs 6-weeks post-operatively.

fracture patterns.

We also noted a large increase in the number of stable ankle fractures that presented during the same time frame. All patients who had a walker boot or temporary cast applied were given verbal advice on the day on cast management. As per our local trust protocol, all patients with an acute fracture and discharged straight from ED have their case reviewed the following day by the on-call team (via an inhouse fracture-clinic referral system). Subsequently, a dictated letter with the review outcome is sent to the patient within 48 h, and a physical follow-up appointment is arranged either at 1, 2 or 6 weeks. In view of the COVID pandemic, follow up plans had to be adjusted to minimize physical contact and if

feasible, attempt to delay and stagger appointments to a safe timeframe. Thirty-five patients with stable fractures were discharged with written advice from this initial review letter. This letter contained details of the nature of the injury, the fracture pattern and when to remove protective measure that was put in place for them (walker boot/cast). Patients were also advised to contact the fracture clinic if they required any further help or advice regarding their injury.

By triaging follow-up appointments to be physical or via telephone consults, the department reduced the number of patients who required to attend for their face-to-face appointment. Of the 65 patients with stable injuries who required follow up assessment, 30 patients had a telephone consult first (46%), with the remainder having staggered physical appointments. By 6 weeks from the

initial injury date, 79% of patients had been discharged from subsequent follow-up. With post-operative patients, majority (67%) still had a two-week physical appointment. This is likely due to post-operative wound checks and cast changes that could not be performed in the community setting. It is important to recognise the limitations of a telephone consultation and virtual examination particularly when assessing wounds and range of motion. However, there is growing evidence modified examination techniques with the shift of care to telemedicine.^{6,7} Our learning points are summarised below.

5. Learning points

- Assesses suitability of CCC in selective patients, particularly in the vulnerable. This can be performed in ED using Pentrox® (Methoxyflurane), under fluoroscopy guidance thus facilitating early discharge from hospital
- Certain fractures may be amenable to partial fixation providing adequate stability and early discharge from the hospital. This would reduce the overall time in theatre as well as reduce the complications associated with surgery.
- Integrating telemedicine into the patient's care pathway, particularly for stable ankle fractures reduces the need for physician-patient contact and eases follow-up burden.
- Patients with stable ankle fractures should be advised on self-implemented plaster removal techniques. Patient education leaflets/letters re-iterating the diagnosis and summarizing the management plan helps supports patients in managing their own injury

6. Conclusion

The COVID-19 pandemic has undoubtedly affected all aspects of healthcare provision. The Orthopaedic department is in a unique position where a large portion of the population is directly affected as a consequence of clinical challenges imposed to both trauma and elective services. By reviewing and modifying our hospital guidelines for the foot and ankle service, we hope to optimise the patient care pathway by adhering to national guidelines without

compromising patient care. Many of our recommended changes are easily replicated in other clinical settings. There is much yet to be learnt from an evolving service. However, should the implemented changes prove successful and sustainable, it is likely they will remain incorporated into future clinical practice.

CRedit author statement

RS: Conceptualization, Methodology; Writing - Original Draft Preparation.

AA: Conceptualization, Methodology; Writing - Original Draft Preparation.

MF: Methodology, Writing- Reviewing and Editing.

JM: Conceptualization, Methodology, Writing- Reviewing and Editing, Supervision.

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Declaration of competing interest

None.

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