



■ GENERAL ORTHOPAEDICS

Providing a paediatric trauma and orthopaedics service during the peak of the COVID-19 pandemic

THE ROYAL NATIONAL ORTHOPAEDIC HOSPITAL EXPERIENCE

**A. D. Iliadis,
D. M. Eastwood,
L. Bayliss,
M. Cooper,
A. Gibson,
R. Hargunani,
P. Calder,
On behalf of Royal
National Orthopaedic
Hospital Paediatric
COVID-19
Collaborative**

*Royal National
Orthopaedic Hospital,
Stanmore, UK*

Introduction

In response to the COVID-19 pandemic, there was a rapidly implemented restructuring of UK healthcare services. The The Royal National Orthopaedic Hospital, Stanmore, became a central hub for the provision of trauma services for North Central/East London (NCEL) while providing a musculoskeletal tumour service for the south of England, the Midlands, and Wales and an urgent spinal service for London. This study reviews our paediatric practice over this period in order to share our experience and lessons learned. Our hospital admission pathways are described and the safety of surgical and interventional radiological procedures performed under general anaesthesia (GA) with regards to COVID-19 in a paediatric population are evaluated.

Methods

All paediatric patients (≤ 16 years) treated in our institution during the six-week peak period of the pandemic were included. Prospective data for all paediatric trauma and urgent elective admissions and retrospective data for all sarcoma admissions were collected. Telephone interviews were conducted with all patients and families to assess COVID-19 related morbidity at 14 days post-discharge.

Results

Overall, 100 children underwent surgery or interventional radiological procedures under GA between 20 March and 8 May 2020. There were 35 trauma cases, 20 urgent elective orthopaedic cases, two spinal emergency cases, 25 admissions for interventional radiology procedures, and 18 tumour cases. 78% of trauma cases were performed within 24 hours of referral. In the 97% who responded at two weeks following discharge, there were no cases of symptomatic COVID-19 in any patient or member of their households.

Conclusion

Despite the extensive restructuring of services and the widespread concerns over the surgical and anaesthetic management of paediatric patients during this period, we treated 100 asymptomatic patients across different orthopaedic subspecialties without apparent COVID-19 or unexpected respiratory complications in the early postoperative period. The data provides assurance for health care professionals and families and informs the consenting process.

Cite this article: *Bone Joint Open* 2020;1-6:287–292.

Keywords: Paediatric, Practice, COVID 19, Safety

Correspondence should be sent to
Deborah M Eastwood; email:
d.m.eastwood@btinternet.com

doi: 10.1302/2633-1462.16.BJO-
2020-0060.R1

Bone Joint Open 2020;1-6:287–
292.

Introduction

The COVID-19 pandemic has had a profound global impact on healthcare services. In March 2020, NHS England announced the imminent cessation of all non-urgent

elective surgery services in an attempt to optimise capacity and redirect resources in anticipation of the COVID-19 surge. Guidelines for the delivery of trauma and orthopaedics services^{1,2} and the management

of musculoskeletal conditions in children (≤ 16 years of age)³ during this period were produced. Recent estimates suggest approximately 28 million elective case cancellations worldwide⁴ The impact on trauma and orthopaedics service provision is significant and recovery will require a significant amount of time and cost.⁵

Early data on COVID-19 has shown that children are likely to become asymptomatic carriers or suffer mild symptoms.⁶⁻⁸ This has raised concerns for the potential spread of disease as previous studies on influenza A virus have shown children to be the primary drivers of household transmission.⁹ The term “super-spreaders” has been widely used in the media and cited as a reason for the justification of school closures⁷. With extensive research and collaboration on a global scale there is now data available to dispute this widely accepted presumption.¹⁰⁻¹² Further concerns have been raised regarding a severe form of the disease affecting children resembling Kawasaki syndrome.¹³ Guidelines for the identification and management of paediatric inflammatory multisystem syndrome temporally associated with SARS-CoV-2 infection (PIMS-TS) have recently been published by the European Centre for Disease prevention and Control.¹⁴

As part of the restructuring of service provision during the pandemic, the Royal National Orthopaedic Hospital, Stanmore, was designated as a trauma hub for the North Central/East London (NCEL) region in an attempt to ease pressure on local trusts which serve a total population of over 1.5 million. The site also continued with the provision of a paediatric musculoskeletal tumour service for the south of England, Midlands, and Wales and emergency spinal pathways for London. As a tertiary referral centre the institution provides a specialist paediatric and limb reconstructive service.

Following the recommendations from NHS England, the British Orthopaedic Association (BOA), the Association of Paediatric Anaesthetists of Great Britain and Ireland (APAGBI), and taking into consideration the experience and lessons learned from colleagues worldwide,¹⁵⁻¹⁹ we rapidly implemented extraordinary changes to our pathways and protocols. During this period, we have provided orthopaedic care to a large cohort of paediatric patients through the three different referral streams. Furthermore, and in line with NHS, BOA, and Royal College of Surgeons recommendations, we have continued to provide an urgent elective paediatric orthopaedic practice for priority one and two cases.²⁰

As the UK is coming out of the peak period, considerable efforts are underway to determine the most safe and effective implementations to allow for resumption of elective services. This process should be guided by available evidence. The aim of this study is to contribute towards this process.

Table 1. Number of paediatric admissions per pathway.

Pathway of admission	Number of admissions
Trauma referral (aged 5 to 16 years)	35
Paediatric elective (time dependant)	20
▶ RCS priority 1 and 2	
Tumour/radiology	43
Spinal	2

Methods

Approval was granted from our institutions research and innovation committee (SE20.24). The institution was opened as an orthopaedic trauma centre on 20 March 2020. Prospective data were collected for all trauma and urgent elective paediatric admissions to our institution throughout the period from March 20 to 8 May 2020. Retrospective data on the sarcoma patients were collected through our patient electronic records. These included demographics, pathology and injury characteristics, anaesthetic and surgical data, as well as all COVID-19-related data. Changes to practice and other protocols implemented to maintain a safe and effective service are described. Telephone interviews were conducted two weeks following discharge. We specifically enquired about the development of any COVID-19-related symptoms (fever, cough, anosmia, and loss of taste) in patients and their households during this period. Patients were admitted through four different pathways (Table 1).

Trauma pathway. During this period our institution has provided a pathway for surgically managed trauma for the North Central/East London Sustainability and Transformation Partnership (NCEL STP) which comprises of four acute trusts (The Royal Free Hospital NHS Trust, Whittington Health, NHS Trust University College London, NHS Trust, North Middlesex Hospital NHS Trust) serving a population of over 1.5 million people. Furthermore, we provided a service to neighbouring trusts, including Watford General and Northwick Park Hospitals.

In order to deliver the service, our paediatric and limb reconstruction unit consultants provided 24/7 cover in parallel with the general adult on-call rota for the hospital. A consultant paediatrician rota was already established. Dedicated paediatric trauma lists with specialist paediatric anaesthetic consultant cover were created. The paediatric ward provided a large number of isolation rooms. Only one carer per patient was permitted.

An online referral pathway (E-trauma, Open Medical Ltd, London, UK) was introduced. Risk assessment for COVID -19 through symptom and contact screening and safeguarding checks were undertaken at both the referring hospital and upon admission. Patients were admitted into side rooms as direct transfers from local Emergency Departments or from home. COVID-19 swabs were not taken routinely during this period. COVID-19-positive, COVID-19-negative, and unknown status

patient pathways for admission to the wards, transfer around the hospital and for high dependency unit (HDU) care, were established. Appropriate theatre pathways were also established.²¹ Pre-existing paediatric pathways for care were maintained throughout.

Urgent elective paediatric pathway. As per GMC and BOA recommendations,³ certain elective paediatric orthopaedic procedures are considered urgent due to time dependency such as the management of developmental dysplasia of the hip, congenital talipes equinovarus, limb discrepancy and deformity. Priority one and two patients from our pooled elective waiting lists were identified.²⁰ We established and maintained a pathway for a dedicated weekly urgent elective list during this period. Admission to the ward and care pathways were adjusted similar to the trauma cases.

Bone and soft tissue tumour pathway. Our institution is one of the five designated centres in England specialising in the diagnosis and surgical treatment of patients with suspected/confirmed bone and soft tissue tumours within the London Sarcoma Service. Our network was expanded during this period as two of the other five centres were unable to provide a paediatric musculoskeletal tumour service. We have continued to deliver a service guided by government and NHS advice.^{22,23} This involved screening of cases for urgency, establishing and maintaining safe pathways for patient care as per NHS and Public Health England (PHE) guidance.

As with all services, outpatient attendances were reduced and there was widespread adoption of telephone and video consultations. Visiting on the ward was restricted, and efforts were made to maintain physical and side room separation of tumour patients from others, in particular trauma cases

Emergency spinal referral pathway. Pre-existing pathways were adapted to comply with all of the recommendations. Further guidance specific for spinal surgery was provided by NHS England.²⁴

Radiology pathway. Pre-existing pathways for GA procedures under image guidance were adapted to comply with recommendations from NHS England and the Royal College of Radiologists.^{25,26} We were able to maintain a weekly, consultant-led pathway for urgent image-guided GA biopsies and radiofrequency tumour ablations during this period.

Anaesthetic perspective. Anaesthesia was delivered by senior paediatric anaesthetic consultants in line with recommendations from the APAGBI.²⁷ The concerns over the spread of disease during aerosol generating procedures have been well documented.²⁸ This poses a particular challenge in the management of paediatric patients. The vast majority of adult surgery was performed under regional blocks when appropriate. This is not feasible in a paediatric population and all our cases were performed under general anaesthesia. Significant alterations to

common practice were introduced to minimize the potential spread of infection.

These included the training of all healthcare professionals in theatres in personal protective equipment (PPE) as per PHE guidelines and fit testing through dedicated daily sessions during the initial stages of transformation. The maintenance of established paediatric surgical care pathways allowed the dedicated paediatric recovery area, due to its layout, to act as the holding bay for patients called to theatre.

The initial pathway involved one parent with the child and a lower threshold for ward pre-medication. Check in and cannulation were performed in the anaesthetic room. Intravenous sedation was administered and transfer to theatre for airway management, performed in the centre of laminar flow canopy, that remained on. Only the anaesthetic assistant and anaesthetist were present during intubation. A ten-minute delay for air changes elapsed before the preparation for the procedure. In order to avoid issues with instrument trays and implants, these were prepared pre-induction and covered with sterile drapes.

Airway management included low flow pre oxygenation with an open adjustable pressure limiting valve (APLV) to minimize aerolization. Induction and then insertion of a supraglottic airway pre-connected to a system with heat and moisture exchanger (HME) filter always present. The circuit was then never disconnected during transfer. Bag-mask valve ventilation was avoided if possible to minimize aerosol risk caused by the positive pressure. If intubated, the same process was undertaken. Again, to minimize the risk of aerolization, the endotracheal tube was clamped on insertion and the clamp only released post cuff inflation at intubation.

Reversal of this process at the end of the procedure involved the patient being placed in the centre of the laminar flow canopy. Pre-oxygenation was performed and then the airway removed with the patient still under anaesthesia and spontaneously breathing to minimize cough. A disposable plastic sheet cover reduced droplet spray. Handover to the recovery team was undertaken at the theatre door to allow anaesthetic team to doff and then move to recovery clean.

Variation did occur with younger children where gas induction was required and older children who specifically requested gas induction due to previous experience or needle-based anxiety. In these cases, the protection that the positive pressure air flow within theatre provided the anaesthetist was abandoned. Standard gas induction and airway management in anaesthetic room with full PPE was undertaken.

Results

In all, 100 paediatric patients (46 female/54 male) were admitted and underwent general anaesthesia during the

Table II. Fractures treated through the trauma pathway.

Type of injury	Number of referrals
Distal radii/ulna fracture	10
Mid-shaft radii/ulna fracture	5
Radial neck fracture	2
Distal humeri lateral condyle fracture	1
Distal humeri supracondylar fracture	3
Proximal femur fracture	1
SCFE	1
Tibial tubercle fracture	2
Triplane ankle fracture	1
Soft tissue injury/laceration	4
Septic arthritis	1
Infected femoral nonunion	1
Trimalleolar ankle fracture	1
Bucket handle tear lateral meniscus	1
Ulnar nerve Injury	1

SCFE, slipped capital femoral epiphysis.

Table III. Procedures performed through trauma pathway.

Operation performed	Number of cases
Forearm fracture MUA	1
Forearm fracture open/closed reduction and flexible nailing	4
Distal radii fracture MUA	5
Distal radii fracture MUA+ K-wire stabilization	5
Elbow Supracondylar fracture closed reduction+ K-wire	3
Elbow lateral condyle ORIF	1
Radial neck fracture MUA	2
SCFE pinning in situ	1
Triplane fracture ORIF	1
Tibial tubercle fracture ORIF	2
Hip joint arthrotomy/washout	1
Proximal femur fracture ORIF	1
Excision of infected non-union and ex-fix application	1
Removal of foreign body	1
Wound management	3
Arthroscopic meniscal repair	1
Ulnar nerve exploration/release	1
Ankle medial malleolus ORIF	1

MUA, manipulation under anaesthesia; K-wire, Kirschner wire; ORIF, open reduction internal fixation.

six-week period. The mean age was 11 years of age (four months to 16 years).

Trauma pathway. A total of 35 trauma operations were performed during this six-week period for various pathologies (Tables II and III). The mean age of our cohort was ten years of age (five to 16 years). There were 25 males and ten females.

Due to the lockdown imposed throughout the UK in this period, the majority of injuries (> 60%) were sustained indoors. The low numbers of trauma referrals for a population of > 1.5 million over a six-week period²⁹ may be explained partly by indoor confinement and the

Table IV. Urgent elective paediatric cases.

Elective case performed	Number of cases
Removal of pediplates (OrthoPaediatrics Corp, Warsaw, USA)/other metalwork	6
Insertion of pediplates	4
Hip examination under anaesthesia / arthrogram±soft tissue releases and casting	2
Tendo-achilles tenotomy and casting	2
Revision of amputation stump	1
Epiphysiodesis	1
Synovial biopsy (suspected infection)	1
Removal/adjustment external fixator	2
Revision intra-medullary telescopic rod femur	1

Table V. Paediatric tumour cases.

Sarcoma procedures	Number of cases
Curettage and grafting ABC	3
Osteosarcoma excision and proximal humeral arthroplasty	2
Osteosarcoma excision and distal femoral arthroplasty	2
Curettage OFD	1
Synovial sarcoma excision	1
Excision osteochondroma (multiple sites)	3
Spindle cell sarcoma excision	1
NOF excision	1
Open biopsy femoral lesion	1
En-block excision for Ewing's, cement spacer and plate fixation	1
Wound washout	2

ABC, aneurysmal bone cyst; OFD, osteo fibrous dysplasia; NOF, non ossifying fibroma.

BOA/BSCOS recommendations for conservative management of injuries when appropriate.

All procedures were consultant led. There were no immediate postoperative complications and the mean length of stay was one night (0 to 5 days); 22 procedures were day cases. Despite the COVID-19-related restrictions, 78% of cases were performed within 24 hours of referral. Our follow-up regime was altered to minimize the number of hospital attendances. Absorbable sutures and removable casts were used when appropriate and instructions given to family for monitoring for complications as well as contact points in the hospital. Video consultations were used to give advice on wound care when necessary.

Urgent elective paediatric pathway. A total of 20 procedures on 20 patients (four male/16 female) were performed (Table IV). The mean age was nine years of age with a range from one to 15 years.

Bone and soft tissue tumour pathway/interventional radiology service. In all, 18 patients (eight male/ten female) underwent procedures for bone or soft tissue tumours under GA. The mean age was 12 years of age (three to 16 years). The procedures included complex resections with

prosthetic arthroplasties and adjuvant therapy (chemotherapy and/or radiotherapy) (Table V). Overall, 25 procedures were performed by the interventional radiology team and included CT and ultrasound guided biopsies and urgent radiofrequency ablation.

Spinal pathway. Two priority one paediatric cases underwent surgery for acute cord compression (one) and infection (one).

Anaesthetic input. All cases were performed under general anaesthesia delivered by paediatric anaesthetic consultants. According to the American Society of Anaesthesiologist (ASA) classification there were 76 ASA 1 cases, 17 ASA 2 cases, and seven ASA 3 cases.

COVID-19-related outcomes. No routine testing was undertaken in the absence of concerning symptoms or history of contact. Six patients underwent COVID-19 swabs prior to or during their admission due to risk factors identified: all swabs were negative. One sarcoma patient had a positive swab three weeks prior to admission but subsequently had two negative swabs and was asymptomatic prior to surgery. There were no immediate postoperative respiratory related complications. We were able to contact 97 out of the 100 families for a telephone interview at a minimum of 14 days post-discharge. In response to specific questioning, no cases of COVID-19 or COVID-19-related symptoms were identified in either the patients or family members in the same household.

Discussion

Following the peak of the COVID-19 pandemic, there is an urgent need to re-establish surgical services for children. Significant efforts are under way to develop evidence-based strategies to optimise the efficiency and safety of trauma and orthopaedic service provision.^{30,31} Concerns have been raised over the possibility of significant COVID-19-related morbidity and mortality following general anaesthesia in previously asymptomatic patients.³²

In our series of asymptomatic paediatric patients, we did not identify any cases of clinical COVID-19 infection or unexpected respiratory or surgical complications in the early postoperative period.

This data was collected in the absence of strict pre and postoperative isolation guidelines and in the absence of routine preoperative COVID-19 testing apart from risk assessment screening for symptoms and contacts. During this period, there was a nationwide lockdown with school closures and therefore a degree of social isolation was already in place for all patients.

There are limitations that should be borne in mind when interpreting our results. This is a small population sample and the absence of complications does not exclude the possibility.³³ Our data is derived from a population sample of unknown positives and there was a degree of selection bias particularly with regard to elective paediatric procedures where only priority one

and two cases with no comorbidities were included. This study was undertaken in a specialist orthopaedic hospital which became an orthopaedic trauma unit during the period 20 March to 8 May 2020. During this period the patient/case mix changed significantly and included many elderly patients with comorbidities. On a daily basis, the hospital had a mean ten to 12 COVID-19-positive inpatients (all adults), and six to eight isolated patients awaiting swab results. All were on HDU/ICU or in cubicles on the respiratory ward. We accept that most paediatric orthopaedic and trauma surgery occurs in a different environment and in such settings the rate of COVID-19 in postoperative patients might be higher.

Our experience and results, however, do add to the current knowledge base and will assist in the development of future pathways as well as provide a template for service planning and delivery in case we are faced with similar situation in future. It provides reassurance for families and professionals regarding morbidity and mortality and informs the consenting process.

References

1. **NHS.** Clinical guide for the management of trauma and orthopaedic patients during the coronavirus pandemic. National Health Service. 2020. <https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/03/C0274-Specialty-guide-Orthopaedic-trauma-v2-14-April.pdf> (date last accessed 16 June 2020).
2. **British Orthopaedic Association.** Emergency BOAST: Management of patients with urgent orthopaedic conditions and trauma during the coronavirus pandemic. 2020. <https://www.boa.ac.uk/resources/covid-19-boasts-combined.html> (date last accessed 16 June 2020).
3. **NHS.** Urgent and emergency musculoskeletal conditions in children (under 16) requiring onward referral. National Health Service. 2020. <https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/04/C0289-specialty-guidance-emergency-and-urgent-msk-guidance-for-children.pdf> (date last accessed 16 June 2020).
4. **Nepogodiev D, Bhangu A, CovidSurg Collaborative.** Elective surgery cancellations due to the COVID-19 pandemic: global predictive modelling to inform surgical recovery plans [published online ahead of print]. *Br J Surg.* 2020;10:0.1002/bjs.11746
5. **Morgan C, Ahluwalia AK, Aframian A, Li L, Sun SNM.** The impact of the novel coronavirus on trauma and orthopaedics in the UK. *Br J Hosp Med.* 2020;81(4):1–6.
6. **Morand A, Fabre A, Minodier P, et al.** COVID-19 virus and children: what do we know? *Arch Pediatr.* 2020;27(3):117–118.
7. **She J, Liu L, Liu W.** COVID-19 epidemic: disease characteristics in children. *J Med Virol.* 2020;92(7):747.
8. **Dong Y, Mo X, Hu Y, et al.** Epidemiology of COVID-19 among children in China. *Pediatrics.* 2020;145(6):e20200702.
9. **Tsang TK, Fang VJ, Chan K-H, et al.** Individual correlates of infectivity of influenza A virus infections in households. *PLoS One.* 2016;11(5):e0154418.
10. **Munro APS, Faust SN.** Children are not COVID-19 super spreaders: time to go back to school. *Arch Dis Child.* 2020;archdischild-2020-319474.
11. **Zhu Y, Bloxham C, Hulme K, et al.** (2020). children are unlikely to have been the primary source of household SARS-CoV-2 infections. *medRxiv.* 2020;20044826.
12. **The National Institute for Public Health and the Environment (RIVM).** Children and COVID-19. 2020. <https://www.rivm.nl/en/novel-coronavirus-covid-19/children-and-covid-19> (date last accessed 1 May 2020).
13. **Verdoni L, Mazza A, Gervasoni A, et al.** An outbreak of severe Kawasaki-like disease at the Italian epicentre of the SARS-CoV-2 epidemic: an observational cohort study. *Lancet.* 2020;395(10239):1771–1778.
14. **European Centre for Disease Prevention and Control.** Paediatric inflammatory multisystem syndrome and SARS-CoV-2 infection in children. ECDC. 2020. <https://www.ecdc.europa.eu/sites/default/files/documents/covid-19-risk-assessment-paediatric-inflammatory-multisystem-syndrome-15-May-2020.pdf>

15. **Farrell S, Schaeffer EK, Mulpuri K.** Recommendations for the Care of Pediatric Orthopedic Patients during the COVID Pandemic [published online ahead of print, 2020 Apr 14]. *J Am Acad Orthop Surg.* 2020.
16. **Randelli PS, Compagnoni R.** Management of orthopaedic and traumatology patients during the Coronavirus disease (COVID-19) pandemic in northern Italy [published online. *Knee Surg Sports Traumatol Arthrosc.* 2020;7:1.
17. **Service BC, Collins AP, Crespo A, et al.** Medically necessary orthopaedic surgery during the COVID-19 pandemic: safe surgical practices and a classification to guide treatment. *J Bone Joint Surg Am.* 2020.
18. **Hirschmann MT, Hart A, Henckel J, et al.** COVID-19 coronavirus: recommended personal protective equipment for the orthopaedic and trauma surgeon. *Knee Surg Sports Traumatol Arthrosc.* 2020;28(6):1690–1698.
19. **Gómez-Barrena E, Rubio-Suárez JC, Fernández-Baillo N, et al.** Limiting spread of COVID-19 in an orthopaedic department—a perspective from Spain. *J Surg Case Rep.* 2020;2020(4):rjaa095.
20. **NHS.** Specialty Guidelines for Surgical Prioritisation. National health service. 2020. <https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/03/CO221-specialty-guide-surgical-prioritisation-v1.pdf> (date last accessed 16 June 2020).
21. **NHS.** Minimum operating standards: Novel Coronavirus (COVID-19) Patient Pathway. National health service. 2020. <https://www.england.nhs.uk/wp-content/uploads/2020/02/coronavirus-patient-pathway.pdf> (date last accessed 16 June 2020).
22. **NHS.** Clinical guide for the management of noncoronavirus patients requiring acute treatment: Cancer. National health service. 2020. <https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/03/specialty-guide-acute-treatment-cancer-23-march-2020.pdf> (date last accessed 16 June 2020).
23. **Palmer C, Johnson P, Powis S.** Advice on maintaining cancer treatment during the COVID-19 response. National health service. 2020. https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/03/CO119-_-Maintaining-cancer-services-_-letter-to-trusts.pdf (date last accessed 16 June 2020).
24. **NHS.** Clinical guide for the management of patients requiring spinal surgery during the Coronavirus pandemic. National health service. 2020. <https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/03/specialty-guide-management-of-patients-requiring-spinal-surgery-v1-20-march-2020.pdf> (date last accessed 16 June 2020).
25. **NHS.** Clinical guide for the management of Radiology patients during the coronavirus pandemic. National health service. 2020. <https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/03/specialty-guide-radiology-and-coronavirus-v1-20-march-2020.pdf> (date last accessed 16 June 2020).
26. **Royal College of Radiologists.** Personal protective equipment advice for imaging departments and teams. Royal College of Radiologists. 2020. https://www.rcr.ac.uk/sites/default/files/radiology_ppe_poster_a3.pdf (date last accessed 16 June 2020).
27. **Association of Paediatric Anaesthetists of Great Britain and Ireland.** APAGBI position statement regarding the delivery and recovery of Children's Surgery during the coronavirus pandemic. APAGBI. 2020. <https://www.apagbi.org.uk/sites/default/files/inline-files/APA%20statement%2015.05.20%20Final.pdf> (date last accessed 16 June 2020).
28. **Health Protection Scotland.** Assessing the evidence base for medical procedures which create a higher risk of respiratory infection transmission from patient to healthcare worker. HPS. 2020. <https://www.hps.scot.nhs.uk/web-resources-container/assessing-the-evidence-base-for-medical-procedures-which-create-a-higher-risk-of-respiratory-infection-transmission-from-patient-to-healthcare-worker/> (date last accessed 16 June 2020).
29. **Rennie L, Court-Brown CM, Mok JYQ, Beattie TF.** The epidemiology of fractures in children. *Injury.* 2007;38(8):913–922.
30. **Royal College of Anaesthetists.** Restarting planned surgery in the context of the COVID-19 pandemic. Royal College of Anaesthetists. 2020. <https://static1.squarespace.com/static/5e6613a1dc75b87df82b78e1/t/5eac2a173d65cd27933fca88/1588341272367/Restarting-Planned-Surgery.pdf> (date last accessed 16 June 2020).
31. **De Caro F, Hirschmann TM, Verdonk P.** Returning to orthopaedic business as usual after COVID-19: strategies and options [published online ahead of print, 2020 Apr 27]. *Knee Surg Sports Traumatol Arthrosc.* 2020:1–6.
32. **Lei S, Jiang F, Su W, et al.** Clinical characteristics and outcomes of patients undergoing surgeries during the incubation period of COVID-19 infection. *E Clinical Medicine.* 2020(21):100331.
33. **Hanley JA, Lippman-Hand A.** If nothing goes wrong, is everything all right? Interpreting zero numerators. *JAMA.* 1983;249(13):1743–1745.

Author information:

- A. D. Iliadis, FRCS (Tr&Orth), Paediatric Orthopaedics
- D. M. Eastwood, FRCS, Paediatric Orthopaedics
- L. Bayliss, FRCS (Tr&Orth), Bone Tumour Unit
- P. Calder, FRCS (Tr&Orth), Paediatric Orthopaedics
Royal National Orthopaedic Hospital, Stanmore, UK.
- M. Cooper, FRCA, Anaesthetics
- A. Gibson, FRCS Orth, Spinal Surgery
- R. Hargunani, FRCR, Radiology
Royal National Orthopaedic Hospital NHS Trust, Stanmore, UK.

Author contributions:

- A. Iliadis: Generated the idea, Collected and analyzed the data, Wrote the manuscript.
- D. Eastwood: Generated the idea, Contributed to data analysis, Edited the manuscript.
- L. Bayliss: Contributed to data collection.
- M. Cooper: Contributed to data collection and manuscript.
- A. Gibson: Contributed to data, Edited the manuscript.
- R. Hargunani: Contributed to data, Edited the manuscript.
- P. Calder: Generated the idea, Carried out data analysis, Contributed to and edited the manuscript.

Funding statement:

- This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

ICMJE COI statement:

- D. Eastwood reports royalties from Oxford University Press, which are unrelated to this article. P. Calder reports payment for development of educational presentations from Smith & Nephew, and travel and accommodation expenses from Smith & Nephew and Nuvasive, all of which are unrelated to this article. A. Gibson reports expert testimony from legal firms, grants/grants pending from AO Spine, and payment for lectures (including service on speakers bureaus) from DePuy Synthes, all of which are unrelated to this article.

Acknowledgements:

- We acknowledge the work of all our NHS colleagues during our transformation. **Royal National Orthopaedic Hospital Paediatric COVID-19 Collaborative* Paediatric and Limb Reconstruction Unit;** Ms Caroline Bagley, Mr Benan Dala-Ali, Mr David Goodier, Mr Aresh Hashemi-Nejad, Mr Simon Hislop, Mr Tahir Khan, Mr Ben Rand, Ms Sally Tennant, Mr Jonathan Wright
Sarcoma Unit; Mr Will Aston, Professor Tim Briggs, Mr Pierluigi Cuomo, Ms Martina Faimali, Mr Craig Gerrand, Mr Panagiotis Gikas, Ms Heledd Havard, Mr Rob Pollock, Professor John Skinner
Spinal Unit; Mr Hanny Anwar, Mr Jan Herzog, Mr Jan Lehovsky, Mr Julian Leong, Mr Michael Mokawem, Mr Sean Mollo, Mr Hilali Noordeen
Radiology Group; Dr Faisal Alyas, Dr Sajid Butt, Dr Michelle Calleja, Dr Michael Khoo, Dr T Muthukumar, Dr Paul O'Donnell, Dr Asif Saifuddin, Dr Bhavin Upadhyay, Dr Alessandro Vidoni
Anaesthetic group; Dr Kate Adams, Dr Kofi Agyare, Dr Jan Chernovsky, Dr Ben Clevenger, Dr Michael Cooper, Dr Geraldine Edge, Dr Mary Fennelly, Dr Jasmeet Kaur, Dr Ramprabu Krishnan, Dr Dan Mihaylov, Dr Prasan Panagoda Dr Melanie Speakman, Dr Julie Taylor
Paediatric Team; Dr Adeb Ahmed, Dr Sherine Dewlett, Dr Jane Hoddes, Dr Cristina Ilea, Dr Benjamin Jacobs, Dr Wolfgang Muller, Dr Mahmood Mustafa, Dr Caroline Oren
Trust Junior Doctors; Dr Effie Menyah, Dr Rebecca Morgan, Dr Valentina Palloni,
Trauma Co-ordinators; Ms Anna Timms, Ms Amanda Denton, Ms Karen Alligan

© 2020 Author(s) et al. This is an open-access article distributed under the terms of the Creative Commons Attribution licence (CC-BY-NC-ND), which permits unrestricted use, distribution, and reproduction in any medium, but not for commercial gain, provided the original author and source are credited.