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Reduced presentations with fractures or orthopaedic infections to a major children's hospital during a national COVID-19 elimination strategy

Blair Mason, Susan Stott and Rebecca Beamish
Starship Children's Hospital, Grafton, Auckland, New Zealand

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COVID-19, orthopaedic surgery, paediatric orthopaedics, trauma.

Correspondence
Dr Blair Mason, Christchurch Hospital, Orthopaedic Department, 2 Riccarton Avenue, Christchurch, New Zealand.
Email: blair.mason@cdhb.health.nz

B. Mason MSc, MBChB; **S. Stott** PhD, FRACS; **R. Beamish** MSc, FRCS.

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Abstract

Background: From 26 March 2020, New Zealand implemented a COVID-19 elimination strategy which initially involved substantive limitations on public movement and assembly, and closure of non-essential businesses. We asked what effect this had on acute paediatric orthopaedic presentations to a tertiary children's hospital.
Method: The numbers, age and gender of patients with orthopaedic presentations, seen by either the Children's Emergency Department (CED) or the orthopaedic service during the study period, were compared with the equivalent 2019 period.
Results: During the first 64 days of lockdown, 708 patients were seen in CED with orthopaedic presentations compared with 1124 patients in the same period in 2019 (37% reduction). We found a 55% reduction in musculoskeletal infections (from 135 to 61), a 40% reduction in total fractures (from 446 to 268) and a 27% reduction in soft tissue injuries (from 520 to 380). In 2020, similar proportions of patients were admitted for operating room procedures (15%) or had fractures reduced under sedation in CED (17%), however, increased numbers of soft tissue injuries were managed through CED under procedural sedation.
Conclusion: A national COVID-19 elimination strategy, closing all but essential businesses, limiting public movement, physical distancing and focusing on hand hygiene, led to reduced presentations not only with fractures and soft tissue injuries but also musculoskeletal infections. Increased numbers of patients had procedural sedation for soft tissue injuries, but there was no significant change in the proportion of patients admitted for surgery.

Background

Starship Children's Health is New Zealand's only stand-alone paediatric hospital and is in central Auckland, part of Auckland District Health Board (ADHB). In New Zealand, all major trauma is managed in public hospitals. The Paediatric Orthopaedic Department provides secondary and tertiary care (acute and elective) to children 15 years and under in the Auckland and Waitemata District Health Boards, a population of 1.1 million.[1] The department also accepts tertiary and quaternary level transfers (acute and elective) from the rest of New Zealand and the Pacific.

In 2020, Starship rapidly adapted to the COVID-19 pandemic. On 30 January 2020, the World Health (WHO) declared a public health emergency of international concern, the highest response level.[2] By 7 March, there were over 100 000 cases globally.[3] The New Zealand Government committed to an elimination strategy, declaring a State of National Emergency on 25 March 2020, which remained until 13 May 2020. During that time, there was severe restriction of the movement and assembly of people to combat disease transmission, defined by a series of Alert Levels. Level 4 was the most stringent and included cessation of all elective surgery and advice to primary care to switch to virtual consultations where possible.[4] These restrictions were progressively relaxed during Levels 3, 2 and 1 as the risk of COVID-19 community transmission subsided (Table 1).

District Health Boards across New Zealand planned for a possible influx of patients, with ADHB defining a response plan based on numbers of patients admitted to the hospital and disruptions to services. All elective surgeries were cancelled, bar those of the highest priority, but the Paediatric Orthopaedic Department was able to admit all patients needing urgent or emergency care. Around this time, the British Orthopaedic Association released guidelines

Table 1 National alert levels

	Level 4	Level 3	Level 2
Time invoked	11:59 pm 25 March 2020	11:59 pm 27 April 2020	11:59 pm 13 May 2020
Travel conditions	Essential personal movement only. Remain in household bubble.	Travel allowed in local area.	Travel allowed.
Physical distancing	2 m when outside the home.	2 m when outside the home. 1 m in workplaces.	2 m outside the home. 1 m in workplaces, gyms and so forth where practical.
Health facilities	Hospitals open for acute work. Routine care postponed. Private hospitals shut.	Hospitals open for acute and selected elective work.	Hospitals open for acute and elective work.
Public gatherings† and schools	All cancelled. Schools closed.	Gatherings up to 10 people. Some early learning centres open, schools open for years 1 to 8.	Gatherings up to 100 people. All schools open.

†Includes playgrounds, gyms, amusement parks (Adapted from COVID-19 Alert Levels[5] and Health and disability services at different Alert Levels[6]).

around the management of paediatric orthopaedic trauma. This advocated for greater use of non-operative treatment to reduce the inpatient burden on hospitals, reducing the number of aerosolising anaesthetic procedures.[7]

This study aimed to identify all patients assessed in the Children's Emergency Department (CED) with paediatric orthopaedic diagnoses over a 2-month period, starting at Level 4, and compare with the equivalent period in 2019. The goals were to understand how a national lockdown, without significant COVID-19 infections, affected the frequency and type of presentations compared with the equivalent period 12 months prior, and how patients were managed.

Methods

Registration and ethics

The study was registered with the ADHB Research Office. Ethics approval was granted by the Northern B Health and Disability Ethics Committee. The study was conducted in accordance with the principles of the Declaration of Helsinki 2013.

Participants

The ADHB Health Information and Technology Service provided the data set for all children presenting to CED with one or more presumptive orthopaedic diagnoses, who were seen either by CED staff or Paediatric Orthopaedics. For this study, 'orthopaedic diagnosis' included any fracture or soft tissue injury or infection of the limbs, neck, back, spine or pelvis. Soft tissue injuries included joint dislocations/subluxations, lacerations, contusions, wound issues, limping and non-specific limb pain. Infections included superficial/deep infections, including cellulitis and limb abscesses. Other orthopaedic diagnoses included any tumour in the limb or bone, cast issues and diagnoses that proved with further work-up to have a non-orthopaedic cause.

Inclusion criteria

All children presenting with presumptive orthopaedic diagnoses were included, even if later work-up showed that the final diagnosis was unclear (e.g. unspecified limb pain) or not orthopaedic (e.g. a suspected septic joint later diagnosed as rheumatic fever). Any patients admitted under another service (through CED) with an associated orthopaedic diagnosis (e.g. polytrauma patients admitted under paediatric surgery) were included.

A small number of patients presented semi-acutely through CED for consultant review, or theatre procedures (e.g. for repeat fracture manipulation, or where fractures were found to have lost position in a clinic). These patients were also included.

Exclusion criteria

Children admitted for elective surgery were excluded. Patients with cellulitis and abscesses of the buttocks, back, face and genitals were excluded, as were infections and tumours of craniofacial bones, sternum and ribs as these are managed by other services.

Study period and data extraction

Sixty-four days were included: 33 days at Level 4 (26 March to 27 April); 16 days at Level 3 (28 April to 17 May) and 15 days at Level 2 (14 to 29 May). Data collection during Level 2 period was limited to 2 weeks, as this was comparable with the Level 3 length and was considered to adequately capture variations in the patterns of behaviour. The three comparator time periods for 2019 were 28 March to 29 April, 30 April to 15 May, and 16 to 31 May. Daylight saving ended on 5 April 2020, and 7 April 2019.

The data set included demographics (age, gender), and discharge diagnoses where available. A small number had more than one orthopaedic diagnosis recorded, and each was captured for analysis (e.g. fractures of two separate bones.) Where diagnoses were not confirmed or unclear at time of discharge, the health record was checked manually, and the patient was included or excluded as appropriate, recording the relevant diagnoses. Whether the patient had received operative intervention in an operating theatre, or in a procedure room, was also recorded.

Statistical analysis

Presentations were analyzed with respect to proportions of fractures, soft tissue injuries and infections. The proportion of each subcategory across the two time periods was analyzed using two proportion z tests, with values deemed significant at $P < 0.05$.

Table 2 Breakdown of Paediatric presentations to CED during 2020 lockdown compared with 2019

	Total		Level 4		Level 3		Level 2	
	2019	2020	2019	2020	2019	2020	2019	2020
No. of children presenting to CED during lockdown period	6518	3056	3160	1431	1574	780	1784	845
No. of children presenting with one or more orthopaedic diagnoses (% of all children seen in CED)	1124 (17%)	708* (23%)	588 (19%)	343* (24%)	276 (18%)	144 (18%)	260 (15%)	221* (26%)
No. of orthopaedic diagnoses†	1164	741	608	358	283	149	273	234
Male: Female	608:516	406:302	309:279	192:151	164:112	93:51	135:125	121:100
Mean age (*SD*)	7.5 (4.2)	7.2 (4.3)	7.3 (4.3)	6.8 (4.2)	7.6 (4.1)	7.1 (4.3)	7.7 (4.3)	8.0 (4.4)

*Significant proportional increase between 2019 and 2020 relative to all presentations to CED ($P < 0.05$).

†Some patients had > one orthopaedic diagnosis.

Results

Three thousand and fifty-six children presented to CED in the 2020 period, compared with 6518 in the 2019 period (Table 2). Seven hundred and eight children in 2020 had 741 orthopaedic diagnoses, compared with 1124 children in 2019 with 1164 orthopaedic diagnoses. This represented a 37% decrease in the absolute numbers of children seen with orthopaedic diagnoses, but a small relative increase in the proportion of children seen with orthopaedic diagnoses compared with other conditions, from 17% in 2019 to 23% in 2020 ($z = -6.868$, $P = < 0.00001$). The number of children presenting with one or more orthopaedic diagnoses was 42% lower in the Level 4 period, 48% lower in Level 3, but only 15% lower in Level 2. Similarly, the number of orthopaedic diagnoses reduced by 41% in Level 4, 47% in Level 3, and 14% in Level 2, with a 36% reduction overall. At each Level, the proportion of children presenting with orthopaedic diagnoses relative to other presentations increased.

There was no change in patient age compared with the 2019 period. Gender ratios showed an increase in the proportion of males in 2020 at each alert Level.

Fractures

The absolute number of children presenting with fractures fell from 446 in 2019 to 268 in 2020 (Table 3), a reduction of 40%. However, the relative numbers were essentially unchanged; in 2019, fractures made up 38% of all presentations with orthopaedic diagnoses, and 36% in 2020 (n.s). In 2019, 80% of fractures were in the upper limb, with a similar proportion (76%) in 2020 (n.s.). Lower limb fractures comprised 19% of all fractures in 2019, and 22% in 2020 (n.s.).

Soft tissue injuries

The absolute number of soft tissue injuries fell from 520 in 2019 to 380 in 2020 (Table 3), a reduction of 27% ($z = -2.8166$, $P = 0.0048$) but made up 51% of all orthopaedic diagnoses in 2020.

Upper limb soft tissue injuries comprised 19% of all orthopaedic diagnoses in 2019, and 23% in 2020 ($z = -2.0556$, $P = 0.0394$). Lower limb soft tissue injuries represented 21% of diagnoses in 2019 and 23% in 2020 ($z = -1.2029$, n.s). Other soft tissue injuries (to the back, neck, and all post-operative wound complications)

Table 3 Paediatric orthopaedic diagnoses by diagnostic category

		Total		Level 4		Level 3		Level 2	
		2019	2020	2019	2020	2019	2020	2019	2020
Fractures	Upper Limb	359 (80%)	204 (76%)	177 (82%)	116 (81%)	95 (78%)	38 (78%)	87 (80%)	50 (66%)
	Lower limb	83 (19%)	60 (22%)	34 (16%)	25 (17%)	27 (22%)	11 (22%)	22 (20%)	24 (32%)
	Spine/pelvis	4 (1%)	4 (1%)	4 (2%)	2 (1%)	0 (0%)	0 (0%)	0 (0%)	2 (3%)
	Total	446	268	215	143	122	49	109	76
Soft tissue injuries	Upper limb	226 (43%)	173 (46%)	118 (43%)	87 (51%)	45 (38%)	32 (41%)	63 (50%)	54 (42%)
	Lower limb	240 (46%)	170 (45%)	129 (47%)	72 (42%)	61 (51%)	36 (46%)	50 (39%)	62 (48%)
	Other†	54 (10%)	37 (10%)	27 (10%)	13 (8%)	13 (11%)	10 (13%)	14 (11%)	14 (11%)
	Total	520	380	274	172	119	78	127	130
Infections	Superficial	111 (82%)	48 (79%)	73 (84%)	20 (71%)	19 (79%)	12 (92%)	19 (79%)	16 (80%)
	Deep‡	24 (18%)	13 (21%)	14 (16%)	8 (29%)	5 (21%)	1 (8%)	5 (21%)	4 (20%)
	Total	135	61	87	28	24	13	24	20
Other§	Total	63	32	32	15	18	9	13	8
Total no. of orthopaedic diagnoses		1164	741	608	358	283	149	273	234

†Neck and back soft tissue injuries, post-operative wound issues.

‡Osteomyelitis, septic arthritis and pyomyositis.

§Cast problems, tumour and diagnoses subsequently confirmed as non-orthopaedic.

Table 4 Patient management in 2020 compared with equivalent time in 2019

	Total		Level 4		Level 3		Level 2	
Time period	2019 $n = 1124$	2020 $n = 708$	2019 $n = 588$	2020 $n = 343$	2019 $n = 276$	2020 $n = 144$	2019 $n = 260$	2020 $n = 221$
Operating theatre procedure	153 (14%)	104 (15%)	80 (14%)	56 (16%)	40 (14%)	16 (11%)	33 (13%)	32 (14%)
Procedure room fracture manipulation	174 (15%)	123 (17%)	80 (14%)	66 (19%)	45 (16%)	23 (16%)	49 (19%)	34 (15%)
Procedure room soft tissue procedure	88 (8%)	96 (14%)	53 (9%)	41 (12%)	15 (5%)	28 (19%)	20 (8%)	27 (12%)
No surgical intervention	709 (63%)	385 (54%)	375 64%)	180 (52%)	176 (64%)	77 (53%)	158 (61%)	128 (58%)

accounted for 5% of all orthopaedic diagnoses in both 2019 and 2020 ($z = -0.2449$, n.s).

In 2020, total soft tissue injuries decreased by 37% in Level 4, 34% in Level 3 and increased by 2% in Level 2. This was due to a 24% increase in lower limb soft tissue injuries, which made up 39% of soft tissue injuries in Level 2 2019, increasing to 48% in Level 2 2020 ($z = -2.2135$, $P = 0.0271$).

Infections

Infections fell from 135 in 2019 to 61 in 2020 (Table 3), a reduction of 55%. Infections comprised 12% of diagnoses in 2019, and 8% in 2020 ($z = 2.3574$, $P = 0.01828$). The reduction was mainly due to less superficial infections (cellulitis and superficial abscesses), with 111 diagnoses in 2019, and 48 in 2020, a reduction of 57% ($z = 2.3529$, $P = 0.01878$). The greatest reduction was seen in Level 4, from 73 to 20. Deep infections (septic arthritis and osteomyelitis) showed an overall reduction from 24 in 2019 to 13 in 2020, but proved non-significant.

Other diagnoses

Other diagnoses included conditions outside of fractures, soft tissue injuries and orthopaedic infections, which were referred to orthopaedics. These included issues with casts and peripheral lines for antibiotics, possible bone and soft tissue tumours, and patients subsequently diagnosed with conditions such as rheumatic fever. These accounted for 63 diagnoses in 2019 and 32 in 2020.

Patient management

In 2019, 709 patients (63%) were managed without surgical intervention (i.e. did not require any procedure with general anaesthesia, procedural sedation or local anaesthetic) (Table 4). This compared with 385 patients (54%) in 2020 ($z = 3.6969$, $P = 0.00022$). In 2019, 174 patients (15%) had fractures manipulated using procedural sedation, compared with 123 (17%) in 2020 (n.s.). In 2019, 88 patients (8%) had soft tissue injuries (e.g. lacerations, nailbed injuries) managed in the procedure room, compared with 96 patients (14%) in 2020 ($z = -3.9732$, $P = 0.00008$). In 2019, 153 patients (14%) had a procedure in the operating theatre, compared with 104 patients (15%) in 2020 (n.s.).

Discussion

This study analysed the effect of a national lockdown on children presenting with paediatric orthopaedic conditions to the ED of a national children's hospital. We found a 37% reduction in the number of children presenting with paediatric orthopaedic conditions over the first 64 days of lockdown (encompassing Levels 4, 3 and 2), with no change in age but a proportional increase in male patients. There was a 55% reduction in superficial and deep musculoskeletal infections, a 40% reduction in fractures and a 27% reduction in soft tissue injuries. Superficial skin infections showed the most significant reduction, most strikingly at Level 4 (73%), however, by Level 2 the reduction was 16%. The proportion of children requiring operating room interventions was unchanged from 2019 at 15%, but 31% of children received procedural sedation in CED (compared with 23% in 2019).

There have been several reports of the effects of lockdowns on children presenting with paediatric orthopaedic conditions. These have generally shown a reduction in trauma and fracture-related presentations, ranging from 37% to 68%.[8,9] There has been more variable experience of the effect of lockdowns on presentations with major trauma. The Women's and Children's Hospital in South Australia saw a one-third reduction in ED presentations but no change in rate of major trauma following early initiation of a lockdown with little COVID-19 in the community.[10] The authors theorized this was due to the continued use of quad bikes in their population.

Consistent with these reports, we saw an overall reduction in fracture-related presentations of 40%, most significantly at Level 4. We did not capture non-orthopaedic trauma, but Hamil and Sawyer reported a reduction in all types of major surgical trauma admissions to Starship from 85 patients in 2019 to 57 during lockdown. There were zero admissions related to motor vehicle crashes and two pedestrian injuries, one transferred from overseas. During this period there was a 5-year high in bicycle-related trauma, which likely reflected the significant reduction in traffic on suburban streets and school closures.[11]

Presentations with superficial infections reduced significantly during lockdown, primarily driven by a reduction in cellulitis in Level 4. Smaller numbers of deep infections were also seen at Level 4. Through a literature search, we could not find any other reports highlighting this occurrence, although paediatric infections in general have been reported as reduced in countries such as Singapore, which also introduced a nationwide lockdown.[12]

Several reasons for reduced infections are proposed. Firstly, parents may have been reluctant to bring children with cellulitis into hospital, due to anxiety regarding catching COVID-19.[13] Some children with cellulitis may have been seen in primary care, virtually or face to face. Nationally, only one child was reported to the New Zealand Paediatric Surveillance Unit as having an adverse outcome due to delayed diagnosis of a skin infection, suggesting that cellulitis was successfully managed during this time, whether through CED or primary care.[13] Secondly, one of the Government's main messages was to stay home. Level 4 required 2 m physical distancing, and stopped children playing at school and in playgrounds, and with children from other 'bubbles', likely reducing their risk of cuts and scratches, and reducing bacterial transmission. Thirdly, a national campaign emphasizing hand hygiene likely contributed to the reductions in presentations with skin infections.[14]

The threat of COVID-19 nationwide remained controlled throughout the lockdown. This likely explains why we saw no change in the proportions of patients having fracture reduction under procedural sedation or admitted for intervention in the operating room (almost a third in total). We saw a relative increase in the use of procedural sedation, or local anaesthesia in CED, for minor soft tissue injuries, which has continued post lockdown in our unit.

Limitations

This study compared data with the equivalent period of 2019, so trends may vary when compared with historic data. However, our data are broadly in line with national data reported by the Ministry of Health showing patient volumes decreased across elective, acute and primary care across New Zealand during March–June 2020 compared with the same months in 2018 and 2019.[15] The same report highlighted a 37.6% drop in ED attendances in April 2020 across all age groups, which strikingly parallels our data. It is possible that some children were seen in private facilities rather than presenting to hospital during Level 4, but access to these was very limited at that time. Finally, this study has not controlled for the effects of weather or seasonal change as daylight hours reduce towards the end of the study period but has allowed for this by comparing with the equivalent period in 2019.

Conclusion

A nationwide lockdown, emphasis on physical distancing and hand hygiene had profound effects on presentations to a children's hospital with infection and trauma-related orthopaedic conditions. While the reduction in trauma can be explained by the cessation of sport and restriction in transportation, the reduction in infections is more likely due to hand hygiene and physical distancing. This has implications for the care of children at home, school and day-care, to reduce the incidence of cellulitis. While the absolute numbers of patients fell during lockdown, similar proportions had either fracture reduction under procedural sedation or needed admission for surgical management in the operating room compared with 2019.

Overall, these findings are important in planning paediatric orthopaedic healthcare during future lockdown events or pandemics. The precipitous drop in acute workload suggests that early re-deployment of some surgical resource towards safe management of elective and semi-acute work is feasible and practicable. Supporting outpatient care includes increased specialist virtual consultations (with X-rays taken locally in advance) plus greater specialist support of primary care to manage non-operative conditions in the community. Increased use of procedural sedation can avoid tying up theatre resources for minor surgical cases, although must be weighed against the time taken to deliver it.

Finally, further work is needed to agree a set of principles to guide prioritization of existing and incoming elective surgical and outpatient face to face work at different Alert Levels. These principles need to balance the risk of continuing work as usual, versus patient harm with delayed treatment. They should take a broad view of potential patient harm (physical, mental and social) and avoid exacerbation of existing ethnic or regional health inequities. These principles would help address prioritization in services with capacity constraints, such as national or regional services, patients for whom care is complex with multiple specialists, and patients who have already experienced multiple deferrals.

Conflict of interest

None declared.

Author contributions

Blair Mason: Conceptualization; data curation; formal analysis; investigation; methodology; project administration; writing – original draft; writing – review and editing. **Susan Stott:** Conceptualization; formal analysis; project administration; supervision; writing – original draft; writing – review and editing. **Rebecca Beamish:** Conceptualization; formal analysis; writing – review and editing.

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