Research Article

Transfer Time After Acceptance to a Level I Trauma Center

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Abstract

Background: Timely treatment of pediatric orthopaedic emergencies at level I trauma centers is frequently dependent on transfers from neighboring centers.

Methods: Records were collected from our level I trauma center for patients with isolated orthopaedic issues accepted for transfer in 2015. Open fractures, compartment syndrome, septic arthritis, and supracondylar humerus fractures with ecchymosis or neurovascular compromise were emergent. The rush hour was 6 AM to 10 AM and 3 PM to 7 PM.

Results: Ninety-six patients met the inclusion criteria; 19% (18/96) were orthopaedic emergencies and 37% (35/96) occurred during the rush hour. The average time from transfer acceptance to accepting hospital admission was 203 minutes (range, 68 to 584 minutes; SD, 85.8 minutes). The average time from transfer acceptance to departure from the transferring facility was 114 minutes (range, 7 to 391 minutes; SD, 71.9 minutes). There was no correlation between the transfer time and rush hour ($P = 0.40$), emergent versus nonemergent ($P = 0.42$), or routed distance from the hospital ($P = 0.46$).

Conclusion: The average transfer time exceeded 3 hours and was independent of the distance, the rush hour, or urgency of patient condition. An average 2-hour delay was encountered for patients while leaving a medical facility after acceptance of transfer.

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This study has been conducted with approval from the Institutional Review Board at Children's Hospital Los Angeles.

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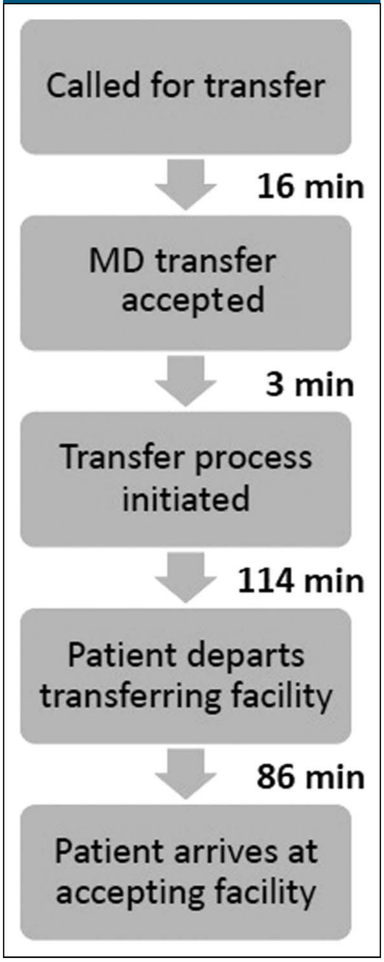
Treatment of time-sensitive orthopaedic emergencies at level I pediatric centers is frequently dependent on transfers from neighboring centers that do not have the capability to provide the necessary care to pediatric patients. Although this consolidation may improve the efficacy of care,[1] the logistical effects of these pediatric transfers have not been well evaluated.

In the adult literature, a recent evaluation of US national incidence of interhospital transfers showed increased costs of care and increased risk of mortality associated with transfer.[2] A review of one Australian hospital revealed that delays occurred in 20% of total transfers, including 9% of all orthopaedic transfers. This was associated with a median time between injury and arrival at the accepting hospital of 4 hours.[3]

To our knowledge, no study has yet examined factors influencing transfer

Figure 1



Average time from call for transfer to patient arrival at the accepting facility.

times between hospitals for pediatric orthopaedic conditions. Our study was conducted to quantify transfer times from outside facilities to a level I pediatric center and to identify factors that affected transfer time.

Methods

An institutional review board–approved retrospective review of medical records for all patients accepted for transfer by the orthopaedics department to a level I pediatric trauma center in 2015 was performed. Patients were identified using the center's Central Logic database. Transfer requests were filtered by the accepting provider, and only those patients accepted by an orthopaedic attending physician were selected. Both the inpatient and outpatient medical records were reviewed. To monitor for possible complications, patients were followed until released from follow-up.

All patients with isolated orthopaedic issues transferred to the participating institution from an outside hospital in 2015 were eligible for the study. Patients were excluded if there was inadequate documentation of transfer initiation (n = 9) or transfer departure (n = 37). Data were collected on patient demographics, diagnosis, time of call for transfer, time of transfer acceptance, time of transfer initiation, time of transfer departure, time of admission to the accepting hospital, and time of patient treatment (Figure 1). Open fractures (n = 7), compartment syndrome, septic arthritis, supracondylar humerus fractures with signs of compartment syndrome, absent palpable pulses, or median, radial, or ulnar nerve palsies (n = 11) were classified as emergent. The rush hour was classified as 6 AM to 10 AM and 3 PM to 7 PM.

Correlations between continuous variables and transfer times were determined using linear regression. Independent *t*-tests were used to analyze relationships between categorical variables and transfer times. Descriptive data were summarized using mean, SD, and range.

Results

Ninety-six patients from 58 different centers met the initial inclusion criteria. The average patient age was 6.8 years (range, 1.1 to 21.3 years; SD, 3.9 years). Of note, 60.4% (58/96) of patients were males and 39.6% (38/96) were females; 65.6% (63/96) of patients had public insurance, and 34.4% (33/96) had private insurance; and 18.8% (18/96) of the cases were classified as orthopaedic emergencies, which are listed in Table 1.

A total of 36.5% (35/96) of transfers were accepted during the rush hour. The average distance from transferring hospitals was 20.5 miles (range, 3.6 to 109 miles; SD, 16.2 miles) by the most direct driving route (Table 2). The average time from call for transfer to transfer acceptance was 15.8 minutes (range, zero to

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93 minutes; SD, 16.6 minutes), the average time from transfer acceptance to transfer initiation was 2.8 minutes (range, zero to 133 minutes; SD, 15.6 minutes), the average time from transfer acceptance to transfer departure from the referring hospital was 114.1 minutes (range, 7 to 391 minutes; SD, 71.9 minutes), and the average time from transfer acceptance to admission at our hospital was 202.7 minutes (range, 68 to 584 minutes; SD, 85.8 minutes) (Figure 1).

There was no relationship between the routed hospital distance and time from transfer acceptance to hospital admission ($R^2 = -0.006$; $P = 0.49$). There was no correlation between transfer during the rush hour and transfer time (rush hour = 214.5 minutes, nonrush hour = 195.9 minutes; $P = 0.31$). There was no correlation between the emergency status and transfer time (emergency = 184.9, nonemergency = 206.8; $P = 0.33$) (Table 2).

On multiple linear regression, there was no correlation between the transfer time and rush hour ($P = 0.40$), emergent versus nonemergent ($P = 0.42$), or routed distance from the hospital ($P = 0.46$).

Sixty-four patients completed follow-up. A total of 10.9% (7/64) of patients developed complications secondary to their original report, including superficial infections (n = 5), secondary surgery for loss of reduction or nonunion (n = 1), and malunion (n = 1) (Table 1).

Table 1

Patient Diagnoses

Diagnosis	Incidence	Emergency	Complication
Supracondylar humerus fracture	66	11	4
Femur fracture	12	0	1
Forearm fracture	11	7	2
Tendon rupture	2	0	0
Extraarticular infection	2	0	0
Lower leg fracture	2	0	0
Slipped capital femoral epiphysis	1	0	0

Discussion

Treatment of time-sensitive orthopaedic conditions is often dependent on transfer from outside facilities due, in part, to the increasing consolidation of specialty services at high-level centers. This study was conducted to quantify the transfer time for orthopaedic conditions and to identify factors that influenced this process.

The mean time between transfer acceptance and admission was 202.7 minutes, with 56% (114.1/202.7) of that time occurring between transfer acceptance and transfer departure. There was no correlation between transfer times and emergency status, rush hour, or hospital distance. Thus, the main factors influencing transfer times seem to come from getting the ambulance to the transferring facility and loading the patient into their transport. Unfortunately, we are not able to determine which factors cause the notable amount of time that this required, and there are many possibilities. This could reflect a shortage of transfer vehicles, difficulty coordinating or contacting available transport vehicles, or factors at the transferring facility such as completing patient preparation for transfer (eg, splinting) or logistics (eg, finishing chart documentation, making a copy of the radiographs). Although we are unable to answer this in our current study, we plan to further investigate these possibilities in a prospective fashion.

More rapid transfer provides an opportunity for improvement in patient care. Ninety-three patients were treated surgically at our institution, and 29% (27/93) were treated between 10 PM and 6 AM, when there is only a skeleton crew available in the operating room If transfer times had been <1 hour instead of 3 hours, at least 12 of these patients would have arrived at the hospital before 10 PM and would have been able to benefit from a better-staffed operating room (Table 3). Furthermore, it is

Table 2

Transfer Characteristics and Significance of Association With Transfer Time

Factor	Value	Transfer Time (min)	*P* value
Emergency			0.33
Yes	18 (18.8%)	184.9	
No	78 (81.3%)	206.8	
Time of transfer acceptance			0.31
Rush hour	35 (36.5%)	214.5	
Nonrush hour	61 (63.5%)	195.9	
Distance (miles) (range, SD)	20.5 (3.6–109, 16.2)	—	0.49

Table 3

Time of Patient Treatment

Time of Treatment	Value (*n* = 96)	Average Transfer Time (min)
6 AM–10 PM	66	204.2
10 PM–12 AM	12	192.7
12 AM–2 AM	8	198.4
2 AM–4 AM	2	145.5
4 AM–6 AM	5	236.2

likely that these 12 cases were highly urgent because they went into surgery during midnight hours, making the potential benefit of rapid transfer even greater.

Overall, we did not observe any complications attributable to a delay in care. This is probably reflective of the fact that many of these complications (ie, pin tract infections, pin migration) are unlikely to be affected by how expeditiously the fracture was cared for. In fact, there were no patients in this study with supracondylar fractures who had a persistent vascular issue or who had compartment syndrome. Similarly, none of the patients with septic hips had osteonecrosis, which is probably reflective of the relatively small number of septic hips in this series. Although many authors, such as Han, Bales, and Skaggs et al,[4–6] have written on the fact that many supracondylar fractures and open fractures may not be emergencies that need to be addressed in the middle of the night, these series excluded patients with vascular injuries, ecchymosis/severe swelling, and neurologic issues. It is certainly possible that, for some of these less common emergent cases, the delay could critically affect the outcome, although this is difficult to demonstrate without a much larger series.

Another factor to consider is the inefficiency that the 2 hours between transfer acceptance and patient departure from the emergency room inevitably creates, that is, the time that the patient is occupying a bed as well as other resources (monitoring by nursing and/or physicians) at a facility that is not able to provide the necessary care. Although some of the time may be spent in preparing the patient for transfer, it is unlikely that most of the time is used for that purpose. Consequently, an effort to expedite this process may not only lead to improvement in the time to care for the patient being transferred but may also have the downstream effect of having other patients at the transferring facility cared for more rapidly.

This study is limited by its retrospective nature. Several patients were excluded because of incomplete documentation in the transfer record. In addition, although we are able to show a significant amount of time at the referring facility, we cannot elucidate the reasons for these delays at this time, although we do plan to investigate the reasons for these delays moving forward.

Providing definitive care for complex pediatric orthopaedic emergencies often involves interhospital transfer. However, transfer times were an average of 3 hours and seem to be largely dependent on factors prior to the patient departure from the transferring hospital. Identification of complicating factors and an emphasis on timely management and transfer of orthopaedic emergencies is likely to improve patient care.

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