Are we choosing wisely for children's distal radius fracture treatment? A population-based study using administrative data.

Authors:
Tara Baxter, MD, MSc
Teresa To, PhD
Maria Chiu, PhD
Mark Camp, MD, FRCSC
Andrew Howard, MD, FRCSC, MSc

Corresponding Author:
Tara Baxter: tara.baxter@medportal.ca

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Abstract

Background:
Low risk distal radius fractures are the most common paediatric fracture. Ten RCTs over the last two decades support treating many of these fractures with removable immobilization and without physician follow-up. We conducted a retrospective population-based cohort study using administrative data to determine the proportion of these fractures being treated according to best-evidence. We also determined whether different hospital and physician types make different choices regarding care.

Methods:
We included children aged 2-14 with distal radius fractures having had no reduction or operation within a six week period, and who were treated in Ontario emergency departments from 2003-2015. Proportions of patients receiving best-evidence care were determined. Multivariable log binomial regression was used to quantify associations between hospital and physician type and best-evidence treatment.

Results:
70,801 fractures were analyzed. Only 21% were treated according to best-evidence, and consistent across all years of the study. Treatment in a small hospital emergency department (RR 1.86, 95%CI 1.72-2.01), treatment by a paediatrician (RR 1.22, 95%CI 1.11-1.34) or subspecialty paediatric emergency medicine trained physician (RR 1.73, 95%CI 1.56-1.92) was most likely to result in best-evidence treatment.

Interpretation:
Significant over-utilization of physician resources for low-risk distal radius fractures continues long after the first randomized trials showed it to be unnecessary. Academic and paediatric physician types that are involved in generating, presenting, and publishing best-evidence for this fracture type are most successfully implementing it.

Introduction

Distal radius fractures are the most common paediatric orthopaedic injury, with an estimated 10,000 fractures yearly in Ontario[1]. The majority of these fractures are minimally displaced (initial angulation <15 degrees in the sagittal plane and <5mm translation on the frontal plane), low-risk and amenable to treatment with a removable splint, yielding excellent clinical results. The largest numbers of such fractures are stable injuries (called either buckle or torus fractures) in which paediatric bone deforms without completely breaking.

Historically these fractures have been seen for follow-up in hospital fracture clinics by orthopaedic surgeons. However, a large body of evidence accumulated over the last two decades has demonstrated that this is unnecessary and results in over treatment, increased costs and more complications[2-7]. Rather, these fractures can be treated using a simplified algorithm which consists of a single x-ray for diagnosis, removable immobilization that is taken off at home, and without physician follow-up, with equivalent outcomes[8-37]. Choosing Wisely UK has even included plaster casting and scheduled follow-up for distal radius buckle fractures in its list of treatments and procedures that are of little or no benefit to patients[38]. Similar widespread guidelines have yet to published in North America.

Despite the evidence, large numbers of referrals to Canadian orthopaedic surgeons have persisted for this fracture type[39-40, 44]. Why is Canada not choosing wisely, we ask? Application of best-evidence is linked to hospital infrastructure and resources, physician education and training, and research affiliation, but these relationships have not been well studied for low-risk paediatric distal radius fractures (LRPDRF) [28, 39-53]. We conducted a retrospective population based cohort study to determine the proportion of LRPDRF being treated according to best-evidence and to determine whether different hospital and physician types make different choices regarding care.

Methods

Design and participants

The design is a retrospective population-based cohort study of children with LRPDRF, using administrative data.

The population studied is all children aged 2-12 years for girls, and 2-14 years for boys with a diagnosis of LRPDRF in an Ontario ED between October 1st, 2003 and February 17, 2015, and living in Ontario at the time of diagnosis and follow-up. Patients were excluded if they were admitted to hospital, the fracture was manipulated or operated on, there were other concomitant fractures, or had comorbidities that would necessitate increased fracture surveillance.

Data sources

Data were obtained by linking multiple administrative databases housed at ICES (formerly the Institute for Clinical Evaluative Sciences) in Toronto, Ontario.

Exposure

The primary exposure of interest was hospital type, having 4 categories:

-Paediatric hospital

-Academic hospital (non-paediatric CAHO members)

-Community hospital (other hospitals)

-Small hospital (single community provider, annual weighted case load <2700[54])

The secondary exposure of interest was physician type providing treatment in the ED, having 6 categories:

-Emergency medicine (ER)

-General or family practitioner with emergency medicine certification (FP/ER)

-Family or general practitioner (FP/GP)

-Paediatrician

-Subspecialty paediatric emergency medicine (PEM)

-Orthopaedic surgery

Covariates

Other covariates collected were year of service, age, gender, rural location of residence, deprivation quintile, year of MD graduation, and hospital rurality.

Primary Outcome

The primary outcome of interest was whether best-evidence treatment occurred, operationalized as a binary, yes/no, variable. Best-evidence treatment was defined as having no follow-up visit with a clinician for the LRPDRF coded in the administrative data for a period of 6 weeks following the initial visit to the ED.

Statistical analysis

Statistical analysis was conducted using SAS v9.4.
Baseline descriptive characteristics were calculated and reported for all variables of interest. The total proportion of children receiving best evidence care was calculated for each year of the study.

A multivariable log binomial regression model was used to assess the association between hospital and physician type and best-evidence treatment. The multivariable model was chosen *a priori* based on physician judgment of the potential clinical relevance of available covariates and consisted of the outcome variable, best-evidence treatment, variables of interest hospital and physician type, and covariates age, sex, deprivation quintile, rural residence, and fiscal year.

Ethics Approval

This study was approved by the Research Ethics Board at the Hospital for Sick Children and the University of Toronto.

Results

After applying exclusion criteria, 70,801 LRPDRF were identified for analysis.

Objective 1: Proportion receiving best-evidence care

Table 1 shows the results of the descriptive analysis. Overall, twenty-one percent of patients with LRPDRF received no follow-up after their initial ED visit (ie.: best-evidence care). The remaining 79% received follow-up with either an orthopaedic surgeon (69%) or a primary care practitioner (10%). This trend was consistent throughout all individual years of the study (Figure 1).

Objective 2: Multivariable log binomial regression

Results of the multivariable analysis are shown in Table 2 and Figure 2.

Hospital Type

Small hospital type had the largest positive association with best-evidence care (RR 1.86, 95% CI 1.72-2.01, $p<0.0001$) when compared with teaching hospitals as a reference category. Paediatric hospital (RR 1.16, 95% CI 1.07-1.26, p .0002) and community hospital (RR 1.13, 95% CI 1.06-1.20, $p<.0001$) types were also statistically significant predictors of receiving best-evidence care in the ED.

Physician Type

The risk ratios for PEM training (RR 1.73, 95% CI 1.56-1.92, $p<.0001$), paediatricians (RR 1.22, 95% CI 1.11-1.34, $p<.0001$), FP/GP (RR 1.09, 95% CI 1.02-1.16, p .0077), and orthopaedic surgeons (RR 0.77, 95% CI 0.64-0.92, p .0027) were statistically significant when compared with ER as a reference category. FP/ER training was not a statistically significant predictor (RR 1.00, 95% CI 0.94-1.06, p .9474).

Other Covariates

Rural patient residence showed a large statistically significant association with best-evidence treatment after adjustment (RR 1.44 95% CI 1.38-1.50, p<.0001). Female sex had a small but statistically significant association (RR 1.08, 95% CI 1.05-1.11, p<.0001). One patient deprivation quintile reached statistical significance (fourth quintile, RR 1.06, 95% CI 1.01-1.10, p .0171), with no trend demonstrated amongst the quintiles. Age was not a significant predictor (RR 1.00, 95% CI 0.99-1.01, p .1572).

Interpretation

A substantial body of evidence exists to support simplified treatment for LRPDRF, with most of the literature having been published since 2002. Until now, little was known about the application of this evidence and the factors that contribute to it. Our results indicate a large gap between what best-evidence recommends, and what is practically done in LRPDRF care. Most surprising is the finding that evidence application has not improved over time. With only 21% of patients receiving care in line with best-evidence recommendations, we are left to wonder where the disconnect exists between evidence generation and application for this injury.

Hospital and physician type emerged as important determinants of treatment received; paediatric and small hospitals and PEM trained physicians were most likely to provide best-evidence care.

Limited resources in the small hospital or rural settings may be an asset in the provision of best-evidence treatment for LRPDRF. ED physicians in these settings have likely developed excellent resource stewardship skills out of necessity. Furthermore, fracture clinics and orthopaedic surgeons may not be as readily available as they are in large or urban centers, or may be located far from the patient's residence.

The finding that paediatric hospital type and PEM specialists are associated with application of best-evidence care is not surprising; Canadian research on best practices for LRPDRF was largely conducted in paediatric hospitals through collaboration with PEM specialists and research groups. Standardized treatment protocols may also exist in these EDs, with their rollout championed by PEM specialists and other research group affiliates.

To our knowledge, this study presents the first population-based investigation of factors affecting the application of best-evidence in LRPDRF care. Strengths of this study are the use of prospectively collected administrative data, large sample size, and robust sensitivity analyses. Furthermore, our results may be generalizable to other Canadian provinces and territories, whose health care systems are similarly structured and experience similar constraints. Limitations of this study include the use of data that was not intended for health research, limitations with data linkage and availability, and the use of a non-validated algorithm to isolate our cohort of interest.

Conclusion

While no follow-up for LRPDRF is ideal, some patients may need reassurance while the fracture is healing and thus may require a follow-up appointment. A visit with a primary care practitioner is appropriate in this setting. Patients can be referred to an orthopaedic surgeon if concerns arise that cannot be addressed in primary care. An orthopaedic follow-up visit for distal radius fracture care can be billed to OHIP for up to 151$, while a follow-up with a family doctor costs 20-33$[55], therefore the potential social and economic impact of this unnecessary care is large[10, 13-14, 22, 56-58].

How can we best encourage adoption of best-evidence practices for LRPDRF? We recommend a multimodal approach with a focus on known barriers[39-41]:

At the hospital level, EDs should have access and funding for materials to provide removable forms of immobilization. The widespread implementation of clinical care guidelines, with enthusiastic support from champions of evidence based care, could help guide decision making in EDs. Fostering a cooperative atmosphere between specialties is imperative for timely and accurate diagnosis and to support ED physicians to confidently apply guidelines.

For physicians, availability of information in interdisciplinary journals and conferences would yield a larger audience. Interactive CME modules covering musculoskeletal topics are currently being explored as an innovative option at our institution. A "virtual fracture clinic" is an approach used in the UK; fracture diagnosis is confirmed virtually by an orthopaedic surgeon, thereby providing decision support for ED physicians and alleviating medicolegal concerns. The development of national guidelines by influential groups like the American Academy of Orthopaedic Surgeons, or Choosing Wisely Canada may be of most benefit. Physician concerns regarding lost income resulting from eliminating follow-up or added workload from additional radiograph interpretations could be addressed with the institution of bundled fees and/or salaried work.

For patients, additional information and support may be beneficial in the form of pamphlets, printed instructions, and phone applications offering specific fracture care information and virtual follow-up.

Future directions include a multicenter prospective cohort study which would increase diagnostic accuracy, allow discrimination between subtypes of LRPDRF, and include more detailed hospital, physician, and patient factors than were available through ICES. Further research on physician behaviour could help identify specific areas of disconnect between best-evidence and practice. Finally, costing analyses could quantify potential cost savings and inform a revision of funding models and/or fee schedules to better reflect and support the provision of best-evidence care.

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Table 1: Description of LRPDRF cohort, stratified by outcome of interest, best-evidence treatment. Mean (SD) for continuous, N(%) for categorical variables

Predictor of interest	Best-evidence treatment	Other treatment	Total
Sample size, N(%)	14,742 (20.82)	56,059 (79.18)	70,801 (100.0)
Patient sex, N(%)			
Male	8775 (59.52)	34,713 (61.92)	43,488 (61.42)
Female	5967 (40.48)	21,346 (38.08)	27,313 (38.58)
Patient age at diagnosis, Mean(SD)	9.22 (3.21)	9.25 (3.20)	9.24 (3.20)
Patient deprivation quintile, N(%)			
(Least Marginalized) 1	3733 (25.32)	15,408 (27.49)	19,141 (27.03)
2	3162 (21.45)	12,228 (21.81)	15,390 (21.74)
3	2856 (19.37)	10,258 (18.30)	13,114 (18.52)
4	2578 (17.49)	8974 (16.01)	11,552 (16.32)
(Most marginalized) 5	2413 (16.37)	9191 (16.40)	11,604 (16.39)
Rural patient residence, N(%)			
Yes	2689 (18.24)	5135 (9.16)	7824 (11.05)
No	12,053 (81.76)	50,924 (90.84)	62,977 (88.95)
Rural ER, N(%)			
Yes	2135 (14.48)	3458 (6.17)	5593 (7.90)
No	12,607 (85.52)	52,601 (93.83)	65,208 (92.10)
Hospital Type, N(%)			
Paediatric	1362 (9.24)	4298 (7.67)	5,660 (7.99)
Teaching	1274 (8.64)	5880 (10.49)	7154 (10.10)
Community	10,394 (70.51)	43,495 (77.59)	53,889 (76.11)
Small	1712 (11.61)	2386 (4.26)	4,098 (5.79)
Year of MD graduation, N(%)			
Before 2002	12,012 (81.48)	44,637 (79.63)	56,649 (80.01)
After 2002	2730 (18.52)	11,422 (20.37)	14,152 (19.99)
Physician specialty in ED, N(%)			
ER	1103 (7.48)	5022 (8.96)	6125 (8.65)
FP/ER	5894 (39.98)	25,276 (45.09)	31,170 (44.02)
FP/GP	6130 (41.58)	20,450 (36.48)	26,580 (37.54)
Peds	984 (6.67)	3559 (6.35)	4,543 (6.42)
PEM	522 (3.54)	1090 (1.94)	1612 (2.28)
Ortho	109 (0.74)	662 (1.18)	771 (1.09)

Fiscal Year			
2003	429 (2.91)	1939 (3.46)	2368 (3.34)
2004	1187 (8.05)	5089 (9.08)	6276 (8.86)
2005	1174 (7.96)	4854 (8.66)	6028 (8.51)
2006	1222 (8.29)	4552 (8.12)	5774 (8.16)
2007	1167 (7.92)	4561 (8.14)	5728 (8.09)
2008	1136 (7.71)	4439 (7.92)	5575 (7.87)
2009	1160 (7.87)	4464 (7.96)	5624 (7.94)
2010	1208 (8.19)	4352 (7.76)	5560 (7.85)
2011	1263 (8.57)	4414 (7.87)	5677 (8.02)
2012	1238 (8.40)	4152 (7.41)	5390 (7.61)
2013	1262 (8.56)	4412 (7.87)	5674 (8.01)
2014	1261 (8.55)	4522 (8.07)	5783 (8.17)
2015	1035 (7.02)	4309 (7.69)	5344 (7.55)

Figure 1: Yearly variation in type of follow-up visit for LRPDRF

Figure 1: Yearly variation in follow-up visits for low-risk distal radius fractures

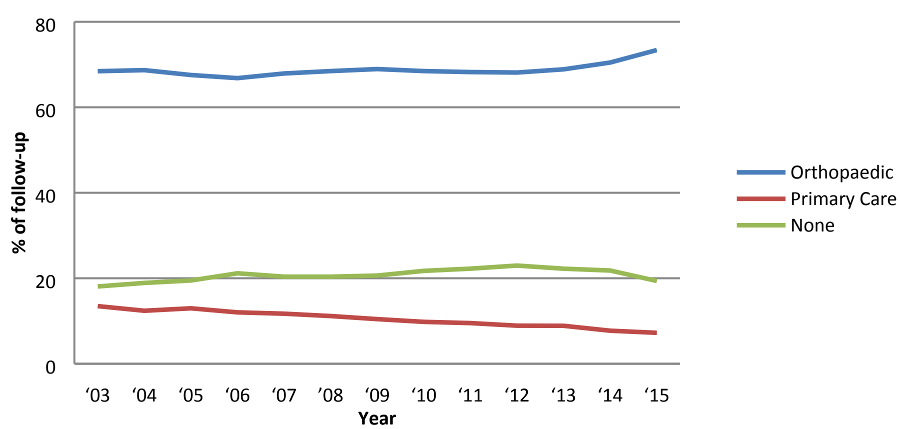
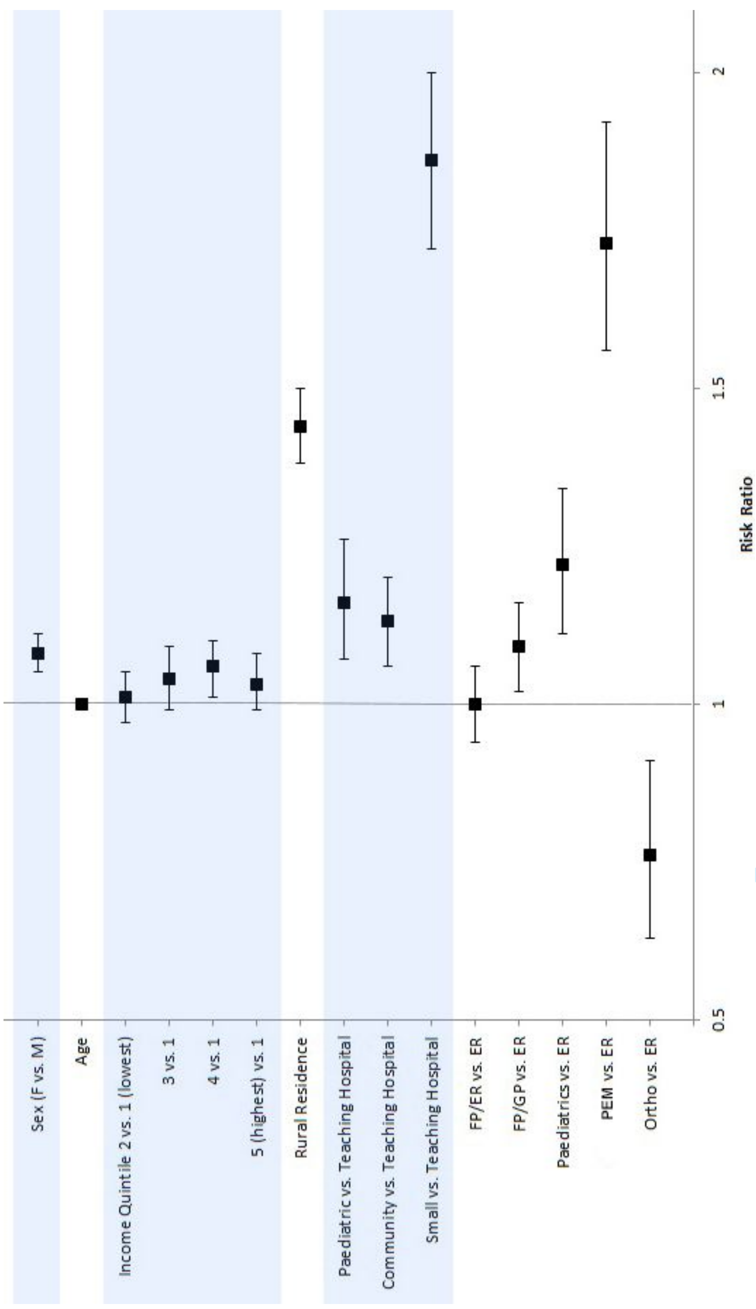


Table 2: Multivariable log binomial regression analysis of factors predictive of receiving best-evidence treatment for a LRPDRF (n = 70,801)

Predictor of interest	Adjusted RR for best-evidence treatment (95% CI)	p-value
Sex		
Male	1.00 (ref)	<0.0001 *
Female	1.08 (1.05-1.11)	
Age	1.00 (0.99-1.01)	0.1572
Patient deprivation quintile, N(%)		
(Least Marginalized) 1	1.00 (ref)	-
2	1.01 (0.97-1.05)	0.6043
3	1.04 (0.99-1.09)	0.0542
4	1.06 (1.01-1.10)	0.0171 *
(Most marginalized) 5	1.03 (0.99-1.08)	0.1847
Rural Residence		
Yes	1.44 (1.38-1.50)	<0.0001 *
No	1.00 (ref)	-
Hospital Type		
Paediatric	1.16 (1.07-1.26)	0.0002 *
Teaching	1.00 (ref)	-
Community	1.13 (1.06-1.20)	<0.0001 *
Small	1.86 (1.72-2.01)	<0.0001 *
Physician specialty in ED		
ER	1.00 (ref)	-
FP/ER	1.00 (0.94-1.06)	0.9474
FP/GP	1.09 (1.02-1.16)	0.0077 *
Pediatrics	1.22 (1.11-1.34)	<0.0001 *
PEM	1.73 (1.56-1.92)	<0.0001 *
Orthopaedics	0.76 (0.63-0.91)	0.0027 *
Fiscal Year		
2003	1.00 (ref)	-
2004	1.05 (0.95-1.16)	0.3119
2005	1.09 (0.99-1.21)	0.0782
2006	1.18 (1.07-1.31)	0.0007 *
2007	1.13 (1.03-1.25)	0.0138 *
2008	1.16 (1.05-1.28)	0.0034 *
2009	1.14 (1.04 -1.26)	0.0074 *
2010	1.19 (1.08-1.32)	0.0004 *
2011	1.20 (1.09-1.33)	0.0002 *
2012	1.24 (1.12-1.37)	<0.0001 *
2013	1.21 (1.09-1.33)	0.0002 *
2014	1.19 (1.08-1.31)	0.0005 *
2015	1.06 (0.95-1.17)	0.2896

*** p significant at < 0.05**

Table 2. Forest plot of multivariable analysis of factors predictive of receiving best evidence treatment



Commented [1]: This figure is the main result and should be included in the manuscript with a descriptive legend.