An Original Study

How Should the Treatment Costs of Distal Radius Fractures Be Measured?

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Abstract

Distal radius fractures (DRFs) are common, but the best way to measure the total cost of treating these injuries is not known. We conducted a study to measure the total treatment cost of DRFs to identify which items should be measured, and for how long, to capture all major cost-drivers.

Eighty-two patients with DRFs were included in this prospective, observational study. All costs, both direct and indirect, were measured. Direct costs were measured for each patient from internal billing records. Indirect costs were obtained with a customized questionnaire.

The major contributors to overall cost were physician fees, operating room costs, occupational therapy, and missed work, which together accounted for 92% of total cost. Recurring indirect costs largely resolved within 3 months for nonoperative management and within 6 months for operative management.

Physician fees, operating room costs, occupational therapy, and missed work are the major cost-drivers for DRFs and should be measured for at least 6 months after injury. Indirect costs, particularly those associated with missed work, represent a significant amount of the total overall cost.

istal radius fractures (DRFs) account for 20% of all fractures seen in the emergency department, and are the most common fractures in all patients under age 75 years.[1,2] Apart from causing pain and disability, DRFs have a large associated economic burden.[3-6] In addition, over the past decade, the fixation technology used for DRF treatment has expanded rapidly and revolutionized operative management. With this expansion has come a growing body of high-level evidence guiding treatment decisions regarding patient outcomes.[7-11] As operative treatment of these injuries has evolved, researchers have begun to critically evaluate both health outcomes and the cost-effectiveness of treatment choices.[12,13]

Determining the cost-effectiveness of any medical intervention requires an accurate and standardized method for measuring the total cost of a course of treatment. Although several studies have attempted to evaluate the treatment costs of DRFs,[14-18] none has rigorously examined exactly what needs to be measured, and for how long, to accurately describe the overall cost. Many studies have examined only direct costs (treatment-related costs incurred in the hospital or clinic itself) and neglected indirect costs (eg, missed work, time in treatment, additional care requirements). As patient-reported disability from these injuries can be high,[19-22] it is likely that the additional indirect costs, often borne by the patient, are correspondingly high. This relationship has been suggested by indirect data from large retrospective epidemiologic studies[3-6] but has never been evaluated with primary data obtained in a prospective study.

Given these questions, we conducted an in-depth study of the treatment costs of these injuries to identify which factors should be captured, and for how long, to accurately describe the overall cost without missing any of the major cost-drivers. We hypothesized that indirect costs (particularly missed work) would be significant and variable cost-drivers in the overall economic impact

of these injuries, and that direct prospective measurement of these costs would be the most reliable method for accurately assessing them. In short, this was a prospective, observational study of all the direct and indirect costs associated with treating DRFs. Its 2 main goals were to determine how much of the overall cost was attributable to indirect costs, and which cost factors should be measured, and for how long, to capture the true economic cost of these injuries.

Patients and Methods

Study Design
This prospective, observational study was approved by our hospital's Institutional Review Board, and patients gave informed consent to participate. Patients with an isolated DRF that was treated either operatively or nonoperatively and followed at our hospital were eligible for the study. Treatment decisions for each patient were made by the treating surgeon and were based on injury characteristics. Patients with multiple concomitant injuries (polytrauma) were excluded. The AO/OTA (Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association) classification system was used to grade all fractures.[23]

Patients were seen 2 weeks, 1 month, 3 months, 6 months, and 1 year after injury. Each time, clinical data (strength, range of motion, patient-rated outcome forms) and economic data were collected. A patient's economic data were considered complete if the patient had full follow-up in our clinic up to 1 year after injury or, if applicable, the patient returned to work and had all recurring direct and indirect costs resolved. Costs were measured and calculated from the broadest possible perspective (overall societal costs) rather than from payer-specific perspectives (eg, institution costs, insurance costs).

Treatment and Rehabilitation Protocol
Each patient who underwent nonoperative treatment was placed in a molded sugar-tong splint with hand motion encouraged and followed in clinic. At 4 to 6 weeks, the splint was removed, and the patient was placed in a removable cock-up wrist splint for another 2 to 4 weeks. Throughout this period, the patient worked on elbow and finger motion with an occupational therapist (OT). On discontinuation of the wrist splint, the patient returned to the OT for gentle wrist motion and continuation of elbow and finger motion.

For each patient who underwent operative

treatment, implant and approach were based on fracture pattern. Implants used included isolated Kirschner wires (K-wires), volar locked plates, dorsal plates, radial column plates, and ulnar plates. After fixation, the patient was placed in a well-padded volar splint and encouraged to start immediate finger motion. Ten to 14 days after surgery, the splint was removed, and the patient was referred to an OT for gentle wrist, finger, and elbow motion. Therapy was continued until wrist, finger, and elbow motion was full.

Direct Costs
Direct costs were obtained from hospital billing and collections records. Cost items measured included physician fees, imaging fees, inpatient bed fees (when applicable), operating room (OR) facility fees, implant costs, and OT costs. Whenever possible, the final amount collected (vs charged) was used for the cost, as this was thought to be the most reliable indicator of the real cost of an item. Total cost was obtained from ultimate collection/reimbursement for all physician, imaging, and OT fees.

In a few cases, ultimate amount collected was not in our system and instead was calculated by normalizing the charges based on internal departmental cost-to-charge ratios. Cost-to-charge ratios were used for OR/emergency department facility fees, inpatient bed fees, and implant costs.

Indirect Costs
Indirect costs were calculated from questionnaires completed by patients at initial enrollment and at each follow-up visit. The initial enrollment form captured basic demographic information, employment status and work type, and annual income. The follow-up form included questions about current work status, physical/occupational therapy frequency, and extra recurring expenses related to transportation, household chores, and personal care, among other items. Total recurring expenses from transportation, chores, and personal care were calculated by multiplying the weekly expenses listed at a given visit by the time since the previous visit.

Costs for missed work were es-

Take-Home Points
- Physician fees, operating room costs, therapy costs, and missed work account for most (92%) of the costs in distal radius fractures.
- Indirect costs (especially missed work) contribute a significant amount to the total cost of injury.
- Patients continue to accrue costs up to 3-6 months post-injury.
- Implant costs make up only 6% of the total costs of operatively treated distal radius fractures.

Table 1. Study Population Characteristics

	Treatment	
	Operative	**Nonoperative**
Demographics		
Patients, n	36	46
Male/female	25%/75%	35%/65%
Mean (SD) age, y	52.5 (16.8)	56.0 (20.5)
Employment		
Employed	89%	77%
Manual labor	7%	33%
Mean annual salary	$80,000	$62,600
Injury type[a]		
A	36%	62%
B	14%	6%
C	50%	32%

[a]AO/OTA (Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association) classification system.

Table 2. Breakdown of Mean Costs Per Patient

	Treatment			
	Operative		**Nonoperative**	
Direct Costs				
Occupational therapy	$750	4.9%	$1020	27.0%
Surgeon fees, office	$586	3.8%	$766	20.3%
ED physician	$276	1.8%	$304	8.1%
ED facility	$186	1.2%	$220	5.8%
Radiology/imaging	$162	1.1%	$105	2.8%
Surgeon fees, OR	$3571	23.2%	—	—
Anesthesiologist	$1491	9.7%	—	—
OR facility	$1890	12.3%	—	—
Implants	$970	6.3%	—	—
Recovery room facility	$649	4.2%	—	—
Inpatient bed facility	$493	3.2%	—	—
Total direct costs	$11,024	72%	$2415	64%
Indirect Costs				
Missed work	$4029	26.2%	$1269	33.6%
Transportation	$175	1.1%	$72	1.9%
Household chores	$118	0.8%	$14	0.4%
Personal care	$57	0.4%	$5	0.1%
Total indirect costs	$4379	28%	$1360	36%
Total Costs	$15,403	—	$3775	—

Abbreviations: ED, emergency department; OR, operating room.

timated as a function of preinjury wages multiplied by decreased level of productivity and period of work missed. For a patient who indicated part-time work status, decreased level of productivity was calculated by dividing the patient's weekly hours by 40 (assumes 40-hour week is full-time), which yielded a percentage of full-time capacity. The patient was also asked to indicate any change in work status, which allowed for an accurate accounting of how long the patient was away from work and how much the patient's capacity was decreased, ultimately providing an estimate of total amount of work missed. Multiplying that period by annual preinjury wages gave the value used for total cost of missed work.

Results

Of the 82 patients enrolled in the study, 36 were treated operatively and 46 nonoperatively. **Table 1** lists additional demographic information about the study population. Complete financial data, defined as 1-year follow-up data, or data collected until recurring indirect costs were negligible, were ultimately available for 75 patients; the other 7 patients were lost to follow-up while they were still incurring indirect costs.

Table 2 provides a full breakdown of costs. OT costs were similar between groups but proportionally made up 27% of the costs for the nonoperative group and 4.9% for the operative group. Of note, implant costs comprised about 6.3% of total costs in the operative group. Of the 36 patients in that group, 2 were treated with K-wires only (average cost, $356), 26 with a single volar locked plate (average cost, $871), and 8 with a volar plate plus supplemental fixation, such as a radial column plate, a dorsal plate, or an ulnar plate (average cost, $1479).

Indirect costs accounted for 28% of the total cost for the operative group and 36% for the nonoperative group. Missed work was the major contributor to overall indirect cost, accounting for 93% of all indirect costs. Additional transportation, household chores, and personal care costs accounted for 4.7%, 1.7%, and 0.8% of total indirect costs, respectively.

Of the nonoperatively treated patients who had been working before being injured, 25% missed at least some work. Except for 1 patient, all were back working full-time within 3 months after injury. Of the operatively treated patients who had been working before injury, 48% missed at least some work, and 24% were still missing at least some

work between 3 and 6 months after injury. All patients in both groups were back working within 1 year after injury.

Indirect costs largely paralleled work status, with 50% of patients still incurring some costs up to 6 months after injury (**Figure**). For the nonoperative group, 92% of all indirect costs were incurred within the first 3 months; for the operative group, 74%. For all patients, more than 96% of all indirect costs were incurred within 6 months after injury.

Discussion

The drive to use evidence-based treatments in medicine has led to increased scrutiny of the benefits of novel treatments and technologies. However, in addition to carefully measuring clinical benefits, we must monitor costs. Implementation of new treatments based on small clinical advantages, without consideration of economic impact, will not be sustainable over the long term.

This study was not intended to report the "true" cost of treating these injuries, or to make direct comparisons between operative and nonoperative groups (regional and institutional costs and practices vary so much that no single-site study can report a meaningful number for cost). Furthermore, the observational (nonrandomized) nature of this study makes direct comparison of operative and nonoperative groups too confounded to draw conclusions. Simply, this study was conducted to help determine what needs to be measured, with the ultimate goal being to obtain a relatively reliable estimate of the total cost to society of a given injury and its treatment.

In this study, physician fees and facility fees were major direct expenses—not surprising given the value of physician time and OR time. In addition, OT was a fairly large direct-cost driver, particularly for nonoperative patients, for whom other costs were relatively low. This finding supports what has been reported in studies of the frequency and duration of therapy as potential targets for cost containment.[24] Surprisingly, OT costs were lower for operatively (vs nonoperatively) treated patients. This finding may be attributable to earlier wrist motion in operatively treated patients (10-14 days) relative to nonoperatively treated patients (6-8 weeks), as earlier wrist motion may reduce stiffness and total need for therapy. Alternatively, the finding may be attributable to sampling error caused by difficulty in obtaining accurate OT costs, as some patients received therapy at multiple private offices, with records unavailable.
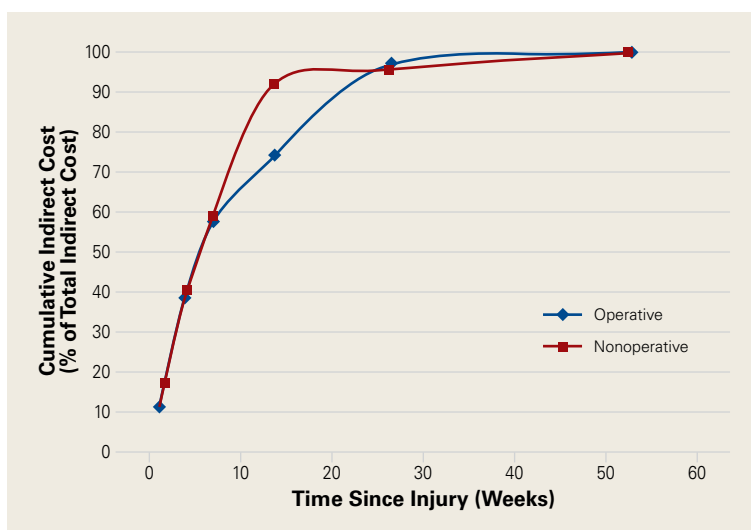
Figure. Relationship between time (in weeks) since initial injury and average cumulative indirect cost as percentage of final total indirect cost.

Although significant attention is often focused on implant costs, these actually comprised a relatively small portion (6%) of the total treatment costs for these injuries. However, implant costs vary significantly between institutions.

Indirect costs were a major factor, accounting for about one-third of total cost. Missed work was the single largest cost item in this study, comprising 93% of the indirect cost and 27% of the total cost. These findings suggest that the cost of missed work is crucial and should be measured in any study that compares the cost-effectiveness of different treatment modalities.

In orthopedic trauma, earlier return to work is often cited as a potential benefit of surgical intervention. However, without defining the exact economic impact of missed work, it is difficult to decide if earlier return to work justifies the added cost of surgery. The situation is further muddled by conflicting priorities, as the entities that bear the cost of missed work (patient, disability insurance) are often different from the entity that bears the cost of surgery (medical insurance). In the light of this complex decision-making with multiple and sometimes conflicting stakeholders, accurate understanding of the economic impact of missed work is paramount. Our data showed return to work took slightly longer for operatively (vs nonoperatively) treated patients, though we think this is more likely a result of higher injury severity than treatment choice.

Patients in both groups were still not back working up to 6 months after injury, indicating that

return of function after these injuries is not as rapid as we might hope or expect, and may play a role in setting expectations during initial discussions with patients.

The major strength of this study is that it was the first of its kind to prospectively measure these costs at a single institution in order to make direct comparisons of different cost factors. Whenever possible, rather than relying on cost-to-charge ratio estimates, we analyzed costs obtained directly from collections reports, which improved the validity of the results generated. Missed work was captured by directly asking patients about work capacity, not by retrospectively reviewing disability applications, which for a variety of reasons often inaccurately reflects true work productivity. In addition, our final follow-up rate was relatively high (91%), which helped minimize bias. Although this study focused on DRFs, the hope is that these data can serve as a template for the kinds of factors that need to be measured to accurately describe the cost of many different upper extremity injuries. This idea, however, needs to be formally tested.

This study had several limitations. First, some costs (OR time, facility fees) still had to be estimated with cost-to-charge ratios—a less precise method. Second, measuring the societal cost of missed work is controversial. We calculated this cost by using standard economic techniques, valuing the decreased productivity period according to baseline salary, though the true "loss" to society is less clear. Third, our data represent the costs at one hospital in one city and might be very different at other institutions with different cost structures. Fourth, this study was observational (vs randomized) and subject to the usual bias of such studies, so conclusions between treatment choices and cost or clinical outcomes could not be drawn (which was not our intent in this study). Although these issues limited our ability to calculate the exact "cost" of these injuries, the relative impact of the different cost factors could be measured (which was our intent).

DRFs are common injuries that can have significant associated expenses, many of which were not captured in previous cost analyses. In the present study, we found that measuring physician, OR, therapy, and missed work costs for at least 6 months after injury was generally sufficient for accurate capture of major costs. We hope these data can help in planning studies of the treatment costs of upper extremity injuries. Only through accurate

and conscientious data gathering can we evaluate the clinical and economic effects of novel technologies and ensure delivery of high-quality care while containing costs and improving efficiency.

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This paper will be judged for the Resident Writer's Award.