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AOA Critical Issues in Education

Value Challenge: A Bottoms-Up Approach to Minimizing Cost and Waste in Orthopaedic Surgery

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Background: Astronomical increases in medical expenses and waste produce widespread financial and environmental impacts. Minor changes to minimize costs within orthopaedics, the most used surgical subspecialty, could result in substantial savings. However, few orthopaedic surgeons are educated or experienced to implement cost containment strategies. This study aims to investigate cost containment opportunities and provide a framework for educating and incorporating residents into cost-saving initiatives.

Methods: Orthopaedic surgical residents from an academic program with a Level I trauma center were queried during 2019 to 2022 regarding suggestions for cost containment opportunities. Based on feasibility and the estimated impact, 7 responses were selected to undergo cost-saving analyses.

Results: The proposed initiatives fell into 2 categories: minimizing waste and optimizing patient care. Eliminating nonessential physical therapy/occupational therapy consults led to the greatest estimated savings ($8.6M charges/year), followed by conserving reusable drill bits ($2.2M/year) and reducing computed tomography scans on lower extremity injuries ($446K/year).

Conclusion: Current medical training provides limited formal education on cost-effective care. Efforts to mitigate the growing financial and environmental costs of health care should include encouraging and incorporating resident feedback into cost reduction strategies. This tactic will likely have a positive impact on the behavior of such resident surgeons as they enter practice and have more awareness of costs and value.

Level of Evidence: V (cost-minimization study)

Introduction

In the United States, management of musculoskeletal disorders accounts for the largest proportion of healthcare expenditure of all aggregated categories[1]. Considerable potential exists for cost containment within orthopaedics to reduce overall expenditure, which private and public payers agree is unsustainable[2]. One basic, effective strategy to lowering costs is waste reduction. Beyond the obvious financial benefits, reducing medical waste

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(one-third of which is attributed to operating rooms) could also mitigate the impact of health care on our environment[3].

Implementing cost containment strategies is challenging. Although most physicians agree that curtailing costs is part of their responsibility, only few are educated or experienced regarding strategies to do so[4,5]. Physicians have limited cost awareness, which is further compounded by the lack of transparency of medical costs and variations in spending across different institutions and regions[4-9]. A substantial portion of these costs and cost variability within orthopaedics is attributed to implants and devices[5]. Despite the influence surgeons have on implant choice and operating room (OR) costs, a survey revealed that only 21% of orthopaedic surgeons were able to correctly estimate device costs[7,10]. It is crucial that orthopaedic surgeons develop a basic understanding of healthcare economic principles.

Studies have shown that successful educational interventions in training physicians to deliver high-value care share 3 common factors: knowledge transmission (e.g., increasing cost awareness), reflective practice (e.g., feedback on resource utilization), and a supportive learning environment[11]. In this study, we aim to describe cost containment opportunities and an educational exercise with the above features to improve awareness of common costs of practice among orthopaedic surgery residents.

Methods

This study was conducted between May 2019 and December 2022 at an academic program with a Level I trauma center and was exempt from institutional review board review. Each week residents participated in a brief conference that addressed issues related to professionalism and the practice of orthopaedic surgery. Some of the topics addressed healthcare costs; thus, this project was a natural extension of those discussions. All residents were invited to participate and were queried during in-person educational sessions regarding suggestions that would create or add value (defined as quality or outcome divided by cost). All responses underwent preliminary review for initial impressions of feasibility and cost-saving potential. Seven ideas were selected to undergo final cost projections.

For these 7 proposed interventions, the orthopaedic registry and monthly operating room data were queried to estimate how often each resource was used. The costs of each resource with respect to hospital purchases were obtained from the financial department using base prices from the years of interest. Facility charges for therapies were obtained from 2021 rates. Given the relatively short time interval, no adjustments for inflation were performed. Projected cost savings were estimated by calculating the difference between current spending and the estimated annual cost after the proposed intervention.

Results

The 7 final responses selected for cost analysis (Table I) fell broadly into 2 categories—minimizing equipment waste and optimizing patient care. Projected cost savings for each intervention ranged between $17,446 and $8.69 million per year. The intervention with the greatest projected savings was eliminating nonessential inpatient physical therapy (PT) and occupational therapy (OT) consults, followed by reusing undamaged drill bits ($1.78 million per year).

Surgical Drapes

Surgical cases at one hospital training site used 1 sterile down sheet under an upper or lower extremity, followed by another extremity or U-shaped drape for a total of 2 drapes, regardless of subspecialty (n = 110 cases per week). This differs from another site that placed a second down sheet before the extremity drape for a total of 3 drapes. Eliminating this extra down sheet based on the 2021 cost ($3.05) leads to a projected savings of $17,446 per year.

Inpatient Therapy Consults

An average of 25 patients per week were admitted after undergoing total hip arthroplasty or total knee arthroplasty, and 60 patients per week were admitted for lower extremity trauma based on a 2019 to 2021 sample from a single site. These patients spent an average of 4 and 6 days in the hospital, respectively. Using 2021 charges for new physical therapy (PT) or occupational therapy (OT) consults ($415) and established consults ($289), these services resulted in an estimated $230,649 in charges to patients per week. The proposed intervention eliminates a subset of healthy, young (younger than 55 years) patients with isolated lower extremity injuries who did not have anticipated need for crutch training and did not have specific exercise or avocational needs necessitating formal PT or OT consults (n = 37.9 per week). On average, these patients remained in hospital and received PT and/or OT for up to 3 days. Notably, this practice was a change from prior practice whereby these younger patients without baseline physical impediments were not routinely provided PT, OT, or crutch training, unless a specific patient or physician request was made. This proposed intervention resulted in projected reduction of $8.69 million of charges per year, in addition to any costs incurred from prolonged hospital stay at the direction of the therapists, which were not specifically calculated.

Tourniquet Waste

In extremity cases, tourniquets are placed in anticipation of possible blood loss or because of case complexity (i.e., difficult articular reduction and fixation). The cost incurred to the hospital is $92 and $99 for upper and lower extremity tourniquets, respectively, regardless of whether they are inflated and regardless of whether they were placed in a sterile or nonsterile fashion. Based on 2019 to 2021 case numbers at a single site, 39.8 tourniquets were placed per week during trauma and hand/upper extremity cases; the tourniquets were not reused. The proposed intervention to reduce tourniquet waste, by only placing tourniquets when inflation is necessary per the attending surgeon request (estimated 10% of cases), would lead to a cost savings of $201,068 per year. Notably, tourniquets at our hospital are not reused, thus a determination of possible cost savings by utilization of reusable tourniquets was not performed.

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TABLE I Projected Total Annual Savings by Proposed Interventions

Proposed Intervention	Before Intervention Mean Usage Per Week	After Intervention Mean Usage Per Week	Mean Cost of Resource/Service	Before Intervention Estimated Annual Charge or Cost	After Intervention Estimated Annual Charge or Cost	Projected Annual Savings
Eliminating extra surgical drapes	330	220	$3.05	$53,338	$34,892	**$17,446**
Eliminating unnecessary inpatient PT/OT consults						**$8,686,870**
New PT consults	93	37.9	$415	$2,006,940	$817,882	$1,180,058
New OT consults	93	37.9	$415	$2,006,940	$817,882	$1,189,058
Established PT consults	291	64	$289	$4,373,148	$961,792	$3,411,356
Established OT consults	240	47.2	$289	$3,606,720	$709,322	$2,897,398
Minimizing tourniquet waste						**$201,068**
Upper extremity	11.7	1.2	$92	$55,813	$5,581	$50,232
Lower extremity	32.6	3.3	$99	$167,596	$16,760	$150,836
Optimizing surgical supply pack						**$51,293**
Lower extremity pack items	1,162	282.7	$86.81 (per pack)	$86,463	$55,386*	$31,077
Split pack items	790.5	150.6	$104.72 (per pack)	$64,089	$43,873*	$20,216
Eliminating unnecessary CT scans						**$446,056**
Tibia shaft fractures	0.94	0.09	$1921	$94,129	$9,413	$84,716
Ankle fractures (excl. tibia plafond)	3.40	0.34	$1921	$340,017	$34,002	$306,015
Distal femur fractures	0.62	0.06	$1921	$61,472	$6,147	$55,325
Changing from brand name (Aquacel) to -simple dressing						**$207,745**
Aquacel dressing	69	0	$58	$208,104	$0	$208,104
Simple dressing (4 × 4 gauze, tape)	0	69	$0.10	$0	$359	- $359
Reusing undamaged drill bits	173.9	47.9	$271	$2,450,247	$674,655	**$1,775,592**

Bold typeface denotes the total projected annual savings for that intervention. Preintervention and postintervention usage and costs are displayed. Notably, some interventions were projected for only certain procedures or service lines, as is described in this study. All estimates presented in USD and rounded up to the nearest dollar; CT = computed tomography, PT = physical therapy, and OT = occupational therapy. *Annual postintervention cost obtained after subtracting individual costs of wasted instruments from each pack.

Surgical Supply Packs

Surgeons and support staff noted substantial waste from surgical supply packs, which contain commonly used supplies for most surgical procedures and are marketed as less expensive than the sum of individual items. Although several different types of supply packs are available at the study facility, focus was placed on 2 types of packs common to orthopaedic lower extremity procedures. One is an orthopaedic split pack used for pelvis, hip, and femur surgeries and not arthroplasty. The other supply pack studied was the orthopaedic lower extremity pack, which is used for many lower extremity procedures at or distal to the knee. The waste from all split packs (n = 51) and lower extremity packs (n = 83) used at a single site was counted over a 1-month period (Table II). Using 2021 base item costs, an estimated $51,293 are wasted per year on these supply packs alone for this subset of orthopaedic procedures.

Lower Extremity Computed Tomography Scans

Several residents noted substantial increases in routine performance of computed tomography (CT) scans for tibial shaft, ankle, and femur fractures. The technical and professional charges for lower extremity CT scans (2D reconstructions only) were $1,921 in 2022. According to a 2019 to 2020 sample, a mean total of 98 tibial shaft, 177 ankle (excluding tibial plafond), and 82 distal femur (including 20 intra-articular, 12 extra-articular/distal metaphysis, and 50 distal shaft) fractures are treated per year. Implementation of indications and requirement for an attending surgeon to request CT scans in these types of cases, for atypical appearance on plain radiography warranting more information, would decrease the frequency of such scans. If CT scans were only obtained with modified indications, in 10% of ankle fractures, in 10% of distal metaphyseal femur fractures, and in 0 tibial and femoral shaft fractures, this intervention would lead to $446,056 of reduced patient charges per year.

Aquacel Dressings

Despite a price cut of over 50% in 2022, an individual large Aquacel dressing still costs $58. This is substantially more expensive than a simple dressing using a 4 × 4 gauze and tape ($0.10). When accounting for the use of Aquacel dressings in all total joint arthroplasty and trauma cases, as well as in-hospital dressing changes on these services, an average of 69 dressings are used per week. Switching to simple dressings, which have

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TABLE II Number of Lower Extremity and Split Pack Items Wasted Per Month

Item	Base Cost Per Item in 2021 ($)	Lower Extremity Pack (N = 83) Mean Items Wasted Per Month n (%)	Split Pack (N = 51) Mean Items Wasted Per Month n (%)	Total Cost of Wasted Items Per Month ($)
Bandage	2.13	0	0	0
Basin	3.10	0	0	0
#15 Blade	1.65	11 (13%)	0	18.15
#10 Blade	1.56	0	0	0
Bulb syringe	1.19	17 (20%)	0	20.23
Cup	1.19	0	0	0
Drape ¾ sheet	3.05	0	99 (39%)	301.95
Drape top sheet	4.25	N/A	32 (63%)	136.00
Electrode, cautery	6.09	0	0	0
Extremity drape	5.35	9 (11%)	N/A	48.15
Gown w/towel	5.19	0	0	0
Ioban drape	16.59	N/A	8 (16%)	148.72
Labels	1.49	0	0	0
Light handle	3.63	0	0	0
Marker	0.79	0	0	0
Medicine cup	0.99	0	N/A	0
Needle counter	3.79	15 (18%)	0	56.85
Pitcher	3.45	0	0	0
Raytec sponges	2.23	0	41 (20%)	91.23
Ruler	0.19	79 (95%)	49 (96%)	24.32
Scalpel holder	2.19	0	0	0
Specimen container	1.48	75 (90%)	50 (98%)	185.00
Split sheet	5.60	N/A	31 (61%)	173.60
Stapler	12.15	77 (93%)	0	935.55
Stockinette (large)	5.69	27 (33%)	40 (78%)	381.23
Suction handle	4.19	0	N/A	0
Suction handle (Yankauer)	4.09	0	0	0
Surgical gowns	3.99	73 (29%)	66 (32%)	554.61
Suture bag	0.79	0	0	0
Table cover	5.19	0	0	0
Towel	1.15	658.8 (50%)	134.2 (16%)	909.47
Tray	1.95	80 (48%)	49 (48%)	251.55
Tubing	1.95	9 (11%)	3 (6%)	37.80

Mean numbers of each item are provided with the percentage of time each item was wasted. Costs per item and total monthly costs of waste are given.

been historically effective, could lead to $207,745 in costs saved per year.

Reusing Undamaged Drill Bits

It was observed that drill bits were routinely being thrown away in 2021 after any use during surgery, even once. Previously, drill bits were reused and discarded only when worn or damaged. A sample of cases where at least 1 drill bit was used and discarded was collected over a 2-month period from a single site in 2021. Most drill bits were discarded in trauma cases (n = 1,818), followed by hand (n =507), total joints (n = 433), and sports medicine (n = 24) cases. Four years earlier, only 126 total drill bits were discarded during the year. Considering this as the baseline number of damaged drill bits per year and using the average 2022 cost of these used drill bits ($271), the cost of discarding undamaged drill bits was $1.78 million per year.

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Discussion

To reduce healthcare expenditure, it is imperative that training physicians not only understand the importance of cost-conscious care but are also given the tools to critically analyze current practices and enact change. There have been several successes in minimizing surgical costs, standardizing care, and reducing OR waste[12-15]. These, along with the growing body of economic analyses within the orthopaedic literature, are promising for physician involvement regarding economic factors[16]. In this study, we demonstrate a simple exercise which identified several opportunities for cost containment at a single institution—in some cases, with savings of up to $8.6 million per year with respect to the hospital system. Incorporating exercises such as this one into any training program provides opportunity for medical trainees to reflect on cost-effectiveness of their medical decisions, to identify areas for improvement, and to discuss possible solutions in a supportive learning environment. In our hospital, this project was incorporated into a weekly educational session for residents and fellows, which discussed issues regarding the practice of orthopaedic surgery.

A review by Stammen et al.[11] examined 79 articles describing interventions designed to promote education and delivery of high-value, cost-conscious care. They examined which factors led to a successful intervention and identified knowledge transmission, reflective practice, and a supportive environment. In the exercise used in our study, knowledge transmission occurs through raising cost awareness and discussing the underlying evidence for current practices. This includes, for example, reviewing the indications for obtaining a CT scan for lower extremity injuries and the costs incurred by obtaining additional CT scans. This exercise also stimulates reflective practice by encouraging both residents and practicing physicians to evaluate their own performance, such as why some surgeons choose to use extra drapes or providing feedback to surgeons who have higher OR costs than their peers for the same procedures. Finally, leading this discussion with faculty who are committed to educating trainees about cost-conscious care contributes to a supportive environment. Future steps in this domain could include sharing these findings with hospital administration and creating incentives and payment systems to encourage physicians to implement these interventions. The studies highlighted by Stammen et al. demonstrated that these educational interventions are effective; however, they largely focused on prescribing practices and ordering laboratory tests within nonsurgical specialties[11]. Training orthopaedic surgeons to be cost-conscious is especially important given the high percentage who practice at community sites or private practice, where spending habits vary from the larger institutions at which they train during residency.[8] Modest improvement in larger hospitals and/or inpatient university settings may also be possible because these sites may have more opportunity for cost savings than are present at private, outpatient surgery centers.

Minimizing nonessential inpatient therapy consults led to the greatest projected reduction in charges. This suggestion stemmed from several residents who observed receiving inpatient PT and/or OT consult requests from ancillary staff for patients who were hospitalized after trauma but whose injuries did not have obvious indications for either therapy. For example, a healthy 30-year-old patient with tibial shaft fracture requires crutches and weight-bearing instructions, but does not routinely need therapy. While acute PT or OT referrals may be helpful in the setting of severe lower extremity trauma or polytrauma, evidence of benefit in simple cases does not exist[17]. Based on our estimates, potential overutilization of these services could cost up to $8.6 million per year. Furthermore, our department has routinely noted that patient discharges from the hospital are delayed for crutch training in otherwise healthy individuals or so that more therapy sessions may be undertaken. This has the added costs of longer inpatient stays and opportunity costs of those beds not being available for other patients. Referrals to outpatient PT and/or OT are an appropriate, cheaper alternative reserved for patients with range-of-motion or strength deficits or those who fail to progress as expected during initial rehabilitation.

While surgical supplies contribute to a substantial portion of OR costs, wasting unused surgical supplies is a well-known occurrence. In this study, the estimated direct costs of wasted surgical supplies totaled up to $2.0 million per year, even when examining a limited list of supplies. These estimates do not include the costs of wasted or dropped implants, which one study estimated to have led to a loss of $634,000 per year at a single institution[18]. This phenomenon is not unique to orthopaedic procedures. Zygourakis et al. reported that the average cost of unused surgical supplies in 58 neurosurgical procedures at a single institution accounted for 13.1% of total surgical supply costs, an estimated $2.9 million per year[15]. Several methods to reduce OR material costs have been described with positive results. For example, an approach described by a regional medical center involved quarterly review of costs for total knee arthroplasty by each surgeon with comparison among peers and equivalent alternative item costs. This activity shifted surgeon preferences (e.g., not ordering routine postoperative radiographs) and to lower use of certain OR supplies (e.g., instruments, drains, additional orthobiologics), resulting in reduced hospital costs for inpatient care by 18%[9]. Other examples include optimizing surgical instrument trays, standardizing implants, and developing methods to reuse some supplies such as external fixator components or tourniquets[7,14,19,20]. In addition to reducing surgical costs, reducing OR waste (which accounts for up to one-third of hospital waste alone) is a fundamental step in decreasing the impact of health care on our environment.[3]

Over time, the utilization of advanced imaging has escalated[21-23]. Modern day CT scanning machines are readily available and efficient, and new trainees are in the habit of obtaining scans on many injuries. Often, emergency department residents or admitting trauma service residents will obtain musculoskeletal scans before even consulting with orthopaedics. This generates substantial increased costs of care and a moderate amount of radiation to patients. While an enhanced understanding of articular injuries is possible, for the fractures presented in this study, most of the scans had no apparent clinical benefit or change in management because of the CT scan. Furthermore, this represents a fraction of potentially unindicated imaging in our hospital. Scrutiny of ordering practices for plain

radiographs, advanced imaging, and other diagnostic tests seems prudent. Trainees should be advised to always consider the value of diagnostic measures in improving their treatment plan.

This study has several limitations. First, these cost estimates and practices are specific to certain services at an academic institution. Extrapolation of these ideas and our findings to other orthopaedic service lines is anticipated to disclose substantial additional cost savings. However, we understand that these results are not generalizable to all orthopaedic settings. Second, because the proposed interventions were not implemented in practice, these numbers may not reflect true savings. We also cannot know whether some of the interventions have unforeseen consequences, especially with behaviors such as draping, which are determined by surgeon preference rather than clinical evidence[24]. Furthermore, projections for savings with CT scans and PT/OT are configured as reductions in charges, not costs. The charges accrue to a patient account, and portions of these charges are usually reduced before payment, based on contractual agreements and federal rates. That being said, our suggestions are likely to reduce overall healthcare expenses in a broader sense.

The scope of our study was to describe an exercise that increased cost awareness, stimulated discussion, and developed a framework for delivering cost-conscious care. Variations of this exercise could include implementing these changes or using more rigorous analyses for more accurate estimates. The data for these numbers, such as ancillary staff salary and time spent counting and reprocessing instruments, were not available.

Conclusion

Within current medical education curricula, limited attention exists regarding providing cost-conscious care, despite growing healthcare spending. This study highlights a potential educational exercise within a regular conference directed toward improving the practice of orthopaedic surgery. Further efforts to mitigate rising financial and environmental costs of health care should include incorporating resident feedback into cost-reduction strategies. ■

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