Orthopedic Implant Waste: Analysis and Quantification

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Abstract

The steadily increasing demand for orthopedic surgeries and declining rates of reimbursement by Medicare and other insurance providers have led many hospitals to look for ways to control the cost of these surgeries.

We reviewed administrative records for a 1-year period and recorded total number of surgical cases, number of cases in which an implant was wasted, and cost of each wasted implant. We determined cost incurred because of implant waste, percentage of cases that involved waste, percentage of total implant cost wasted, and average cost of waste per case. We then analyzed the data to determine if case volume or years in surgical practice affected amount of implant waste.

Results showed implant waste represents a significant cost for orthopedic procedures within all subspecialties and is an important factor to consider when developing cost-reduction strategies.

The cost of health care in the United States is increasing at an unsustainable rate.[1-3] To decrease or even reverse this trend, we must decrease the cost of care without adversely affecting quality. Porter[4] defined *value* as the quality of care divided by its cost. The economics of total joint arthroplasty (TJA) has received a great deal of attention because of both increasing demand and increasing cost.[5-9] About 33% of all orthopedic surgeries and the majority of TJAs are paid for by Medicare.[9] In recent years, the rate of reimbursement for orthopedic cases has steadily declined while the cost of implants has increased.[3,10,11] Given the significant cost of implants, health care providers in some subspecialties have focused on implant costs as a potential area for cost reduction.[12] For example, in TJA this has proved effective in reducing the overall cost, as has decreasing length of stay after surgery.[8,10,13-16]

With little evidence suggesting any specific orthopedic implant has outcomes superior to those of others, with the exception of select poorly performing outliers, we must increase value of care by lowering the cost when considering these devices.[17,18] In addition, some experts have suggested that intraoperative waste is a significant factor in TJA cost, and it does contribute to the average implant cost for a TJA case.[6,19] Using data collected from 72 institutions, Zywiel and colleagues[19] estimated the annual cost of wasted hip and knee arthroplasty implants to be more than $36 million in the United States.

However, considering the aging US population, TJA is not the only orthopedic surgery with increased demand. An estimated 600,000 spine surgeries are performed each year in the United States.[20] Between 1992 and 2003, Medicare spending for lumbar spinal fusion increased 500%.[21] In addition, in a 15-month observational study of incidence of intraoperative waste in spine surgery, Soroceanu and colleagues[22] reported waste occurring in 20% of spine procedures.

Although these studies have described implant waste in TJA and spine surgeries, little has been published on the cost of wasted implants in a center performing the full range of orthopedic procedures. In this article, we detail the implant waste costs incurred by surgeons for all orthopedic subspecialties at a single orthopedic specialty hospital over a 1-year period. Our study goals were to identify types of implants wasted, and incidence and cost of implant waste, for all total hip arthroplasties (THAs), total knee arthroplasties (TKAs), and lumbar spinal fusions performed at the hospital and to determine whether case volume or years in surgical practice affect the rate or cost of implants wasted.

Methods

We performed a retrospective economic analysis of 1 year of administrative implant data from our institution. Collected data were quantified and analyzed for factors that might explain any variance in implant waste among surgeons. We were granted exempt institutional review board status, as no patient information was involved in this study.

We reviewed the administrative implant data for the 12-month period beginning June 2012 and ending May 2013. For that period, number of cases in which an implant was used and number of cases in which an implant was wasted were recorded. For each instance of waste, type and cost of the wasted implant were entered into the administrative database. In addition, overall cost of implants for the year and cost of wasted implants were determined. Data were available for 81 surgeons across 8 orthopedic divisions (subspecialties). From this information, we determined

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percentage of cases in which waste occurred, percentage of total implant cost wasted, average cost of waste per case, and most commonly wasted implants. All 3 variables were also calculated for THAs, TKAs, and lumbar spinal fusion procedures.

Statistical Analysis

The data were analyzed to determine if surgeon case volume or years in surgical practice affected implant waste. All analyses were performed at department, division (subspecialty), and surgeon levels. Case volume was analyzed in 3 groups: top 25%, middle 50%, and lower 25%. Number of years in surgical practice was analyzed in 3 groups: fewer than 10 years, 10 to 19 years, and 20 years or more. Normality assumption of variables was tested using the Shapiro-Wilk test ($P < .05$). For between-group differences, 1-way analysis of variance and the Tukey honestly significant difference post hoc test were performed for variables with a normal distribution, and the Kruskal-Wallis and Mann-Whitney tests were performed for variables without a normal distribution.

For the subspecialty-level analyses, only the Adult Reconstruction, Sports Medicine, and Spine divisions were analyzed for the effects of volume, and only the Sports Medicine and Spine divisions were analyzed for the effect of surgical experience, as surgeon numbers were insufficient for adequate grouping(s).

Data are presented as means with corresponding 95% confidence intervals (CIs). Categorical variables are presented as counts with percentages. All statistical analyses were performed with SPSS Version 21.0 (IBM SPSS) statistical software. Statistical significance was set at .05.

Results

During the 1-year period, 8954 department cases involved an implant of any type. Waste occurred in 12% (1072) of these cases. The rate ranged from 8% in the Adult Reconstruction division to 30% in the Trauma division (**Table 1**), and the rate for individual surgeons ranged from 3% to 100%, though the surgeon with 100% performed only 1 case, and the next highest rate was 50%.

Total implant cost for our hospital during the period was $34,340,607. Of that total cost, 1.8% ($634,668) was lost because of implant waste. Percentage of total implant cost wasted ranged from 1.6% in the Adult Reconstruction division to 4.7% in the Sports Medicine division (Table 1). Percentage of total implant cost wasted for individual surgeons ranged from 0.2% to 16.1%. **Tables 2 and 3** list the most commonly wasted implants by count and cost, respectively.

When total cost of wasted implants was averaged over all implant cases performed during the period, the loss resulting from waste amounted to $71 per case for the department and ranged from $21 per case for the Hand division to $105 per case for the Pediatric division (Table 1). For individual surgeons, the loss ranged from $4 to $250 per case.

During the period studied, an implant was wasted in 9% (100) of the 1076 primary THAs performed, 4% (42) of the 1003 primary TKAs, and 14% (30) of the 217 lumbar spinal fusions (**Tables 4, 5**).

There was no significant difference between groups for department ($P = .46$) or for the Adult Reconstruction ($P = .83$), Spine ($P = .10$), or Sports Medicine ($P = .69$) division. Analyzing for variance by years in surgical practice, we found a significant difference for department ($P = .01$) but not for the Adult Reconstruction ($P = .12$) or Spine ($P = .14$) division. The department difference resulted from a significant difference ($P = .001$; 95% CI, 1.112-17.408) between surgeons (<10 years of surgical practice) who wasted implants in 12.8% of their cases and surgeons (>20 years of surgical practice) who wasted implants in 9% of their cases (Table 4).

There was no significant difference between groups for department ($P = .83$) or for the Adult Reconstruction ($P = .29$)

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Table 1. **Implant Waste for Divisions and Entire Department**

Division	Cases With Implant, n	Cases With Wasted Implant		Total Implant Cost, $	Wasted Implant Cost, $	Wasted Cost Per Case, $	Total Implant Cost Wasted, %
		n	%				
Adult Reconstruction	3689	306	8	13,743,326	214,869	58	1.6
Spine	1771	199	11	13,677,060	176,080	99	1.3
Sports Medicine	1381	169	12	2,010,993	94,139	68	4.7
Pediatric	452	68	15	1,201,912	7910	105	3.9
Trauma	517	157	30	1,224,809	42,888	83	3.5
Hand	596	78	13	432,933	12,648	21	2.9
Foot and Ankle	297	67	23	756,363	26,320	89	3.5
Shoulder/Elbow	160	16	10	223,295	8229	51	3.7
Other	91	12	13	1,069,916	12,034	132	1.1
Entire department	8954	1072	12	34,340,607	634,668	71	1.8

Table 2. **Top 10 Most Expensive Implants Wasted**

Implant	n	Cost
Adult Reconstruction		
Acetabular shell Biofoam group D size 52	1	*Most expensive*
Femoral hip porous-coated lateral offset size 9	1	
Suture anchors hip 2.9×15.5 mm	16	
Femoral component total knee arthroplasty size E right 61.5×68 mm	1	
Liner acetabular nonhooded neutral MP9 36 mm ID	2	
Hemostatic agent 10 mL	8	
Femoral stem hip	2	
Bone cement with gentamicin 1×40 mm	9	
Femoral stem taper 19×135 mm	1	
Acetabular cup hip resurfacing 54 mm	1	
Acetabular cup hip resurfacing 52 mm	1	*Least expensive*
Totals	**43**	**$47,412.95**
Spine		
Screw 6.5×45 mm	7	*Most expensive*
Bone morphogenetic protein large kit	1	
Vertebral body cage titanium 12° 14 mm	1	
Implant screw 10° lordotic 10×18×45 mm	1	
Implant cage PEEK 8×18×50 mm	1	
Screw 3 titanium polyaxial 4.5×30 mm	5	
Screw polyaxial 5×40 mm	5	
Screw 4.0×14 mm	12	
Spacer lordotic 8×14×12 mm	1	
Spacer lordotic 10×14×12 mm	1	*Least expensive*
Totals	**35**	**$40,682.90**
Sports Medicine		
Femoral medial hemi condyle lt	1	*Most expensive*
NDL delivery system curved	14	
NDL Fast-Fix 360 straight	10	
Suture anchor PEEK SwiveLock 4.75×19.1 mm	11	
Biocomposite SwiveLock C	10	
Anchor Healix 4.5 mm	13	
Tendon gracilis	3	
Quickset kit 16 c^3	1	
Suture anchor SutureTak 3×12 mm	12	
Tendon Achilles with calcaneus 19.5 cm	2	*Least expensive*
Totals	**77**	**$43,695.38**
Pediatric		
Hook rib titanium	3	*Most expensive*
Lock distraction VEPTR	6	
Bone anterior lumbar interbody fusion L 12 mm × 4°	1	
Hook rib titanium small	1	
Plate contour locking compression femur 8 holes left	1	
Plate compression 4 holes 20 mm	1	
Plate 45 mm Ch Bl 4 holes 120°	1	
Cable double with integral crimp 11	4	
Screw ilios rev polyaxial 8.5×35 mm	2	
Screw spine reduction 5.5×35 mm	1	
Screw uniplanar titanium 5.5×30 mm	1	
Screw uniplanar reduction 5.5×35 mm	1	*Least expensive*
Totals	**23**	**$27,337.52**
Trauma		
Nail arthrodesis T2 right 11.5×580 mm	1	*Most expensive*
Screw cortex 2.7×14 mm	11	
Femoral component hip tmze pl no. 25	1	
Nail tibial 10×360 mm	1	
Screw 3 lag titanium 10.5×100 mm	2	
Plate clavicle LCP right 3.5×115 mm	1	
Plate LCP clavicle 6 holes lt 3.5×85 mm	1	
Plate humerus distal lateral lt 5 holes	1	
Plate clavicle locking 6 holes lt 3.5×94 mm	1	
Plate clavicle LCP 5 holes lt 3.5×94 mm	1	*Least expensive*
Totals	**21**	**$16,672.20**
Hand		
Plate distal radius volar bl lt 2.5 mm	1	*Most expensive*
Plate intermediate column left 2.4 mm	1	
Screw locking with StarDrive 2.4×12 mm	4	
Bone graft synthetic C 5 c^3	1	
Screw locking straight 3.5×16 mm	1	
Plate 12-hole recon 3.5×168 mm	1	
Screw micro 12 mm	1	
Screw cortical 3.5×12 mm	5	
Suture anchor mini	1	
Screw locking straight 3.5×34 mm	1	*Least expensive*
Totals	**17**	**$5257.05**
Foot and Ankle		
Plate compression U-shaped 17×20 mm	1	*Most expensive*
Plate compression 4 holes 20 mm	2	
Plate calcaneus mini	1	
Plate TTC 6 holes lt	1	
Plate 2 holes 17 mm	1	
Plate 50 mm	1	
Screw cannulated cancellous threaded 22×50 mm	4	
Suture anchor PEEK 2.9×15.5 mm	2	
Screw 3.5×34 mm	2	
Mini biocomposite suture anchor with needles 2.4×8.5 mm	2	*Least expensive*
Totals	**17**	**$14,702.48**
Shoulder/Elbow		
Plate periarticular proximal humerus LCP stainless steel 2 holes right 3.5×91 mm	1	*Most expensive*
Tendon tibial anterior	1	
Biocomposite suture anchor	3	
Meniscal cinch	2	
NDL delivery system curved	1	
NDL Fast-Fix 360 reverse curved	1	
Ultra Fast-Fix AB assembly straight	1	
Screw locking straight 3.5×34 mm	1	
Suture anchor PEEK 2.9×15.5 mm	1	
Screw cortex straight 3.5×22 mm	2	*Least expensive*
Totals	**14**	**$6838.04**
Other		
Allograft anterior lumbar interbody fusion 7.5° 26×26×14 mm	1	*Most expensive*
Screw cannulated 6.5×45 mm	1	
Screw uniplanar reduction 5.5×30 mm	1	
Screw Fas titanium 6.5×45 mm	2	
Plate 130° 4 holes 4.5×50 mm	1	
Insert acetabular con art size 3-4 9 mm	1	
Rod cobalt-chrome NS straight 5.5×500 mm	1	
Screw 3 titanium polyaxial 5.5×25 mm	1	
Screw polyaxial 6×45 mm	1	
Guide wire 2.4 mm	2	*Least expensive*
Totals	**12**	**$10,861.50**

Abbreviations: LCP, locking compression plate; PEEK, polyetheretherketone.

Table 3. **Most Frequently Wasted Implants**

Implant	n	Cost
Adult Reconstruction		
Suture anchor hip 2.9×15.5 mm	16	
Screw bone cancellous 6.5×25 mm	10	
Screw head spherical 25 mm	9	
Bone cement with gentamicin 1×40 mm	9	
Hemostatic agent 10 mL	8	
Bone cement with tobramycin unit pack	6	
Suture anchor PEEK 2.9×15.5 mm	6	
Screw bone cancellous 6.5×35 mm	5	
Screw bone cancellous 6.5×16 mm	5	
Screw bone cancellous 6.5×20 mm	5	
Totals	**79**	**$20,011**
Spine		
Set screw titanium break-off hex	35	
Set screw 6.5×40 mm	12	
Set screw titanium break-off	12	
Screw 4.0×14 mm	12	
Screw distraction 14 mm	9	
Cap locking titanium	7	
Screw multiaxial 6.5×45 mm	7	
Blocker titanium XIA 3	6	
Screw 3 titanium polyaxial 4.5×30 mm	5	
Screw polyaxial 5×40 mm	5	
Totals	**110**	**$22,465**
Sports Medicine		
NDL delivery system curved	14	
Suture anchor 4.5 mm	13	
Suture anchor 3×12 mm	12	
Suture anchor 4.75×19.1 mm	11	
Meniscal repair anchor 360 straight	10	
Biocomposite suture anchor	10	
Suture anchor PEEK 4.5 mm	8	
Screw interference 1.5×9×20 mm	6	
Assembly AB curved	5	
Screw PEEK 8×12 mm	4	
Corkscrew PEEK fully threaded 5.5 mm	4	
Totals	**97**	**$31,627**
Pediatric		
Blocker titanium XIA 3	12	
Screw cortical NL 12×3.5 mm	7	
Lock distraction VEPTR	6	
Kirschner wire sterile 0.062×9 in	6	
Cable double with integral crimp 11	4	
Hook rib titanium	3	
Screw cannulated threaded 4.5×16 mm	3	
Kirschner wire sterile single-arm 6×0.062 in	3	
Screw ilios rev polyaxial 8.5×35 mm	2	
Screw cannulated threaded 4.5×20 mm	2	
Totals	**48**	**$14,487**
Hand		
Kirschner wire sterile 0.045×6 in	11	
Screw cortex 3.5×12 mm	5	
Screw cortex 2.4×14 mm	5	
Screw cortex 2.4×12 mm	4	
Screw cortex HD7 GLD 2.5×14 mm	4	
Kirschner wire double-trocar sterile 0.35×6 in	4	
Screw variable locking with StarDrive 2.4×12 mm	4	
Peg thread long 2.5×20 mm	4	
Peg 2.5×20 mm fully threaded	3	
Peg partial threaded 2.5×18 mm	3	
Peg 2.5×16 mm threaded long	3	
Screw bone nonlocking 2.7×16 mm	3	
Totals	**53**	**$3125**
Trauma		
Screw cortex 2.7×14 mm	11	
Screw cortex straight 3.5×36 mm	8	
Screw cortex straight 3.5×16 mm	7	
Screw cortex recessed 2.7×16 mm	7	
Screw cortex straight 3.5×20 mm	6	
Bone cement radiopaque 10 pack	6	
Screw cortex straight 3.5×14 mm	5	
Screw cancellous 38 mm	5	
Screw cortex straight 3.5×28 mm	4	
Screw cortex straight 3.5×22 mm	4	
Totals	**63**	**$4444**
Shoulder/Elbow		
Biocomposite suture anchor	3	
Meniscal repair device	2	
Screw cortex straight 3.5×22 mm	2	
Suture no. 2	2	
Plate periarticular proximal humerus LCP stainless steel 2 holes right 3.5×91 mm	1	
Tendon tibial anterior	1	
NDL delivery system curved	1	
NDL 360 reverse curved	1	
Meniscal anchor AB assembly straight	1	
Screw locking straight 3.5×34 mm	1	
Totals	**15**	**$6590**
Foot and Ankle		
Screw cortex straight 3.5×24 mm	5	
Screw cannulated cancellous threaded 22×50 mm	4	
Screw cannulated cancellous lag 4.0×38 mm	3	
Plate compression 4 holes 20 mm	2	
Suture anchor PEEK 2.9×15.5 mm	2	
Screw stainless steel 3.5×34 mm	2	
Suture Mini Biocomposite Tak with needles with 2.0 suture	2	
Screw 6.5-mm cannulated 40×65 mm	2	
Screw 6.5-mm cannulated 40×75 mm	2	
Screw 6.5-mm cannulated 40×80 mm	2	
Screw cannulated cancellous threaded 22×45 mm	2	
Totals	**28**	**$7917**
Other		
Screw locking straight with T25 RCS 5.0×36 mm	3	
Screw titanium 6.5×45 mm	2	
Guide wire 2.4 mm	2	
Screw locking straight with T25 RCS 5.0×30 mm	2	
Allograft anterior lumbar interbody fusion 7.5° 26×26×14 mm	1	
Screw cannulated 6.5×45 mm	1	
Screw uniplanar reduction 5.5×30 mm	1	
Plate 130° 4 holes 4.5×50 mm	1	
Insert con art size 3-4 9 mm	1	
Rod cobalt-chrome NS straight 5.5×500 mm	1	
Totals	**15**	**$10,067**

Abbreviations: LCP, locking compression plate; PEEK, polyetheretherketone.

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or Spine (P = .41) division when analyzed by years in surgical practice. Analyzing by case volume, we found a significant difference for the Sports Medicine division (P = .004): Percentage of total implant waste was significantly higher (P = .003; 95% CI, –12.61 to –2.97) for surgeons with the lower 25% of case volume (9.8%) than for surgeons with the middle 50% of case volume (3.5%) (Table 5). No other significant difference was found for department (P = .52) or for the Adult Reconstruction (P = .69) or Spine (P = .45) division.

Analyzing by case volume and years in surgical practice, we found no significant difference for department (case volume, P = .76; years in surgical practice, P = .07), Adult Reconstruction division (case volume, P = .47; years in surgical practice, P = .78), Spine division (case volume, P = .11; years in surgical practice, P = .15), or Sports Medicine division (case volume, P = .08).

Selected Procedures

Total Hip Arthroplasty. Regarding variance by case volume and years in surgical practice, we found no significant difference for any variable analyzed: percentage of cases with waste (volume, P = .072; years in practice, P = .076), percentage of total implant cost wasted (volume, P = .074; years in practice, P = .12), cost of waste per case (volume, P = .075; years in practice, P = .32).

Total Knee Arthroplasty. Regarding variance by years in surgical practice, we found no significant difference for any variable analyzed: percentage of cases with waste (P = .38), percentage of total implant cost wasted (P = .50), cost of waste per case (P = .50). Regarding variance by volume, there was no significant difference for percentage of cases with waste (P = .70) or cost of waste per case (P = .05), but we found a significant difference for percentage of total implant cost wasted (P = .038). That difference was caused by an outlier: One surgeon with the lower 25% of case volume wasted an implant in the only TKA he performed that year. Correction for the outlier removed the significance.

Posterior Lumbar Spinal Fusion. Regarding variance by case volume and years in surgical practice, we found no significant difference for any variable analyzed: percentage of cases with waste (volume, P = .36; years in surgical practice, P = .22), percentage of total implant cost wasted (volume, P = .33; years in surgical practice, P = .41), cost of waste per case (volume, P = .34; years in practice, P = .15).

Discussion

The steadily increasing demand for orthopedic surgeries and declining rates of reimbursement by Medicare and other insurance providers have led many hospitals to look for ways to

Table 4. **Implant Waste by Years of Surgical Practice**

Group	Cases With Implant, n	Cases With Wasted Implant n	Cases With Wasted Implant %	Total Implant Cost, $	Wasted Implant Cost, $	Wasted Cost Per Case, $	Total Implant Cost Wasted, $
Department							
<10 y	2093	268	13	7,884,661	156,705	75	2.0
10-19 y	3431	476	14	13,800,227	267,230	78	1.9
>20 y	3339	316	9	11,585,804	198,699	60	1.7
Adult Reconstruction							
<10 y	1015	97	10	2,990,424	56,659	56	1.9
10-19 y	950	70	7	3,264,235	41,841	44	1.3
>20 y	1724	139	8	7,488,666	116,369	67	1.6
Spine							
<10 y	519	81	16	4,012,660	71,017	137	1.8
10-19 y	951	90	9	7,348,458	87,378	91	1.2
>20 y	300	27	9	2,306,146	17,435	58	0.8
Total Hip Arthroplasty							
<10 y	313	39	12	1,334,852	29,051	93	2.2
10-19 y	228	11	5	1,010,896	10,568	46	1.0
>20 y	535	50	9	2,592,345	47,908	90	1.8
All THA	1076	100	9	7,283,841	127,146	118	1.7
Total Knee Arthroplasty							
<10 y	235	12	5	769,019	4917	21	0.6
10-19 y	257	11	4	875,990	8017	31	0.9
>20 y	511	19	4	1,835,442	10,058	20	0.5
All TKA	1003	42	4	3,480,452	22,992	23	0.7
Lumbar Spinal Fusion							
<10 y	56	12	21	527,518	10,700	191	2.0
10-19 y	106	13	12	1,198,686	12,586	119	1.0
>20 y	55	5	9	482,101	2896	53	0.6
All LSF	217	30	14	2,208,306	26,182	121	1.2

Abbreviations: LSF, lumbar spinal fusion; THA, total hip arthroplasty; TKA, total knee arthroplasty.

control the cost of these surgeries. Reducing operating room costs, lowering implant prices, and shortening hospital stays have all proved successful.[6,15,20,23] One area that has not been thoroughly explored is the cost burden of wasted implants. Our findings suggest implant waste contributes significantly to the cost of orthopedic surgeries.

One weakness of this study is that its data, though encompassing all orthopedic subspecialties and procedures, come from a single teaching institution and therefore are less representative of all orthopedic departments across the United States. However, the findings are useful in that the analysis was performed across multiple specialties at a high-volume institution and may be applied to similar institutions. Another weakness of this study is that the data cover only 1 year. Collecting data over a longer period could improve the magnitude and power of the analysis. Nonetheless, 1 year of data is a good starting point in identifying the issues and guiding the initiation of measures to address them. Last, we did not explore the reason for each instance of waste during the period reviewed. Knowing the reason for implant waste would be helpful in developing strategies to reduce implant waste.

Our study results showed that, in 1 year, implant waste occurred in 1.8% of procedures that required an implant—representing a loss of $634,000. Other studies have quantified implant waste for selected procedures or single departments, but to our knowledge none has quantified implant waste for an entire orthopedic department or hospital. It is therefore difficult to compare our institutional results with other results. For instance, definitions of waste differ. A study that found waste in 20% of spine surgery cases[22] included all intraoperative waste, whereas our 11% of spine cases were implant waste only. Similarly, though rates of implant waste in trauma cases differed significantly between a multi-institution study by Zywiel and colleagues[24] (0.6%) and our institution (30%), their study excluded arthroplasty cases from the trauma subset and reported implant waste for a single vendor, whereas we included arthroplasty cases and a wide array of implant vendors. In addition, costs cannot be directly compared because, in our study, implants wasted may have differed. Although the Trauma division had the highest incidence of waste (30%) in our analysis, it did not have the highest waste-related costs. Instead, the Adult Reconstruction division, with waste in 8% of cases, had the highest waste cost, $214,869. The cost difference is certainly the result of the difference in type of implants wasted. The implants most commonly wasted in the Trauma division were screws, which cost between $17 and $150; a single femoral stem, though wasted

Table 5. **Implant Waste by Case Volume**

Group	Cases With Implant, n	Cases With Wasted Implant		Total Implant Cost, $	Wasted Implant Cost, $	Wasted Cost Per Case, $	Total Implant Cost Wasted, %
		n	%				
Department							
Upper 25%	4146	481	12	13,859,293	270,760	65	2.0
Middle 50%	3926	477	12	16,576,898	293,331	75	1.8
Lower 25%	782	101	13	2,829,675	58,280	75	2.1
Adult Reconstruction							
Upper 25%	1790	159	9	6,870,995	96,472	54	1.4
Middle 50%	1628	124	8	5,836,587	104,642	64	1.8
Lower 25%	271	23	8	1,035,744	13,755	51	1.3
Sports Medicine							
Upper 25%	623	77	12	983,954	56,361	91	5.7
Middle 50%	709	84	12	998,365	34,965	49	3.5
Lower 25%	49	8	16	28,675	2813	57	9.8
Spine							
Upper 25%	792	57	7	4,103,058	44,723	56	1.1
Middle 50%	910	137	15	8,959,416	122,377	134	1.4
Lower 25%	69	5	7	614,586	8980	130	1.5
Total Hip Arthroplasty							
Upper 25%	744	71	10	3,393,796	54,867	74	1.6
Middle 50%	319	28	9	1,481,218	31,745	100	2.1
Lower 25%	13	1	8	63,079	915	70	1.5
Total Knee Arthroplasty							
Upper 25%	607	31	5	2,040,107	17,576	29	0.9
Middle 50%	376	10	3	1,382,372	4489	12	0.3
Lower 25%	20	1	5	57,972	927	927	1.6
Lumbar Spinal Fusion							
Upper 25%	121	13	11	936,906	9925	82	1.1
Middle 50%	82	13	16	1,019,098	11,262	137	1.1
Lower 25%	14	4	29	252,302	4995	357	2.0

less often, cost significantly more, $2000 to $6000.

Our results showed a combined implant waste incidence of 6.8% for primary THA and primary TKA cases over the year. In their multi-institution study, Zywiel and colleagues[19] reported a combined incidence of implant waste in 2% of THA and TKA cases. The difference is that Zywiel and colleagues[19] reported data from a single implant vendor and included revision surgeries, hip hemiarthroplasties, and unicondylar knee arthroplasties. Another study reported implant waste in 5.7% of all TKA cases but did not specify whether revision or unicondylar arthroplasties were included.[25] For lumbar spinal fusion, we found an implant waste incidence of 14%. Given the lack of studies in this area, we cannot make a comparison of results.

To our knowledge, there has been no other study of the effects of case volume and years in surgical practice on implant waste. Our analysis showed that waste incidence was not related to surgeon case volume but was related to years in surgical practice. Incidence of waste was significantly lower among surgeons practicing 20 years or more than among surgeons practicing fewer than 10 years. The difference may be a reflection that case volume during a single year is not totally indicative of a surgeon's lifetime case volume. For example, several surgeons with many years of experience and a significant lifetime case volume had an annual case volume in the lower 25% of the department because they were approaching retirement or had only recently joined the institution. More rigorous prospective studies are needed to further understand this relationship.

Conclusions

Our study demonstrated significant costs related to implant waste. These costs are important to consider not only for traditional cases, such as total joint and spine procedures, in which implant costs are routinely scrutinized, but for all subspecialties, such as sports medicine, in which the majority of cases are performed on an outpatient basis. Considering the estimated $36 million wasted during THAs and TKAs and $126 million wasted on spine surgeries in the United States annually, and the significant waste we observed in other orthopedic subspecialties, decreasing the rate of intraoperative waste during orthopedic surgeries represents another area that could provide significant cost reduction through implant cost savings.[19,22] A few successful programs have been reported. Soroceanu and colleagues[22] found an almost 50% decrease in intraoperative waste during spine surgery after an educational program was used to address such waste. Elsewhere, use of a computer-based system (e.Label and Compatibility) led to an estimated cost reduction of $75,000 in implant waste.[25] Efforts to develop and implement other programs to reduce implant waste are needed and should be part of any orthopedic operating room cost reduction strategy.

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References

1. Alhassani A, Chandra A, Chernew ME. The sources of the SGR "hole." *N Engl J Med*. 2012;366(4):289-291.
2. Hariri S, Bozic KJ, Lavernia C, Prestipino A, Rubash HE. Medicare physician reimbursement: past, present, and future. *J Bone Joint Surg Am*. 2007;89(11):2536-2546.
3. Keehan SP, Sisko AM, Truffer CJ, et al. National health spending projections through 2020: economic recovery and reform drive faster spending growth. *Health Aff*. 2011;30(8):1594-1605.
4. Porter ME. What is value in health care? *N Engl J Med*. 2010;363(26):2477-2481.
5. Belatti DA, Phisitkul P. Trends in orthopedics: an analysis of Medicare claims, 2000–2010. *Orthopedics*. 2013;36(3):e366-e372.
6. Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. *J Bone Joint Surg Am*. 2007;89(4):780-785.
7. Lavernia CJ, Hernandez VH, Rossi MD. Payment analysis of total hip replacement. *Curr Opin Orthop*. 2007;18(5):23-27.
8. Mendenhall S. 2003 hip and knee implant review. *Orthop Network News*. 2003;14(3):2.
9. Mendenhall S. 2008 hip and knee implant review. *Orthop Network News*. 2008;19(3):20.
10. Healy WL, Rana AJ, Iorio R. Hospital economics of primary total knee arthroplasty at a teaching hospital. *Clin Orthop Relat Res*. 2011;469(1):87-94.
11. Mendenhall S. 2007 hip and knee implant review. *Orthop Network News*. 2007;18(3):16.
12. Iorio R, Davis CM 3rd, Healy WL, Fehring TK, O'Connor MI, York S. Impact of the economic downturn on adult reconstruction surgery: a survey of the American Association of Hip and Knee Surgeons. *J Arthroplasty*. 2010;25(7):1005-1014.
13. Healy WL, Iorio R, Ko J, Appleby D, Lemos DW. Impact of cost reduction programs on short-term patient outcome and hospital cost of total knee arthroplasty. *J Bone Joint Surg Am*. 2002;84(3):348-353.
14. Iorio R, Robb WJ, Healy WL, et al. Orthopaedic surgeon workforce and volume assessment for total hip and knee replacement in the United States: preparing for an epidemic. *J Bone Joint Surg Am*. 2008;90(7):1598-1605.
15. Rana AJ, Iorio R, Healy WL. Hospital economics of primary THA decreasing reimbursement and increasing cost, 1990 to 2008. *Clin Orthop Relat Res*. 2011;469(2):355-361.
16. Robinson JC, Pozen A, Tseng S, Bozic KJ. Variability in costs associated with total hip and knee replacement implants. *J Bone Joint Surg Am*. 2012;94(18):1693-1698.
17. de Steiger RN, Miller LN, Davidson DC, Ryan P, Graves SE. Joint registry approach for identification of outlier prostheses. *Acta Orthop*. 2013;84(4):348-352.
18. Havelin LI, Fenstad AM, Salomonsson R, et al. The Nordic Arthroplasty Register Association: a unique collaboration between 3 national hip arthroplasty registries with 280,201 THRs. *Acta Orthop*. 2009;80(4):393-401.
19. Zywiel MG, Ulrich SD, Suda AJ, Duncan JL, McGrath MS, Mont MA. Incidence and cost of intraoperative waste of hip and knee arthroplasty implants. *J Arthroplasty*. 2010;25(4):558-562.
20. Kim P, Kurokawa R, Itoki K. Technical advancements and utilization of spine surgery—international disparities in trend-dynamics between Japan, Korea, and the USA. *Neurol Med Chir*. 2010;50(9):853-858.
21. Weinstein JN, Lurie JD, Olson PR, Bronner KK, Fisher ES. United States' trends and regional variations in lumbar spine surgery: 1992–2003. *Spine*. 2006;31(23):2707-2714.
22. Soroceanu A, Canacari E, Brown E, Robinson A, McGuire KJ. Intraoperative waste in spine surgery: incidence, cost, and effectiveness of an educational program. *Spine*. 2011;36(19):E1270-E1273.
23. Bosco JA, Alvarado CM, Slover JD, Iorio R, Hutzler LH. Decreasing total joint implant costs and physician specific cost variation through negotiation. *J Arthroplasty*. 2014;29(4):678-680.
24. Zywiel MG, Delanois RE, McGrath MS, Ulrich SD, Duncan JL, Mont MA. Intraoperative waste of trauma implants: a cost burden to hospitals worth addressing? *J Orthop Trauma*. 2009;23(10):710-715.
25. Ast MP, Mayman DJ, Su EP, Gonzalez Della Valle AM, Parks ML, Haas SB. The reduction of implant-related errors and waste in total knee arthroplasty using a novel, computer based, e.Label and Compatibility system. *J Arthroplasty*. 2014;29(1):132-136.