In orthopaedic surgery today, the combination of rising healthcare costs, imminent policy reform, emphasis on patient value, and decreased reimbursement has placed the onus of reducing costs on the surgeon. In particular, the combination of rising implant costs and decreased reimbursement for orthopaedic procedures has contributed to a marked decrease in profitability across all subspecialties.\(^1\text{-}^3\)

With the predicted rise in demand for elective procedures\(^4\text{-}^7\) and the ever-present demand for orthopaedic trauma services,\(^8\) it is beneficial for both individual surgeons and hospital systems to identify methods to maintain profitability in a world of ever-shrinking margins.

Significant strides have been made in the last twenty years in reducing operative cost in orthopaedic surgery such as efficient use of an operative room, well-organized surgical technique, and the use of specialized intraoperative support staff. Cost containment and cost reduction programs are aimed to ensure both healthcare value and maintained profitability. While there have been numerous cost containment strategies attempted within both various orthopaedic subspecialties as well as specific hospital systems in the last decade,\(^9\text{-}^{13}\) only a select few have specifically focused on intraoperative implant waste.\(^15\text{-}^{17}\)

Previous work has demonstrated that orthopaedic implant waste represents a significant source of health care cost.

The purpose of this study was to report on a simple reporting method that attempts to socially and psychologically compel a large group of orthopaedic surgeons to reduce surgical implant waste. We hypothesize that a significant waste reduction will be seen with implementation of a publically posted implant report.

**METHODS**

Financial billing and coding data from 3,973 hip (CPT 27130), knee (CPT 27447), and shoulder (CPT 23472) arthroplasties conducted at a physician owned orthopedic specialty hospital (Crystal Clinic Orthopaedic Center, Akron, OH, USA) was retrospectively reviewed over a two-year period. A wasted implant financial report was posted starting the second year of the study. Each surgeon’s performance could be identified by his peers.

After posting of the financial report, 1.11% of all hip and knee arthroplasty cases had a waste event compared to 1.50% during the control year. Shoulder arthroplasty waste events occurred twice as often than that observed in hip and knee arthroplasty during the study period. A decrease in waste events was observed but was not statistically significant \((p = 0.30)\).

Posting a non-blinded wasted implant data sheet was associated with a reduction in the number of wasted orthopedic surgical implants in this series, although the reduction was not statistically significant.

**Keywords:** Implant waste, Knee arthroplasty, Hip arthroplasty
year period (2010 to 2011). Implant waste was defined as “... during the course of a surgical procedure, it was un-packaged or otherwise prepared for use but ultimately did not remain implanted in the patient at the end of surgery and could not be reused in a different patient.” All waste data was collected by the nursing staff during the operative procedure and recorded. A wasted implant financial report was posted in the surgery lounge starting the second year of the study. Surgeon identity was not blinded, and each surgeon’s performance could be identified by his peers. This intervention year was compared to the prior year when the financial wasted implant data was not made available to the surgeon. The data was analyzed based on hip and knee arthroplasty implant waste as well as shoulder arthroplasty alone. Descriptive statistics were performed for all groups. Potential differences between rates and proportions of occurrences were assessed with the use of a Pearson chi-square test. Significance was set at a two-tailed α < 0.05. This project qualified for Institutional Review Board exemption.

### RESULTS

#### Hip and Knee Arthroplasty

In 2010, 25 of 1,662 total hip arthroplasty (THA) and total knee arthroplasty (TKA) cases had a waste event (1.50%) for an average cost of $2,555.13 per event (Table 1). In 2011, 21 of 1,888 THA and TKA cases had a waste event (1.11%) for an average cost of $4,878.32 per event. The difference in proportions between 2010 and 2011 was 0.39% ± 0.75% (95% confidence interval [CI]). Although there was a decrease in arthroplasty waste events between 2010 and 2011, the reduction was not statistically significant (p = 0.30). The cost associated with waste accounted for 0.32% and 0.55% of the total cost associated with hip and knee arthroplasty implants in 2010 and 2011, respectively.

#### Shoulder Arthroplasty

In 2010, 7 of 206 shoulder arthroplasty cases had a waste event (2.47%) for an average cost of $1,149.92 per event (Table 2). In 2011, 7 of 224 shoulder arthroplasty cases had a waste event (2.27%) for an average cost of $626.46 per event.

### Table 1. Waste Event Data for Hip and Knee Arthroplasty

|                    | 2010       | 2011       |
|--------------------|------------|------------|
| Hip and knee arthroplasty |           |            |
| Waste              | 25         | 21         |
| No-waste           | 1,637      | 1,867      |
| Total              | 1,662      | 1,888      |
| Waste probability (%) | 1.50      | 1.11       |
| Proportion difference (%) | 0.39 ± 0.75 (95% confidence interval), p = 0.30 |
| Cost per waste event ($) | 2,555.13 ± 572.97 | 4,878.32 ± 1,138.10 |
| Proportion spent on waste (%) | 0.32 | 0.55 |

### Table 2. Waste Event Data for Shoulder Arthroplasty

|                    | 2010       | 2011       |
|--------------------|------------|------------|
| Shoulder arthroplasty |           |            |
| Waste              | 7          | 7          |
| No-waste           | 199        | 217        |
| Total              | 206        | 224        |
| Waste probability (%) | 2.47      | 2.27       |
| Proportion difference (%) | 0.27 ± 3.36 (95% confidence interval), p = 0.87 |
| Cost per waste event ($) | 1,149.92 ± 433.04 | 626.46 ± 436.69 |
| Proportion spent on waste (%) | 1.10  | 0.55 |
event. The difference in proportions between 2010 and 2011 was 0.27% ± 3.36% (95% CI). Although there was a decrease in arthroplasty waste events between 2010 and 2011, the reduction was not statistically significant ($p = 0.87$). The cost associated with waste accounted for 1.10% and 0.56% of the total cost associated with shoulder arthroplasty implants in 2010 and 2011, respectively.

**DISCUSSION**

Several authors have previously reported the cost burden of implant waste within the disciplines of total joint arthroplasty, orthopaedic spine surgery, and orthopaedic trauma surgery. In these studies, an implant was considered waste when “...during the course of a surgical procedure, it was unpackaged or otherwise prepared for use but ultimately did not remain implanted in the patient at the end of surgery and could not be reused in a different patient.” The first study, which examined waste in the subspecialty of total joint arthroplasty, demonstrated an average incidence of 2% and annualized average cost of over $100,000 per hospital. This extrapolates to $36 million dollars per year for the entire United States and a predicted $112 million per year with the anticipated increase in demand for total joint arthroplasty by 2030. Interestingly, there was no difference in incidence when comparing academic hospitals to community institutions. In contrast, a similar study examining orthopaedic trauma surgery found more waste in community hospital settings versus academic institutions. These authors additionally noted that the low incidence (0.6%) and annualized cost ($18,000 per hospital) of trauma implant waste was unlikely to decrease significantly with even the most stringent of interventions. A third article investigating spine surgery implant waste noted an annualized cost of $126 million per year for the entire United States, similar to the first study, with waste occurring in approximately 20% of all cases. This study went further, however, and implemented an educational program on intraoperative waste for all operative room staff and posted a public, monthly tally of individual surgeon's implant waste and associated cost burden, without anonymity (spine). These achieved a remarkable 50% reduction in incidence (20.2% to 10.3%) and a cost reduction of 66% ($212,000 annually per hospital to $70,000).

The results from this study did show a trend toward decreasing waste events in the hip and knee arthroplasty as well as the shoulder arthroplasty group. After the wasted implant financial report was posted, 1.11% of all hip and knee arthroplasty cases had a waste event compared to 1.50% during the control year. Although there was a decrease in waste events after posting the report, the reduction was not statistically significant ($p = 0.30$). This resulted in an absolute waste reduction was 0.39% ± 0.75% (95% CI). The cost associated with waste accounted for 0.55% and 0.32% of the total cost associated with hip and knee arthroplasty implants in the intervention and control year, respectively.

When comparing to previously published arthroplasty implant waste literature, the results of this study showed a lower proportion of cost associated with implant waste for hip and knee arthroplasty (0.32% to 0.55% vs. 2%). The data from this study was recorded from a for-profit physician owned hospital; thus, the surgeons may have already been aware of significant profit loss from implant waste. Therefore, their surgical implant waste may have already been minimized prior to this study.

Shoulder arthroplasty waste accounted for 182% greater proportional cost than observed in hip and knee arthroplasty during the study period. In an effort to reduce implant waste, efforts should be focused specifically on shoulder arthroplasty cases. More attention should be paid to component trialing prior to implantation of the final prosthesis in order to achieve more accurate sizing. In addition, the final humeral bearing (head or liner) should not be opened on the sterile field until the shoulder is retracted with the definitive stem to ensure subsidence did not alter the final optimal humeral component size.

It appears that with current techniques there will be a small percentage of cost associated with surgical implant waste during joint reconstruction surgery. It is the up to the surgeon and hospital system to continue to investigate methods to minimize surgical waste and the associated cost.

The current healthcare climate in the United States is forcing both surgeons and healthcare systems to find novel ways to decrease healthcare costs while maintaining quality outcomes. Posting a non-blinded wasted implant data sheet was associated with a reduction in the number of wasted orthopedic surgical implants in this series, although the reduction was not statistically significant. A higher powered study may have demonstrated significance. Since shoulder arthroplasty represented 182% greater proportional cost than observed in hip and knee arthroplasty during the study period, shoulder arthroplasty represents an appropriate target to reduce healthcare costs with further implant waste reduction strategies.
CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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