

Maximizing Value of Knee Injections: A Prospective Cost-Effectiveness Comparison of Hyaluronic Acid versus Corticosteroids

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INTRODUCTION: In the US, nearly half of the population will develop some degree of knee osteoarthritis in their lifetime. Prior to total knee replacements, 50% of patients will trial intra-articular knee injections. But there is no clear consensus on which injection type, corticosteroids (CS) or high molecular weight hyaluronic acid (HMW-HA), delivers the greatest value to patients. The purpose of this study is to compare the value of each injection using comprehensive cost accounting and prospectively collected patient-reported outcomes. We hypothesize that CS injections will demonstrate the greatest value compared to HMW-HA.

METHODS:

Patients receiving CS and HMW-HA injections were recruited from a Midwestern academic health center. Total costs were categorized into the following groups:

Direct Variable Labor (DVL): Average per-minute personnel cost

Direct Variable Supply (DVS): Equipment used during visit

Direct Fixed (DF): Maintenance and utilities

Indirect: Marketing, administration

Using time-driven activity-based costing (TDABC), process maps outlining the steps that a patient takes from check-in until discharge were created. Time utilized by personnel at each step was used to determine DVL costs. DVS costs were calculated using activity-based costing (ABC). DF and indirect costs were calculated using claims-based technical fee data, using a proportion calculated by our institution's allocation of technical fee reimbursement, validated by data comparison of over 4000 orthopaedic surgeries.

Patient reported outcomes (PROM) were measured using Patient Reported Outcomes Measurement Information System Pain Interference (PROMIS PI), Physical Function (PROMIS PF), and Knee injury and Osteoarthritis Outcome Score – Joint Replacement (KOOS-JR). Differences between pre- and post-injection PROMIS PI, PROMIS PF, and KOOS-JR scores at 3-months were multiplied by the average length of effectiveness of each injection type to calculate PROMIS and KOOS quality adjusted life years for each type of injection ($QALY_{PI}$, $QALY_{PF}$, $QALY_K$). For ease of interpretation, a positive value signifies improvement in each of the three measurements.

Total costs were divided by $QALY_{PS}$ and $QALY_K$ to calculate the Value ($Value_{PI}$, $Value_{PF}$, $Value_{KOOS}$) per patient. Cohorts with lower, non-negative, Value are interpreted as more cost-effective than those with greater or negative Value.

RESULTS:

12 patients in each cohort have been recruited at this time. On average, HMW-HA injections cost significantly more than CS (\$606.85 versus \$124.58, $p < 0.0001$). The average DL cost of CS is \$13.41 and average HMW-HA DL costs were \$12.64 ($p = 0.66$). The DS cost differed significantly between CS and HMW-HA (\$10.61 versus \$367.14, $p < 0.0001$).

For PROMs, no significant differences were seen across all 3 surveys. Comparing PROMIS PI, CS cohort on average had a pre- and post-injection change of 2.42, while HMW-HA had a change of 3.5 ($p = 0.67$). Comparing PROMIS PF, CS cohort had a change of 3.67 while HMW-HA cohort had a change of 1.83 ($p = 0.96$). For KOOS-JR, CS cohort had a change of 10.36 and HMW-HA saw a change of 9.08 ($p = 0.82$).

When calculating adjusted life-years, no significant differences were seen between cohorts either. CS $QALY_{PI}$ averaged 0.6 while HMW-HA averaged 0.88 ($p = 0.67$). $QALY_{PF}$ for CS was 1 while HMW-HA was 0.96 ($p = 0.96$). $QALY_K$ for CS was 2.59 and HMW-HA was 2.27 ($p = 0.82$).

Value was calculated by dividing the average total cost of each injection by $QALY$ of each patient reported outcome measurement. For CS cohort, $Value_{PI}$ was 129.71 ($\$/QALY_{PI}$), $Value_{PF}$ was 78.37 ($\$/QALY_{PF}$), and $Value_{KOOS}$ was 48.09 ($\$/QALY_K$). For HMW-HA cohort, $Value_{PI}$ was 693.55 ($\$/QALY_{PI}$), $Value_{PF}$ was 633.24 ($\$/QALY_{PF}$), and $Value_{KOOS}$ was 271.71 ($\$/QALY_K$).

DISCUSSION AND CONCLUSION:

CS injections saw significantly lower costs compared to HMW-HA, primarily driven by HMW-HA's higher supply costs. Outcomes between the cohorts did not have a significant difference, but both cohorts saw improvements in patient reported outcomes at 3 months. Across all PROMs, the CS cohort had a lower number for Value, indicating that CS provides greater cost effectiveness compared to HMW-HA, primarily driven by the lower cost of CS injections.

One limitation to our study is that while guidelines and existing literature suggest the length of effectiveness for CS and HMW-HA injections are around 3 months, studies have shown that both may be effective for up to 6 months. Continued follow-up with our established cohort to obtain 6-months outcomes may be beneficial.

In summary, our results highlight the importance of considering both PROMs and cost when determining value for patients, physicians, and health systems.

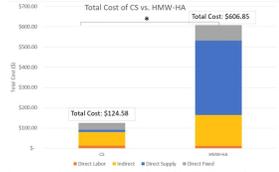


Figure 1. Bar graph comparing average total cost between CS and HMW-HA, stratified by individual costs, derived into the calculation of the total.

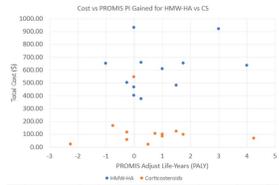


Figure 2. Scatterplot of the total cost of care versus QALYx gained at 3 months post-injection. Data points lower and to the right of the scatterplot indicate greater value. N= 12 for CS and n= 12 for HMW-HA.

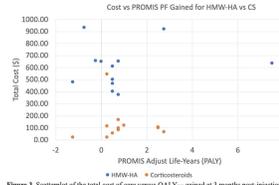


Figure 3. Scatterplot of the total cost of care versus QALYx gained at 3 months post-injection. Data points lower and to the right of the scatterplot indicate greater value. N= 12 for CS and n= 12 for HMW-HA.

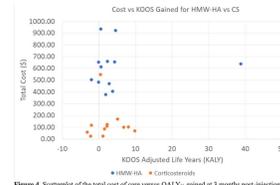


Figure 4. Scatterplot of the total cost of care versus QALYx gained at 3 months post-injection. Data points lower and to the right of the scatterplot indicate greater value. N= 12 for CS and n= 12 for HMW-HA.