Original research

Patient risk taking and spending habits correlate with willingness to pay for novel total joint arthroplasty implants

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**Abstract**

In this study, we compare patients’ risk-taking and spending behaviors to their willingness to pay (WTP) for novel implants in a joint arthroplasty. 210 patients were surveyed regarding risk-taking and spending behavior, and WTP for novel implants with either increased-longevity, increased-longevity with higher risk of complications, or decreased risk of complications compared to a standard implant. Patients with increased recreational risk-taking behavior were more WTP for increased-longevity. Patients who “rarely” take health-risks were more WTP for decreased risk of complications. Patients with higher combined risk scores were more WTP for all novel implants. Patients who paid more than $50,000 for their current car were more WTP for decreased complications. This study shows that patients’ risk-taking and spending behavior influences their WTP for novel implants.

**Introduction**

As healthcare policy makers in the United States continue to seek to limit the growing costs of healthcare there is an increasing interest in utilizing healthcare models that emphasize better cost-awareness by all parties involved. Consequently, this focus brings forth new challenges for both the surgeon and the patient, as both would like to utilize the highest quality materials, implants, devices, etc. [1], but also we must learn to increasingly see cost as a significant factor in healthcare decisions. As such, healthcare models that increasingly “share the cost” with the patient can be an effective means of increasing the patient’s role in healthcare decisions where cost is a significant factor.

Various studies in the past have used “willingness-to-pay” (WTP) as a means of measuring how much value a patient places on a certain procedure or device [1–5]. While WTP is most specifically applicable to a system where the patient shares a higher burden of healthcare costs, WTP data is also indicative of what type of care or interventions are actually important to the patient and can help guide healthcare administration in even traditional insurance models where patients pay little more than the premiums [3]. However, WTP data is perhaps most valuable to determine whether patients are willing to share the cost for an “upgraded” procedure. As an earlier study by Schwarzkopf et al. showed, only 20% of patients at their institution were satisfied with a “standard of care” implant for total knee arthroplasty (TKA) or total hip arthroplasty (THA), while 86% of patients were willing to pay for an upgraded prosthesis [4]. Therefore, WTP data may play an especially important role as further restrictions are placed on surgeons and patients regarding which total joint replacement (TJR) prostheses will be covered by payers, further placing patients’ unease over settling for “standard-of-care” quality at odds with the goals of cutting healthcare costs.

TJRs, especially TKAs and THAs, are widely regarded as an effective treatment for end-stage joint arthritis [6, 7]. Each year, over 800,000 TKA and THA operations are performed [8, 9] and as the population in the United States ages, this number is projected to increase dramatically in the coming years [10, 11]. Various studies have found TJRs to be among the more cost-effective procedures when considering quality-of-life years gained per amount spent [12–17]. However, the cost of TJR operations, especially THA and TKA operations has increased substantially over the past decade, while reimbursement for the procedures has not increased similarly [9]—in fact, from 1999 to 2007. Medicare reimbursement declined by 20% for TKA and 21% for THA [18]. Consequently, this has left many surgeons and patients feeling frustrated over the...
prospect of letting cost be the determining factor in implant choice rather than quality [1]. To add to this dilemma, advances in implant technology for THA and TKA operations have led to the creation of various novel implants that may have superior longevity and decreased risks of complications, though at an increased cost which is unlikely to be covered by many insurers.

Therefore, considering the direction of healthcare policymaking, it is important to elucidate the factors that are associated with patients’ WTP for novel TJR prostheses. The purpose of this study is to identify which patient characteristics are most associated with a WTP for novel, improved implants. We hypothesize that certain risk taking behaviors and spending habits will be associated with an increased WTP for a novel implant. Although some studies have previously sought to correlate patient demographics or income with WTP for TJR implants, including a previous work by Schwarzkopf et al. [19], no previous study has observed how patients’ behavioral patterns or lifestyle choices contribute to their willingness to be treated with a novel technology and their WTP for novel TJR implants. Consequently, our work adds to the growing body of literature concerning risk aversion from novel technology and WTP for total joint arthroplasty prostheses.

Material and Methods

Design and sample

The study was approved by our institutional review board. We conducted a prospective cross-sectional survey among patients attending tertiary medical center. All the patients included in the study were enrolled during their visit at the Orthopaedic and Arthritis center while waiting for their rheumatology clinic visit. Inclusion criteria included: presenting to the rheumatology clinic, willing and able to complete and comprehend the survey in English, being between the ages of 18–89 years old. Exclusion criteria included if the patient was currently scheduled for joint replacement surgery or if he had joint replacement surgery in the past. All patients that met inclusion criteria were invited to participate by a research assistant during the clinic visit in the before or after their rheumatology appointment. All completed surveys were collected and stored by the research staff. During the course of the clinic visit and the survey no educational material discussing implant characteristics, price or arthroplasty procedure cost was provided to the patients.

Survey instrument

Subject demographics were collected in the survey as well as patients’ risk taking behavior in different aspects of their life and daily activity (Appendix 1).

Patient willingness to pay and their life style risk taking behavior were examined with relation to different novel implant attributes. We presented to the patient features of a ‘standard’ implant which included longevity of about 15 years and risk of short-term complications (e.g. infection, fracture, dislocation, or nerve injury) estimated at 3% during the first postoperative year. We asked whether patients would be willing to pay, as well as the amount, to the cost of three ‘novel implants’ (The amount the patients were willing to add as a co-payment was entered as free text into the survey). We then asked the patient to define his risk taking behavior in different aspects of his daily life and recreational activity.

The 3 novel implants that were presented in the survey had the following presumed characteristics: 1) proposed longevity of 25 years accompanied by the same 3% risk of short-term complications; 2) proposed longevity of 25 years associated with an increased (5%) risk of complications; and 3) proposed standard longevity (15 years) associated with a lower 1% risk of complications (Table 1).

Table 1

| Description of novel implants                                                                 | WTP                                      |
|------------------------------------------------------------------------------------------------|------------------------------------------|
| ‘Standard’ implant: 15 year lifespan with 3% reoperation risk                                  |                                          |
| Novel implant 1: 25 year lifespan with 3% reoperation risk                                     |                                          |
| Novel implant 2: 25 year lifespan with 5% reoperation risk                                     |                                          |
| Novel implant 3: 15 year lifespan with 1% reoperation risk                                     |                                          |

Statistical analysis

To compare the willingness to pay (WTP) of groups of patients with different risk taking behavior and different spending habits, we categorized patients based on their answer to each individual question concerning risk taking behavior or spending habits. Using these groupings, we then compared the WTP for the three different implant choices across the groups. A Pearson Chi Square test was used to find statistical differences in WTP between these groups.

To better analyze overall trends in risk-taking behavior and WTP, the average risk score was calculated for each patient. This was achieved by assigning numbers to each of the patient responses in regard to frequency of risk-taking behavior; the number 0 corresponded to the response “never,” 1 to the response “rarely,” 2 to the response “sometimes,” 3 to the response “often,” and 4 to the response “very often.” However, this number scale was reversed for health risk-taking behavior, with the number 0 corresponding to the response “very often” and the number 4 corresponding to the response “never.” The scores for each of the risk-taking categories were summed and the patients were then divided into groups of “low,” “medium,” and “high” risk-taking scores using cutoffs of less than 5 for “low,” 5 to 9 for “medium,” and 10 or more for “high.” These groups were then compared using the Pearson Chi Square test.

Results

Two hundred and fifty-one patients at the Orthopedic and Arthritis Center were screened for study eligibility and approached in clinic. Of those, 210 (84%) agreed to participate and 195 (78%) completed the questionnaire. Out of the 195 study participants recruited from the offices of 4 clinicians in the 9 months, 32% were male; average age was 56 years (22–89 years); 51% were <60 years old, 35% between 60–70 years old, and 14% ≥ 70 years old.

Comparing patients grouped based on their response to how often they participate in recreational risk-taking, there was a significant difference (p = 0.033) between groups in their WTP for a novel implant with a proposed 25–year longevity and a 3% reoperation risk (novel implant 1) (Table 2). Amongst these groups, those patients who “very often” participated in recreational risk-taking were the most likely to be willing to pay for novel implant 1 (increased longevity), while those patients who reported “never” participating in recreational risk-taking were the least likely to be willing to pay for novel implant 1 (increased longevity). There was no significant difference amongst these groups in terms of WTP for novel implants with either a 25 year longevity with a 5% reoperation rate (novel implant 2) or a 15 year longevity with a 1% reoperation rate (novel implant 3).

Comparing patients grouped based on their response to how often they take health risks (i.e. smoking), there was a significant difference between groups in their WTP for novel implant 3 (decreased risk) (p = 0.032). Those patients who reported taking health risks “very often” were the least likely to pay for novel implant 3, while those patients who reported taking health risks “rarely” were the most likely to pay for novel implant 3 (decreased risk).
risk). There was no significant difference amongst groups regarding their WTP for novel implants 1 or 2 (Table 2).

Comparing patients grouped based on their reported frequency of taking career risks, financial risks, safety risks, or social risks; there was no significant difference in WTP for novel implants 1, 2, or 3 amongst these groups (Table 2).

There was a significant difference in WTP for novel implants 1, 2, and 3 amongst patients grouped by their combined risk score ($p = 0.004$, $p = 0.023$, $p = 0.014$; respectively) (Table 2). Those patients with a “high” combined risk score were the most likely to be willing to pay for either novel implant 1, 2, or 3. Patients with a “low” combined risk score were the least likely to be willing to pay for either novel implant 1, 2, or 3. Those 44 patients with a “low” combined risk score, 113 patients with a “medium” combined risk score, and 38 patients with a “high” combined risk score (Table 2).

Comparing patients grouped by their response to how much they paid for their current car, there was a significant difference in WTP for novel implant 3 (decreased risk) between groups ($p = 0.038$). Those patients who paid more than $50,000 for their current car were the most likely to be willing to pay for novel implant 3 (decreased risk), while those patients who paid less than $10,000 for their current car were the least likely to be willing to pay for novel implant 3 (decreased risk) (Table 2). There was no significant difference in WTP for novel implants 1 or 2 when patients were grouped by how much they paid for their current car.

Comparing patients grouped by their response to how much they paid for their current TV, there was a significant difference in WTP for both novel implant 1 and novel implant 3 ($p = 0.005$ and $p = 0.006$, respectively). Those patients who do not own a TV were the most likely to be willing to pay for novel implant 1 (increased longevity with out increased risk), while those patients who paid less than $500 for their TV were the least likely to be willing to pay for novel implant 1. Those patients who paid $1,000 to $2,000 (or more than $2,000) for their TV were the most likely to be willing to pay for novel implant 3 (decreased risk), while patients who paid less than $500 for their TV were the least likely to be willing to pay for novel implant 3 (Table 3).

Overall, 45% of the 195 patients were willing to pay for an implant that had greater longevity than the standard implant (either novel implant 1 or implant 2). However, only 26% of the 195 patients were willing to pay for an implant that had a decreased risk of complications without a gain in longevity (novel implant 3).

Discussion

In a previous study using our study population, the overall WTP for a novel implant over the standard-of-care implant was found to

Table 2
Risk-taking behavior and willingness to pay for implant upgrades.

| Willingness to pay for: | 25 year lifespan with 3% reoperation risk | 25 year lifespan with 5% reoperation risk | 15 year lifespan with 1% reoperation risk |
|-------------------------|----------------------------------------|----------------------------------------|----------------------------------------|
| **Recreational risks**  |                                        |                                        |                                        |
| Never                   | 33.0%                                  | 19.8%                                  | 24.4%                                  |
| Rarely                  | 54.9%                                  | 39.2%                                  | 33.3%                                  |
| Sometimes               | 56.8%                                  | 25.0%                                  | 40.5%                                  |
| Often                   | 50.0%                                  | 20.0%                                  | 10.0%                                  |
| Very often              | 66.7%                                  | 33.3%                                  | 33.3%                                  |
| Chi square (p-value):   | 10.464 (0.013)*                        | 6.644 (0.156)                          | 5.470 (0.242)                          |
| **Health risks**        |                                        |                                        |                                        |
| Never                   | 36.8%                                  | 33.3%                                  | 37.8%                                  |
| Rarely                  | 54.7%                                  | 32.8%                                  | 39.1%                                  |
| Sometimes               | 43.5%                                  | 19.7%                                  | 23.0%                                  |
| Often                   | 38.1%                                  | 14.3%                                  | 14.3%                                  |
| Very often              | 42.9%                                  | 28.6%                                  | 0.0%                                   |
| Chi square (p-value):   | 3.907 (0.419)                          | 5.262 (0.261)                          | 10.581 (0.032)*                        |
| **Career risks**        |                                        |                                        |                                        |
| Never                   | 42.9%                                  | 23.9%                                  | 28.6%                                  |
| Rarely                  | 57.1%                                  | 28.6%                                  | 31.0%                                  |
| Sometimes               | 42.9%                                  | 30.0%                                  | 36.8%                                  |
| Often                   | 33.3%                                  | 50.0%                                  | 33.3%                                  |
| Very often              | 33.3%                                  | 33.3%                                  | 0.0%                                   |
| Chi square (p-value):   | 3.227 (0.521)                          | 2.381 (0.666)                          | 1.876 (0.759)                          |
| **Financial risks**     |                                        |                                        |                                        |
| Never                   | 41.9%                                  | 21.9%                                  | 23.3%                                  |
| Rarely                  | 42.9%                                  | 27.5%                                  | 30.0%                                  |
| Sometimes               | 56.8%                                  | 27.8%                                  | 41.7%                                  |
| Often                   | 50.0%                                  | 40.0%                                  | 30.0%                                  |
| Very often              | 0.0%                                   | 100.0%                                 | 0.0%                                   |
| Chi square (p-value):   | 3.393 (0.494)                          | 4.569 (0.334)                          | 4.347 (0.361)                          |
| **Safety risks**        |                                        |                                        |                                        |
| Never                   | 35.6%                                  | 21.3%                                  | 24.7%                                  |
| Rarely                  | 56.9%                                  | 28.1%                                  | 41.4%                                  |
| Sometimes               | 51.7%                                  | 28.6%                                  | 25.0%                                  |
| Often                   | 44.4%                                  | 44.4%                                  | 22.2%                                  |
| Very often              | 50.0%                                  | 50.0%                                  | 16.7%                                  |
| Chi square (p-value):   | 7.135 (0.129)                          | 4.540 (0.338)                          | 5.894 (0.207)                          |
| **Social risks**        |                                        |                                        |                                        |
| Never                   | 35.5%                                  | 18.7%                                  | 20.3%                                  |
| Rarely                  | 43.8%                                  | 23.9%                                  | 31.3%                                  |
| Sometimes               | 60.4%                                  | 37.7%                                  | 37.7%                                  |
| Often                   | 50.0%                                  | 41.7%                                  | 41.7%                                  |
| Very often              | 50.0%                                  | 0.0%                                   | 0.0%                                   |
| Chi square (p-value):   | 7.951 (0.093)                          | 8.075 (0.089)                          | 6.559 (0.161)                          |
| **Combined risk**       |                                        |                                        |                                        |
| Low                     | 23.3%                                  | 11.6%                                  | 11.6%                                  |
| Medium                  | 50.9%                                  | 28.4%                                  | 34.5%                                  |
| High                    | 54.1%                                  | 37.8%                                  | 35.1%                                  |
| Chi square (p-value):   | 10.990 (0.004)*                        | 7.544 (0.023)*                         | 8.520 (0.014)*                         |

* $p < 0.01$. 
be 26–45% [19]. This was substantially less than previous studies, some of which demonstrated a WTP for an advanced implant in up to 86% of studied patients [1–5]. While the design of the questionnaire and description of the implants may play a role in this, it is important to note the substantial discrepancies between patient populations at different institutions involved in these studies. Furthermore, the population of patients in this study were recruited from a rheumatology specialty clinic and were not scheduled for or had in the past a joint replacement surgery. Many previous studies done on WTP data studied only patient who were either scheduled for or had already had joint replacement surgery. The concurrent perception of a need for joint replacement in these previous patient populations would likely increase the WTP over a population of patients who is, at least, not concurrently considering joint replacement surgery in the near future.

Both recreational risk taking behavior and health risk taking behavior were independently associated with a difference in WTP for a novel implant, though in a different way. Patients who took many recreational risks were more likely to pay for an implant with increased longevity (implant 1), while patients who took few, if any, health risks were more likely to pay for an implant with a decreased complication rate (implant 3). One likely reason for this is that these types of risk-taking behavior are actually not very similar at all. Many patients who frequently take recreational risks, by doing extreme sports for instance, may also be patients who take very few health risks (smoking, unhealthy diet, etc.). Furthermore, patients who frequently partake in recreational risks may appreciate having an implant with greater longevity that will allow further use during recreational activities. Likewise, patients who infrequently take health risks, by choosing not to smoke for instance, may also place substantial value on a decreased risk of medical complications, and are, consequently, more willing to pay for such.

The higher the combined risk score, which combined the full spectrum of risk-taking behaviors, the more likely the patient was willing to pay for any of the novel implants. Therefore, in our patient population, overall risk-taking behavior was associated with a willingness to pay for both increased longevity of an implant (implant 1), increased longevity in exchange for a greater risk of post-operative complications (implant 2), and for decreased post-operative complications overall (implant 3). Of note, it was decided that overall risk would best be represented using a combined score that utilized a reversed scale for health risk-taking behavior. The reason for this decision was that on initial observation of the data, an opposite trend in WTP was seen in health risk-taking as opposed to other types of risk-taking (as discussed above).

When considering spending habits of the patients, those who paid more for their current car were more willing to pay for a novel implant with a decrease in risk of complications (novel implant 3). This finding could be merely due to increased income and wealth with these patients. As Cross et al. demonstrated in their study, patients who had higher incomes were more willing to pay “something” for a total hip replacement [3]. Likewise, Tucker et al.

### Table 3

| Willingness to pay for:                      | 25 year lifespan with 3% reoperation risk | 25 year lifespan with 5% reoperation risk | 15 year lifespan with 1% reoperation risk |
|---------------------------------------------|------------------------------------------|------------------------------------------|------------------------------------------|
| How much did you pay for the car you        | 47.6%                                    | 15.0%                                    | 10.0%                                    |
| typically drive?                             | 45.9%                                    | 28.8%                                    | 29.7%                                    |
| More than $25,000                            | 48.1%                                    | 26.4%                                    | 35.2%                                    |
| Don’t own a car                              | 66.7%                                    | 40.0%                                    | 53.3%                                    |
| Chi square (p-value):                       | 7.655 (0.105)                            | 3.328 (0.505)                            | 10.165 (0.038)*                          |
| How often do you                            |                                         |                                          |                                          |
| typically purchase a new TV?                |                                         |                                          |                                          |
| Every 1–3 years                             | 50.0%                                    | 23.1%                                    | 21.4%                                    |
| Every 4–6 years                             | 51.2%                                    | 29.3%                                    | 34.1%                                    |
| Every 6–10 years                            | 51.4%                                    | 29.0%                                    | 34.3%                                    |
| Never (Don’t own a car)                     | 26.7%                                    | 20.0%                                    | 17.2%                                    |
| Chi square (p-value):                       | 6.568 (0.161)                            | 1.152 (0.886)                            | 3.784 (0.436)                            |
| How much more are you willing to pay over baseline for a car that comes fully loaded? | 39.0%                                    | 27.5%                                    | 17.5%                                    |
| More than $1,000                            | 40.9%                                    | 27.7%                                    | 25.8%                                    |
| Chi square (p-value):                       | 7.234 (0.065)                            | 2.671 (0.445)                            | 5.966 (0.113)                            |
| How much did you pay for your TV?           |                                         |                                          |                                          |
| Less than $500                               | 29.0%                                    | 16.4%                                    | 11.5%                                    |
| $500 to $1,000                              | 46.8%                                    | 27.4%                                    | 37.1%                                    |
| $1,000 to $2,000                            | 55.6%                                    | 34.1%                                    | 40.0%                                    |
| More than $2,000                             | 53.3%                                    | 33.3%                                    | 40.0%                                    |
| Don’t own a TV                              | 87.5%                                    | 42.9%                                    | 28.6%                                    |
| Chi square (p-value):                       | 14.725 (0.005)*                          | 5.855 (0.210)                            | 14.440 (0.006)*                          |
| How often do you                            |                                         |                                          |                                          |
| typically purchase a new TV?                |                                         |                                          |                                          |
| Every year                                  | 40.0%                                    | 60.0%                                    | 40.0%                                    |
| Chi square (p-value):                       | 6.023 (0.110)**                          | 4.092 (0.252)**                         | 3.827 (0.281)**                          |
| How much more are you willing to pay for a more advanced TV over the base model? | 38.5%                                    | 22.4%                                    | 25.0%                                    |
| Less than $250                              | 53.4%                                    | 29.3%                                    | 37.9%                                    |
| More than $1,500                            | 60.0%                                    | 20.0%                                    | 40.0%                                    |
| Chi square (p-value):                       | 3.984 (0.263)**                          | 3.148 (0.369)**                         | 3.602 (0.308)**                          |

* p < 0.01.

** – More than 20% of cells have expected count of less than 5.
showed that patients who had higher income were more willing to pay out-of-pocket fees for a joint replacement operation in general as well as an “advanced technology” joint replacement operation [5]. Indeed, in a previous study Schwarzkopf et al. demonstrated that income was significantly associated with WTP for all 3 novel implants [19].

Interestingly, not owning a TV at all was associated with an increased WTP for novel implant 1 (increased longevity). However, this “spending habit” can commonly reflect a choice to not have a TV due to cultural and social values rather than reflecting actual financial choices or burdens. On the other hand, those patients who spent the most on their TV (more than $1,000) were more likely to be willing to pay for a novel implant with a decreased risk of complications, while those who spent less than $500 on their TV were the least likely to be willing to pay for a novel implant. Again, this finding may be confounded by the income and wealth of the patients.

There are several limitations to our study. First, when observing the risk taking behaviors of patients, our study only measured the patient’s perception of their own risk-taking behavior. A future study could use a questionnaire to quantify actual risk-taking activities rather than simply the patient’s self-reported perception. Second, the findings regarding spending behavior are difficult to interpret given that some behavior inevitably reflects personal wealth, rather than simply spending tendencies. It would be very difficult to separate these two factors in a study, though one could better control for income/assets in the study design. Finally, of clinical relevance, our study population consisted of rheumatology patients with no current scheduled joint replacement surgery in their future, while many previous studies on WTP only included patients who were scheduled for or had already had joint replacement surgery. We can not exclude the possibility of selection bias between patients that were willing to participate in the survey and ones that did not, this limitation is common to all studies using a survey as part of the methods.

Conclusion

While not all types of risk-taking behavior were associated with differences in WTP for a novel implant, patients with certain risk-taking behavior, like recreational and health risk-taking (lower), were significantly more likely to be willing to pay for a novel implant; likewise, patients with higher combined risk scores were more likely to be willing to pay as well. In regards to spending habits, patients who spent higher amounts on their current car or TV were both more likely to be willing to pay for a novel implant. While further work is needed to fully characterize which patient groups would be willing to pay for a novel implant in joint replacement surgery, this study demonstrates that some risk-taking behavior and some spending habits are associated with patients’ willingness to share the cost for such an implant.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.artd.2014.12.004

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