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Predictors of Risk Tolerance Among Oral Surgery Patients

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Abstract

Purpose—This study attempts to provide insight on how the treatment preference for a mandible fracture and treatment received and its consequences, are related to the patient's risk tolerance, as measured by the Standard Gamble(SG).

Patients and Methods—Data from a prospective cohort study of 203 subjects receiving treatment at the former King/Drew Medical Center (KDMC) in Los Angeles for either a mandible fracture(n=98) or third-molar removal (n=105) are examined. Subjects were interviewed at four time points; upon admission to the medical center, and at three monthly follow-up visits. Risk tolerance for hypothetical treatment scenarios is measured using the SG, a health-value utility measure assessing the tradeoff between good outcomes and serious complications associated with treatment. Separate regression analyses with subsets of predictors (sociodemographic, psychosocial health, and clinical characteristics) were conducted and then synthesized using the significant predictors in separate analyses.

Results—For fracture subjects, there is a noticeable rise in the SG reports from admission to the one-month follow-up. Their greater risk tolerance was associated with being older, receiving surgery, having a lower PTSD score, and having a swollen jaw or face. For third-molar subjects, SG does not change substantively over the course of the study. Predictors of greater risk tolerance for third molar subjects include the jaw or face being swollen and having to use less pain medication.

Conclusions—Findings from this study demonstrate a preference for less invasive treatment, with the majority of both groups preferring wiring and support the theory that treatment choices differ between subjects with different health states. Factors associated with risk tolerance include the patient's age, treatment received, psychosocial health state, experience with prior treatment, and value for oral health quality of life.

Introduction

Today, the process of informed consent requires risks and benefits of competing medical procedures and clinical outcomes to be communicated to an increasingly diverse patient population. Selection of treatment regimens may depend on patient perceptions of the likelihood that a given treatment will be successful. But patient values can differ, and

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treatment preferences vary widely even among patients with similar health states.^{1, 2, 3, 4, 5} One explanation is the influence of the patient's acceptance of, or tolerance for risk associated with treatment.^{1, 6, 7, 8, 9, 10} For this study, risk tolerance is defined as the level of risk of adverse side-effects resulting from a given surgical or non-surgical procedure that an individual deems acceptable. In other words, individuals who prefer to gamble for a better outcome when the expected value of the gamble is less than the value of a likely alternative outcome are said to be *risk tolerant*. Conversely, those who stay with a known outcome, or prefer not to gamble for a better outcome when the expected value of the new outcome is in their favor are said to be *risk averse*.

According to expected utility theory, people's tolerance towards risk involves a comparison and valuation of desired outcomes. However, exact risks and benefits of treatment choices involving quality-of-life outcomes are usually not known.¹ Fraenkel, et al. (2003) examined the association between risk tolerance and treatment preferences in women with lupus nephritis and found that risk tolerant patients had a stronger preference for a more toxic drug treatment for lupus nephritis than risk-averse patients.⁹ Prosser, et al. (2002) evaluated risk tolerance as a patient characteristic related to treatment choice for patients with multiple sclerosis and found that risk tolerant patients were more likely to choose no treatment compared to risk-averse patients.⁸

Risk tolerance is influenced by a probable outcome of death versus a probable outcome of reduced quality of life. For example, Hellinger (1989), in a survey of 50 employees of the U.S. Department of Health and Human Services, found that people exhibit more risk-averse behavior as the probability of death increases.¹ Similarly, Cykert (2004) reported that lung cancer patients avoided risk if surgery could lead to lifelong disability or dependence.¹¹ However, when death due to lung cancer was deemed certain to occur within a limited time frame without surgery, patients were willing to assume high risks of postoperative complications and surgery-related death. Cykert's interpretation, consistent with intuition, is that risk aversion toward death supersedes all other health states. In quantifying how much risk was needed to make people act, Brown, et al. reported that among visitors to an emergency department, even a 0.05 percent risk of an adverse event associated with chest pain resulted in 44% of subjects choosing hospital admission.¹² Risk tolerance may also be influenced by prior dental experience. In a study by Patel et al (2006), the decision to have either surgical or non-surgical periodontal treatment was not influenced by gender, age, education, or socioeconomic status, but was influenced by dental fear and anxiety and the level of rapport or trust that they reported with their dental provider.¹³

In a previous manuscript describing the baseline association between the patient's preference for treatment (wiring or surgery to repair a fractured jaw) and patient socioeconomic and health-related characteristics, we reported that the predominantly male, unemployed fracture patients demonstrated no significant differences in their SG score than third-molar patients.¹⁴ For both groups, however, subjects who chose surgery were willing to accept a greater hypothetical risk of possible nerve damage or scarring than those who chose wiring. Among 15 potential predictors of SG and WTP studied in 4 subgroups defined by actual treatment and treatment preference, significant predictors varied. For SG, education was a significant predictor for the wire preference group and clinical experience for the surgery preference group. For WTP, income was a significant predictor for the wire preference group and depression was the significant predictor for those preferring surgery. A second analysis demonstrated that patient preferences for treatment are not stable across the course of healing and that only 51 subjects (37 for wiring, and 14 for surgery) chose the same treatment at all four hospital visits.¹⁵ Four factors predicted a preference for surgery at the one-month follow-up, higher income, higher acceptance of risk with surgery, being a fracture patient, and reporting a higher number severity of symptoms. The present study,

which extends the baseline analysis by including data from multiple follow up interviews, provides insight on how the treatment preference and treatment received, and its consequences, are related to the patient's risk tolerance, as measured by the SG.

Methods

This paper uses follow-up data from a prospective cohort study of 203 patients receiving treatment at the former King/Drew Medical Center (KDMC) in Los Angeles for either mandible fracture (n=98) or third-molar removal (n=105). The study protocol called for patients to be interviewed at four time points, namely upon medical-center admission (but before clinical treatment) and at three follow-up time points slated to occur one month, two months, and three months post-treatment.

An oral/maxillofacial surgeon at KDMC screened all study subjects. Inclusion criteria were: males and females between 18 and 60 years of age, ability to speak English or Spanish, admitted to the hospital for either a mandible fracture or planned surgical removal of impacted third-molar teeth under general anesthesia, being capable of answering a medical history, not suffering from uncontrolled epilepsy or a severe psychiatric problem, and deemed capable of giving informed consent. Fracture patients were excluded from the study if either their fracture displacement was less than 2 mm, in which case MMF would be a presumptive treatment, or if they presented with either a gunshot wound or fracture displacement greater than 4mm, in which case RIF would be the presumptive treatment.

We selected the third molar sample as a comparison group with similar characteristics to the diverse, disadvantaged south central Los Angeles community represented by the fracture subjects. This ambulatory sample will help answer the question of whether decision-making regarding treatment preferences is compromised when physical and mental health is impaired, as represented by the fracture subjects with the precipitating traumatic stressors of interpersonal violence and Post-traumatic stress disorder (PTSD) associated with the fracture condition.. Third molar patients accepted for removal of teeth under general anesthesia by the oral and maxillofacial surgery department reported relatively minor problems such as pain and repeated infection with their third molars. Indeed, while subject characteristics such as previous dental problems, being a younger age, somewhat better educated, more likely employed, and more likely to be female were found to differentiate the two samples in bivariate analysis, when comparing the two groups by treatment preference, only age (third molar subjects were 3 years younger) and Standard Gamble(SG) were significant.¹⁴

Fracture patients were screened during admission prior to discussion of treatment options. Third-molar patients were screened prior to being scheduled for surgical extraction under general anesthesia. Informed consent took place for those who agreed to participate; see Atchison, et al. (2007) for additional detail regarding the protocol for informed consent, screening procedures, survey instrumentation, and data collection.¹⁴

Risk tolerance is often measured using the SG, a health-value utility measure assessing the tradeoff between good outcomes, such as improved health function or appearance, and a serious complication associated with treatment.^{7,8,10,11,12,14,15,16,17,18} The strength of the preference for a specific treatment is expressed in terms of the amount of risk the respondent would accept for obtaining improved health function. At their initial interview and at each follow-up interview, subjects were asked to provide the value they were willing to place on a health outcome using a scale with a lower anchor point of 0%, representing a patient's decision never to select surgery instead of non-surgical fixation, and upper anchor

point of 100%, representing a strong preference for surgery regardless of the possibility of scarring or nerve damage. Specifically, subjects were asked:

Serious problems happen in a certain percentages of patients. For what percent chance of possible nerve damage or scar formation (between 0% and 100%) would you select surgery instead of jaw wiring?

Independent Variables for Consideration in the regression analysis

Socio-demographic indicators used in these analyses included age, education, income, gender, ethnicity, and employment. Age of respondents ranged from 18 to 64 years and is measured as a continuous variable. Gender, ethnicity (African American vs. other, most of whom were Hispanic) and employment status (employed or not) were measured using dichotomous variables. Completed education was measured on an ordinal scale from 0 to 4 reflecting 8th grade or less (0); some high school (1); completed high school (2); vocational/technical school or some college (3); and college graduate (4). Four categories of monthly household income were measured, with 0 representing either receipt of public assistance or a monthly income of \$616 or less and with 1, 2, 3 representing, respectively, a monthly income of \$617 to \$766, \$767 to \$999, or \$1,000 or more, with cutoffs corresponding to natural break points in annual income.

Psychosocial health was assessed at baseline and each follow up visit using items from previously validated scales. PTSD symptoms were measured by four yes/no questions related to having nightmares, intrusive thoughts, anxiety, and feeling detached during the past two weeks; a composite score was obtained by counting the number of such symptoms from 0 to 4.¹⁷ Depressive symptoms included five Likert-scaled CES-D items related to feeling down, feeling lonely, having little interest or pleasure, and having difficulty concentrating. Responses on each item were recorded on an ordinal scale ranging from never (0) to always (4), yielding a summary score from 0 to 20.²⁰ A substance abuse screener using four yes/no responses was used to capture alcohol and drug use, yielding a summary score from 0 to 4.²¹ Patient reports of number of close family members or friends available to them were used to measure the extent of their social networks. Social support was measured using four Likert-scaled items related to availability of someone to give advice, to confide in, to prepare meals, and to accompany the patient to the doctor if needed.²²

A number of prior oral surgery history, clinical characteristics and oral symptoms were collected. At baseline, we collected four indicators of prior surgical treatment experienced within the past five years (gum surgery, tooth extractions, previous broken jaw, previous gun shot wound). Current pain was measured at baseline and at each follow-up visit using a visual analog scale from 0, representing no pain, to 10, representing severe pain. Twelve General Oral Health Assessment Index (GOHAI) items were included at each follow up visit to assess functional status and quality of life issues related to oral health (see Atchison, 1997)²³. Finally, we collected five clinical indicators of intermittent pain, swelling, bad breath, biting of gum tissue, and pressure around teeth at each follow up visit.

Analysis Plan

Histograms and plots of standard gamble (SG) percentage across time were used to inform analysis strategies appropriate to the distribution of observed outcomes, focusing our analysis on predictors of risk-tolerance. We used two alternative cut points to distinguish between *risk-tolerant* and *risk-averse*. First, we distinguished SG > 0% from SG = 0%, or

equivalently any willingness to assume risk of nerve damage or scar formation ($Y=1$) versus no willingness to assume such risks ($Y=0$). Alternatively, we distinguished $SG > 50\%$ from $SG \leq 50\%$, which had the effect of reclassifying the small number of individuals who reported nonzero SG percentages that were no greater than 50%. For each version of the binary outcome, we fit a sequence of logistic regression models, examining demographic predictors, psychosocial characteristics, and treatment received, and clinical characteristics and oral symptoms which occurred during healing. Because the findings of the alternative models were qualitatively equivalent, our focus in this report is on the analysis considering any tolerance versus no tolerance of risk (i.e., using the first of the two definitions).

To better understand the effect of specific health state variables on *risk tolerance* a logistic analysis was first conducted using SG at F1 as the dependent variable and entering socio-demographic, psychosocial health and prior oral surgery experience and clinical characteristics and oral symptoms which occurred during healing at first follow-up as covariates. Those variables found to have significant effects in the previous logistic regression were included in the final logistic model.

Results

Figure 1 shows average SG percentages, medians, and standard deviations by subject type across the study follow-up periods. For third-molar subjects, SG does not change appreciably over the course of the study, with median values at each time period of 0. For fracture subjects, there is a noticeable rise from admission to the one-month follow-up (median increases from 0 to 89), after which the average value remains stable. Due to the stability of our findings across the three follow-up time points, our subsequent analyses focus on risk tolerance at the one-month follow-up.

For both fracture and third-molar subjects, SG at the one-month follow-up had a bimodal distribution (see Figures 2a and 2b). For fracture subjects, 40% reported no risk tolerance ($SG=0\%$), 56% reported SG values of 80% or higher, and the remaining 4% reported values of either 20% or 50%. For the third molar group, 67% reported no risk tolerance ($SG=0\%$), 25% reported SG values of 80% or higher, and the remaining 8% answered with values between 0% and 80%.

As a follow-up to baseline data reported in a previous manuscript (see Atchison, 2007), Table 1 shows three follow up SG categories --Subjects preferred Wiring at all follow ups, ; Subjects preferred Surgery at all follow ups; Treatment preference varied -- stratified by the initial treatment preference and the treatment received. At baseline, a majority of the fracture subjects preferred wiring ($n=65$) rather than surgery ($n=33$). The majority (91%) of fracture subjects who initially preferred wiring had SG values of zero at baseline and all (100%) fracture subjects who preferred surgery chose SG greater than zero.

Of the 28 fracture subjects who preferred and received wiring and whose baseline SG value was zero, 19 consistently reported $SG=0$ at all three follow-up time points, 5 reported a preference for surgery (all 3 FU SGs greater than zero), and 4 subjects had varying preferences from one time period to the next (SG scores varied). Of the 31 fracture subjects who preferred wiring and received surgery and whose SG value was zero at baseline, 20 reported a preference for surgery (SG values greater than zero at all FU), while only 6 consistently reported a preference for wiring (all $SG = 0$), with 5 reporting varying scores. Of the 27 fracture subjects who preferred and received surgery and whose SG value was greater than zero at baseline, 17 consistently reported at a preference for Surgery (SG greater than zero at all FU), 3 reported a preference for Wiring (all $SG = 0$), and 7 had varying treatment preferences (SG scores varied).

While the 3rd molar group did not receive treatment for a mandible fracture, they identified a hypothetical baseline treatment preference and report SG values at each follow-up visit. Most of the 103 third molar subjects preferred wiring (n=78) rather than surgery (n=25). Of those who preferred wiring and whose SG value was 0 at baseline (n=69), 49 subjects consistently reported a SG value of zero across all three time points while 10 subjects consistently reported SG values greater than 0 and 10 subjects had SG scores that fluctuated across time points. The remaining 9 subjects whose baseline SG scores were greater than 0, reported a variety of SG scores. Similar to the fracture subjects, all of those who preferred surgery at baseline had SG values greater than 0, and the majority (n=13) remained consistent across all three time points with SG scores greater than 0.

Because of the number of candidate predictor variables, we carried out separate regression analyses with subsets of the predictors (specifically, we carried out one analysis using demographic and psychosocial characteristics, and another analysis with indicators for prior oral surgery experience, clinical characteristics and oral-health symptoms), entering variables in each of these analyses using a forward selection procedure with a significance level of 0.20, and then we synthesized the results using the predictors selected in the separate analyses. We pursued this strategy separately for fracture subjects and third-molar subjects and report the final fitted model for each subject group. In regression analysis predicting a greater risk tolerance (SG >0) using data on fracture subjects (Table 2), the final model was significant and significant variables (at the 0.05 level) included older age, having received surgery for the fracture, having a lower PTSD composite score and having a swollen jaw or face. Being unemployed, having higher education, and having a lower use of pain medication one month post treatment showed borderline significance ($0.05 < p < 0.10$).

For third-molar subjects (Table 3), the final significant model predicting greater risk tolerance included having a swollen jaw or face and lower use of pain medication emerging as significant at the 0.05 level and having to limit contact with people because of the oral surgery emerging as borderline significant.

The analysis was repeated using the alternative cut-point for risk tolerance: SG > 50% (Y=1) versus SG ≤ 50% (Y=0). The logistic regression results were qualitatively equivalent (i.e., same significance findings with same direction of effects) for the fracture group. For the third-molar group, the smaller number of cases coded Y=1 gave rise to an over-specified model when we included all of the predictors listed in Table 3. As an alternative approach, we entered this set of predictors in a forward selection procedure and found feeling of jaw or face being swollen and use of pain medication to be borderline significant. The directions of these effects were consistent with our findings for Table 3.

Discussion and Conclusion

This study confirms studies of the dynamic nature of the decision making process when using hypothetical treatment scenarios.^{4,5} While our results demonstrate a decided preference for less invasive treatment, with the majority of both groups preferring wiring, the higher proportion of fracture subjects choosing surgery supports the theory that treatment choices differ between subjects with different health states (fracture vs third molar). It also demonstrates that patients' preference for treatment and acceptance of risk may change during the recovery process. Factors associated with risk tolerance may include the patient's age, a particular medical intervention, psychosocial health state, experience with prior treatment, and value for oral health quality of life. The only common factor among the fracture and third molar subjects was having a swollen face or jaw.

Contrary to findings of adolescents with cystic fibrosis;¹⁷ and among people being treated for cancer⁵ in which younger subjects were significantly more likely to accept more risk for

potentially small benefit, older subjects were *more* likely to take risks ($p < .05$) in this study, controlling for other factors.

This study gives evidence that a patient's risk tolerance may be useful in evaluating whether or not a patient is an appropriate subject for invasive treatment. Soliciting patients' risk tolerance may provide a starting point for a discussion between the clinician and patient about how the patient may weigh the factors that might influence their selection of a treatment. Risk tolerance may also provide a window to the value patients place on specific oral health quality of life issues. For example, we found having the jaw or teeth prevent speaking was an important predictor for fracture subjects but third molar subjects chose concern about scar from the surgery.

Many questions remain regarding the use of questions about risk tradeoffs in clinical situations. Do patients express a higher SG score during the recovery stage, indicating acceptance of risk with treatment, because they are depressed, or are they depressed because treatment is failing leaving them with few options for recovery? Do patients who have conditions related to risky behavior report a higher SG because they have greater symptoms, or did the fracture result due to previous risk-taking behavior? Ultimately, assessment of risk tolerance provides another measure for clinicians to assess how patients process information when making important health care decisions.

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Figure 1.
Average Risk Tolerance (Standard Gamble Percentage) by Patient Type Across Study Periods

Figure 2.

Figure 2a. One-month Standard Gamble Histogram for *Fracture* Subjects (n=94)

Figure 2b. One-month Standard Gamble Histogram for *Third Molar* Subjects (n=103)

Table 1
Type of Treatment Preference, by Treatment group and Baseline Treatment Preference

Treatment Preference at Baseline	Treatment Received	Subject Preferred Wiring at all Follow Ups All 3 FU SG=0	Subject Preferred Surgery at all Follow Ups All 3 FU SG 0	Follow Up SG varied **	Total Subjects
Fracture Subjects (n=98)					
Wire (n=65)					
Baseline SG=0 (n=59)	Wire	19	5	4	28
	Surgery	6	20	5	31
Baseline SG 0 (n=6)	Wire	1	1	1	3
	Surgery	0	1	2	3
Surgery (n=33)*					
Baseline SG=0 (n=0)	Wire	0	0	0	0
	Surgery	0	0	0	0
Baseline SG 0 (n=32)	Wire	2	0	2	4
	Surgery	3	17	7	27
Third-Molar Subjects (n=103)					
Wire (n=78)					
Baseline SG=0 (n=69)		49	10	10	62
		2	2	5	9
Surgery (n=25)					
		0	0	1	1
Baseline SG 0 (n=24)		5	13	6	24

* 2 missing cases, either on baseline SG or follow-up SG

** Based on three follow-up data; SG=0 or SG 0 for the three follow-up reports

Table 2Logistic Regression Predicting Greater Risk Tolerance (SG>0) at First month Follow-up for *Fracture* Subjects

Covariates	Regression Coefficient	Standard Error	Odds Ratio	p-value
Age	0.096	.033	1.101	.003
Employed	−1.099	.657	0.333	.094
Education	0.803	.453	2.233	.076
Treatment Received	1.822	.739	6.185	.014
PTSD at F1	−0.645	.260	.525	.021
Oral Health Symptoms				
Difficulty sleeping	−0.323	.261	.724	.216
Face or jaw swollen	1.382	.414	3.982	.001
Tingling or numbness	0.360	.263	1.434	.171
Weird sensation in jaw	−0.386	.312	.680	.216
GOHAI items				
Jaw/teeth prevented from speaking the way wanted	−0.280	.209	.756	.180
Used pain medication	−0.539	.299	.583	.071
Intercept	−3.662	1.439	.026	.011

Cox & Snell R-square: .423, Model Chi-square: 51.756, $p < .000$

Table 3

Logistic Regression Predicting Greater Risk Tolerance (SG>0) at First One-month Follow-up for *Third-Molar* Subjects

Covariates	Regression Coefficient	Standard Error	Odds Ratio	p-value
Age	0.066	0.041	1.068	.107
Employed	−0.684	0.548	0.505	.212
Education	−0.141	0.307	0.869	.647
Oral Health Symptoms				
Face or jaw swollen	0.797	0.299	2.218	.008
GOHAI items				
Limit contacts with people because of jaw condition	−2.412	1.248	0.090	.053
Displeased or unhappy with looks of teeth/gums/jaw	0.516	0.734	1.675	.482
Concerned by appearance of scar from surgery	−0.216	0.722	0.806	.765
Used pain medication to relieve discomfort around mouth	−0.603	0.296	0.547	.041
Intercept	−2.209	1.277	0.110	.084

Cox & Snell R-square: .214, Model Chi-square: 24.599, $p < .002$