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Patients value their own pain over braking safety when deciding when to return to driving: a discrete choice experiment on lower extremity injuries

Genaro A. DeLeon, MS, Nicholas P. Rolle, BS, Cynthia E. Burke, BS, Phillip C. McKegg, MS, Zachary D. Hannan, BS, Qasim M. Ghulam, DO, Jayesh Gupta, BS, Abdulai Bangura, BS, Katherine C. O'Connor, MS, Gerard P. Slobogean, MD, Robert V. O'Toole, MD, Nathan N. O'Hara, PhD

Abstract

Objective: To quantify patient preferences towards time to return to driving relative to compromised reaction time and potential complication risks.

Design: Cross-sectional discrete choice experiment.

Setting: Academic trauma center.

Patients: Ninety-six adult patients with an operative lower extremity fracture from December 2019 through December 2020.

Intervention: None.

Main Outcome Measurement: Patient completed a discrete choice experiment survey consisting of 12 hypothetical return to driving scenarios with varied attributes: time to return to driving (range: 1 to 6 months), risk of implant failure (range: 1% to 12%), pain upon driving return (range: none to severe), and driving safety measured by braking distance (range: 0 to 40 feet at 60 mph). The relative importance of each attribute is reported on a scale of 0% to 100%.

Results: Patients most valued a reduced pain level when resuming driving (62%), followed by the risk of implant failure (17%), time to return to driving (13%), and braking safety (8%). Patients were indifferent to returning to driving at 1 month (median utility: 28, interquartile range [IQR] −31 to 80) or 2 months (median utility: 59, IQR: 41 to 91) postinjury.

Conclusion: Patients with lower extremity injuries demonstrated a willingness to forego earlier return to driving if it might mean a decrease in their pain level. Patients are least concerned about their driving safety, instead placing higher value on their own pain level and chance of implant failure. The findings of this study are the first to rigorously quantify patient preferences toward a return to driving and heterogeneity in patient preferences.

Level of Evidence: V

Keywords: braking safety, driving safety, implant failure, lower extremity, pain, patient preferences, return to driving

1. Introduction

Patients commonly ask their physician when they can return to driving after management of a lower extremity fracture. While broadly accepted return to driving guidelines for lower extremity fracture patients are lacking; simulation studies, meta-analyses, and editorials summarizing the evidence are available.[1–5] Several studies have been conducted to explore patients' driving performance after orthopaedic procedures of lower extremity injuries, focusing on the patient's brake reaction time (BRT) returning to normal.[3,6–7] Although BRT is an important measure

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R Adams Cowley Shock Trauma Center, Department of Orthopaedics, University of Maryland School of Medicine, Baltimore, Maryland.

** Corresponding author. Address: Department of Orthopaedics, University of Maryland School of Medicine, 110 South Paca St., Suite 300, Baltimore, Maryland 21201. E-mail address: nohara@som.umaryland.edu (Nathan N. O'Hara).*

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of an individual's ability to drive, studies have also shown that even when BRT has returned to normal, other factors such as pain and range of motion can prevent patients from driving.[4,8] Medicolegal implications should also be considered, since physicians are often legally responsible for advising patients about a disability that might endanger society.[9] In a survey of orthopaedic surgeons, Chen et al[10] found that 68% of surgeons reported feelings of unease about telling patients to return to driving, and 44% reported concerns about potential litigation in the event that a patient was involved in a motor vehicle collision upon returning to driving. The decision is ultimately left to the patient to return to driving when they feel it is safe.

With limited guidance in the decision-making process, understanding patient concerns and the demographic factors associated with differential concerns can improve value-based care.[11–13] To our knowledge, existing studies have not yet examined patient preferences for return to driving. The purpose of this study was to identify patient preferences towards time to return to driving, determine preference heterogeneity among respondents, and examine acceptable trade-offs of potential complications related to these different time points.

2. Materials and methods

2.1. Study design

A discrete choice experiment (DCE) was prospectively administered to patients with an operative lower extremity orthopaedic trauma at a level I trauma center. DCEs are regularly used in healthcare to determine individual preferences by presenting individuals with a survey containing several hypothetical choice sets or scenarios, each with 2 or more options.[14–16] Respondents choose their preferred option, which are described with fixed attributes and varying levels in each choice set. The data collected is analyzed to estimate the importance of each attribute, acceptable trade-offs between attributes, and total satisfaction or utility that patients place on each attribute.[17]

2.2. Study setting and population

The study received approval by the local institutional review board and written informed consent was obtained as required for all enrolled patients. All adult (≥18 years), English-speaking patients with an operative lower extremity fracture were assessed for eligibility from December 2019 through December 2020. Eligible patients were enrolled in the study as inpatients or at an outpatient follow-up appointment. All patients provided informed consent prior to their inclusion in the study.

2.3. Questionnaire development

The DCE's attributes and their corresponding levels were selected based on a literature review, expert consultation, and a retrospective review of patient outcomes. Patients chose between 2 return to driving options that vary in 4 attributes: time to return to driving, risk of implant failure within 6 months of driving, pain level, and braking distance (Supplemental Digital Content Table 1,

Scenario 1: Of these two options, which do you prefer? Check **one option.**

	Option A	Option B
How long will it take to **return to driving**	2 months after injury	2 months after injury
Chance of **hardware failure** within 6 months of driving	1%	8%
Pain level after you start driving	Mild Pain	Moderate Pain
Additional distance traveled by vehicle before **braking** when driving speed is 60 mph	40 feet	0 feet
Check one →	Prefer **Option A** ☐	Prefer **Option B** ☐

Figure 1. Example choice set from the discrete choice experiment survey administered to participants. In each choice set, the values for each hypothetical return to driving option are varied.

http://links.lww.com/OTAI/A55). Braking distance was defined as additional distance traveled by vehicle before braking when driving speed is 60 mph. The levels for each of these attributes were based on available literature and clinical experience treating patients with lower extremity orthopaedic injuries.

We developed 1 survey with 12 distinct choice sets using a D-optimal design with JMP Pro Version 14 (SAS Institute, Cary, North Carolina) to minimize respondent burden. Each choice set compared 2 hypothetical return to driving options described by attributes with varying levels. Figure 1 shows the format in which the choice sets were presented to the patients. A member of the research team was available to answer any questions from the patients completing the survey. The demographic data collected included age, sex, race, highest level of education completed, marital status, employment status, type of injury, personal income, health insurance status, and timing of recruitment all of which were collected from both the survey and the medical record. Patients were also asked to identify whether or not they had access to other transportation options (e.g., bus access, ride share services, etc).

2.4. Statistical analysis

Research by de Bekker-Grob et al[18] suggests the sample size required to estimate the main effects of a DCE analysis is 500 multiplied by the maximum number of levels in an attribute (n = 4, current study) divided by the product of the number of choice sets (n = 12) and the alternative in each choice set (n = 2). With this calculation, 83 patients were required for adequate statistical power.

We performed all statistical analyses using JMP Pro Version 14 (SAS Institute, Cary, North Carolina) and R Version 4.0.0 (Vienna, Austria). We used a hierarchical Bayesian model to estimate the patient preferences (or utility) for each attribute. One advantage of hierarchical Bayesian modeling over other traditional discrete choice analysis methods is it allows for individual-level utility estimates in addition to aggregate estimates. In the models, we generate a utility estimate for each individual in the sample and combine the individuals' utilities to derive posterior estimates. Model parameters were calculated iteratively using Gibbs sampling. In our model, we ran 10,000 iterations, including 5000 burn-in iterations. The utility of each attribute level estimates the strength and direction of the respondents' preference towards a given attribute. Utility values can be positive or negative, with values further from zero indicating a stronger preference.

We determined each attribute's relative importance by constructing a ratio with the numerator equaling the difference of the maximum median value for the levels of a particular attribute and the minimum median value for the levels of that same attribute. The ratio's denominator is the sum of the median values obtained in the numerator for all the attributes.

We performed hierarchical cluster analysis to determine the number of clusters in our sample that best predict preference heterogeneity among respondents. Based on the cubic cluster criterion, we selected 2 clusters for our sample. We reported all patient characteristics by cluster to evaluate differences by cluster membership.

3. Results

Of the 123 respondents enrolled, only 96 passed the internal comprehension check and were included in the final analysis. Table 1 describes the patients who completed the survey. Of the 96 patients, the mean age was 41 years (standard deviation,15), 56% were male, and 59% were White. The majority of participants were working before the injury (73%) and lived with others (96%). A significant percentage of participants were married (40%) and had dependents (33%). Over one-third of respondents were college educated (36%), and the median household income was $45,000 (interquartile range [IQR]: $35,000 to $75,000). Nearly one-half of the participants had other available transportation (49%) at the time of survey administration.

Table 1

Patient characteristics.

Characteristics	Patients (n = 96)
Age, years, mean (SD)	41 (15)
Male, n (%)	54 (56)
Race, n (%)	
White	57 (59)
African-American	28 (29)
Hispanic	2 (2)
Other	9 (9)
College educated, n (%)	35 (36)
Married, n (%)	38 (40)
Lives with others, n (%)	92 (96)
Has dependents, n (%)	32 (33)
Working before injury, n (%)	70 (73)
Household income (median [IQR])	$45,000 ($35,000 to $75,000)
Other available transportation, n (%)	47 (49)

SD, standard deviation.

The attribute with the greatest relative importance to patients' return to driving was reduced pain level (62%). This was distantly followed by the risk of implant failure (17%), and time to return to driving (13%) (Fig. 2). Braking safety (8%) was the least important attribute to patients when resuming driving.

The parameter estimates of utilities for each attribute and their associated levels are shown in Supplemental Digital Content Table 2. http://links.lww.com/OTAI/A56. Attributes with a positive median utility parameter indicated improved patient satisfaction, whereas attributes with a negative median utility parameter would reduce patient satisfaction. Signs of the parameter estimates appeared as expected with increased pain level and risk of implant failure having a negative utility. Earlier return to driving and decreased pain level had a positive utility. The highest parameter estimates were for "No Pain" when resuming driving (median utility: 186, IQR 129.7 to 210), followed by "Mild Pain" when resuming driving (median utility: 129.8, IQR 86.7 to 144.9) and a "1%" risk of implant failure (median utility: 80.9, IQR 44.6 to 124.6). "Severe Pain" when resuming driving (median utility: −315.9, IQR −354.8 to −180.1) distantly followed by "12%" risk of implant failure (median utility: −59.3, IQR −124.1 to 16.1) were the lowest parameter estimates.

Based on cubic cluster criterion in the hierarchical clustering analysis, 2 clusters were identified from our sample that differed in their preferences. Forty respondents (42%) were members of cluster 1 and 56 (58%) were members of cluster 2 (Supplemental Digital Content Table 3, http://links.lww.com/OTAI/A57). Cluster 1 membership had a higher proportion of male respondents (68% vs 48%). Respondents in cluster 1 were also more likely to have lower educational attainment (college degree: 28% vs 43%).

Cluster 1 members placed increased importance on returning to driving sooner (relative importance: 29% vs 9%) and a compromised reaction time (18% vs 6%). Cluster 2 members

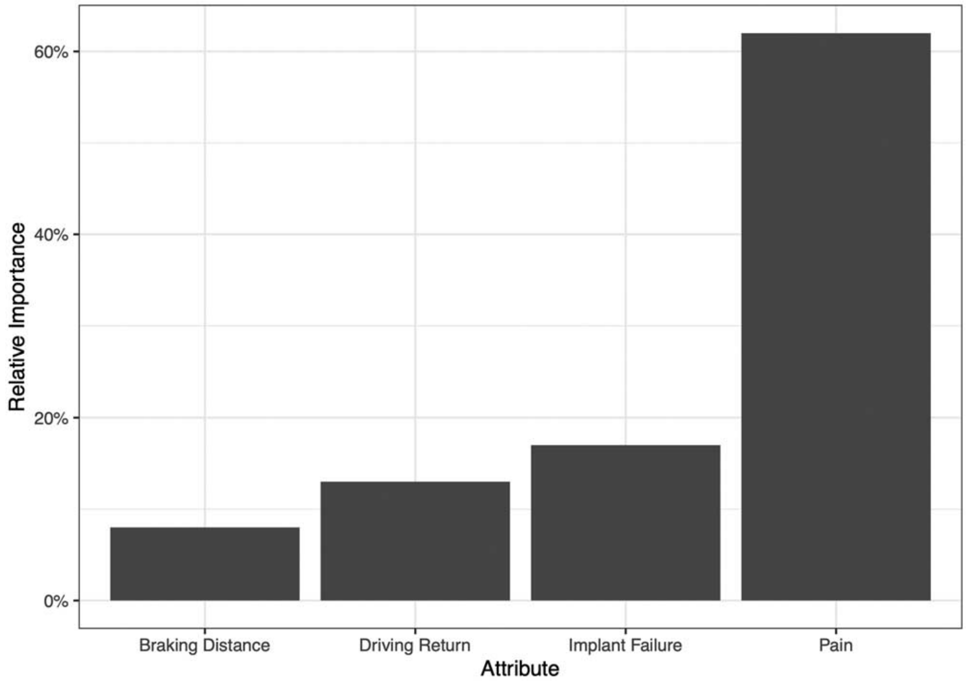

Figure 2. Relative importance of included attributes.

were more concerned with increased pain level attributable to driving (61% vs 36%) (Fig. 3).

Cluster 2 members had more negative utility associated with pain level compared to cluster 1 members, with the largest difference in the "Severe Pain" level (median utility, −338.8 vs −150.7), showing high importance in avoiding increased pain (Fig. 4). Cluster 2 members also had lower utility associated with increased risk of implant failure, with the largest difference in the "12%" level (median utility, −104.6 vs 1.7).

4. Discussion

Our study indicates that patients with lower extremity orthopaedic trauma demonstrate a strong willingness to forego earlier return to driving if it could mean decreased pain level. When considering

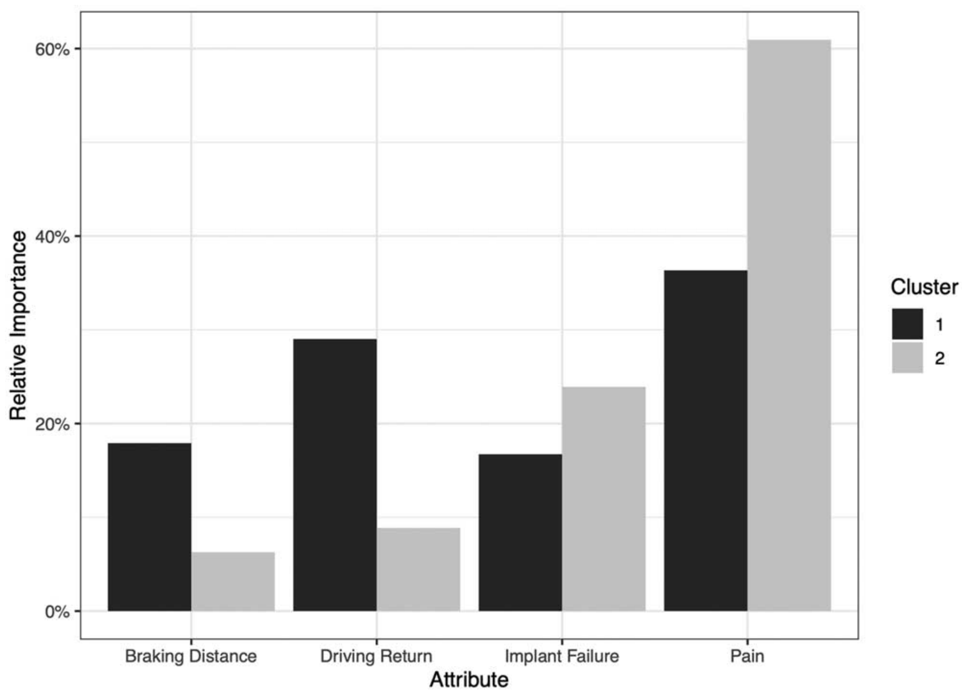

Figure 3. Relative importance of included attributes by cluster.

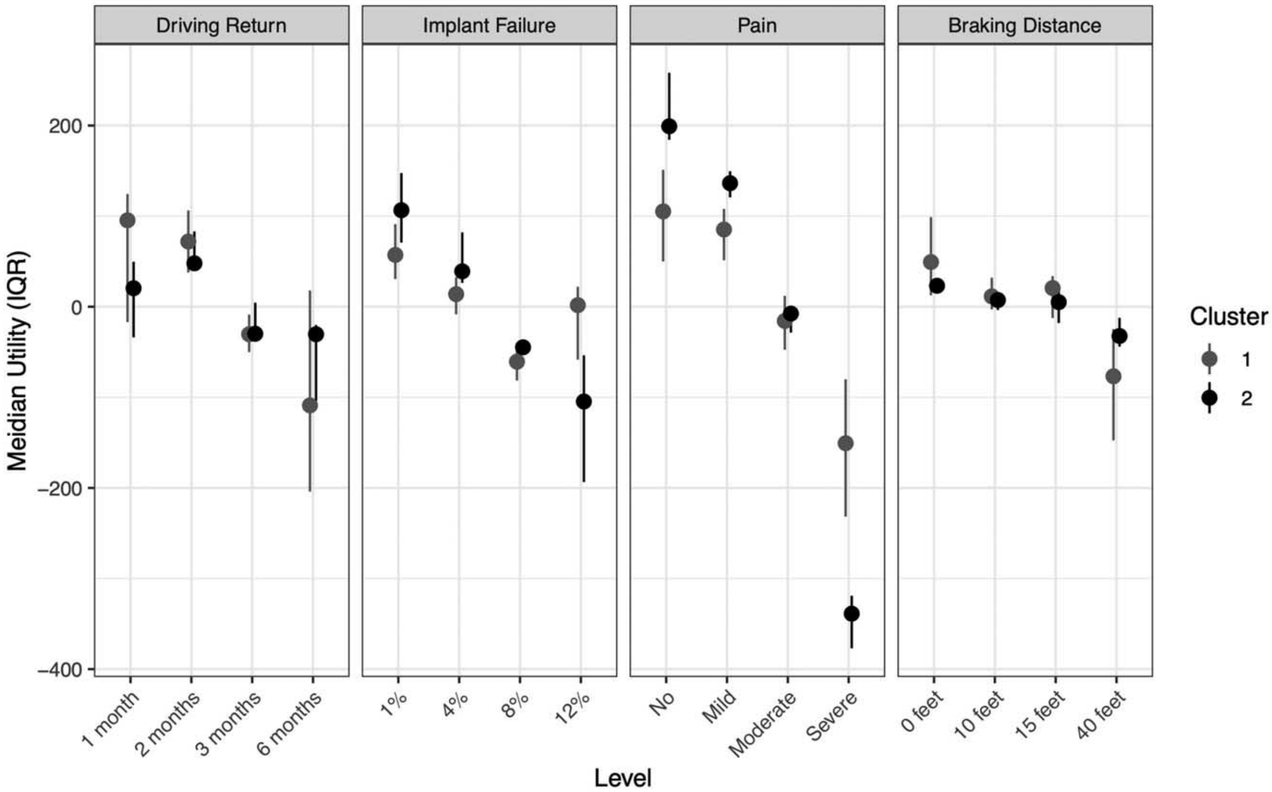

Figure 4. Median utilities with interquartile range of the included attribute and levels by cluster.

return to driving, patients place the greatest relative importance on pain level and chance of implant failure. Furthermore, patients are least concerned about driving safety, placing the least relative importance on braking function. Additionally, patient factors such as sex and level of education led to heterogeneity in patient preferences. Hierarchical clustering analysis identified 2 clusters that differed in their preferences. The cluster with higher education level and predominately female were willing to delay their return to driving to avoid a pain increase. The cluster with lower education level and predominately male were more concerned with impaired braking function and preferred a shorter return to driving.

To our knowledge, this is the first study to quantify patient preferences toward a return to driving using the DCE methodology. Previous studies on driving typically have focused on factors such as the brake response time by utilizing a driving simulator.[7–8,19–21] A 2018 prospective clinical study investigating return to car driving after operative treatment of right ankle fractures, used a stationary reaction timer consisting of a computer screen and an external driving simulator to measure break reaction time at three postoperative time points.[1] However, brake response time might not be the best estimator of driving ability considering the numerous effects that orthopaedic injuries and operations can have on a patient's return to driving. Pain and range of motion have been shown to significantly affect driving ability and safety.[22] A patient could demonstrate a normal brake response time soon after orthopaedic surgery but might still be taking narcotic analgesics for postoperative pain and would not be ready to operate a vehicle.[5] Our findings did demonstrate a strong patient preference for lower pain levels when returning to driving, although it did vary by sex and education level. The risk of implant failure was a secondary concern for patients and possibly correlated with weightbearing and fracture healing concerns. This apprehension may be mitigated through patient education, contextualizing the likelihood of implant failure upon a return to driving. The multitude of factors to consider when advising on a return to driving timeline includes side of injury, type of surgical procedure, limb immobilization, pain level, range of motion, narcotic medication use, and ability to brake. These considerations should be discussed between the surgeon and the patient, with each decision to return to driving being made on a case-by-case basis.[23–24]

The study had several limitations. Although the DCE design quantifies patient preferences among subgroups, it does not provide the means for qualitative analysis of preferences. Therefore, we could only speculate as to the reasons behind the value patients placed on certain attributes compared to others. Additionally, the validity of the results relies on the assumption that the respondents understood the choice sets, as intended. It is possible that patients may have had less understanding of the importance of braking distance as it relates to driving safety and therefore placed less value on it, whereas the other factors were more easily understood by this patient population. Another limitation of this study is the analysis of patients' stated preferences to hypothetical choice sets, meaning their actual choices might be different. In addition, respondents were recruited at various timepoints within their first few months after injury. It is possible that some patients were counseled on returning to driving prior to completing the survey. While this study was not designed to assess the impact of these external factors, previous research has demonstrated that patient recovery preferences remain relatively robust during the first 12 months after injury.[25] We did not collect data on the type or severity of the lower extremity fracture and are, therefore, unable to investigate preference variation based on these factors. Our study excluded non-English speaking patients, which may limit the generalizability of the results. Finally, 27 patients failed the internal comprehension check of the survey, and following best practices,[26] we excluded these responses from the main analysis. However, our results did remain robust to their inclusion.

With the current focus on patient-centered care, the importance of incorporating patient preferences and values when developing guidelines or care models to deliver quality and cost-effective healthcare has never been greater.[13,27] A Driver Fitness Medical Guidelines statement was issued by the American Association of Motor Vehicle Administrators in conjunction with the National Highway Traffic Safety Administration, but the only orthopaedic procedure with a recommendation for return to driving at 4 to 6 weeks was anterior cruciate ligament surgery.[28] The lack of guidelines for other orthopaedic injuries along with the medicolegal considerations for clinicians will continue the push for high-quality research that provides surgeons with evidence-based recommendations for their patients.[29]

In conclusion, this study elicited patient preferences for return to driving after sustaining a lower extremity orthopaedic injury. When presented with varying levels of postoperative complications or braking function, patients strongly preferred lower levels of pain when resuming driving and placed the least value on braking function. Surgeons and other healthcare providers should recognize the paramount importance of pain upon return to driving when counseling their patients. Further, the study identifies a subset of patients who were willing to tolerate moderate levels of pain to return to driving faster. Future study designs aimed at forming clinical guidelines for safe and efficient return to driving should focus on attributes that patients place the most value. These patient values are of interest to orthopaedic surgeons to guide clinical decisions and improve patient satisfaction.

References

1. Ho SWL, Yam M, Chan ML, et al. Return to car driving is safe 6 weeks after operative treatment of right ankle fractures. *Arch Orthop Trauma Surg* 2018; 138:1691–1697.
2. Roberts C, Protzer L. “Doctor, can I drive?”: the need for a rational approach to return to driving after musculoskeletal injury. *Injury* 2016; 47:513–515.
3. Yousri T, Jackson M. Ankle fractures: when can I drive, doctor? A simulation study. *Injury* 2015; 46:399–404.
4. MacLeod K, Lingham A, Chatha H, et al. “When can I return to driving?”: a review of the current literature on returning to driving after lower limb injury or arthroplasty. *Bone Joint J* 2013; 95-B:290–294.
5. DiSilvestro KJ, Santoro AJ, Tjoumakaris FP, et al. When can I drive after orthopaedic surgery? A systematic review. *Clin Orthop Relat Res* 2016; 474:2557–2570.
6. Egol KA, Sheikhazadeh A, Mogatederi S, et al. Lower-extremity function for driving an automobile after operative treatment of ankle fracture. *J Bone Joint Surg Am* 2003; 85:1185–1189.
7. Egol KA, Sheikhazadeh A, Koval KJ. Braking function after complex lower extremity trauma. *J Trauma* 2008; 65:1435–1438.
8. Gotlin RS, Sherman AL, Sierra N, et al. Measurement of brake response time after right anterior cruciate ligament reconstruction. *Arthroscopy* 2000; 16:151–155.
9. Giddins GE, Hammerton A. “Doctor, when can I drive?”: a medical and legal view of the implications of advice on driving after injury or operation. *Injury* 1996; 27:495–497.
10. Chen V, Chacko AT, Costello FV, et al. Driving after musculoskeletal injury. Addressing patient and surgeon concerns in an urban orthopaedic practice. *J Bone Joint Surg Am* 2008; 90:2791–2797.
11. Whiting PS, Greenberg SE, Thakore RV, et al. What factors influence follow-up in orthopedic trauma surgery? *Arch Orthop Trauma Surg* 2015; 135:321–327.
12. Kiefe CI, Heudebert G, Box JB, et al. Compliance with post-hospitalization follow-up visits: rationing by inconvenience? *Ethn Dis* 1999; 9:387–395.
13. Krahn M, Naglie G. The next step in guideline development: incorporating patient preferences. *JAMA* 2008; 300:436–438.
14. Lancsar E, Louviere J. Conducting discrete choice experiments to inform healthcare decision making: a user’s guide. *Pharmacoeconomics* 2008; 26:661–677.
15. Ryan M, Gerard K. Using discrete choice experiments to value health care programmes: current practice and future research reflections. *Appl Health Econ Health Policy* 2003; 2:55–64.
16. de Bekker-Grob EW, Ryan M, Gerard K. Discrete choice experiments in health economics: a review of the literature. *Health Econ* 2012; 21:145–172.
17. Ryan M, Farrar S. Using conjoint analysis to elicit preferences for health care. *BMJ* 2000; 320:1530–1533.
18. de Bekker-Grob EW, Donkers B, Jonker MF, et al. Sample size requirements for discrete-choice experiments in healthcare: a practical guide. *Patient* 2015; 8:373–384.
19. Dalury DF, Tucker KK, Kelley TC. When can I drive?: brake response times after contemporary total knee arthroplasty. *Clin Orthop Relat Res* 2011; 469:82–86.
20. Ganz SB, Levin AZ, Peterson MG, et al. Improvement in driving reaction time after total hip arthroplasty. *Clin Orthop Relat Res* 2003; 413:192–200.
21. Hernandez VH, Ong A, Orozco F, et al. When is it safe for patients to drive after right total hip arthroplasty? *J Arthroplasty* 2015; 30:627–630.
22. Rod Fleury T, Favrat B, Belaieff W, et al. Resuming motor vehicle driving following orthopaedic surgery or limb trauma. *Swiss Med Wkly* 2012; 142:w13716.
23. MacKenzie JS, Bitzer AM, Familiari F, et al. Driving after upper or lower extremity orthopaedic surgery. *Joints* 2019; 6:232–240.
24. Patel PV, Giannoudis VP, Palma S, et al. Doctor when can I drive? A systematic review and meta-analysis of return to driving after total hip arthroplasty. *Hip Int* 2021; 18:1120700021998028.
25. O’Hara NN, Kringos DS, Slobogean GP, et al. Patients place more of an emphasis on physical recovery than return to work or financial recovery. *Clin Orthop Relat Res* 2020; 479:1333–1343.
26. Reed Johnson F, Lancsar E, Marshall D, et al. Constructing experimental designs for discrete-choice experiments: report of the ISPOR Conjoint Analysis Experimental Design Good Research Practices Task Force. *Value Health* 2013; 16:3–13.
27. Tunis SR, Clarke M, Gorst SL, et al. Improving the relevance and consistency of outcomes in comparative effectiveness research. *J Comp Eff Res* 2016; 5:193–205.
28. National Highway Traffic Safety Administration. Driver fitness medical guidelines. Washington, DC: National Highway Traffic Safety Administration/American Association of Motor Vehicle Administrators. 2009. Available at: https://www.nhtsa.gov/sites/nhtsa.gov/files/811210.pdf. Accessed on April 1, 2021.
29. Frane N, Bandovic I, Hu V, et al. Return-to-driving recommendations after lower-extremity orthopaedic procedures. *JBJS Rev* 2020; 8:e20.00066.