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The Impact of Information Presentation Format on Preference for Total Knee Replacement Surgery

Liana Fraenkel, MD[1,2], **W. Benjamin Nowell, PhD**[3], **Christine E Stake, DHA**[3], **Shilpa Venkatachalam, PhD**[3], **Rachel Eyler, PharmD**[4], **George Michel, MS**[1], and **Ellen Peters, PhD**[5]

[1]Yale University School of Medicine, New Haven, CT, 06520

[2]VA Connecticut Healthcare System, West Haven, CT, 06516

[3]CreakyJoints, Global Healthy Living Foundation, Upper Nyack, NY, 109604

[4]University of Connecticut School of Pharmacy, Storrs, CT 06269

[5]Psychology Department, Ohio State University, Columbus, Ohio, 43210

Abstract

Background—Patients have a poor understanding of outcomes related to total knee replacement (TKR) surgery, with most underestimating the potential benefits and overestimating the risk of complications. In this study, we sought to compare the impacts of descriptive information alone or in combination with an icon array (IA), experience condition (images), or spinner on participants' preference for TKR.

Methods—648 members of an online arthritis network were randomized to one of four outcome presentation formats: numeric only, numeric with an IA, numeric with a set of 50 images, and numeric with a functional spinner. Preferences for TKR were measured before and immediately after viewing the outcome information using an 11-point numeric rating scale. Knowledge was assessed by asking participants to report the frequency of each outcome.

Results—Participants randomized to the IA, images and spinner had stronger preferences for TKR (after controlling for baseline preferences) compared to those viewing the numbers only format (mean differences all $p < 0.05$). Knowledge scores were highest in participants randomized to the IA; however, knowledge did not mediate the association between format and change in preference for TKR.

Conclusions—Decision support at the point-of-care is being increasingly recognized as a vital component of care. Our findings suggest that adding graphical information to descriptive statistics strengthens preferences for TKR. Although experience formats using images may be too complex to use in clinical practice, IAs and spinners may be a viable and easily adaptable decision aid to support communication of probabilistic information.

Corresponding Author: Liana Fraenkel, MD, MPH, Yale University School of Medicine, Section of Rheumatology, 300 Cedar St, TAC Bldg, RM #525, P.O. Box 208031, New Haven, CT, 06520-8031, tel 203 932 5711 #5914, fax 293 937 4932, liana.fraenkel@yale.edu.

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Total knee replacement (TKR) surgery is a cost-effective treatment option for patients with knee arthritis who continue to have pain and disability despite medical management.(1) Most patients have an excellent clinical response; however, a significant number continue to have pain after the procedure.(2, 3) Patient satisfaction after TKR ranges from 75% to over 90% (4, 5) and is strongly associated with pre-surgery expectations in addition to post-operative pain and function.(6) Patients are likely to first hear about TKR from their primary care providers, and ideally would leave these discussions with an accurate understanding of their chances of having an excellent, moderate or bad outcome following surgery. Both qualitative and quantitative studies suggest, however, that patients have a poor understanding of outcomes related to TKR, with most underestimating the potential benefits and overestimating the risk of complications.(7–10)

Numerous studies have documented the difficulties associated with communicating probabilistic information.(11–13) Graphics, such as bar graphs and icon arrays, have been shown to improve understanding of probabilities and are recommended to support patient decision making.(14) Yet, even with these aids, comprehension remains poor among many patients.(15) There is, therefore, a need to develop novel approaches to ensure effective communication and high quality decision making.

Although the most common method of communicating probabilistic information is through descriptive formats (i.e. using words or numbers to describe probabilities), risk information can also be communicated through experience. In a seminal paper, Hertwig et al. found that participants learning about probabilities by receiving feedback while performing a sampling task underweighted the probability of a rare outcome compared to those receiving a description of the probability of each outcome, presumably because they are less likely to encounter rare outcomes.(16) The potential use of experience as a decision aid has been recently examined in health care decisions. Tyszka and Sawicki presented students with a hypothetical scenario in which they were asked to consider prenatal genetic testing.(17) Participants “experienced” risk by viewing a series of photographs of children with and without Down’s Syndrome. The authors found that worry about the genetic disease was lower among those randomized to the experience versus description format. Similarly, Wegier and Shaffer found that students’ estimates of the positive predictive value of prenatal screening for Down’s syndrome were more accurate among those viewing simulated test results using a series of grids compared to those given explicit statistics.(18) In contrast, Fraenkel et al. did not find any difference in preferences for lung cancer screening among participants in a pulmonary practice randomized to an experience task (composed of 250 CT scan images representing the expected number of normal, false positive, lives saved, and cancer deaths despite screening) versus those receiving descriptive statistics.(19)

Eyler et al. recently examined whether a spinner (an arrow in the center of a donut shaped ring with a colored segment representing the risk of an adverse event) could be used to facilitate risk communication.(20) Spinners might improve understanding of probabilistic events by displaying proportions in a continuous format.(21) Unlike pie charts, spinners allow participants to experience “chance” by observing varying outcomes with each spin. In this study, the authors found that knowledge scores were higher among participants (recruited from outpatient medicine clinics) randomized to the spinner format compared to

those receiving numeric information only. Participants also preferred the spinner format over the descriptive statistical information.

In this experimental study, we sought to compare the impact of descriptive information alone or in combination with an icon array (IA), experience condition, and spinner on participants' preference for TKR. Given previous data demonstrating that participants are only likely to consider new information when they do not have strong baseline preferences (either for or against a specific treatment), (22) we also examined the effect of information format among subgroups of participants with varying baseline preferences for TKR.

METHODS

English speaking participants were recruited via email invitations with a unique survey link to CreakyJoints members. CreakyJoints (https://creakyjoints.org/) is an online community of over 100,000 patients with arthritis which supports education, support, advocacy and patient-centered research. CreakyJoints members were identified as eligible to participate if they were age 50 and older, living in the U.S., had self-reported a physician diagnosis of rheumatoid, psoriatic and/or osteoarthritis involving one or both knees, and had not had previous total hip or knee replacement surgery. Individuals who received the invitation email were already CreakyJoints members or existing fans of the CreakyJoints Facebook page. To prevent people signing up to take the survey more than once, unique survey links were generated, each of which could be used only once by the individual who received the email invitation. We report both the open (i.e., opening the email invitation) and click (i.e. clicking on the link to open the survey) rates. This study was classified as exempt from Institutional Board Review by the Yale Human Subjects Research Program.

Risk Formats

After collecting demographic data (listed in Table 1), we presented participants with the following information: "Total knee replacement surgery is an option for patients with arthritis who continue to have significant knee pain despite having tried physical therapy, medications and injections. If you are (or were to become) someone with this type of knee pain, please indicate how you feel about this surgery on the scale below." Baseline preference for TKR was measured using an 11-point numeric rating scale (NRS): 0= I am certain that I would not want total knee replacement surgery, 5= unsure, and 10= I am certain that I would want total knee replacement surgery.

Numeric information (23, 24) (viewed by all participants) read as follows: "One of the most common questions patients ask is what should I expect after total knee replacement surgery? There are 3 possibilities:

- Most patients (about 42 in 50) do great. They have significant pain relief and are very satisfied with the surgery. These patients would have the surgery again without hesitation.
- Some patients (about 7 in 50) don't do as well as they expected. They continue to have a fair amount of pain and are not very satisfied with the surgery. They don't

think they would have this surgery again if they had bad arthritis in their other knee.

- A few patients (about 1 in 50) have a serious complication after the surgery (such as an infection in the replaced knee). These patients regret having had the surgery."

Participants were then randomized to one of four information presentation formats: numeric only (the frequency information in the prior paragraph), numeric with an icon array (IA) (hereafter referred to as IA), numeric with a set of 50 images (hereafter referred to as images), and numeric with a functional spinner (hereafter referred to as spinner). Participants in the IA format then viewed an IA depicting people who do great in blue, people who don't do as well as expected in orange, and people who have a serious complication in black. Those in the images format viewed a set of images: 42 of active happy people representing people who do great, 7 of people with knee pain representing people who don't do as well as expected, and 1 red inflamed knee representing a serious complication. Each image was presented for two seconds in random order. Images were obtained from stock photo websites. Participants randomized to the spinner format viewed a donut shaped figure with a blue, orange and black section sized to represent the corresponding number of people who do great, not as well as expected, and have a serious complication, respectively. The spinner was programmed to rotate with a limited-range, randomly generated, initial speed after being clicked on by the participant. A constant damping factor was applied and the spinner gradually reached a minimum speed. When the spin was completed, the participant could spin again. The IA, sample images, and spinner are illustrated in the Appendix.

Preference for TKR was remeasured immediately after viewing the outcome information. We also measured knowledge using three questions designed for this study: How many people, out of every 50, 1) do really well after having total knee replacement surgery? 2) are not satisfied with the amount of pain relief that have after total knee replacement surgery? 3) suffer a serious complication after total knee replacement surgery? Responses ranging from 40 to 44, 5 to 9, and 1 to 3 were considered correct for the first through 3rd question, and the number of correct responses were summed. We measured risk perceptions (perceived benefit and riskiness of TKR) and worry about the risk of a serious complication on 5-point scales ranging from Very to Not at all. Risk-benefit expectation was measured by asking participants to choose one from the following five statements: The benefits of total knee replacement surgery greatly outweigh the risks; The benefits of total knee replacement surgery slightly outweigh the risks; The benefits of total knee replacement surgery are equal to the risks; The risks of total knee replacement surgery slightly outweigh the benefits; The risks of total knee replacement surgery greatly outweigh the benefits. These items are frequently used to measure risk perceptions, but have not been validated.(12, 13)

Lastly, we measured overall health status on a 5-point scale (ranging from Excellent to Poor), knee pain over the past week on an 11-point NRS (0= No pain at all, 10= Worst pain imaginable), and whether participants knew anyone who did really "Well" or really "Poorly" after having TKR surgery (Yes/No).

Analyses

We compared characteristics across formats using ANOVA and Chi-square tests for continuous and categorical variables, respectively. We examined least square mean differences in TKR preferences across the four formats after controlling for baseline preference. We performed subgroup analyses to examine the association between format and change in preference among participants with baseline preference leaning against TKR (score 4 or lower), uncertain (score= 5), leaning towards TKR (score between 6 and 9), and strong preference for TKR (score= 10).

RESULTS

Participant Characteristics

Invitations to participate in the online survey were sent to 3,465 members of the CreakyJoints community who had self-reported a doctor diagnosis of arthritis (32% open rate, 8% click rate). We followed up the initial invitation with up to three email reminders. The lead generation on Facebook yielded 2,227 email addresses to whom invitations were sent (55% open rate, 34% click rate). A total of 648 individuals completed the survey between April and June 2017. The mean (SD) age of the study population was 61.7 (6.9) years, 93% were female, 88% Caucasian, and 44% were college graduates. The most common self-reported type of arthritis was osteoarthritis (57%), 12% reported having rheumatoid arthritis, and 25% reported having both rheumatoid and osteoarthritis. The remaining reported having psoriatic arthritis with (4%) or without (2%) concomitant osteoarthritis. Mean (SD) knee pain was 6.5 (2.4) and 34% reported having a fair or poor overall health status. Characteristics did not differ across formats (Table 1).

Impact of Format on Preference for TKR

Baseline preference for TKR did not differ across formats (Table 1). After controlling for baseline preference, probability format was related to preference for TKR ($F= 6.77$, $p= 0.0002$). Preferences for TKR were higher in the IA [LS mean (SE) = 7.17 (0.10), $p= 0.0002$], images [LS mean (SE) = 7.14 (0.10), $p= 0.0005$] and spinner groups [LS mean (SE) = 7.19 (0.10), $p= 0.0001$], compared to the numbers only format [LS mean (SE) = 6.66 (0.10)], after controlling for baseline preference. Results remained unchanged after also controlling for age, insurance (private vs other), knowing someone who did poorly after TKR, and knee pain.

Among participants with preferences leaning against TKR, least square mean preferences (SE) were greater in participants randomized to the images compared to those viewing numbers only ($p= 0.0376$) (Table 2). The association between format and change in preference for TKR was accounted for primarily by participants with baseline preference scores leaning towards TKR. Within this group, all formats had greater preferences scores compared to the numbers only group (all $p < 0.05$) (Table 2). No significant differences in preferences were observed across formats for participants with an uncertain or very strong preference for TKR at baseline (Table 2).

Impact of Format on Knowledge

Format influenced knowledge (F= 13.62, p < 0.0001). The mean (SD) knowledge score (possible range 0 to 3) was higher in the IA group [2.0 (1.1)] compared to all other formats [numeric= 1.4 (1.2), images= 1.4 (1.1), spinner= 1.3 (1.1)]. The median knowledge score for participants randomized to the IA was 2.0 compared to 1.0 for participants randomized to the other three formats. Knowledge was also related to preference (after controlling for baseline preference, F= 8.16, p= 0.0044). The estimates for both format and knowledge remained largely unchanged when included in the same multivariate model, indicating that knowledge did not mediate the association between format and change in preference for TKR.

Impact of Format on Risk Perceptions and Judgement

Mean (SD) worry, riskiness, and judgement scores were 2.95 (1.15), 2.85 (0.85), and 1.87 (1.13), respectively. We found no relationship between format and perceived riskiness of TKR, worry related to potential complications of TKR, or judgment related to the benefit-risk trade-off associated with TKR (data not shown).

DISCUSSION

In this study, we found that the format used to communicate the probabilities of possible outcomes related to TKR affected participants' preferences for the procedure. Stronger preferences for TKR were seen in participants randomized to view an IA, set of images, or spinner compared to the numbers only format. As expected, format did not influence participants who had a strong preference for TKR at baseline. These results contribute to the literature demonstrating that added graphical information influences preferences (14, 25) and highlight the importance of accounting for baseline choice predisposition when evaluating the impact of specific interventions on patient preferences. We did not find any difference in risk perceptions or judgement across the four formats, indicating that these factors did not mediate the relationship between format and preference for TKR. This result is in line with previous research showing that direct effects of IAs do not always exist on perceived riskiness or worry.(26) Consistent with previous research, the IA improved knowledge scores; still, knowledge did not account for the effect of format on preference. Given that the additional graphical information affected those whose baseline preferences were in favor of TKR, it is possible that the added information reinforced positive beliefs or expectations related to TKR, leading to stronger preferences. However, we did not measure these variables, and this hypothesis should be tested in future research.

Describing outcomes through experience (images) is an appealing concept because this approach may correct patients' overweighting of rare adverse events. But, learning through experience is limited by the need to attend to tasks that may be too long and/or complex to ensure adequate representation of all possible events. In this study, we constrained the denominator to 50 to simplify the task (as opposed to the frequently used "100") based on feedback we obtained while piloting the survey. Wegier and Shaffer developed a method which may overcome this limitation. In their study, students viewed grids representing the experiences of cohorts composed of 100 participants in rapid succession without

compromising the impact of the task.(18) Further research is needed to determine whether this approach is feasible and effective in patients facing personal health-related decisions.

Despite their intuitive appeal, spinners have not been rigorously tested as a decision aid. Eyler et al. demonstrated that they were at least as effective as IAs in communicating the risk of adverse events associated with a medication.(20) The spinner used in this study was more complex, in that it included the spectrum of expected outcomes. Thus, this format may be a possible approach to effectively communicate the range of outcomes experienced by patients undergoing a specific treatment. Whether the spinner offers any advantage over IAs, for example among patients with lower education or numeracy levels, requires further study.

There are several limitations of this study. Although we recruited a large number of participants with arthritis, our study population represents a narrow demographic segment which limits generalizability of our results. Moreover, participants volunteered to take the survey and do not represent a population-based sample of arthritis patients. For example, the relatively low click rates may indicate that people who did choose to take part were more engaged and had higher disease knowledge and possibly higher health literacy than nonparticipants. In addition, eligibility criteria were ascertained based on self-report and diagnoses were not confirmed by medical record or claims data. The high education level of the participants precluded examining whether this variable might modify the impact of format on preference and/or knowledge.

Decision support at the point-of-care is being increasingly recognized as a vital component of care. The Centers for Medicare and Medicaid Services, for example, mandate the use of one or more decision aids when counseling patients about lung cancer screening. Our findings suggest that adding graphical information to descriptive statistics, strengthens preferences for TKR. Although experienced formats using images may be too complex to use at the point-of-care, spinners may be a viable and easily adaptable decision aid to support communication of probabilistic information. Experienced formats including images could, however, be used in conjunction with other decision aids at home in preparation for a surgical consultation. Further research is required to examine whether these tools increase the accuracy of patients' expectations in clinical practice.

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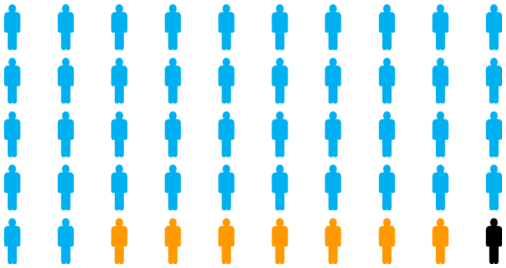
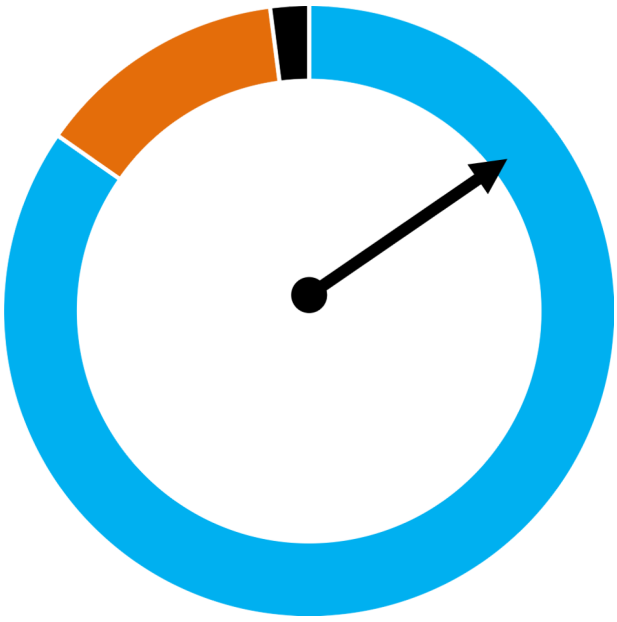
Appendix

Icon Array



This picture represents what happens to 50 people after surgery. People who do great are in **BLUE**. People who don't do as well as expected are in **ORANGE**. People who have a serious complication are in BLACK.

Spinner



Clicking on the spinner represents what happens to 50 people after surgery. People who do great are in **BLUE**. People who don't do as well as expected are in **ORANGE**. People who have a serious complication are in BLACK. You can click on the spinner as many times as you like.

Sample Images*

Example of people who do great (dreamstimes #503212)

Example of people who don’t do as well as expected (dreamstimes #560316)

Significance and Innovations

- Adding graphical information (in the form of icons, photographs, or a spinner) to descriptive statistics strengthens participants' preferences for total knee replacement surgery. However, the format of information did not influence participants who had a strong preference for total knee replacements at baseline.
- Visual aids may help improve communication of probabilistic information in clinical practice.

Table 1

Respondent Characteristics

	Numbers (n= 154)	Icon Array (n= 176)	Images (n= 157)	Spinner (n= 161)	p Value
Age, mean (SD)	61.5 (7.2)	61.6 (6.9)	61.6 (6.7)	62.2 (6.6)	0.8
Female, n (%)	142 (92.2)	163 (92.6)	142 (90.5)	153 (95.0)	0.5
Caucasian, n (%)	134 (87.0)	154 (87.5)	136 (86.6)	145 (90.1)	0.8
College graduate, n (%)	64 (22.3)	74 (26.0)	73 (25.6)	74 (26.0)	0.7
Married, n (%)	87 (56.5)	99 (56.3)	88 (56.1)	88 (54.7)	1.0
Employed, n (%)	54 (35.1)	65 (36.9)	44 (28.0)	52 (32.3)	0.3
Private insurance, n (%)	68 (44.2)	75 (42.6)	65 (41.4)	55 (34.2)	0.3
Fair or poor health status, n (%)	50 (32.5)	57 (32.4)	55 (35.0)	56 (34.8)	0.9
Pain, mean (SD)	6.27 (2.4)	6.64 (2.4)	6.39 (2.4)	6.56 (2.2)	0.5
Osteoarthritis, n (%)	84 (54.6)	97 (55.1)	94 (59.9)	96 (59.6)	0.7
Know someone who did well, n (%)	124 (81.1)	146 (85.4)	128 (82.6)	132 (82.5)	0.8
Know someone who did poorly, n (%)	85 (55.6)	90 (52.6)	84 (54.2)	94 (58.8)	0.7
Baseline preference for TKR	6.7 (2.7)	6.8 (2.5)	6.8 (2.6)	6.8 (2.6)	0.9

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Table 2

Preference [least square means (SE)] for TKR by baseline preference

Format	Leaning against TKR (n=107)	Uncertain (n= 101)	Leaning towards TKR (n= 319)	Strongly in favor of TKR (n= 121)
Numeric	2.72 (0.39)	5.72 (0.24)	7.27 (0.17)	9.41 (0.16)
Icon array	3.78 (0.41)	5.88 (0.23)	7.74 (0.15) *	9.71 (0.16)
Images	3.92 (0.41) *	5.56 (0.24)	7.82 (0.17) *	9.69 (0.15)
Spinner	3.04 (0.42)	5.68 (0.24)	8.01 (0.16) *	9.66 (0.16)

* Significantly greater preference for TKR ($p < 0.05$) compared to the numbers only format.