A Decision Tool to Improve the Quality of Care in Rheumatoid Arthritis

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Preparation of this article and funding for this research was made possible by the American College of Rheumatology Research and Education Foundation Within Our Reach: Finding a Cure for Rheumatoid Arthritis campaign; by NSF grant SES-1047757 to the second author; and by contracts/grants to the last author from the National Cancer Institute and the National Institute on Aging (RC1AG036915-01). This work was also supported by the resources of the Claude D. Pepper Older Americans Independence Center at Yale University School of Medicine (#P30AG021342 NIH/NIA).

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Word Count: 3249

Key Words: rheumatoid arthritis, anti-rheumatic drugs, decision support techniques, patient education, biological products, fuzzy-trace theory.

This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process which may lead to differences between this version and the Version of Record. Please cite this article as an ‘Accepted Article’, doi: 10.1002/acr.21657

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Received: Sep 19, 2011; Revised: Feb 10, 2012; Accepted: Feb 27, 2012
Abstract

Objectives: Despite the importance of achieving tight control, many rheumatoid arthritis (RA) patients are not effectively treated with disease modifying anti-rheumatic drugs (DMARDs). The objective of this study was to develop a decision support tool to inform RA patients with ongoing active disease about the risks and benefits related to biologic therapy.

Methods: We developed a balanced, web-based, decision support tool. Options, values and probabilistic information were described using theoretically supported formulations. We conducted a pre-post test study to assess preliminary evidence of the tool’s efficacy in improving knowledge related to biologics, clarity of values, willingness to take a biologic and informed choice.

Results: We interviewed 104 subjects; mean age = 62; 84% female, 86% White; median duration of RA =13 years. Knowledge (coded on a 0 to 20 scale) and willingness to take a biologic (coded on a 0 to 10 scale) significantly increased after viewing the tool (mean differences = 3.1 and 1.4 respectively, both p < 0.0001). Perceived knowledge and value clarity (coded on 0 to 100 scales) also significantly improved (mean differences 20.4 and 20.7 respectively, both p<0.001). The proportion of subjects making an informed, value-concordant choice increased substantially from 35% to 64%.

Conclusion: A tool designed to effectively communicate the risks and benefits associated with biologic therapy increased knowledge, patient willingness to escalate care, and the likelihood of making an informed choice. The results of this study support the need for a clinical trial to examine the impact of the tool in clinical practice.
Significance and Innovation

- Currently, no proven mechanisms exist to effectively inform RA patients and enable them to process the complex information related to escalating care after failing traditional disease-modifying anti-rheumatic drugs.

- In this study we developed a web-based decision support tool to effectively inform patients and promote high quality decision making in RA patients who are candidates for biologic disease-modifying drugs.

- Viewing the tool resulted in improved knowledge, willingness to escalate care, and the likelihood of making an informed, value-concordant choice.
A targeted strategy to minimize disease activity has been shown to significantly improve both short- and long-term outcomes in rheumatoid arthritis (RA) and guidelines strongly recommend that physicians monitor and escalate treatment to achieve this goal (1, 2). Yet, despite the widespread endorsement of this approach, many patients are not effectively treated with disease modifying anti-rheumatic drugs (DMARDs) (3, 4). While access (both geographic and financial) and logistics (time) are frequently cited barriers, this gap in care persists even among insured patients under the care of a rheumatologist, indicating that patient factors over and above access to services may adversely affect quality of care in RA (5). A study by Wolfe and Michaud (6) highlighted the potential effect of such factors in clinical practice. In this study, the authors found that 71% of RA patients were reluctant to escalate care despite objective findings of active disease. Concern regarding the risks of side effects and losing control of their disease were important factors influencing patients’ preference to remain with the status quo. van Hulst et al (7) recently found that patients and physicians differ substantially in how they approach the decision of whether or not to escalate care and suggested that better patient-physician communication is needed to improve decision making. These studies indicate that decision support tools which effectively inform RA patients and improve patient-physician communication may lead to improved decision making and ultimately adherence to evidence based guidelines.

While escalation of care in RA can involve many different treatment decisions, one of the more difficult decisions patients face is whether or not to initiate biologic therapy after failing non-biologic DMARDs. Risk communication is particularly challenging in this situation because of the sheer number of risks to disclose, the difficulty explaining the risks of extremely rare, but dreaded, adverse events, and the tendency for people to discount (or underweight) future benefits (8). A traditional view of decision making, founded in expected utility theory, is based on the premise that people think quantitatively about risks and benefits, and process numbers resulting in a choice reflecting overall utility (value). However, numerous studies have
demonstrated that this theory falls short in predicting how people make decisions in the real world (9-12). Fuzzy trace theory (FTT) builds directly on the advances of earlier research in risk perception and medical decision making to provide a more useful framework to guide the development of intuitive decision aids for patients (9, 13-15). FTT contends that people code and retrieve information using gist and verbatim representations. In this context, gist refers to the overall picture or the general meaning that people attach to a specific medication characteristic (9). Gist is qualitative, subjective, and dependent on individual factors (e.g. education, culture and experience) that affect meaning. For example, the gist representation of the extremely rare risk of progressive multifocal leukoencephalopathy for one patient might be “I could get something like mad cow disease and die” and for another patient “bad things can happen with all medications, but this is really rare and unlikely to happen to me.” In contrast, verbatim representations refer to the literal risk. A large body of evidence based on studies using controlled experiments, mathematical models, and neuroimaging, supports the conclusion that people preferentially rely on gist, and not verbatim, representations when making decisions (9, 14). For example, knowing one’s precise risk of developing breast cancer (verbatim representation) does not increase the rate of screening. In contrast, perceived risk (i.e., “my risk is high,” a gist representation) is a much stronger predictor of health-related behaviors (16, 17).

Currently, no proven mechanisms exist to effectively inform RA patients and enable them to process the complex information related to escalating care after failing traditional disease modifying anti-rheumatic drugs (DMARDs). The objective of this study was to develop a theory-based decision tool to effectively inform patients and promote high quality decision making in RA patients who are candidates for biologic disease-modifying drugs. Informed choice requires that patients accurately understand salient differences between available treatment options. More important than being able to recall precise “verbatim” risk estimates, is the ability to attach accurate meaning to this information (9, 14).
METHODS

Tool Design

The tool is an interactive, web-based, computerized educational module with voice-overs that subjects navigate through using a menu bar. Information is provided for all tumor necrosis factor inhibitors, abatacept, rituximab and tocilizumab. To promote accurate gist representations, the tool begins with an educational segment describing the natural history of RA and why biologics are frequently recommended for patients with persistent disease activity despite the use of traditional DMARDs. The introduction’s objective is to ensure that subjects have accurate illness perceptions regarding the consequences of chronic inflammation and the role of biologics.

Because the amount of information can influence risk perceptions (18, 19), the same amount of attention was devoted to benefits as was to risks. Benefits included improvements in pain, joint swelling, fatigue, progression of erosions, chance of remission, sleep disturbance, cardiovascular outcomes, work, and overall quality of life. Links were provided to view bar graphs demonstrating the benefit of adding the specific biologic to a traditional DMARD (20-38).

We surveyed a panel of 13 internationally renowned RA experts and, based on their ratings, stratified AEs into those that: 1) must be disclosed to all patients considering biologics, 2) should be provided as supplemental information via links for patients desiring additional information, and 3) need not be included at all. This flexible approach addresses needs of patients desiring additional information without overwhelming others.

The expert panel was presented with three groups of AEs: not serious and easily reversible, moderately serious and requiring treatment, and those associated with significant morbidity. Experts rated the AEs from “Extremely important” (1) to “Not important at all” (7). AEs were treated per the following rules: Step 1: If over 75% of the panel rated the AE between 5 and 7, the AE was excluded from the tool. The remaining AEs were included if 75% or more of the panel rated the AE between 1 and 4; otherwise, they were included as a link. Graphics were used to facilitate understanding of probabilistic information. Pie charts (for AEs with a risk of 1%
or greater) and pictographs (for AEs occurring in less than 1%) were used to describe AEs and to specifically prevent denominator neglect (39). We also inserted questions to test patient knowledge and provide feedback. Knowledge questions emphasized accurate gist representations and not recall of specific “verbatim” data. After subjects responded, feedback highlighted the correct response. Illustrative screen shots are provided in the Appendix.

**Pre-Post Test**

Subjects were recruited from community-based rheumatology practices. Potential subjects were referred by their treating physician and screened for eligibility. Subjects who were at least 18 years of age; able to speak and read English; were taking one or more traditional DMARDs and/or using a biologic (including rituximab in the last 12 months) were eligible to participate.

We did not exclude patients currently on a biologic because, except for optional links which demonstrate graphs comparing biologics + methotrexate to methotrexate alone, the tool content is also relevant for patients considering switching to a new biologic. For example, while the tool defaults to first presenting tumor necrosis factor inhibitors, a navigation bar allows subjects to choose tabs linking to a different biologic. In view of the literature demonstrating that patients are frequently under-informed about their medications, we expected the information included in the tool to also be relevant to subjects currently using a biologic (40).

Given the timeline and budget for this study, it was not possible to recruit patients at the time of an actual treatment decision. Ideally, because the tool is designed to complement patient-physician communication, physicians would refer patients to access the tool after discussing the need to consider escalating care. Implementing the tool in this setting, however, requires significant resources and is better justified once preliminary data support its potential value.
Exclusion criteria included relative or absolute contraindications to any approved biologic (class III or IV congestive heart failure, open skin wound, active infection, history of demyelinating disease, untreated latent tuberculosis); co-morbidities that may overwhelm RA treatment decisions (e.g., history of malignancy within the past five years, excluding basal cell carcinoma, end-stage renal disease on dialysis, end-stage chronic obstructive pulmonary disease, or hearing or visual impairment).

**Data Collection**

RA patients participated in a single face-to-face interview during which they completed questionnaires before and after viewing the tool. We measured change in knowledge, perceived knowledge and values clarification (41), willingness to try biologics (42) and value-concordant choices. Values were assessed as simple gist principles (9, 14, 15). Because no questionnaires existed to measure patient knowledge related to biologics, we developed 20 True/False statements (10 each; Appendix). Items were pilot tested to ensure comprehension. Item order was determined using a random-numbers generator. Perceived knowledge and clarity of values were measured using two subscales from the well-validated Decisional Conflict Scale (41). These six items are coded on 5-point scales ranging from “Strongly agree” to “Strongly disagree.” The perceived knowledge items are: “I know which options are available to me; I know the benefits of each option; I know the risks and side effects of each option.” The clarity of values items are: “I am clear about which benefits matter most to me; I am clear about which risks and side effects matter most to me; I am clear about which is more important to me (the benefits or the risk and side effects.)” Patients’ willingness to take a (new) biologic was measured using the choice predisposition scale (42): “If your doctor recommended that you consider taking a (new) biologic, would you be willing to take one?” This item is coded on an 11-point scale anchored by “Not willing at all ” and “Extremely willing” with “Unsure” at the midpoint (42).
Although no currently available instruments exist to measure informed choice, there is agreement that such choice is based on accurate knowledge that is concordant with one’s values (43). Thus, we classified subjects as having made an informed choice based on a priori criteria set before enrollment: 1) they answered 75% of the knowledge items correctly, were willing to try a (new) biologic as indicated by a choice predisposition score of 8 or greater, and had values that favored the use of medications to control disease activity; or 2) they answered 75% of the knowledge items correctly, were less willing to try a (new) biologic as indicated by a choice predisposition score of less than 8, and had values that demonstrated reluctance to take medications to control disease activity. Participants rated their values (core beliefs) on 4-point scales (“Strongly agree” = 1 and “Strongly disagree” = 4) to 10 statements developed by investigators (See Appendix). Value statements were solicited from patients and framed based on input from experts in risk communication (EP) and Fuzzy-trace theory (VR). Statement order was determined using a random-numbers generator. Subjects were classified as having values that favored biologics if the sum of scores of statements favoring medication use to minimize disease activity was less than the sum of scores for statements consistent with reluctance to escalate care. Sums were computed in real time and those favoring biologics are shown the following statement: “Your responses show that you may be interested in changing your medications to better control your arthritis. This tool will help you learn about biologics and will give you the opportunity to think about specific questions you may want to discuss with your rheumatologist.” Subjects with values demonstrating reluctance towards escalating care see: “Your responses show that you may be concerned about changing your medications to better control your arthritis. This tool will help you learn about biologics and will give you the opportunity to think about specific questions you may want to discuss with your rheumatologist.”

Disease activity was measured using the RAPID-4 which includes four components of the Multi-Dimensional Health Assessment Questionnaire: physical functional assessment, arthritis-related pain numeric rating scale, patient global assessment of disease activity, and the
rheumatoid arthritis disease activity index self-report joint count (44-46). Acceptability of the tool was assessed by asking subjects to rate the quality, quantity, and balance of information presented (5-point scale ranging from “Excellent” to “Very poor”); whether they thought the tool was helpful for learning about biologics (“Very helpful”, “Somewhat”, “Not helpful”) and whether they would recommend the tool for other patients (“Yes”; “No”).

Analysis

Statistical analyses were conducted with SAS software (Version 9.22). Pre-post test differences for continuous variables were performed using paired t-tests. The proportion of subjects having a value-concordant choice before and after completing the tool was compared using McNemar’s test. Pre-post test differences, including baselines scores, were also examined using general linear models to adjust for age, education, disease activity (RAPID4 score) and current biologic use (47).

The study was powered to detect a difference in the pre-post perceived knowledge scores because it has been shown to discriminate between patients who reject or accept medical interventions (41). Based on previous studies, 90 subjects were needed to detect a Cohen’s d effect size of at least 0.3 (41) assuming a correlation between ratings $r = 0.5$, alpha $= 0.05$, 80% power, and 2-tailed test.

This protocol was determined to be exempt from continuing review by the Human Investigations Committee at our institution. Verbal consent was obtained from all participants.

RESULTS

We interviewed 104 subjects (48 eligible subjects refused to participate), mean age (SD) 62 (12) years. The majority of subjects were White (87%), female (84%) and had some college education (72%). Thirty-nine percent were employed, 40% were retired, 15% were on disability, and 6% were unemployed. The median (range) duration of RA was eight years (1-61) and the median (range) RAPID4 score was 16.1 (4.3-31.2). Thirty-eight percent reported overall health
status of very good or excellent, and 40% were on a biologic. Most subjects’ values were consistent with a tight-control approach (Table 1).

Knowledge related to biologics significantly improved after viewing the tool [mean (SD) difference = 2.3 (3.0)], as did perceived knowledge and clarity of values [mean (SD) differences = 20.4 (27.2) and 20.7 (26.2)] (Table 2). Subjects were more willing to try a biologic after viewing the tool [mean (SD) difference = 1.4 (2.3)] (Table 2). Improvements were seen in subjects who were, and were not, currently on a biologic (Table 3). The proportion of subjects making an informed, value-concordant choice significantly increased from 35% to 64% (p=0.0001). The proportion of subjects making an informed, value-concordant choice improved from 29% to 56% (p=0.001) among subjects who were not currently on a biologic, and from 44% to 78% among those who were currently on a biologic (p=0.002).

Pre-post test differences, measured using general linear models including baseline scores, are presented in Table 4. Improvements in knowledge were similar in older (65 years or older) and younger adults (64 years or younger). Statistically significant improvements in knowledge were seen across education levels, but those with less than a college education benefited more than those with at least some college education (mean (SD) difference = 3.3 (4.4), p=0.0004 versus 1.9 (2.2), p<0.0001) (Table 4, Figure 1).

Improvement in perceived knowledge was greater among older versus younger adults (mean (SD) difference = 22.5 (29.9), p<0.0001 vs 19.1 (25.4), p<0.0001) as was improvement in clarity of values (mean (SD) difference = 18.7 (29.5), p=0.0003 vs 22.0 (24.0), p<0.0001) (Table 4, Figure 2).

Increased willingness to try a biologic was greater among subjects with at least some college education (mean (SD) difference = 1.7 (2.3), p<0.0001) compared to those without such education (mean (SD) difference = 0.7 (1.9), p=0.05) and among younger adults (mean difference (SD) = 2.0 (2.4), p<0.0001) compared to older adults (mean (SD) difference = 0.6 (1.7), p=0.05) (Table 4, Figures 1 and 2).
Over 90% of participants rated the quality and quantity of information as very good or excellent. Eighty-nine percent found the tool to be very helpful and 100% would recommend it for patients with RA.

DISCUSSION

Based on principles of FTT, a tool to support decision making for RA patients who are candidates for biologic therapy, significantly increased knowledge, decreased decisional conflict (improved perceived knowledge and clarification of values), and increased patient willingness to escalate care in a pre-post test. Most importantly, the tool increased the proportion of patients making an informed, value-concordant choice by over 80%.

Decision aids have largely focused on supporting patient decision making in situations that include at least two plausible treatment options (including the possibility in some cases of refusal or deferral) and choice depends on individual patient preferences. Widely studied examples include treatment for early-stage breast and prostate cancer, screening for colorectal cancer, and the decision to undergo elective orthopedic surgery. These decisions are considered “preference-sensitive” because neither option clearly dominates. In contrast, escalating care for RA patients with ongoing active disease is a decision in which the benefits clearly outweigh the risks for the vast majority of patients, yet biologics are nonetheless underused. Data suggest that patient and physician-related factors are responsible. Wolfe et al (6) found that fear of losing control over their disease and fear of AEs both contribute to patients’ reluctance to change therapy, even when clinically indicated. van Hulst et al (7) recently found that patients and physicians differ substantially in how they approach the decision of whether or not to escalate care and suggested that better patient-physician communication is needed to improve decision making.

In this study, we addressed barriers impeding adherence to the principles of tight control. We took several steps to overcome patients’ bias towards maintaining the status quo. We
devoted as much attention to the benefits associated with biologics as to the risks and we included graphs to ensure that patients attended to denominators, which include the number of patients who do not experience an AE. Our results suggest that these efforts were successful in improving knowledge and in helping patients clarify their values. Improving patient knowledge and clarity of values is necessary to prepare patients to better communicate with their physicians. While we did not measure actual behavior change in this study, we did find that willingness to try a biologic also significantly increased after viewing the tool. Most importantly, the tool significantly increased the likelihood of making an informed, value-concordant choice. Improvements were seen across demographic groups, although some differences were larger for subgroups. Specifically, subjects without a college education demonstrated greater improvements in knowledge compared to those with at least some college. The fact that those with less education significantly improved is an encouraging finding, and suggests that the tool was constructed at a level that will benefit subjects across a wide range of backgrounds, including those most in need. Twenty-four percent of subjects without a college education scored 18 or higher (maximum score=20) on the baseline knowledge assessment compared to 44% of subjects with a college education. Thus, the difference noted may be due in part to a ceiling effect among those with a college education. It is possible that people with college education who were already on a biologic (40% in our sample) were more likely to have already sought information about biologics than those without college education. We also found that, despite significant improvements in objective/perceived knowledge and values clarification, older adults were less likely than their younger counterparts to be willing to escalate care. This finding is consistent with some papers reporting greater risk aversion among older adults (48, 49). However, others have failed to find a significant association between age and treatment preference (50, 51), suggesting that this relationship is likely context specific.

There are several limitations of this study. The majority of the subjects had a college education and most were White, thereby limiting the generalizability of the results. In addition,
the tool was not administered to patients at the time of an actual treatment decision. Given this limitation, these results should be interpreted as providing preliminary data to support the potential value of the tool. The results of this study support the need for a clinical trial to examine the impact of the tool in clinical practice. As recommended, we tested our pre-post findings using general linear models including the baseline estimate as a covariate to reduce systematic bias and error variance (47). However, a pre-post test study design is only strong enough to demonstrate proof-of-concept. To test the impact of the tool in clinical practice, a controlled trial is now required.

The decision support tool described in this paper was designed based on strong theoretical principles, and pre-post testing demonstrates that it successfully promotes valid gist representations, facilitates processing of tradeoffs, and enables patients to understand the salient differences between the treatment options available to them.
Acknowledgements

We greatly appreciate the time and effort of the expert panelists who made this project possible: Joan Bathon, Maarten Boers, Mark Genovese, Arthur Kavanaugh, Joel Kremer, Diane Lacaille, Ted Mikuls, Larry Mooreland, James O’Dell, Ken Saag, Robert Schoen, Vibeka Strand, and Michael Weinblatt.

Preparation of this article and funding for this research was made possible by the American College of Rheumatology Research and Education Foundation Within Our Reach: Finding a Cure for Rheumatoid Arthritis campaign; by NSF grant SES-1047757 to the second author; and by contracts/grants to the last author from the National Cancer Institute and the National Institute on Aging (RC1AG036915-01).
REFERENCES


34. Strand V, Singh JA. Newer biological agents in rheumatoid arthritis: Impact on health-related quality of life and productivity. Drugs 2010;70:121-45


47. Barry J. Data Analysis of Pre-Post Study Designs. 


Table 1. Subjects’ value ratings before performing the tool.

<table>
<thead>
<tr>
<th>Value Direction</th>
<th>Statement</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>It is better to continue with the pain I know than to change my medications.</td>
<td>3.2 (0.7)</td>
</tr>
<tr>
<td>Positive</td>
<td>It is important to reduce my chances of becoming disabled, even if it means taking medications with a risk of serious side effects.</td>
<td>2.2 (0.8)</td>
</tr>
<tr>
<td>Positive</td>
<td>It is okay to ignore the risk of a serious side effect if it is extremely rare.</td>
<td>2.6 (0.8)</td>
</tr>
<tr>
<td>Positive</td>
<td>It is important to take the strongest possible medications needed to control my arthritis now to improve my chances of being able to function in the future.</td>
<td>2.4 (0.8)</td>
</tr>
<tr>
<td>Positive</td>
<td>It is important to accept the risk of side effects now in order to improve my chances of being healthy in the future.</td>
<td>2.2 (0.7)</td>
</tr>
<tr>
<td>Negative</td>
<td>Even if my medications are not working well, it is better to stay on them than to try a new medication that could cause cancer.</td>
<td>2.7 (0.8)</td>
</tr>
<tr>
<td>Negative</td>
<td>It is okay to delay treating my arthritis in order to take care of my family responsibilities.</td>
<td>3.2 (0.8)</td>
</tr>
<tr>
<td>Negative</td>
<td>It is better to take natural remedies than prescription medications for my arthritis.</td>
<td>3.1 (0.7)</td>
</tr>
<tr>
<td>Negative</td>
<td>It is wrong to take medications for my arthritis that could cause serious side effects.</td>
<td>2.7 (0.8)</td>
</tr>
<tr>
<td>Positive</td>
<td>It is important to take care of my disease so that I can be as productive as possible.</td>
<td>1.6 (0.7)</td>
</tr>
</tbody>
</table>

Statements are coded on a 1-4 scale with 1 = strongly agree and 4 = strongly disagree.
Table 2. Changes in knowledge, perceived knowledge, values clarity and willingness to try a biologic before and after using the tool.

<table>
<thead>
<tr>
<th></th>
<th>Pre-Test (Mean ± SD)</th>
<th>Post-Test (Mean ± SD)</th>
<th>p Value (Paired t-test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge¹</td>
<td>15.7 ± 3.5</td>
<td>18.0 ± 1.9</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Perceived knowledge²</td>
<td>74.7 ± 26.2</td>
<td>54.3 ± 18.3</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Clarity of values³</td>
<td>68.2 ± 26.4</td>
<td>47.4 ± 16.7</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Willingness to try a biologic⁴</td>
<td>6.1 ± 2.8</td>
<td>7.5 ± 2.5</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

1. Objective knowledge measured using a 20 item survey (possible range 0-20). Increased score indicates improvement.
2. Perceived knowledge measured using the Informed subscale from the Decisional Conflict Scale (possible range 0-100). Decreased score indicates improvement.
3. Clarity of values measured using a Values Clarity subscale from the Decisional Conflict Scale (possible range 0-100). Decreased score indicates improvement.
4. Willingness to try a biologic measured using the choice predisposition 11-point scale anchored by “not willing at all” and “extremely willing” with “unsure” at the midpoint (possible range 0-10). Increased score indicates increased willingness.
Table 3. Changes in knowledge, perceived knowledge, values clarity and willingness to try a biologic by biologic exposure.

<table>
<thead>
<tr>
<th></th>
<th>Subjects Not Currently on a Biologic (N = 63)</th>
<th>Subjects Currently on a Biologic (N = 41)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Difference (95% CI Mean) t value P Value</td>
<td>Mean Difference (95% CI Mean) t value p Value</td>
</tr>
<tr>
<td>Knowledge</td>
<td>2.8 (1.9-3.6) 6.3 &lt;0.0001</td>
<td>1.7 (1.0-2.3) 5.3 &lt;0.0001</td>
</tr>
<tr>
<td>Perceived knowledge</td>
<td>26.5 (29.8-34.0) 7 &lt;0.0001</td>
<td>11.2 (5.1 17.2) &lt;0.0006</td>
</tr>
<tr>
<td>Clarity of values</td>
<td>26.3 (18.8-33.8) 7 &lt;0.0001</td>
<td>12.2 (7.1 17.3) &lt;0.0001</td>
</tr>
<tr>
<td>Willingness to try a biologic</td>
<td>1.4 (0.8-1.9) 5.0 &lt;0.0001</td>
<td>1.5 (0.7-2.2) 4.1 &lt;0.0002</td>
</tr>
</tbody>
</table>
Table 4. Standardized estimates of post-test outcomes after adjusting for baseline value and covariates.

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Post Knowledge $(R^2 = 0.29)$</th>
<th>Post Perceived Knowledge $(R^2 = 0.15)$</th>
<th>Post Clarity of Values $(R^2 = 0.22)$</th>
<th>Post Willingness $(R^2 = 0.55)$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standardized estimate (SE*)</td>
<td>p value</td>
<td>Standardized estimate (SE)</td>
<td>p value</td>
</tr>
<tr>
<td>Age</td>
<td>-0.09 (0.01)</td>
<td>0.28</td>
<td>0.23 (0.15)</td>
<td>0.02</td>
</tr>
<tr>
<td>Education</td>
<td>0.21 (0.20)</td>
<td>0.04</td>
<td>-0.07 (1.98)</td>
<td>0.49</td>
</tr>
<tr>
<td>Current biologic</td>
<td>0.03 (0.35)</td>
<td>0.78</td>
<td>-0.04 (3.97)</td>
<td>0.74</td>
</tr>
<tr>
<td>Rapid-4</td>
<td>-0.003 (0.03)</td>
<td>0.97</td>
<td>0.01 (0.30)</td>
<td>0.89</td>
</tr>
<tr>
<td>Baseline**</td>
<td>0.39 (0.05)</td>
<td>&lt;0.0001</td>
<td>0.22 (0.07)</td>
<td>0.04</td>
</tr>
</tbody>
</table>

*SE= Standard Error

**Baseline knowledge, perceived knowledge, values clarity and choice willingness in columns 1 through 4 respectively.
Figure 1. Improvements in knowledge and willingness to try a biologic among subjects with and without some college education

Change in Knowledge

Change in Willingness to Try a Biologic

1. Higher scores indicate improvement
Figure 2. Improvements in perceived knowledge, values clarity, and willingness to try a biologic among older and younger subjects.

1. Higher scores indicate improvement
2. Lower scores indicate improvement