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Balance Sheets versus Decision Dashboards to support patient treatment choices: A comparative analysis

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Abstract

Background—Growing recognition of the importance of involving patients in preference-driven healthcare decisions has highlighted the need to develop practical strategies to implement patient-centered shared decision making. The use of tabular balance sheets to support clinical decision making is well established. More recent evidence suggests that graphic, interactive decision dashboards can help people derive a deeper understanding of information within a specific decision context. We therefore conducted a non-randomized trial comparing the effects of adding an interactive dashboard to a static tabular balance sheet on patient decision-making.

Method—The study population consisted of members of the *ResearchMatch* registry who volunteered to participate in a study of medical decision making. Two separate surveys were conducted: one for the control group and one for the intervention group. All participants were instructed to imagine they were newly diagnosed with a chronic illness and asked to choose between three hypothetical drug treatments that varied with regard to effectiveness, side effects, and out-of-pocket cost. Both groups made an initial treatment choice after reviewing a balance sheet. After a brief washout period, members of the control group made a second treatment choice after reviewing the balance sheet again while intervention group members made a second treatment choice after reviewing an interactive decision dashboard containing the same information. After both choices participants rated their degree of confidence in their choice on a 1–10 scale.

Results—Members of the dashboard intervention group were more likely to change their choice of preferred drug, (10.2% vs. 7.5%, $p=0.054$) and had a larger increase in decision confidence than the control group: 0.67 vs. 0.075, $p<0.03$. There were no statistically significant between group differences in decisional conflict or decision aid acceptability.

Conclusion—These findings suggest that clinical decision dashboards may be an effective point of care decision support tool. Further research to explore this possibility is warranted.

Introduction

Growing recognition of the importance of involving patients in preference-driven healthcare decisions has highlighted the need to develop practical strategies to implement patient-

centered decision making. Proposed strategies include better ways to provide patients with the information needed to make an informed decision, improved doctor-patient communication methods, and comprehensive decision aids that include both pertinent information and decision making guidance. Of these, decision aids have received the most attention. Research to date has found that patient decision aids increase patients' knowledge, lower decisional conflict, increase patient involvement in the decision making process, and promote decisions that are more consistent with patient preferences. [1] Their effects on patient care, however, have been limited due to difficulty implementing them in routine practice settings. [2–4]

These results have sparked interest in decision support interventions designed specifically to augment regular doctor-patient interactions at the point of care. [5–7] Such interventions should make patients aware that several options exist, provide information about the options' advantages and disadvantages, and help patients choose which option they prefer. [6] This approach is potentially capable of overcoming many of the barriers that have impeded the implementation of decision aids. [2] Preliminary evidence supporting this approach exists in the context of medication treatment for patients with type 2 diabetes and additional studies are underway. [8–10]

Research in the field of information visualization has shown that graphic, interactive information displays can help people derive a deeper understanding of information within a specific decision context. [11, 12] These advances have led to increasing interest in the use of visual information displays to support decision making. [11–13] One of the first products of these activities is the computer-based, interactive decision dashboard. A decision dashboard is “... *a visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance*”. [14] Decision dashboards have been widely adopted as business intelligence tools to help managers and other decision makers quickly and easily access decision-related information and incorporate it in their decision making processes. [15, 16] These findings suggest that decision dashboards can effectively help people establish their decision making priorities and make any preference-based tradeoffs between decision options needed to make a decision.

In a previous study, we found that an interactive decision making dashboard could be used to inform medical decisions, was well-received by a volunteer sample, augmented understanding of the information presented, and helped users identify and make the key trade-offs involved in making a treatment choice. [17] This initial study was, however, limited by a small sample size and lack of a control group. The goal of the larger study presented here was to continue this line of investigation by determining whether adding an interactive decision dashboards to a static tabular balance sheets changes patients' decisions or confidence in their choice of preferred decision option.

Methods

Study population

The study population consisted of members of the *ResearchMatch* panel. *ResearchMatch* is a national registry of people in the United States who have volunteered to be contacted about clinical research studies. It is maintained by the NIH Clinical Translational Science Award consortium. [18] Panel members were eligible for the study if they were 35 years of age or older and had no reported health conditions. Brief notices containing a brief description of the study were sent to 1781 panel members. Those who indicated interest in the study were then invited to participate and sent a link to the online study survey.

Study intervention

Two separate surveys were conducted: one for the control group and one for the intervention group. All participants were instructed to imagine being diagnosed with a chronic illness that impedes their daily activities. They were then asked to choose between three hypothetical treatments - Drug A, Drug B, and Drug C – that varied with regard to effectiveness, side effects, and out-of-pocket cost. Effectiveness was divided into controlling symptoms and halting disease progression. Side effects were divided into two categories: serious and common. Out-of-pocket cost was defined as the monthly direct cost to the patient. A copy of the survey is included in a supplemental file.

After reading the introduction, participants in both groups examined the balance sheet shown in Table 1. They were then asked to choose a preferred treatment option and indicate how confident they were about their choice on a scale from 1 (very unsure) to 10 (very sure). After making their first treatment choice, study participants answered a series of questions regarding their demographic characteristics including age, racial and ethnic background, household income, and education level. They then completed the subjective numeracy scale and the Chew health literacy question, which are validated measures of perceived health numeracy and subjective health literacy respectively. [19, 20] Following this “washout” period, control group participants were shown the balance sheet for a second time and the intervention group participants interacted with a clinical decision dashboard. After this second review of information comparing the three treatment choices, both groups were then asked to again select a preferred treatment choice and indicate how sure they were of their choice using the same 1–10 scale as before.

After indicating their revised preferred treatment, all study participants completed the decisional conflict scale and evaluated the acceptability of the decision aid. [21] We evaluated acceptability using questions regarding the helpfulness and clarity of the information presented and the likelihood of recommending the decision aid to others. The questions and response scales used are summarized in Table 3.

The main screen of the clinical decision dashboard is shown in Figure 1. Its design is based on the prototype used in a prior study. [17] It consisted of five graphs each showing a single drug attribute using the same data as contained in the balance sheet. A different color was used to represent each drug treatment option uniformly throughout the dashboard. Buttons for additional information were provided under each bar graph. Using a series of

checkboxes, study participants had the option of displaying each drug separately or in any combination. The dashboard was created using N2, a content-management system framework, for ASP.NET web form and html and implemented on the Internet. A timer was included that measured the total time spent with the website open. In addition to written instructions, an instructional video was provided to show volunteers how to use the interactive features of the dashboard.

Statistical analysis

Our primary study outcomes were differences in participants' preferred treatment option and confidence in treatment choice between the first and second decision points. We hypothesized that use of the dashboard would affect the options preferred and increase subjects' decision confidence. Secondary outcomes included time needed to complete the study, decisional conflict, and decision aid acceptability.

We used standard descriptive statistics to summarize the characteristics of the study population, preferred treatment choices, decision confidence, and decisional conflict. Extreme outliers, defined as values greater than 10 times larger than the upper quartile plus 3 times the interquartile range of minutes spent on the website were excluded to minimize errors due to users leaving the website open after completing the intervention. [22] We used Fisher's exact test to compare the number of preferred treatment choices that differed between the initial and final treatment choice in each group. Because the data are not normally distributed, we used the Mann-Whitney test to compare group differences in total time spent on the survey, decisional conflict, and changes in decision confidence scores between the initial and final treatment decision. Linear regression was used to determine if inter-group age differences are associated with changes in decision confidence scores. We used Chi square analysis to compare group ratings of the clarity, helpfulness, and likelihood of recommending to a friend after combining response categories needed to ensure adequate responses in each category to perform the analysis. We discuss results as providing weak evidence if $0.05 < p < 0.1$, moderate evidence if $0.01 < p < 0.05$, and strong evidence if $p < 0.01$; results with $p > 0.1$ were considered as providing insufficient evidence to support the tested claims. We conducted all analyses using JMP 10.0. [23]

Results

Participation and Demographics

Participation rates among panel members invited to join the study were 51.0% for the control group and 31.7% for dashboard group. This difference is statistically significant, $p = 0.002$. The characteristics of the study population are summarized in Table 2. Seven subjects, 5 in the control group and 2 in the dashboard group did not provide demographic information and are not included in this analysis. The study sample consisted of mostly white and non-Hispanic females who have obtained post-graduate degrees, have an annual household income of greater than \$100,000, and good to excellent subjective numeracy and health literacy. The intervention group was significantly older than the control group ($p = 0.036$). The two study groups did not differ otherwise.

Study results are summarized in Table 3. The most commonly preferred treatment was Drug A, followed by Drug B and Drug C for both dashboard and control groups. Members of the dashboard group were more likely to change their choice of preferred drug, 10.2% vs. 7.5% respectively, $p=0.054$. The dashboard group had a larger increase in decision confidence than the control group: 0.67 vs. 0.075, $p<0.03$. There was no association found between age and change in decision confidence score ($p=0.68$). There were also no significant differences between the two groups in time spent, decisional conflict, decision aid clarity, helpfulness, or likelihood of recommending to a friend. Reliabilities of the decisional conflict scale and user evaluation questionnaire as measured by Cronbach's alpha were 0.89 and 0.72 respectively.

Discussion

Our study provides moderate evidence that users of a clinical decision dashboard in addition to a tabular option summary are more confident in their choice of a preferred treatment than users of a static, non-interactive tabular display alone. The results also provide weak evidence that table plus dashboard users are more likely to change their initial choice of preferred treatment and to take slightly longer to complete the task. These findings are consistent with our prior study and other research suggesting that dashboards can effectively support decision making in applied contexts.

The structure of the dashboard provides an explanation for our findings. Decision dashboards provide a visual summary of decision-related information displayed in a single view, make extensive use of graphical information displays, and include features that allow users to easily interact with and explore the information being presented. They facilitate understanding of the relative advantages and disadvantages of decision alternatives by presenting comparative information in a structured format, reducing the cognitive effort required by actively engaging well-developed human visual capabilities that help people process and understand information, highlighting factors that merit consideration, and providing information in a non-linear format to facilitate its incorporation in decision making deliberations. [11, 13, 24–31] Additionally, because dashboards allow users to control the extent and content of information displayed, they provide a means for users to self-regulate information exposure and avoid overload in the face of large amounts of information. [24]

Our findings are subject to several limitations. The first is that our data were generated by a group of volunteers presented with a hypothetical decision scenario rather than patients facing an actual health care decision. Although this design was appropriate for an early stage developmental study, it cannot address the comparative effectiveness of clinical dashboards versus balance sheets when used as a point of care tool in actual practice. In addition, our study sample was highly educated, numerate and literate and the participation rate in the dashboard group was significantly lower than in the control group.

Despite these limitations, the results of this early phase study indicate that the combined use of a tabular information display and a decision dashboard may be better than a tabular display alone in supporting patient-centered, shared clinical decision making. The most

likely mechanism for this effect is by enabling patients to better define their decision-related preferences and priorities. Further research to explore the effectiveness of dashboard-based decision support interventions on clinical decision making, doctor-patient communication, and patient involvement in decision-making is warranted.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Stacey, Dawn; Bennett, Carol L.; Barry, Michael J.; Col, Nananda F.; Eden, Karen B.; Holmes-Rovner, Margaret; Llewellyn-Thomas, Hilary; Lyddiatt, Anne; Légaré, France; Thomson, Richard. Decision aids for people facing health treatment or screening decisions. *Cochrane Database Syst Rev*. 2011; 10
2. Legare F, Witteman HO. Shared Decision Making: Examining Key Elements And Barriers To Adoption Into Routine Clinical Practice. *Health Affairs*. 2013; 32:276–284. [PubMed: 23381520]
3. Elwyn G, Scholl I, Tietbohl C, Mann M, Edwards Adrian GK, Clay C, et al. "Many miles to go ...": a systematic review of the implementation of patient decision support interventions into routine clinical practice. *BMC Med Inform Decis Mak*. 2013; 13(Suppl 2):S14. [PubMed: 24625083]
4. Lin GA, Halley M, Rendle KAS, Tietbohl C, May SG, Trujillo L, et al. An Effort To Spread Decision Aids In Five California Primary Care Practices Yielded Low Distribution, Highlighting Hurdles. *Health Affairs*. 2013; 32:311–320. [PubMed: 23381524]
5. Elwyn G, Lloyd A, Joseph-Williams N, Cording E, Thomson R, Durand M, et al. Option Grids: Shared decision making made easier. *Patient Education and Counseling*. 2013; 90:207–212. [PubMed: 22854227]
6. Elwyn G, Frosch D, Thomson R, Joseph-Williams N, Lloyd A, Kinnersley P, et al. Shared Decision Making: A Model for Clinical Practice. *J Gen Intern Med*. 2012; 27:1361–1367. [PubMed: 22618581]
7. Jones LA, Weymiller AJ, Shah N, Bryant SC, Christianson TJH, Guyatt GH, et al. Should Clinicians Deliver Decision Aids? Further Exploration of the Statin Choice Randomized Trial Results. *Medical Decision Making*. 2009; 29:468–474. [PubMed: 19605885]
8. Légaré F, Ratté S, Stacey D, Kryworuchko J, Gravel K, Graham ID, et al. Interventions for improving the adoption of shared decision making by healthcare professionals. *Cochrane Database Syst Rev*. 2010; 5
9. Montori VM, Breslin M, Maleska M, Weymiller AJ. Creating a conversation: insights from the development of a decision aid. *PLoS Med*. 2007; 4:e233. [PubMed: 17683195]
10. Mullan RJ, Montori VM, Shah ND, Christianson Teresa JH, Bryant SC, Guyatt GH, et al. The diabetes mellitus medication choice decision aid: a randomized trial. *Arch Intern Med*. 2009; 169:1560–1568. [PubMed: 19786674]

11. Few, S. Now you see it: Simple visualization techniques for quantitative analysis. Oakland, Calif.: Analytics Press; 2009.
12. Spiegelhalter D, Pearson M, Short I. Visualizing Uncertainty About the Future. *Science*. 2011; 333:1393–1400. [PubMed: 21903802]
13. Chen C. Information visualization. *Wiley Interdisciplinary Reviews: Computational Statistics*. 2010; 2:387–403.
14. Few, S. Information dashboard design: The effective visual communication of data. 1st ed. Beijing, Cambridge [MA]: O'Reilly; 2006.
15. Watson HJ, Wixom BH. The Current State of Business Intelligence. *Computer*. 2007; 40:96–99.
16. Yigitbasioglu OM, Velcu O. A review of dashboards in performance management: Implications for design and research. *International Journal of Accounting Information Systems*. 2012; 13:41–59.
17. Dolan JG, Veazie PJ, Russ AJ. Development and initial evaluation of a treatment decision dashboard. *BMC Med Inform Decis Mak*. 2013; 13:51. [PubMed: 23601912]
18. Harris PA, Scott KW, Lebo L, Hassan N, Lighter C, Pulley J. ResearchMatch: a national registry to recruit volunteers for clinical research. *Academic medicine: journal of the Association of American Medical Colleges*. 2012; 87:66. [PubMed: 22104055]
19. Fagerlin A, Zikmund-Fisher BJ, Ubel PA, Jankovic A, Derry HA, Smith DM. Measuring Numeracy without a Math Test: Development of the Subjective Numeracy Scale. *Med Decis Making*. 2007; 27:672–680. [PubMed: 17641137]
20. Chew LD, Griffin JM, Partin MR, Noorbaloochi S, Grill JP, Snyder A, et al. Validation of Screening Questions for Limited Health Literacy in a Large VA Outpatient Population. *J GEN INTERN MED*. 2008; 23:561–566. [PubMed: 18335281]
21. O'Connor AM. Validation of a decisional conflict scale. *Medical Decision Making*. 1995; 15:25–30. [PubMed: 7898294]
22. Tukey, JW. Exploratory data analysis. 1977. Massachusetts: Addison-Wesley; 1976.
23. JMP 10.0.2. SAS Institute, Inc.;
24. Hibbard JH, Peters E. SUPPORTING INFORMED CONSUMER HEALTH CARE DECISIONS: Data Presentation Approaches that Facilitate the Use of Information in Choice. *Annu. Rev. Public. Health*. 2003; 24:413–433. [PubMed: 12428034]
25. Ware, C. Information visualization: Perception for design. Amsterdam, Boston: Elsevier/MK; 2013.
26. Vessey I. Cognitive Fit: A Theory-Based Analysis of the Graphs Versus Tables Literature*. *Decision Sciences*. 1991; 22:219–240.
27. Oppenheimer DM, Frank MC. A rose in any other font would not smell as sweet: Effects of perceptual fluency on categorization. *Cognition*. 2008; 106:1178–1194. [PubMed: 17618616]
28. Shah AK, Oppenheimer DM. Easy does it: The role of fluency in cue weighting. *Judgment and Decision Making*. 2007; 2:371–379.
29. Reber R, Schwarz N. Effects of perceptual fluency on judgments of truth. *Consciousness and cognition*. 1999; 8:338–342. [PubMed: 10487787]
30. Hansen J, Dechêne A, Wänke M. Discrepant fluency increases subjective truth. *Journal of Experimental Social Psychology*. 2008; 44:687–691.
31. Nelson W, Reyna VF, Fagerlin A, Lipkus I, Peters E. Clinical Implications of Numeracy: Theory and Practice. *Ann. Behav. Med*. 2008; 35:261–274. [PubMed: 18677452]

Key points for decision makers

- Patient-centered decision making requires adequately informed patients.
- Addition of interactive decision dashboards to static tabular balance sheets may be more effective than using the balance sheet alone in preparing patients to participate in decisions regarding their healthcare

Table 1

Drug-related information presented in balance sheet

Drug	Effectiveness		Risk of Adverse Effects		Cost
	Symptom Relief	Stop disease progression	Reported rate of common side effects	Reported rate of serious side effects	
Drug A	95.00%	65.00%	1.00%	0.10%	\$15.00
Drug B	90.00%	75.00%	5.00%	0.50%	\$50.00
Drug C	85.00%	85.00%	10.00%	1.00%	\$100.00

Table 2

Characteristics of the study population

	Control Group n = 75	Dashboard Group n = 86	Overall n = 161*	P value
Mean age (95% CI), years	47.4 (44.8 to 50.0)	49.8 (47.6 to 51.8)	48.7 (47.1 to 50.3)	0.036
Gender				0.112
female	62 (83%)	62 (72%)	124 (77%)	
male	13 (17%)	24 (28%)	37 (23%)	
Race				0.50
White	60 (80%)	69 (80%)	129 (80%)	
African-American	6 (8%)	11 (13%)	17 (11%)	
American Indian	0	1 (1%)	1 (0.6%)	
Asian	4 (5%)	2 (2%)	6 (4%)	
Other	5 (12%)	3 (4%)	8 (5%)	
Ethnicity				0.60
Hispanic	2 (3%)	1 (1%)	3 (2%)	
non-Hispanic	73 (97%)	85 (99%)	158 (98%)	
Education level				0.90
less than high school	1 (1%)	1 (1%)	2 (1%)	
high school	1 (1%)	4 (5%)	5 (3%)	
some college [†]	21 (28%)	20 (23%)	41 (26%)	
college	21 (28%)	25 (29%)	46 (29%)	
post-graduate	31 (41%)	36 (42%)	67 (42%)	
Annual household income (US dollars)				0.75
<10,000	2 (2.7%)	3 (3.5%)	5 (3.1%)	
10,000–24,999	6 (8.0%)	4 (4.7%)	10 (6.2%)	
25,999–39,999	6 (8.0%)	8 (9.3%)	14 (8.7%)	
40,000–59,999	14 (18.7%)	19 (22.1%)	33 (20.5%)	
60,000–74,999	11 (14.7%)	10 (11.6%)	21 (13.0%)	

	Control Group n = 75	Dashboard Group n = 86	Overall n = 161 [*]	P value
75,000–99,999	9 (12.0%)	17 (19.8%)	26 (16.2%)	
>100,000	27 (36.0%)	25 (29.1%)	52 (32.3%)	
Subjective health literacy				
extremely	60 (80%)	67 (78%)	128 (79%)	0.97
quite a bit	12 (16%)	15 (17%)	27 (17%)	
somewhat	3 (4%)	3 (4%)	6 (4%)	
a little bit	0	1 (1%)	1 (0.6%)	
Mean (95% CI) Subjective Numeracy Score				
	4.8 (4.6 to 5.0)	4.9 (4.7 to 5.1)	4.8 (4.7 to 5.0)	0.82

* These data were not available for 5 members of the control group and 2 members of the Dashboard group.

[†] category includes associate's degree

Table 3

Results

	Control Group N = 80	Dashboard Group N = 88 *	P value
Mean time spent (95% CI), minutes	13.5 (11.5 to 15.5)	14.7 (12.7 to 16.6)	0.09
	missing	6	
Preferred drug			
First choice			0.84
Drug A	44 (55%)	52 (59%)	
Drug B	25 (31%)	24 (27%)	
Drug C	11 (14%)	12 (14%)	
Second choice			0.78
Drug A	43 (54%)	52 (59%)	
Drug B	23 (29%)	23 (26%)	
Drug C	14 (18%)	13 (15%)	
Change in preferred drug choice	6 (7.5%)	9 (10.2%)	0.60
Change in confidence level, mean (95%CI)			
First choice	7.2 (6.6 to 7.7)	7.1 (6.6 to 7.6)	0.82
Second choice	7.2 (6.7 to 7.7))	7.8 (7.3 to 8.2)	0.14
Change in confidence level, mean (95%CI)	0.075 (-0.26 to 0.41)	0.67 (0.21 to 1.1)	0.02
Decisional conflict, mean (95%CI)	29.4 (25.8 to 33.0)	28.9 (25.8 to 32.0)	0.90
How helpful did you find the decision aid?			0.15
Not helpful	3 (4%)	11 (12.5%)	
A little helpful	14 (19%)	20 (23%)	
Somewhat helpful	20 (27%)	23 (26%)	
Very helpful	38 (51%)	34 (39%)	
Missing	5	0	
How clear was the information in the decision aid? *			0.63

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	Control Group N = 80	Dashboard Group N = 88 *	P value
Mostly unclear	3 (4%)	1 (1%)	0.19
Somewhat clear	8 (11%)	15 (17%)	
Mostly clear	37 (42%)	37 (42%)	
Everything is clear	27 (40%)	35 (40%)	
Missing	5	0	
Would you recommend this decision aid to others? *			
Definitely not	0	0	
Probably not	10 (13%)	17 (19%)	
Probably	31 (41%)	43 (49%)	
Definitely will	34 (45%)	28 (32%)	
Missing	5	0	

* There are no missing data unless noted