Author's response to reviews

Title: Development and Validation of the Diabetes Numeracy Test (DNT)

Authors:

Mary Margaret Huizinga (mary.margaret.huizinga@vanderbilt.edu)
Tom A Elasy (tom.elasy@vanderbilt.edu)
Kenneth A Wallston (ken.wallston@vanderbilt.edu)
Kerri Cavanaugh (kerri.cavanaugh@vanderbilt.edu)
Dianne Davis (dianne.davis@vanderbilt.edu)
Rebecca P Gregory (becky.gregory@vanderbilt.edu)
Lynn S Fuchs (lynn.fuchs@vanderbilt.edu)
Robert Malone (robb_malone@med.unc.edu)
Andrea Cherrington (cherrington@uab.edu)
Darren A DeWalt (dewaltd@med.unc.edu)
John Buse (jbuse@med.unc.edu)
Michael Pignone (pignone@med.unc.edu)
Russell L Rothman (russell.rothman@vanderbilt.edu)

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To the Editor:

We appreciate the reviews from Drs. Rudd and Bosworth and have addressed each comment below. Attached please find the revised manuscript “Development and Validation of the Diabetes Numeracy Test (DNT),” which we are submitting as an original research article. We hope that you will again consider it for publication in BMC Health Services Research. The scales described in this paper are available through a weblink referenced in the paper (http://vanderbiltdrtc.org/preventionandcontrol/tools.php).

This manuscript focuses on the development and psychometric testing of the DNT and DNT15. There is a second manuscript that describes the relationship between the DNT and clinical outcomes. Some of the issues raised by the reviewers are covered in this second manuscript. In particular, this second manuscript further explores the predictive value of the DNT compared to general numeracy skills (as measured by the WRAT-3R) in relationship to clinical outcomes.

Thank you for your consideration of this revised manuscript. This study represents original work that has not been published elsewhere. An abstract related to this work was presented at the Society for General Internal Medicine in 2006. The current authors do not have any significant financial disclosures or conflict of interest. Please refer all correspondence to the address below.

Sincerely,

Mary Margaret Huizinga, MD MPH
Instructor in Medicine
Vanderbilt University Medical Center
Center for Health Services Research
Medical Center East, Suite 6000
Nashville, TN 37232
Phone: 615-936-7308
Fax: 615-936-1269
Email: mary.margaret.huizinga@vanderbilt.edu
Response to Dr. Bosworth comments:

1. Further justification for the need of disease specific measure is required. We currently do not use disease-specific measures of literacy and there are concerns of using a disease-specific measure of numeracy will limit its utilization.

We feel that there is need for a diabetes specific numeracy measure because diabetes has considerable numeracy requirements compared to many other chronic illnesses. Diabetes management requires the frequent interpretation of glucose values and nutrition labels, carbohydrate counting and medication measurement and adjustment. Successful treatment of diabetes requires building on basic skills as the disease progresses. For example, understanding the glucose value to differentiate hypoglycemia, normoglycemia and hyperglycemia is a critical basic step. If a provider knows that a patient has difficulty with number hierarchy, then that education or compensation must be provided before the next disease management skill can be taught. Having a diabetes specific numeracy measure will allow for: (1) more accurate assessment of baseline numeracy skills in patients with diabetes, (2) more accurate examination of the role of patient’s numeracy in predicting diabetes related behaviors and outcomes over time, and (3) the potential to have a tool that can be used for both baseline and outcome assessment to see if there are any potential improvements in diabetes related numeracy over time. Our justifications for having a diabetes specific numeracy measure are now more thoroughly described in the Introduction (Page 4), and the Clinical Applications section (Pages 12 and 13).

2. Prior to further using the proposed measure, details regarding the predictive validity of the measure need to be examined particularly in terms of comparing the predictive validity of the DNT and WRAT.

In a second manuscript, which is currently under review, a significant, moderate relationship between the DNT and glycemic control (A1C) is described. This relationship was robust after adjusting for age, sex, race, education status, literacy, general numeracy and duration of diabetes. However, no relationship between the WRAT-3R and A1C was found.

We did not examine the predictive validity of the WRAT-3R any further because we do not feel that the WRAT-3R is a feasible test for use in a clinical setting. Administering a “math test” like the WRAT-3R may be intimidating for patients. In addition, the WRAT-3R consists only of calculations. It does not assess a patient’s ability to determine the numeracy skill needed to solve a health-related problem or their ability to apply the solution correctly. A clinician would not know how to translate the WRAT-3R directly to diabetes management. Each question of the DNT provides the clinician with important information about the patient’s skills in diabetes management. The clinician can then tailor their education to the necessary skill level.
3. The feasibility of using a 33 minute measure is questionable. Further details on the time required to complete the DNT15 would increase the likelihood of the measure being disseminated.

The DNT15 was not tested specifically in this study. It was developed through split sample analysis. We are currently using the DNT15 in a randomized controlled trial of a numeracy sensitive diabetes management program. In that study, the average time was 19.13 minutes with a median of 18 minutes for the DNT15 at baseline, and the average time was 17.76 minutes with a median of 15 minutes for the DNT15 at 6 months. The range was 0 to 41 minutes (one patient refused to take the DNT15). This information will be reported in the outcome paper of that trial.

4. The content validity of the measure did not include patients. That is, what are important aspects of numeracy patients perceive are necessary to maintain their diabetes regimen.

The DNT was developed with input from experts in the fields of diabetes, health literacy, and education. We also developed questions after examining previously validated tests of numeracy, health literacy, and health numeracy (TOFHLA). While we did not conduct focus groups of patients to allow them to inform the development of the test, we did conduct cognitive interviews with patients to assess their opinions and comprehension once the questions were developed. In addition, questions were, in part, informed by several of the investigators experiences in the clinic caring for diabetes patients and observing specific numeracy related deficits. Our lack of patient focus groups for the development of the DNT has been added to the limitations section (see page 11).

Response to Dr. Rudd's comments:

1. First, the authors point out at the very start, that significant numbers of US adults have basic or below basic literacy and numeracy skills. They also note that diabetes management requires the application of many literacy and numeracy skills and that these skills are even more important as the disease progresses. Given the general mismatch between existing skills and existing demands, the logical conclusion is that universal precautions ought to prevail. The authors need to make a very strong argument for the value of testing numeracy skills in clinical practice. This reader is not persuaded.

We agree with Dr. Rudd that practicing “universal precautions” by assuming that all patients have low literacy/numeracy skills can have important practical impacts when caring for patients. However, we still feel that the DNT or DNT15 can play an important role for both research and clinical purposes. The DNT was developed primarily to measure diabetes specific numeracy skills for research purposes, but may also have clinical applicability. We feel that the DNT may be a helpful tool to: (1) help to more accurately assess the prevalence of low diabetes related numeracy in a population, (2), “open the eyes” of local providers about
the problem of poor diabetes related numeracy, (3) the DNT may be a useful research tool for examining the relationship between diabetes related numeracy and diabetes behaviors and outcomes over time, and (4) the DNT may be a potential tool for examining changes in diabetes related numeracy skills over time as the result of a numeracy focused intervention (the role of the DNT as a responsive measure would need to be tested in a future study).

We believe the DNT provides useful information for the providers in the care of diabetes and allows for individualized approaches to management. A diabetes educator or clinician may use the DNT15 to help target education or guide therapy. Patients with higher level diabetes related numeracy skills may be able to escalate the management of their diabetes in a different, more complex but more efficacious way than those with lower skills. In addition, specific information about what areas of diabetes management patients struggle with is clinically relevant. For example, a patient may be able to perform basic food label interpretation but have difficulty understanding a syringe or vice versa. These two problems would be treated very differently.

We are not trying to make an argument to test general numeracy skills (with an instrument like the WRAT-3R) in clinical practice and agree that this is not useful. In addition, many patients would refuse to take such a test such as the WRAT-3R or might be traumatized by it. The DNT may provide clinically useful information that could potentially allow individualization of the treatment plan. The exact clinical benefit will need to be studied in the future. This study describes the development of a tool we will use to measure diabetes related numeracy skills in future clinical studies. We have added more information to the “Clinical Applications” section to further highlight our perceived value and role for the DNT (see page 12).

2. The authors need to present more information re: the items on the scale with particular attention to % of simple and complex numeric calculations.

7. Needed analysis: the authors make note of an initial analytic process that involved a delineation of numeracy tasks in diabetes management. At the same time, they do not seem to differentiate between relatively easy tasks and higher level, more difficult tasks. An analysis of the difficulty level of items is needed. The authors might want to look at the development of the adult literacy measures to understand how the education scholars scored various quantitative items [See Kirsch’s What was measured?]. The panel determined that the 45-item scale covered the range of numeracy skills. One cannot understand the scale without some indication of the number of easy items [simple math vs the number of complex numeric tasks.

The level of difficulty of items was considered when developing the DNT. We included a wide range of items that included a host of different numerical skill types and levels of complexity and also spanned the five main domains of diabetes self-management. We have added an additional table to give further information about the complexity of the items. (See Table 1)
1. Page 4 – Missing details in background: Details focused on the quantitative scores from the NALS and the NAALS is needed. The authors ought to present findings. They should make some meaning of the fact that prose, document, and quantitative scores do differ. They need to present the quantitative score findings.

We give more specific information about NAALS in the background (see page 4).

2. Page 4 – Confusing use of terms: the authors do not differentiate between measures of quantitative skills and measures of numeracy. The NALS and the NAALS measured quantitative skills. The Adult Literacy and Lifeskills [ALLS] changed from quantitative measures to measures of numeracy. Scholars in the field differentiate between the two.

We agree that the ALLS made a more concerted effort to measure numeracy as opposed to the more quantitative literacy measured in the NAALS and the NALS. However, all of these scales were primarily devoted to measuring general literacy/numeracy without a specific focus on health (except the HALS items). While there is currently no consensus in the field on the definition of numeracy, we have tried to better define what we mean by numeracy in the introduction.

3. Page 4 – Weak source for definition of key terms: More detailed discussion of the term numeracy is needed. The citation for the definition of numeracy comes from an article in a medical journal focused on the use of food labels. Definitions of critical terms ought to be derived from more appropriate sources within the education field. The authors might want to look at the definition of terms in the Adult Literacy and Lifeskills Surveys, assessments of adult literacy skills used in industrialized nations [see Education Testing Services and/or Statistics Canada].

There is currently no general agreement in the academic community on the definition of health related numeracy. The ALLS defined numeracy very broadly as the “knowledge and skills required to effectively manage and respond to the mathematical demands of diverse situations”. We have provided our perspective on how numeracy should be defined based on our own work and the work of others. We have now cited additional sources, including the ALLS definition of numeracy, in support of the definition used.

4. Page 5 -Silence regarding the TOFHLA: the authors make no mention of the fact that the TOFHLA attempted to measure quantitative skills. This is relevant to the study at hand.

We agree with the reviewers concerns, and have now added several sentences about the TOFHLA to the Introduction (Page 5). The TOFHLA is now discussed as a measure of literacy that does not give specific information about diabetes related numeracy. The numeracy section of the TOFHLA consists of 17 items that tests a person’s ability to read and understand numbers. These items primarily focus on reading prescriptions and other materials that test simple mathematical skills such as understanding dates and timing of medication.
dosage. These items are highly dependent on reading ability and, not surprisingly, they are highly correlated to reading ability. Based on these findings, many investigators have used a shortened TOFHLA (S-TOFHLA) that does not include any numeracy questions. We would contend that the numeracy section of the TOFHLA was not designed to accurately measure the host of numeracy skills that patients with diabetes require, and focuses too much on measuring simple quantitative skills that rely more heavily on one’s reading ability than on one’s numeracy skills. The DNT is designed to achieve granularity in the numeracy skills used in the management of diabetes and provide clinical information to guide that management.

5. Page 5 – Needed clarification of purpose: it is not clear whether the authors are focused on a ‘diabetes related literacy assessment’ or a ‘diabetes related numeracy assessment’.

The term literacy is used as the umbrella term that incorporates qualitative and quantitative skills (numeracy). This is in concordance with that term usage in the NALS and NAALS and by the IOM. We were specifically interested in a narrow range of literacy – the diabetes specific numeracy skills.

6. Page 5 – Incomplete argument: why is it important to develop a scale that measures ‘diabetes related numeracy’ rather than develop a scale that measures ‘health related numeracy”? Need researchers develop numeracy scales for all chronic diseases? Asthma management, for example, requires monitoring, measuring, calculations, use of measurement tools, medicine labels and directions…

This is addressed in the responses to comments 1&2 of Dr. Bosworth and comment 1 of Dr. Rudd. In the background, discussion and clinical implications sections of the article we have tried to clarify the need for a specific numeracy measure for diabetes. More than any other chronic illness, diabetes requires a depth and breadth of numeracy skills. Understanding a patient’s ability level in the different numeracy skills required enables a provider to better individualize treatment for the patient and hopefully improve clinical outcomes. We have a randomized controlled trial underway now to test this hypothesis. However, we first needed a valid and reliable tool to assess diabetes related numeracy. This manuscript describes the development and psychometric properties of this tool – the DNT.

8. Suggestion for additional Ho: The authors measured duration of diabetes [table 1] but do not appear to consider duration in any of the analyses. Might patients, over time, improve their understanding of their disease, their use of existing materials and tools, and their management skills? Would this compensate for limited skills?

We report this association in the second manuscript. There was no significant association between DNT score and duration of diabetes. The relationship between DNT and A1C remained strong even after adjustment for duration of diabetes.
9. Page 8 - Convenience sample. The authors draw their convenience sample from an academic health center and a VA health center. They might have INCREASED DIVERSITY AMONG PARTICIPANTS HAD THEY drawn a more diverse convenience sample through the use of additional community based sites.

We agree and have included this in the limitation section. This study included a convenience sample from 2 academic primary care clinics, an academic diabetes clinic and a VA endocrine clinic. We hope that this tool can be used in more diverse population in the future.

9. Pages 9-10: WRAT-3R. The DNT is strongly correlated with the WRAT-3R. Is the WRAT-3R also correlated with education, income, word recognition [REALM], and DKT? THE ANALYSIS OUGHT TO INDICATE WHAT, IF ANY, ADDED VALUE THERE IS IN THE ADMINISTRATION OF THE DNT.

The second manuscript addresses the additional value of the DNT when compared to the WRAT-3R as outlined in response to Dr. Bosworth's comments 1 and 2. After adjustment for general numeracy skills (as measured by the WRAT-3R) and other factors, the association between DNT and A1C remained robust.