Reaching Women Through Health Information Technology: The Gabby Preconception Care System

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Abstract

Purpose—The CDC has endorsed the concept of preconception care (PCC). New tools must be developed to promote PCC.

Design—Development and testing of a health information technology system to provide PCC.

Setting—An urban safety net hospital and an urban university.

Subjects—Community recruitment of 31 women in focus groups and 15 women participating in observed usability testing; 9 students recruited from the Office of Minority Health Preconception Peer Educators program participated in pilot testing for 2 months.

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Intervention—Online interactive animated character ("Gabby") designed to identify and modify preconception risks.

Measures—Qualitative transcripts, preconception risk assessment, server data for system usage, self-administered satisfaction surveys and follow-up phone calls.

Analysis—Descriptive statistics of subjects' demographics, satisfaction, PCC risks and system usage. Transcripts coded using NVIVO.

Results—Subjects (n=24) reported an average of 23 preconception risks; in the pilot, 83% of risks added to the "My Health To-Do List" were addressed by the subject. 73% of risks identified as Contemplative progressed to Action or Maintenance. Differences were noted in effectiveness of the system based on initial stage of change for each risk.

Conclusion—Results suggest that the PCC system could be effective in influencing positive behavior change. Adding stage of change-focused functionality might have added benefits. This system has great potential to assist in the delivery of preconception care.

Keywords

preconception care; health IT; healthcare disparities; low birth-weight

PURPOSE

The organized effort to improve pregnancy outcomes by improving the health of women and mitigating risk factors prior to pregnancy has been called Preconception Care (PCC). This involves addressing a range of issues like family planning, specific medical conditions (e.g., diabetes), exposure to teratogens, and preventive behaviors (e.g., immunization and folic acid supplementation). By identifying and intervening on risk factors, women can have a healthier pregnancy and a decreased risk for adverse birth outcomes.[1,2]

Rates of poor reproductive health and family planning outcomes among young women in the United States disproportionately affect young women of demographic minority status and socioeconomic disadvantage.[3] For decades the United States has performed poorly in maternal and infant mortality in comparison to other nations.[4] Despite increased access to early prenatal care over the course of the past 20 years, outcomes have not improved.[5,6] Moreover, approximately half of all pregnancies are unplanned, making delivery of PCC during general wellness visits a potential solution to address risks before the start of pregnancy in order to reduce maternal and infant mortality and other adverse birth outcomes.[7]

PCC concepts have been discussed for more than 20 years, but despite broad interest[8] there has been only modest progress in implementing these concepts into clinical practice. Although most women understand the importance of optimizing their health before pregnancy and most physicians think PCC is important, few obstetricians/gynecologists or family physicians provide comprehensive PCC to their patients.[9, 10]

In 2006, the Select Panel on Preconception Care, formed by the Centers for Disease Control (CDC), published the guiding vision for preconception health and healthcare.[11] Then in 2008, the Panel's clinical workgroup published a series of articles that defines the evidence-based best practices in PCC.[12] There is now a great need to fulfill these guidelines.

Health information technology (HIT) presents new opportunities to expand and improve delivery of PCC. Emerging evidence suggests that HIT increases access to healthcare by streamlining clinical services, reducing barriers such as remote geographic location, and

tailoring patient education and health promotion messages to fit patients' health literacy levels, personal values, and cultural and linguistic preferences.[13]

Among the most encouraging advances is technology called the "Virtual Patient Advocate" or VPA. The VPA is a computerized, animated character designed to integrate best practices from provider–patient communication theory. The VPA emulates the face-to-face conversational behavior of an empathic clinician, including nonverbal communicative behavior such as gaze, posture, and hand gestures to deliver patient education messages tailored to individual needs, assess patient comprehension, and record progress.[14, 15, 16] It also allows for sophisticated levels of tailoring of information. VPAs are ideal for delivering PCC because they can potentially reach a large number of patients, alleviate clinician time restraints, and control costs while simultaneously having high patient acceptability through culturally appropriate content[17] and information appropriate to those with low health literacy.[18, 19]

Based on our experience using VPA technology to assist clinicians in preparing hospitalized patients for discharge[18] we hypothesized that a VPA could be developed to screen for and address preconception risks, specifically for young African American women, to address high rates of poor birth outcomes. This paper reports on the initial development and early testing of a VPA designed to deliver preconception care that we call the Gabby Preconception Care System, or "Gabby."

METHODS

Overview

Gabby is a VPA configured for delivery via internet so that users can access the system on any computer with Web access. The Gabby system: (1) screens women for their PCC risks; (2) assesses their readiness for behavior change, specific to each risk; (3) educates them about their risks; and (4) helps them create a "My Health To-Do List," which users may choose to share with their medical providers and other health advisors. It delivers information in a patient-centered way, tailored to the risks identified. It has a novel story-authoring function that allows participants to write their own health-related stories and listen to stories authored by others. For this grant, the system was designed for episodic use over a two month period. Based on available content and other features of the system, participants were encouraged to use the system weekly but could self-determine how many sessions to complete. The content differs for each interaction, based on the risks discussed.

Study Design

The Gabby system went through four main phases: (1) development; (2) eight focus groups (n=31); (3) individual observed testing (n=15) in our laboratory to determine how well the system functioned ("usability testing"); and (4) a 2-month pilot test (n=9). The study was approved by the *<Removed for Blind Review>* Institutional Review Board.

1. Development of the Gabby System

Development of the Preconception Risk Assessment: The Gabby system's online preconception risk assessment is based on risk assessment tools used in prior studies[20] and updated based on the published work of the CDC clinical work group.[12] The risk assessment instrument records information in 12 domains of preconception care and includes over 100 individual risk factors, derived from the risks selected for the American Journal of Obstetric and Gynecology (AJOG) supplement for Preconception Health and Health Care.[21] The selection criteria for the AJOG guidelines included: (1) consideration of the health impact on the mother and infant; (2) burden of suffering and prevalence of the condition; (3) ability to

detect the condition in a primary or specialty setting; (4) availability of screening methods that are sufficiently predictive; and (5) existence of clinical practice guidelines that suggest that preconception interventions be implemented. The strength of each clinical recommendation was ranked using these criteria. In addition, the Gabby risk assessment was reviewed and edited by members of the clinical committee of the CDC Select Panel on Preconception Care in the areas of their clinical expertise. The preconception risk assessment used in the Gabby system is available upon request.

Development of the Information about Individual Risks: After a woman completes the risk assessment, Gabby then offers to discuss each of the identified risks. A woman controls her conversation with Gabby by clicking on the button she feels best represents her own response to Gabby's previous dialogue (e.g. "Yes let's talk more," "No thanks"). The information provided about each risk is spoken by Gabby using synthesized speech. The Gabby script content is adapted from the information prepared by the CDC workgroup and written at a 6th grade reading level. For each risk identified, the woman is given an opportunity to have Gabby explain basic information about the risk by choosing from buttons entitled "what is it?", "why does it matter to me now?", and "why does it matter for pregnancy?" Thus, Gabby can explain the potential implications of that risk to general health and to a future pregnancy. By clicking buttons on the screen, women can control the order in which they to hear this content and can control how much content to listen to for each risk. Women are given the opportunity to hear the information multiple times in order to aid with comprehension.

Development of the "My Health To-Do List": Gabby then asks the user if she would like to add this risk to her "My Health To-Do List," which is a reproductive life plan that includes a tailored list of preconception risks as well as tasks, chosen by the participant, to help address those risks. For example, if a participant adds "Multivitamin with Folic Acid" to her My Health To-Do List, she can choose from a list of activities that includes: talk to a family member or friend, talk to a healthcare provider, go to a website for more information, or buy a multivitamin. The list is updated in subsequent interactions so that tasks are checked off as they are completed and risks are removed as they are resolved. The woman is able to view the list online at any time. Gabby encourages the woman to print the list and to share it with her medical provider or other health advisors.

2. Focus Groups—Throughout the development process, various components of the system were tested during eight focus groups. Thirty-one English-speaking female participants who were between the ages of 15 and 22, self-identified as African American, and reported to not be pregnant at the time of enrollment were recruited from a variety of community-based sites. Using a semi-structured interview guide, participants were asked about their impressions of the online risk assessment, the layout and components of existing preconception care websites, the appearance of the VPA character, the content and length of several of Gabby's educational scripts, social networking features to disseminate the Gabby system, as well as the format and usefulness of the My Health To-Do List. Analysis of focus group transcripts began after the first focus group so that early findings could inform initial programming, which participants in later focus groups reviewed and provided feedback on.

3. Usability Testing—Once focus group findings were integrated into a first design of the Gabby system, fifteen African American women between the ages of 15-25 were recruited from community-based sites to further test and debug the system. The participants came to our research laboratory for individual 90-minute sessions, where they completed the online preconception risk assessment and heard Gabby dialogue about six health risks. Then, each participant filled out a quantitative survey about her reactions to the system and participated

in a 30 minute one-on-one interview about her experience interacting with the system. Many updates were made to the Gabby system prior to the pilot based on usability testing feedback. For example, the usability testing participants did not report the story-telling function to be intuitive, so a simpler interface was created prior to the start of the pilot test. This iterative process allowed us to determine whether the Gabby system is perceived to be culturally acceptable by our target population, and identify areas of the system that need further development.

4. Pilot Intervention—We then conducted a pilot test of the Gabby system among women enrolled in the Office of Minority Health Preconception Peer Educator (OMH PPE) program.[22] The OMH PPE program is a two-day program where undergraduate and graduate students receive information and training in the epidemiology and public health importance of poor reproductive outcomes, particularly low birth-weight among African American women, and information about potential ways in which PCC could lower reproductive risks. From a group of 32 students undergoing PPE training at Northeastern University, we recruited nine women between the ages of 18-25, who reported that they had access to a computer with internet access, had a telephone, and were willing to receive a follow-up telephone call from the investigators two months after beginning the online interaction(s) with Gabby. Each woman was given a unique username and password. Each then participated in a brief group demonstration version of the Gabby system, completed the preconception risk assessment, and were asked to access the Gabby system online for the next two months.

Measures and Analysis

Focus groups and individual interviews during usability testing were audio-recorded, transcribed verbatim, and transcripts were reviewed for accuracy and screened for identifying information to honor participant confidentiality. Two research team members coded each transcript, and coding discrepancies were reconciled using supportive evidence from transcripts. A total of 74 content codes were identified from the topics discussed during focus groups, and 44 content codes from usability testing. These codes were then organized into categories and themes, and managed using the software program NVIVO.

Results from the preconception risk assessment were used to measure frequencies of individual risks identified and percentage of total risks per domain. Prior to hearing information about a risk, the participant's stage of change from the Transtheoretical Model[23] for that risk was assessed. Gabby asked, "What best describes your attitude towards <desired behavior to resolve risk>?" Participants could choose from the following choices: "I have no plan to address this anytime soon," (*precontemplation*); "I plan on addressing this in the next six months," (*contemplation*); "I plan on addressing this in the next month," (*preparation*); "I've already addressed this," (*action/maintenance*). Furthermore, to measure participant satisfaction with the Gabby system, both the participants in the usability and pilot studies completed a self-administered survey. Descriptive statistics of system satisfaction were calculated from survey results; mean scores were computed and continuous scales of 1-7 were collapsed into three categories. For example, responses to the question "How easy was it to talk to Gabby?" were collapsed into "Easy" (scores 1-3), "Neutral" (score 4), and "Difficult" (scores 5-7).

Women participating in the pilot study received a follow-up phone call two months after enrollment to collect updated stage of change for each risk, using the same questions and answer choices as described above. Additionally, the participants reported the outcome of each risk (i.e. resolved, action taken, or no action taken) or reported their belief that the risk was falsely identified. Information collected from the system server provided system usage

data including: the number of interactions; minimum, maximum, and mean length of interaction; mean number of PCC risks discussed per participant; and mean number of PCC risks added to the "My Health To-Do List."

RESULTS

Focus Groups

Findings suggest that participants prefer a VPA character that resembles their racial and ethnic background. Participants were shown eight potential VPA characters, and one participant explained,

> People that are my color or, you know, a little bit of my nationality, they probably understand what you're going through…But it's just, you know, they better understand us than white or other doctors or nurses...Just to, like, clarify what I was saying, not like I think, like, white people are bad or anything, or I'm against that. It's just all about comfort. And, like Eve [another participant] was saying, it would help because you feel like someone who is at least from where you're from, or the same race as you or something, they'll understand you better.

In addition, participants unanimously agreed that they would be more comfortable discussing preconception care topics with a VPA who was a young, female, health care professional and suggested this could be symbolized by a uniform or fitted professional shirt, name badge, or stethoscope. However, participants also highlighted the importance of the VPA having style and layers, and looking like a young adult they might see walking down the street, and therefore suggested that a stylish haircut, accessories (e.g. jewelry, glasses), and subtle makeup be added to the existing VPA. These suggestions will be incorporated into Gabby's appearance in future projects. Participants also suggested that the VPA have a modern name, and consensus decided the name "Gabby" (Figure 1).

Focus group participants found that the language in the preconception risk assessment was understandable and the format was well-designed but suggested some changes. For example, one question that calculates BMI asks participants to enter their height in inches. Several participants reported difficulty with this calculation and suggested including two separate response boxes for feet and inches. Participants also suggested allowing users to complete the questionnaire in multiple sessions, and adding a progress bar to visually represent their progress in completing the risk assessment to improve usability. To further increase usability, participants recommended adding an "Information" button where they could receive an additional explanation about a question, if needed. For example, after noticing a question about cat litter (to assess risk for *Toxoplasmosis*), one participant stated: "Because if I saw that I would…be like, what does cat litter have to do with my health?"

Participants also made specific recommendations to improve the content of the scripts that Gabby provides about each identified risk. For example, participants suggested that Gabby present both the pros and cons of an action recommended to minimize a risk, in order to allow the user to make an informed decision. The research team reviewed and updated the script content to ensure that it reflected this suggestion. Participants also warned against Gabby sounding "preachy;" and as one participant explained,

> I don't like people telling me what to do. With me, when people tell me to do something, I do the opposite, just because. So, if they just give me ideas, they're going to be in the back of my head. And, I'll think about them. And, chances are, I might do them.

When asked whether they would prefer to talk to Gabby or a doctor or nurse, feedback was mixed. Some favored Gabby for the anonymity, lack of embarrassment, and convenience,

while others did not think that Gabby could give them enough in-depth, personalized information. However, many viewed Gabby as a valuable addition to their healthcare visits, either as a way to prepare for an appointment, or as a way to review and reinforce the information discussed during a clinical encounter, as 87 percent of participants reported to have a primary care physician.

Focus group findings confirmed that our web-based system is a culturally relevant, familiar, and viable method for delivering a health risk assessment and interventions, as 97 percent of participants reported to have internet access via their home computer/laptop, Smartphone, or both; 71 percent described accessing the internet an average of five or more times per day.

Usability and Pilot Testing

Preconception Risk Assessment—Table 1 shows the frequency of all the risks identified within each preconception domain for the usability (n=15) and pilot (n=9) participants combined. The average time needed to complete the preconception risk assessment was less than 12 minutes. There were 550 total individual risks identified; the average number of risks identified per woman was 23, with a range of 13 to 37 risks.

There were many important risks that were identified. Seventeen of 24 participants were sexually active and only one wanted to be pregnant in the next year; yet, eight who were sexually active were not using birth control and 14 had not been tested for sexually transmitted diseases. Within the nutrition domain (which had the most risks identified), 18 of 24 subjects noted poor diet, 11 were overweight, and eight used herbal or weight loss supplements. Further, 18 of 24 did not use folic acid or multivitamins with folic acid, 19 did not take calcium, and 19 used over-the-counter medications and/or prescription medications. In terms of identifying risks to personal safety, five of 24 noted physical or sexual abuse, nine noted emotional or verbal abuse, and four did not feel safe in their home.

Table 2 shows the results of usability and pilot testing participants' responses to questions about the preconception risk assessment. Almost all women thought that the preconception risk assessment was useful (19 of 24), user-friendly (22 of 24), and of an appropriate length (16 of 24).

Gabby and Risk Dialogue—Table 3 shows the results of the satisfaction survey administered to the usability subjects (n=15), as well as satisfaction data from pilot subjects at day one of use (n=9) and after two months of use (n=6). Combining usability participants and pilot participants at first use (n=24), most participants trusted Gabby (17 of 24), and thought it was easy to talk with her (15 of 24). Fifteen of 24 also ranked the session length as "just right," and 15 believed that Gabby did a good job answering their questions. Notably, 17 of 24 thought that they would use information from Gabby to improve their own health. When comparing pilot participants at intake (n=9) and follow-up (n=6), they reported it was easier to talk to Gabby at follow-up than at intake (average score of 2.33 at 2 months and 3.11 at intake), but reported they didn't believe that Gabby answered their questions as well (4.17 versus 3.43) and they didn't trust Gabby as well (2.78 versus 3.5). Additionally, difficulty maintaining privacy while using the system in public, such as at the library, was identified as a barrier to regular use by two pilot testing participants. To address this issue, future development could include a subtitle option, instead of speech delivered by Gabby,

System Use and Outcomes from Pilot Testing—Table 4 reports results from our pilot test. During the two month pilot testing period, six of the nine participants logged in to the Gabby system at least once, for a total of 63 sessions, an average of 10.5 sessions per participant. The maximum number of sessions was eighteen. The average session lasted twelve minutes, with a range from two to 32 minutes.

Out of six participants who used the system, there were 128 risks identified; 67 (52%) were discussed with Gabby, and of those discussed, 43 (64%) were added to the My Health To-Do List. Two participants reviewed all of their risks; of participants who logged in to the system at least once (n=6), each reviewed an average of 11 risks.

As shown in Table 4, when asked at the two month phone call about the risks that had been added to the My Health To-Do List, participants reported that 83 percent were either resolved (54%) or the participant had taken some action towards resolving the risk (29%).

Table 5 shows the results of the stage of change analysis of the 43 risks that were added to the My Health To-Do List. Of the risks added to the list, 73 percent of risks that started at contemplation ended at the action or maintenance stage, suggesting that the Gabby system was effective for that group. Almost 92 percent of risks that started in action or maintenance stage remained in action or maintenance stage. However, only one of the sixteen risks that were regarded as precontemplative was added to the My Health To-Do List, and ten out of 19 starting in preparation regressed to precontemplation or contemplation, indicating that the system was not as effective for these sub-groups, and future programming should focus on stage-specific interventions.

DISCUSSION

We created an innovative online health communication system designed to ascertain and lower preconception risks and showed that participants can use the system to create a personalized health profile. The participants felt that the system was useful, easy to use, took an appropriate amount of time, trustworthy, and reliable.

Each participant identified an average of 23 health risks and discussed an average of 11 risks with the system. Participants added the majority of the risks they discussed to their "My Health To-Do List" and took action to partially or fully mitigate 83 percent of the risks on their lists. Future research will look in more detail at the types of risks that women are comfortable or not comfortable discussing with Gabby or adding to the "My Health To-Do List."

These data indicate that the Gabby system is promising in its ability to deliver needed care to African American women, and can address problems of fidelity of message, scale, ease of delivery, quality, clinician time restraints, and patient acceptability. Thus, it addresses problems that we identified as barriers to translating PCC best practices to clinical care[24] -- and that might be important in addressing racial disparities.[25] Finally, it can be used across a range of health care, educational and community settings.

It is not surprising that the participants in the usability and pilot testing reported that the Gabby system was easy to use. In our other studies a VPA named "Louise" guided inpatients through the hospital discharge process; twice as many patients preferred Louise to deliver discharge instructions over a doctor or nurse.[26] It is also possible that African American women might particularly benefit from a HIT system designed for their use.[27] Participants in our qualitative research provided recommendations for Gabby's gender, name and physical appearance. These results confirm a previous research finding that African Americans prefer a VPA who is their same race and gender.[27] A web-based system is a familiar and viable method for delivering health risk assessment and interventions to young African American women, as focus group participants all reported to have internet access via their home computer/laptop, smartphone, or both, and described accessing the internet an average of six times per day. We are encouraged by the potential of the story-authoring functionality for young African American women. However, in the pilot test

(n=9), the story-authoring component was only utilized by two participants. We are continuing to work on programming this feature to increase its ease of use.

Future Plans

Development efforts will center on extending Gabby to provide more substantial interventions; we are working to extend her counseling capabilities with the addition of dialogue designed to promote longitudinal health behavior change, using interventions for each stage of change, as we have done previously.[28] This new functionality will take into account the woman's readiness for change for each risk. Using interactive dialogue, Gabby reviews the risk and identifies the degree to which the woman is motivated to change this risk, following the stages of change from the Transtheoretical Model,[23, 29] and Gabby will respond with a stage-appropriate intervention. For example, if a participant is in *precontemplation*, Gabby will use the client-centered, nonjudgmental, empathetic and encouraging approach of Motivational Interviewing (MI), which is well-suited to those who are in the early stages of behavior change.[30] By approaching the health behavior using MI techniques, Gabby can help resolve the user's ambivalence about taking action, by asking permission, using reflective listening, and eliciting change talk.[30, 31] MI also has a long history of application to addiction counseling but has shown promise in other health behaviors such as diet and physical activity.[32]

This first version of the system was also not effective for those in "preparation," as more than half (10 out of 19) regressed to contemplation or precontemplation. However, ongoing interactions with Gabby will allow the system to identify the degree of behavior change achieved and will encourage participants to continue ongoing behavior change by using interventions appropriate for this new stage, like goal setting and giving tips to overcome barriers. The system is designed to recall previous interactions with subjects and build on previous content. We hypothesize that with longer interventions this new functionality will help Gabby make an impact on users in all stages of change and we will test this in future studies. We also have reason to believe that adding additional content will help address the issue of trust; pilot participants reported trusting Gabby less at two months than at intake (Table 3). Comments made during the phone calls at two months suggest that participants would trust Gabby more if she had more information to share.

We are planning a randomized control trial to test the hypothesis that participants who receive the Gabby intervention will have fewer preconception risk factors after six months than participants in the control group. We will recruit 18-25 year old African-American women from various sites of the PPE program. Beyond the RCT, future work will expand Gabby's capabilities to include texting, social media, or access through smart-phones to meet the technological expectations of our target audience.

Limitations

Though our results are quite encouraging, the number of pilot test subjects to date has been low. Recruitment of subjects was limited to a half-day at a PPE training. We report in this manuscript the results of early testing of this innovative system; we believe that these early results are worthy of dissemination to the preconception care research community, as we continue to develop and test the system. Also, despite being developed for an African American target population, the results reported here include participants of various races. The PPE program usually attracts a group that contains a high proportion of African American women; we were expecting similar proportions at the training from which we recruited for the pilot testing. Our current pool of users was too small to test for the possibility that the system may or may not have a different effect according to the race of the user. It is also possible that participants recruited from the PPE population were more

interested and informed about health and more motivated to improve their preconception health status.

Another limitation is that all of the health information collected from each participant is self-reported; participants could have inaccurately reported their health risks and behaviors due to lack of knowledge or because they did not feel comfortable sharing their health information with the computer or with the researcher during the two month follow-up phone call. Specifically, the finding that 83 percent of risks were either resolved or the participant had taken action at the two-month follow-up could have been influenced by social desirability bias.

Conclusions

Preliminary data on the Gabby system are very encouraging and show that an automated system may be able to improve the quality, reach, delivery, acceptability, and high cost of preconception care.

References Cited

1. Atrash H, Jack BW, Johnson K, Coonrod DV, et al. Where is the "w"oman in MCH? Am J Obstet Gynecol. 2008; 199(suppl):S259–265. [PubMed: 19081420]

2. Atrash H, Jack BW, Johnson K. Preconception care: a 2008 update. Curr Opin Obstet Gynecol. 2008; 20(6):581–9. [PubMed: 18989135]

3. Hall KS, Moreau C, Trussell J. Determinants of Disparities in Reproductive Health Service Use Among Adolescent and Young Adult Women in the United States, 2002-2008. Am J Public Health. :e1–e9. published online ahead of print December 15, 2011. 10.2105/APHA.2011.300380

4. MacDorman, MF.; Mathews, TJ. Behind international rankings of infant mortality: how the United States compares with Europe. NCHS data brief, no 23. Hyattsville, MD: National Center for Health Statistics; 2009.

5. Klerman LV, Ramey SL, Goldenberg RL, Marbury S, Hou J, Cliver SP. A randomized trial of augmented prenatal care for multiple-risk, medicaid-eligible African American women. Am J Public Health. 2001; 91(1):105–111. [PubMed: 11189800]

6. Stevens-Simon C, Orleans M. Low-birthweight prevention programs: the enigma of failure. Birth. 1999; 26(3):184–191. [PubMed: 10655819]

7. Finer LB, Henshaw SK. Disparities in rates of unintended pregnancy in the United States, 1994 and 2001. Perspect Sex Reprod Health. 2006; 38(2):90–96. [PubMed: 16772190]

8. Jack BW, Culpepper L. Preconception care: risk reduction and health promotion in preparation for pregnancy. Journal of the American Medical Association. 1990; 264(9):1147–1149. [PubMed: 2384939]

9. Henderson JT, Weisman CS, Grason H. Are two doctors better than one? women's physician use and appropriate care. Women's Health Issues. 2002; (12):138–149. [PubMed: 12015186]

10. Williams J, Abelman S, Fassett E, et al. Health care provider knowledge and practices regarding folic acid: United States, 2002-2003 [electronic version]. Maternal and Child Health Journal. 2006; 10(suppl):S67–S72. [PubMed: 16721664]

11. Centers for Disease Control and Prevention (CDC). Recommendations for improving preconception health and health care—United States: a report of the CC/ATSDR preconception care workgroup and the select panel on preconception care. Morbidity and Mortality Weekly Reports. 2006; 55(RR-6):1–23.

12. Jack BW, Atrash H, Coonrod DV, Moos M-K, O'Donnell JK, Johnson K. The clinical content of preconception care: an overview and preparation of this supplement. Am J Obstet Gynecol. 2008; 199(Suppl):S266–279. [PubMed: 19081421]

13. Bickmore T, Pfiefer L, Yin L. The role of gesture in document explanation by embodied conversation agents. International Journal of Semantic Computing. 2008; 2(1):47–70.

14. Bickmore T, Gruber A, Picard R. Establishing the computer-patient working alliance in automated health behavior change interventions. Patient Education and Counseling. 2005; 59:21–30. [PubMed: 16198215]

15. Bickmore T, Giorgino T. Health dialog systems for patients and consumers. Journal of Biomedical Informatics. 2006; 39:556–571. [PubMed: 16464643]

16. Bickmore, T.; Pfeifer, L. Relational agents for antipsychotic medication adherence. Proceedings of the CHI'08 Workshop on Technology in Mental Health; Florence, Italy. Apr 6. 2008

17. King A, Bickmore T, Campero M, Pruitt L, Yin L. Employing 'Virtual Advisors' in Preventive Care for Underserved Communities: Results from the COMPASS Study. Journal of Health Communication. (to appear).

18. Bickmore T, Pfeifer L, Jack B. Taking the time to care: empowering low health literacy hospital patients with virtual nurse agents. Computers in Medicine. 2009

19. Bickmore TW, Pfeifer LM, Byron D, et al. Usability of conversational agents by patients with inadequate health literacy: evidence from two clinical trials. J Health Commun. 2010; 15(Suppl 2): 197–210. [PubMed: 20845204]

20. Jack BW, Culpepper L, Babcock J, Kogan M, Wesimiller D. Addressing preconception risks at the time of a negative pregnancy test? a randomized trial. Journal of Family Practice. 1998; 47:33–38. [PubMed: 9673606]

21. Jack B, Atrash H. Preconception health and health care: the clinical content of preconception care. AJOG. Dec.2008 199(6) Supplement B.

22. Schiavo R, Gonzalez-Flores M, Ramesh R, Estrada-Portales I. Taking the pulse of progress toward preconception health: preliminary assessment of a national OMH program for infant mortality prevention. Journal of Communication in Healthcare. 2011; 4(2):106–117.

23. National Cancer Institute. Theory at a glance: a guide for health promotion practice. 2. US Department Health and Human Services; 2005.

24. Jack B, Atrash A, Bickmore T, Johnson K. The future of preconception care. Women's Health Issues. 2008; 18S:S19–25. [PubMed: 19059546]

25. Institute of Medicine (IOM). Unequal treatment: confronting racial and ethnic disparities in healthcare. Washington, DC: The National Academies Press; 2003.

26. Jack, BW.; Bickmore, TW. Analysis of patient satisfaction with virtual patient advocate for hospital discharge. 2012. Unpublished raw data.

27. Baylor, AL.; Shen, E.; Huang, X. E-Learn (World Conference on E-Learning in Corporate, Government, Healthcare, & Higher Education). Phoenix, Arizona: 2003. Which pedagogical agent do learners choose? the effects of gender and ethnicity.

28. Bickmore T, Schulman D, et al. A Reusable Framework for Health Counseling Dialogue Systems based on a Behavioral Medicine Ontology. Journal of Biomedical Informatics. 2011; 44:183–197. [PubMed: 21220044]

29. Kreuter MW, McClure SM. The role of culture in health communication. Ann Rev Public Health. 2004; 25:439–455. [PubMed: 15015929]

30. Resnicow K, Dilorio C, Johanna SE, Borrelli B, Hecht J, Ernst D. Motivational interviewing in health promotion: it sounds like something is changing. Healthy Psychology. Sep; 2002 21(5): 444–451.

31. Resnicow K, McMaster F. Motivational interviewing: moving from why to how with autonomy support. International Journal of Behavioral Nutrition and Physical Activity. 2012; 9:19. [PubMed: 22385702]

32. Schulman D, Bickmore T, Sidner C. An intelligent conversational agent for promoting long-term health behavior change using motivational interviewing. AAI Spring Symposium on AI and Health Communication. 2011

33. Mathews TJ, MacDorman MF. Infant mortality statistics from the 2005 period: linked birth/infant death data set. Natl Vital Stat Rep. 2008; 57(2):1–32. [PubMed: 18972721]

SO WHAT?

### What is already known on this topic?

Focus on the health of young African American women is clearly warranted. Substantial disparities in birth outcomes remain, despite over 30 years of research in this area. Black women are approximately twice as likely to deliver a low birth-weight (LBW) infant as white women (14% and 7.3%, respectively).[33] Interventions have focused on care during pregnancy, but this is perhaps too late to impact pregnancy outcomes. The current project is part of an effort to focus on engaging young women before they become pregnant – a concept called preconception care. Simply, healthy women are more likely to have healthy babies.

What does this article add?

This article describes an innovative health communication system (Gabby) that provides preconception care. Our preliminary data indicate that the Gabby system is promising in its ability to deliver needed care to women, and can address problems of fidelity, scale, ease of delivery, clinician time restraints, and patient acceptability, and can be used across a range of health care, educational and community settings.

What are the implications for health promotion practice or research?

The Gabby system can be applied in a range of health care, educational and community settings to improve young women's access to preconception care. Identifying the health risks and intervening on them may improve quality and cost.
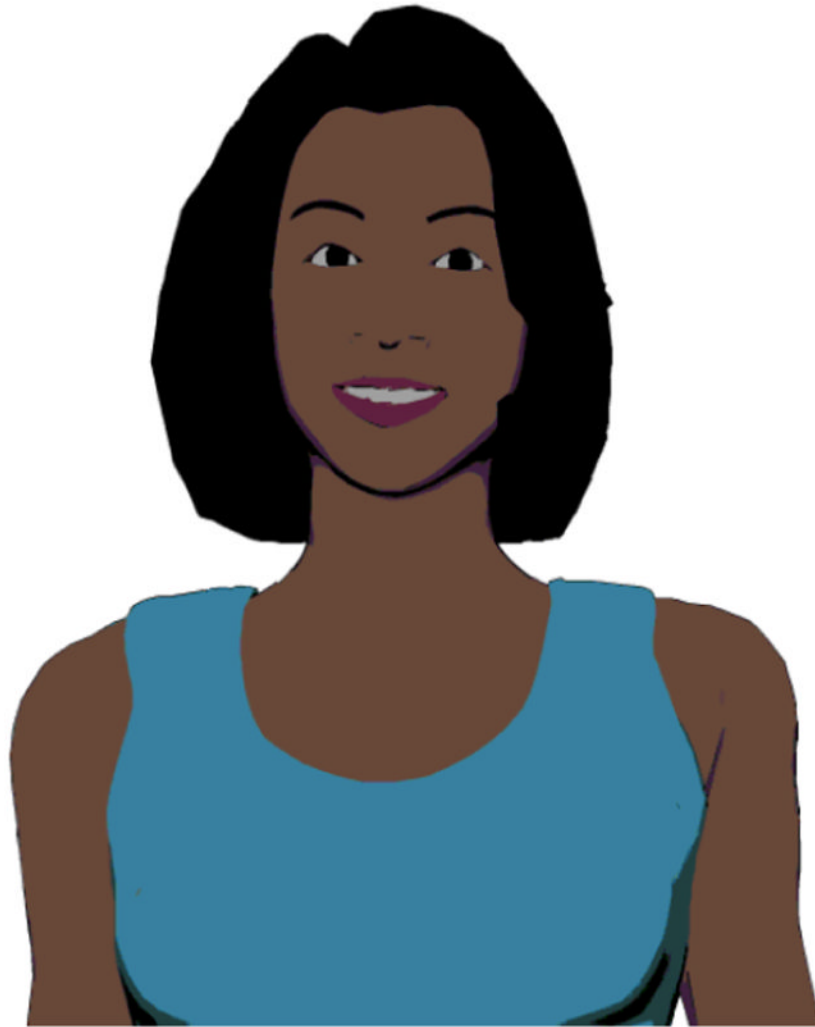
Gabby

Figure 1.
An image of "Gabby," the preconception care virtual patient advocate

Table 1

Preconception Risks Organized by Domain, with Frequency Identified in Risk Assessment [*] (n=24)

Domain	Preconception Risk	Frequency Identified by Preconception Risk Assessment # of risks (% of total risks)
Healthcare and Programs	Health Insurance, none	1
	Inadequate Health Insurance	3
	Access to Care, No PCP	2
	Inadequate Financial Resources[‡]	10
	Periodontal Disease	8 [†]
	Total, Healthcare and Programs	**24 (4.4%)**
Relationships	Physical or Sexual Abuse	5
	Emotional or Verbal Abuse	9
	Don't feel safe	4
	Total, Relationships	**18 (3.3%)**
Reproductive Health	Not using birth control	8
	Prior Preterm Birth Infant	1
	Uterine Anomalies	1
	Abortion	1
	Infant or Child Death	1
	High birth-weight infant	1
	Low birth-weight infant	1
	Birth defect	1
	Neonatal Intensive Care Use	1
	Vaginal Bleeding in Pregnancy	1
	Born low birth-weight or preterm	4
	Mother was born low birth-weight or preterm	13
	Total, Sex and Reproductive Health	**34 (6.2%)**
Health Conditions and Medicines	Overactive Thyroid Disease	2
	Asthma	5
	Woman with Disabilities	1
	Prescriptions	8 [†]
	"Over the Counter" Medicines	16 [†]
	Total, Health Conditions and Medicines	**32 (5.8%)**
Genetic Health History	Personal History	6
	Don't know about genetic history	5
	Family history	16 [†]
	Ethnicity-Based Health Risk	23 [†]
	Total, Genetic Health History	**50 (9.1%)**
Emotional and Mental Health	Depression	3

Domain	Preconception Risk	Frequency Identified by Preconception Risk Assessment # of risks (% of total risks)
	Anxiety	3
	Family history of psychiatric condition	12
	Positive Screening for Depression	1
	Feeling Stressed	14
	Total, Emotional and Mental Health	**33 (6.0%)**
Immunizations and Vaccines	At risk for Hepatitis B	3[†]
	Need Varicella Vaccine	3
	Need MMR Vaccine	3
	Need Influenza Vaccine	12
	Need Tdap Vaccine	3
	Need Td Vaccine	4[†]
	Need HPV Vaccine	7[†]
	Unsure of Immunization Status for All Immunizations	3
	Total, Immunizations and Vaccines	**38 (6.9%)**
Infectious Diseases	At risk for Hepatitis C	7
	At risk for Tuberculosis (TB)	14[†]
	TB, has infection	1
	At risk for STI	14[†]
	Not tested for an STI and is sexually active	14[†]
	At risk for Cytomegalovirus	4
	Immigrant or Refugee status	6[†]
	At risk for Malaria	8
	History of or at risk for Gonorrhea	1
	Total, Infectious Diseases	**69 (12.6%)**
Substance Use	Alcohol	10[†]
	Tobacco	2
	Illicit Substances	5
	Total, Substance Abuse	**17 (3.1%)**
Nutrition and Activity	Healthy Eating[§]	18[†]
	Mercury	5[†]
	Listerosis	15[†]
	Need more Omega-3 Fatty Acids	5[†]
	Eating Disorder	5
	Exercise	4
	Multivitamin with Folic Acid	18[†]
	Need more Calcium	19[†]

Domain	Preconception Risk	Frequency Identified by Preconception Risk Assessment # of risks (% of total risks)
	Vitamin D	17[†]
	Iron	12[†]
	Vitamin A	6[†]
	Caffeine	9
	Overweight	11[†]
	Herbal and Weight Loss Supplements	8
	Total, Nutrition	**152 (27.6%)**
Environmental Issues	Well Water	6
	Lead	8
	Plastic Bottles	17[†]
	Plastic Lining of cans	4
	Toxoplasmosis	8[†]
	Workplace exposure	7
	Household exposure	4[†]
	Total, Environmental Issues	**54 (9.8%)**
Men and Healthcare	Partner has not been to doctor in past year	13[†]
	Partner does not have a PCP	6
	Partner has not been counseled on RLP	10[†]
	Total, Men and Healthcare	**29 (5.3%)**
	Total for All Domains	**550 (100%)**

[*] **The following risks were not identified by any participants:** Using withdrawal method for contraception, Plan B, Rhythm Method, Miscarriage (1 or 2), Miscarriage (3 or more), Two second trimester miscarriages, Prior Cesarean Section, Prior Stillbirth, Short time between pregnancies, Diabetes, Pre-diabetes, Gestational Diabetes, Underactive Thyroid Disease, Phenylketonuria, Hypertension, Rheumatoid Arthritis, Lupus, Renal Disease, Cardiovascular Disease, Thrombophilia, Seizure Disorders, Cancer, Bipolar Disorder, Schizophrenia, Hepatitis C (current infection), Chlamydia, Syphilis, HIV, Soil Hazards.

[†] Those risks marked with † indicate risks where at least one pilot participant (n=9) reported that the risk was "addressed," meaning that the risk had been resolved and/or action had been taken towards resolving the risk

[‡] Inadequate Financial Resources" was identified as a risk if the participant indicated that she: 1) has trouble paying bills like rent, water, heat or electricity; 2) uses assistance programs like Medicaid, Health Safety Net or Free Care, TANF or welfare, food stamps, housing assistance, energy assistance, or WIC; or 3) has trouble getting to work or appointments.

[§] "Healthy Eating" means that the participant was at risk for having an unhealthy overall diet. It was identified as a risk if the participant indicated that: 1) she did not eat 5 or more servings of fruits and vegetables combined per day; or she 2) she tends to snack on junk food (chips, soda, candy, desserts) most days.

Table 2

Usefulness and Usability of the Preconception Risk Assessment Among the Usability and Pilot Subjects

	Usability Subjects[*] (mean) (n=15)	Pilot Subjects[†] (mean) (n=9)	Scale
How useful was the health survey that you took at the beginning?	2.60	2.44	1= Very Useful 4= Neutral 7= Not Useful At All
How easy or difficult where the questions to answer?	1.87	1.67	1= Easy 4= Neutral 7= Difficult
Did you feel that the health survey was (too short…just right…too long)?	4.13	3.89	1= Too short 4= Just Right 7= Too Long
Would you be willing to retake the health survey in:	2.20	2.00	1= A month 2= 3 months 3 = 6 months 4 = A year or more 5= Never

[*] These subjects responded to the survey after interacting with Gabby at a singe session while observed in our laboratory.

[†] These subjects responded to the survey after interacting with Gabby in a single training session that discussed 3 preselected risks.

Table 3

Results of Satisfaction Survey Administered to Usability and Pilot Test Subjects after Interacting with Gabby

	Usability Testing[*] (n=15)	Pilot Training Session[†] (n=9)	Pilot Testing After 2 Months of Use[‡] (n=6)	Scale
How easy was it to talk with Gabby?	2.40	3.11	2.33	1= Easy 4= Neutral 7= Difficult
How much do you trust Gabby?	2.93	2.78	3.5	1= Very Much 4= Neutral 7= Not At All
Did you feel your session with Gabby was too short, just right or too long?	4.27	4.44	4	1= Too Short 4= Just Right 7= Too Long
How well did Gabby answer any questions that you had?	2.67	3.43	4.17	1= Very Well 4= Neutral 7= Not At All
Do you think you will use some of the information from Gabby to improve your health?	2.40	3.33	3.5	1= Definitely Yes 4= Neutral 7= Definitely No
To what degree would you rather have talked to a doctor or nurse than Gabby?	3.93	2.78	3.5	1= Definitely Doctor or Nurse 4= Neutral 7 = Definitely Gabby
Would you like to interact with Gabby again?	2.80	2.56	N/A	1= Definitely Yes 4= Neutral 7= Definitely No

[*] These subjects responded to the survey after interacting with Gabby at a singe session while observed in our laboratory.

[†] These subjects responded to the survey after interacting with Gabby in a single training session after discussing 3 preselected risks.

[‡] These subjects responded to the survey after interacting with Gabby for up to 2 months and discussed their own preconception risks with Gabby online.

Table 4

Status of Risks for Participants Two Months After Beginning to Use the Gabby System

Risks for Pilot Participants that Used the Gabby System (n=6)		
Risks identified per participant	**21.3**	**100%**
Risks discussed with Gabby per participant	11	52%
Risks added to MHTDL [*] **per participant:**	**7.2**	**64%**
Status of Risks Added to MHTDL at 2 Months [†]		
Risks Resolved	3.5	54%
Took action at 2 months	2.2	29%
No action to reduce risk	1.5	17%
Risks not added to MHTDL per participant [‡]	**4**	**35%**
Disagreed that item was a risk	2.5	74%
Past/Resolved Risk	0.8	13%
Agreed it was a risk but did not want to address	0.7	12%

[*] MHTDL stands for "My Health To-Do List"

[†] This is information is self-reported by the participant on a telephone call 2 months after beginning to use the Gabby system. The participant agreed that all risks in this section were correctly identified at baseline. "Risks Resolved" are no longer a risk due to action taken by the participant. "Took action at 2 months" refers to risks the participant is still in the process of resolving. "No action to reduce risk" means that the user reported that the risk was correctly identified at baseline but has done nothing to resolve it.

[‡] This is information is self-reported by the participant on a telephone call 2 months after beginning to use the Gabby system.

Table 5

Stage of Change at Enrollment Compared to After 2 Months of Using the Gabby System Progression for Each Risks Added to the "My Health To-Do List"

Stage at Enrollment	# Risks added to MHTDL* (out of # discussed with Gabby)†	# Risks at 2-month Phone Call (%)				
		Precontemplation	Contemplation	Preparation	Action or Maintenance	# self-reported not a risk
Pre-contemplation	1 (out of 16)	0 (0%)	0 (0%)	0 (0%)	1 (100%)	0 (0%)
Contemplation	11 (out of 12)	1 (9%)	2 (18%)	0 (0%)	8 (73%)	0 (0%)
Preparation	19 (out of 21)	5 (26%)	5 (26%)	1 (5%)	7 (37%)	1 (5%)
Action or Maintenance	12 (out of 16)	0 (0%)	0 (0.00%)	1 (8%)	11 (92%)	0 (0%)
Total	43 (out of 67)	6 (14%)	7 (16%)	2 (5%)	27 (63%)	1 (5%)

*
MHTDL stands for the "My Health To-Do List

†
67 risks were discussed with Gabby, of which 43 were added to the My Health To-Do List