

Interactive Voice Response: A highly tailored mobile health method to promote behavior change.

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In the UK, adults report spending 226 billion minutes per year in voice calls (OfCam, 2015), which highlights the huge potential of phone platforms to reach people and generate large amount of data.

Automated phone-based tools, such as Interactive Voice Response (IVR), can enable health behaviour change and generate novel data on the underline factors of behaviour change and maintenance in a limited time. However, to date the vast majority of such interventions have been developed and tested in the USA. This article is an overview of the development and pre-test of the first IVR intervention within the UK to support medication adherence.

What is Interactive Voice Response?

Interactive Voice Response (IVR) is an automated, phone-based platform that facilitates health care communication using speech files. A series of highly quality pre-recorded chunks of information are delivered to participants' mobile phones and/or landlines. Participants use their keypad or microphone as an interface to exchange information with an interactive algorithm.

IVR platforms were introduced in the early seventies, and since then their definitions have varied depending on their architecture and the

purpose of use. IVR platforms can be structured to contain from a single prompt to multiple navigation options. The degree of interaction can also vary significantly between platforms. Some IVR systems facilitate one-way communication, where no features for participants' response are integrated, whereas other platforms integrate software that enables participants' engagement in a series of dialogues. IVR platforms can also vary in duration and include from very brief to lengthy audio files.

IVR was initially used as an automated interviewing technique to screen medical symptoms and collect survey data (Piette, 2000; Piette et al., 2015). In later versions IVR was integrated into the health care to interchange clinical data between patients and practitioners, aiming to reach those patients in lower socioeconomic backgrounds with limited access to healthcare. In its simplest format, patients reported clinical data (e.g. blood glucose levels) or symptoms to the IVR system. More complex IVRs incorporated decision support systems to facilitate real-time adjustments to health care (e.g. adjustment in medication dosage).

One of the advantages of IVR that appealed to those with poorer health or literacy is the use of speech instead of text. Speech data require less effort than traditional writing techniques, allowing articulation of thoughts and facilitating multi-tasking. On the other hand, more complex information might be more difficult to comprehend when heard rather than read. The high acceptability of IVR is also associated with the flexibility of the platforms to run automatically, continuously, be adaptable to participants' pace

and allow patients' elaboration of their perceived treatment needs and priorities, in addition to the increased anonymity and confidentiality to sensitive information.

IVR and Behavior Change: the use of Theory and Behavior Change Techniques

Given its popularity, IVR has recently been used as a platform to deliver behaviour change messages (Kassavou & Sutton, 2016). However, it is largely unknown whether IVR interventions can be effective at changing behaviour, let alone the mechanisms that account for their efficacy. To answer this questions, we conducted a systematic review of randomized controlled trials. We found 14 trials, the great majority of which were conducted in North America. Meta-analytic results suggested that IVR interventions can effectively promote changes in medication adherence and physical activity but showed limited efficacy in changing diet and alcohol consumption. We further looked at the features of the IVR interventions that might impact on their efficacy and assessed the use of theory and behaviour change techniques (BCTs) (Michie et al., 2013).

To assess the theoretical basis of the interventions we used a theory coding frame of five criteria with "yes" or "no" responses based on the Michie and Prestwich (2010) framework for coding theories. Studies were assessed in terms of whether: (1) a theory/theoretical construct(s) or techniques were mentioned in the introduction, (2) an explicit description of how intervention technique(s) were linked to theoretical construct(s) was described, (3) changes in theoretical constructs, as result of the intervention were measured, (4) mediation effects of any/all theoretical constructs on behaviour were measured, and (5) findings were explained in relation to

theory/ theoretical construct(s) or suggestions were made to refine theory.

Out of the 14 included trials, 10 discussed a theoretical construct, theoretical model or other theoretical approaches in relation to the content of the intervention. Four studies mentioned the use of multiple theories, and five studies used a single theory or theoretical approach. Specifically, the Transtheoretical Model was mentioned in four studies; Cognitive Behavioural Therapy was mentioned in three studies; each of the Theory of Planned Behaviour, Social Cognitive Theory, beliefs regarding medications, and Motivational Interviewing was mentioned in two studies; and each of the Social Norms Theory, Planning, Health Belief Model, Chronic Care Model, Reflective listening, and Communication Theory was mentioned in one study. However, none of the included studies satisfied all, or even half, of our coding criteria. Only one study, which was informed by five different theoretical approaches, measured changes in one of the targeted theoretical construct at baseline and follow up. None of the interventions tested the mediating effect of theoretical construct(s) to produce effects on the targeted behaviour, which emphasizes our limited knowledge on the underlying mechanisms that produce changes in response to IVR interventions. Nevertheless, when we coded the BCTs we identified a range of techniques, with each IVR intervention including between two and 19 BCTs delivered within a voice message lasting between 40 seconds and 10 minutes. These results highlight the potential of IVR interventions to deliver complex behaviour change messages in a very brief period of time.

IVR to support medication adherence

We designed a new IVR platform to provide

highly tailored advice and support to address each patient's reasons for medication non-adherence. Our decisions on the structure and the topography of the platform were informed by consultations with telecommunication experts in the University of Cambridge and discussions with experts in the industry. The IVR system has been structured to flexibly implement from simple prompts to more elaborative dialogues. Participants have the option to listen to more complex messages repeatedly, and can provide their input during the intervention and at a time they prefer to interact with the IVR system (e.g. by triggering an inbound call). Participants can further tailor elements of the delivery mode (e.g. frequency of the calls) and the intervention content (e.g. requesting additional or different information) using the voice recognition software.

We pre-tested the acceptability of the IVR system with 13 people with long-term conditions (i.e. Hypertension and/or Diabetes type 2), recruited via primary care databases. Participants were asked to trigger IVR calls, interact with the IVR system and provide experiential feedback on the delivery mode and intervention content. Participants enjoyed the pitch and the tone of the voice delivering the messages and the flow of the dialogue. They found the voice warm, friendly and easy to distinguish from cold calls. Moreover participants reported preferences on female voices and of greater volume. They all reported being satisfied with the voice recognition software and the available options to tailor the intervention content and delivery to their perceived needs. Moreover, participants made recommendations on the structure of the platform (e.g. navigation options), the delivery style (e.g. duration of each call) and provided input on message content. Based on the participants' input and theory we developed the intervention content and delivery mode, and we will further test the feasibility of the IVR to support medication adherence to people with long term condition recruited by primary care practices.

Future research and conclusion

Mobile devices have the potential to act as highly tailored tools to automate informed healthcare. Still, without rigorous evidence on the mechanisms of behaviour change, the type of targeted behaviour and the outcomes of the change produced, our understanding on how we can promote behavior change will be limited.

IVR has the capacity to support patients' process of initiation and maintenance of behaviour change in real time, and to bring new perspectives to existing theories, by providing objective data on the process that account for sustained behavior change. Speech data can be analyzed to objectively identify participants' emotions and provide tailored advice to further facilitate articulation of thoughts. Future interventions could integrate voice recognition and sensors of behavioural enactment (e.g. ingestible pill sensors, wearable patches, refill medication records, accelerometers) to trigger highly tailored messages and enhance participants' behavioural performance. Future intervention could usefully integrate the IVR to other delivery modes, such as face-to-face consultations and text messaging to facilitate effectiveness and potential assessment of the cost-effectiveness of behavior change interventions. Moreover, integration of objective clinical outcomes could lead to better insights into health care communication and optimize therapies.

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