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# Smart health and innovation: facilitating health-related behaviour change

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Non-communicable diseases (NCD) are the leading cause of death globally. Smart health technology and innovation is a potential strategy for increasing reach and for facilitating health behaviour change. Despite rapid growth in the availability and affordability of technology there remains a paucity of published and robust research in the area as it relates to health. The objective of the present paper is to review and provide a snapshot of a variety of contemporary examples of smart health strategies with a focus on evidence and research as it relates to prevention with a CVD management lens. In the present analysis, five examples will be discussed and they include a physician-directed strategy, consumer directed strategies, a public health approach and a screening strategy that utilises external hardware that connects to a smartphone. In conclusion, NCD have common risk factors and all have an association with nutrition and health. Smart health and innovation is evolving rapidly and may help with diagnosis, treatment and management. While on-going research, development and knowledge is needed, the growth of technology development and utilisation offers opportunities to reach more people and achieve better health outcomes at local, national and international levels.

**Ehealth: mhealth: Technology: Smartphone: Chronic disease**

### Chronic and non-communicable diseases burden

Non-communicable diseases (NCD), also known as chronic diseases, are the leading cause of death globally, accounting for 68 % of the total deaths globally in 2012[1]. NCD tend to be of long duration and are the result of a combination of genetic, physiological, environmental and behavioural factors[2]. The main types of NCD are CVD (including heart attack and stroke), cancers, chronic respiratory diseases and diabetes[2]. NCD are responsible for the deaths of more than 40 million people each year, equivalent to 70 % of all deaths globally[2]. In 2013, the WHO member countries adopted a comprehensive global monitoring framework at the World Health Assembly and set a global target of 25 % relative reduction in overall mortality from NCD, including a 25 % relative reduction in the prevalence of raised blood pressure and halting the rise in diabetes and obesity[1]. However, these targets cannot be achieved unless concerted actions are taken by all stakeholders immediately. The associated challenge is that more people are living with chronic diseases, hospital stays are becoming much shorter and there are escalating numbers of people requiring ongoing management and support. Chronic diseases generally cannot be cured, do not resolve spontaneously and management is ongoing and long-term.

### Potential opportunities resulting from technology

Mobile phone technology offers opportunities to maximise reach and effectiveness of health-related behaviour change. Worldwide, more than seven billion people own mobile phones and two billion own and use a smartphone[3]. The rapid development in affordable technology has led to predictions that >50 % of people globally will

**Abbreviations:** AF, atrial fibrillation; ECG, electrocardiogram; NCD, non-communicable diseases; CONNECT, The COnsumer NavigatioN of Electronic Cardiovascular Tools; TORPEDO, the Treatment Of cardiovascular Risk in Primary care using Electronic Decision support.

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own a smartphone by 2018[3]. Mobile health (mHealth) and smart health are terms used to describe the use of mobile and wireless technology for delivering and improving healthcare. However, despite rapid growth in the availability and affordability of technology and mobile devices, to date there remains a paucity of published robust research in the area as it relates to health. This is potentially due to the time constraints associated with securing research funding, conducting, analysing and reporting robust clinical trials[4]. Therefore, research in this area is vital and expanding with increasing opportunities to develop and evaluate innovative strategies. A recent review by Neubeck *et al.*[4] explored features and evidence associated with mobile phone applications (commonly known as apps) for CVD management. The authors offer some excellent examples but conclude that the complexity of selecting and evaluating an app remains challenging[4]. Overall mobile devices and smart health technology have great potential in terms of flexibility particularly in relation to modes of delivery and time. Indeed mobile technology can reach people in remote and resource-poor environments in efficient ways that were previously unachievable[5].

## Mobile technology to deliver healthcare

Health-related services via mobile and wireless communication technologies can be delivered via mobile phones, smartphones, tablets and personal digital assistants to support the achievement of health objectives[6]. Strategies for delivery include (but are not limited to) text messaging, smartphone apps and utilisation of hardware that connects to mobile devices. Each strategy requires different resources, technology and connectivity. For example, text messaging requires a connection to a telecommunications service, while apps require connection to the internet[5]. Text messages have the advantages of an instant transmission and low cost, being less intrusive compared with phone calls[7], as well as being a push technology where the text message will be received independent of the mobile phone being in use at the time. In addition, automatic computer systems can be used to deliver text messages on a large scale, being easy and saving the costs of hiring dedicated personnel for this task[5]. Hence, text messages are being used in the healthcare setting as a tool to support healthy behaviours and deliver preventive care. In contrast, smartphones require an internet connection and combine features of a traditional mobile phone with computer capabilities[8]. This enables the download of an enormous number of software apps that can greatly impact in the day-to-day management of chronic disease[9].

The aim of the present review is to provide insight and highlight of a variety of strategies that utilise smart health and innovation to facilitate health-related behaviour change. Five examples focused on management of CVD risk are included. They are the (i) TORPEDO (The Treatment of cardiovascular Risk in Primary care using Electronic Decision supOrt) study[10,11] that tested a web-based physician-directed electronic decision system; (ii) CONNECT (The COnsumer NavigatioN of Electronic Cardiovascular Tools) study[12,13] that is testing a consumer-directed responsive web-app; (iii) TEXTME (The Tobacco, EXercise and diet Messages) study[14–16] that is a stand-alone text message intervention; (iv) FOODSWITCH[17] texting a public health approach to improving food choices at the point of purchase and (v) SEARCH AF (The screening for atrial fibrillation (AF) using iPhone electrocardiogram (ECG) in pharmacies)[18] that utilised smartphone hardware to provide widespread screening for AF.

### *The Treatment of cardiovascular Risk in Primary care using Electronic Decision supOrtstudy*

The TORPEDO study provides one example of robust research conducted to determine effectiveness of a physician-directed technology-based strategy. The trial itself was a parallel arm cluster-randomised controlled trial involving forty general practices and twenty Aboriginal Medical Services in Australia[10]. Practices were eligible to participate if there was exclusive use of one of the two compliant software systems to record risk factor information, pathology test results and prescribe medications and a willingness from all staff to use the intervention[10].

The TORPEDO intervention was multifaceted and comprised point-of-care electronic decision support, audit and feedback tools, and clinical workforce training improved CVD risk management[10]. The final TORPEDO cohort comprised 38 725 patients[11]. At follow-up, the proportion of patients with recommended CVD risk factor measurements was higher in the intervention than control arm (63 *v.* 53 %, $P = 0{\cdot}02$)[11]. There were also significant treatment escalations (new prescriptions or increased numbers of medicines) for antiplatelet (17·9 *v.* 2·7 %; $P < 0{\cdot}001$), lipid-lowering (19·2 *v.* 4·8 %; $P < 0{\cdot}001$) and blood pressure-lowering medications (23·3 *v.* 12·1 %; $P = 0{\cdot}02$)[11]. Overall, the TORPEDO study demonstrated that a computer-guided intervention comprising point-of-care decision support, audit and feedback tools, training and support improved cardiovascular risk factor screening for CVD in primary care[11]. It provides a contemporary example of how technology can be used to facilitate better delivery of healthcare via physician-directed strategy.

### *The COnsumer NavigatioN of Electronic Cardiovascular Tools study*

The CONNECT study provides an example of a CVD risk management app and website for consumers. The trial itself is ongoing and is a multi-centre single blind randomised controlled trial involving 1000 participants with 18 months follow-up[12]. The aim is to test the effectiveness, compared with usual care, of a mobile intervention with a website and responsive app that is integrated with each patient's primary care record on CVD risk management[12]. The trial is augmented by formal economic and process evaluations to assess

acceptability, equity and cost-effectiveness of the intervention[12].

The intervention is electronically integrated with the primary care provider's software and includes interactive smartphone and internet platforms. For development, a collaborative user-centred design process with four phases was documented and followed[13]. The phases involved defining the target audience and needs, testing and refinement, software development including validation and algorithm testing as well as user acceptance evaluation and β testing[13]. Through this process, the team were able to better understand end-user needs and preferences, thereby improving and enriching the detailed system designs and prototypes for the mobile responsive web app[13]. The final technology is interactive, has visual appeal, content is based on credible health information, includes virtual rewards and there is a focus on CVD risk factors, medications and psychosocial support. A key learning from this process is that considerable upfront investment in user-centred design with consumer engagement aided the integration of their needs into the concept, specifications, development and refinement of the intervention[13].

### *The Tobacco, EXercise and diet Messages study*

The TEXTME study provides a contemporary example of how text messaging can be successfully used in management of a chronic disease. The study was a single-blind randomised controlled trial that aimed to reduce cardiovascular risk in 710 patients with CHD[14,15]. The intervention was delivered by purpose built text message software system[19]. Therefore, participants required a mobile phone to participate but not a smartphone or internet connection. A program of four semi-personalised text messages per week were sent to participants for 6 months and messages were sent on random days and at random times[14]. The text messaging program development is detailed elsewhere[20] but was based on behaviour change techniques linked to the theoretical framework[21]. In brief, the messages provided practical tips and advice, motivation and information that aimed to improve general heart health, diet, physical activity and encourage smoking cessation if relevant[20].

After 6 months, those allocated to the text message intervention group had a significantly lower cholesterol, blood pressure and BMI, rate of smoking and significant increases in physical activity, compared with the control group[15]. The authors concluded that a lifestyle-focused text messaging service compared with usual care resulted in improvement in other CVD risk factors but the long-term outcomes are yet to be determined and require further research[15]. The program was also found to be cost-effective[22] and a parallel process evaluation found that almost all participants found the text message program to be useful and easy to understand[16]. Detailed qualitative research revealed that factors increasing engagement with the program included: (i) ability to save and share messages, (ii) support of providers and family, (iii) a feeling of support, (iv) program initiation close to the time of a CVD event, (v) personalisation of the messages, (vi) opportunity for initial face-to-face contact and (vii) program having content from a credible source[16]. The authors highlighted that exploring the theoretical frameworks for engagement and effect provides insight into the causal pathway between the text message intervention, behaviour change and impact on risk factor measures.

### *FoodSwitch*

FoodSwitch provides an example of a public health initiative using technology. FoodSwitch is a smartphone app that allows consumers to scan the barcodes of packaged foods at the supermarket or at home, using the camera on their phone[17]. The app was first developed as a collaboration between researchers based at The George Institute for Global Health, developers from Xyris Software Pty Ltd and the health communications team at Bupa Australia[17]. The objective was to deploy a mobile phone app that would allow users to access quick and easy-to-understand information about the nutritional characteristics of packaged foods and, where possible, would suggest healthier alternative products[17]. Simplicity was a clear objective during the development of FoodSwitch and the app uses a colour-coded system (red, amber and green) that is specific to each nutrient. If a barcode is scanned but the corresponding product is not identified in the database, then the user is asked to photograph the front of the package and the nutritional information. The data are then forwarded to the coordinating centre and the information is added to the centralised database[17]. This crowdsourcing function was a highly innovative concept that enabled consumers to contribute information on missing products.

When launched in Australia in 2012, the FoodSwitch app was downloaded by 400 000 users in the first 18 months[17]. The original database of food products was based on 17 000 Australian packaged foods but through crowdsourcing more than 60 000 additional products have since been added[17]. Based on this success and the clear potential for scalability, a series of further upgrades have been released and the app has been launched in multiple countries around the world[17]. The implementation of FoodSwitch in Australia was initially done with the objective of providing consumers with a tool that would enable them to make better food choices, both by providing nutritional information in an at-a-glance, easy-to-understand format and by suggesting healthier alternative products within the same category[17]. However, consumer-level behaviour change is not the only means by which FoodSwitch has had a public health impact. The development team highlight that data collected through crowdsourcing presents a new capacity to define and track the nutritional composition of the food supply over time[17]. These data potentially make it possible to influence the food industry and policy-makers as well as provide opportunity to objectively evaluate the extent to which the food industry and government deliver on commitments to improve the quality of the food supply[17].

*The screening for atrial fibrillation using iPhone electrocardiogram in pharmacies study*

The SEARCH AF study is an example of a tested approach for screening of health conditions using external hardware that is connected to a user's smartphone[18]. The aim of the study was to investigate the effectiveness and cost-effectiveness of community screening (in pharmacies) for AF using an external hardware device that enables real-time single lead ECG assessment. The overarching objective was to identify unknown AF in the community and enable subsequent anti-thrombotic treatment and reduction in stroke risk[18]. For the study, pharmacists performed the ECG and an automated AF algorithm was applied to determine if the patients was experiencing AF[18].

The hardware device is now marketed as Kardia Mobile (previously AliveCor Heart Monitor) and is able to record, store and transfer single-channel ECG rhythms[23]. To use the device, the user simply rests two or more fingers on the sensors for 30 s[23]. The associated software then displays ECG rhythms on the smartphone screen and detects the presence of AF and normal sinus rhythm[18]. In the SEARCH AF cohort study (*n* 1000) newly identified AF was found in 1·5 % (95 % CI 0·8, 2·5 %) and overall AF prevalence was 6·7 %[18]. The smartphone ECG algorithm showed 98 % sensitivity for AF detection and 91 % specificity and the strategy was found to be cost effective[18]. The authors concluded that the smartphone hardware offered a feasible and cost-effective strategy for widespread community screening for AF[18].

## Conclusion

NCD have common risk factors and all have an association with nutrition and health. Therefore, the management of these conditions requires a focus on nutrient intake, physical activity and weight management among other considerations. All the examples presented in the present paper address health concerns and management strategies directly related to nutrition. For example, the CONNECT responsive app includes interactive goal setting and support for weight management and nutritional advice that supports CVD prevention. The TEXTME program has a specific focus on dietary advice and behaviour change. The FoodSwitch app is a public health approach to point of purchase and government decision-making in relation to nutrient content of foods. Overall, within the context of NCD and CVD, management nutrition and diet-related health needs to be considered within the broader context of each individual's condition, risk factors and preferences.

Smart health and innovation is evolving rapidly and may help with diagnosis, treatment and management of NCD including a focus on nutrition and its role in health. There are various platforms available that target physicians, consumers and public health strategies. The challenge for researchers and clinicians is that technology is developing faster than evidence. Ideally, patients/consumers, clinicians, researchers and developers should work together to produce optimum models and services and balance rapid evaluation with quality. While on-going research, development and knowledge is needed, the growth of technology development and utilisation offers opportunities to reach more people and achieve better health outcomes at local, national and international levels.

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## Conflict of Interest

The author is an academic researcher and has contributed to the development, analysis and reporting of the earlier mentioned studies summarised in the present review.

## Authorship

J. R. conceived the manuscript and prepared the draft and final paper.

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