BMJ Innovations Publish Ahead of Print, published on August 24, 2017 as doi:10.1136/bmjinnov-2017-000191

Challenges on the medical front due to individualisation of medical equipment in ageing developed countries, and proposed solutions

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Accepted 31 July 2017

To cite: Kobayashi T, Maita H, Kato H. *BMJ Innov* Published Online First: [please include Day Month Year]. doi:10.1136/bmjinnov-2017-000191

INTRODUCTION

Technology evolves over time through different stages, from centralisation to decentralisation and further on to individualisation. In recent years, this trend has affected every sphere of our lives, including the food chain, accommodation, finance, transportation, safety, hygiene, education and communications. With the passage of time, humans have developed a huge variety of systems, to dispel anxiety and concerns, and to pursue greater convenience and comfort. Medical equipment is no exception.[1] In the centralisation stage, the medical equipment for treatment was used only inside limited medical institutions such as hospitals under the close control and management of trained medical personnel because it was expensive and difficult to operate. It gradually became less expensive, easier to operate and more portable as a result of the rapid progress of technology and it came to be used in a distributed or decentralised manner at primary-care medical facilities such as clinics. In more recent years, it has become more individualised in the form of devices for mobile health (mHealth) and handy healthcare devices for disease prevention, health enhancement and healthcare, and has come to be used in medical care outside of formal medical facilities such as home medical care, and is even accessible to ordinary people. In the past, it was generally believed that specialist physicians provided medical care with heavily armed high-grade equipment, whereas primary-care physicians provided it with lightly armed lower-grade equipment. Recent advances in technology, however, have enabled medical personnel other than doctors to provide services with *lightly armed high-grade equipment*, which is quickly blurring the borderline between medical care and healthcare as it is also used even by ordinary people. This paper discusses the impact of individualised medical equipment, as observed in Japan, a country that is experiencing a rapid ageing of society, and attempts to identify specific challenges on the medical front and to suggest a few countermeasures.

NEW ANXIETIES CREATED BY ADVANCES IN TECHNOLOGY

In Japan, where practically everyone is covered under the national health insurance programme and has easy access to medical institutions, many people go to outpatient departments with such slight anxieties as 'I'm worried about high readings of my blood pressure gauge. Might I have a stroke one day?' The concept of hypertension was not common in clinical medicine until the 1930s, when small, handy and inexpensive blood pressure gauges became readily available worldwide. In Japan, the advent of automatic blood pressure gauges for home use in the 1980s enabled everyone to easily measure their blood pressure at home. As a result, the concepts of 'home blood pressure' and 'white coat hypertension' emerged, triggering the need for medical research into blood pressure control with higher precision. This situation contributed to the stricter medical management of blood pressure, while urging medical personnel to acquire the skills necessary to deal with patients' anxiety called 'blood pressure measurement phobia'.[2] Only a few years ago, the need to measure blood pressure more easily led to the development of a device which measures the pulse wave in

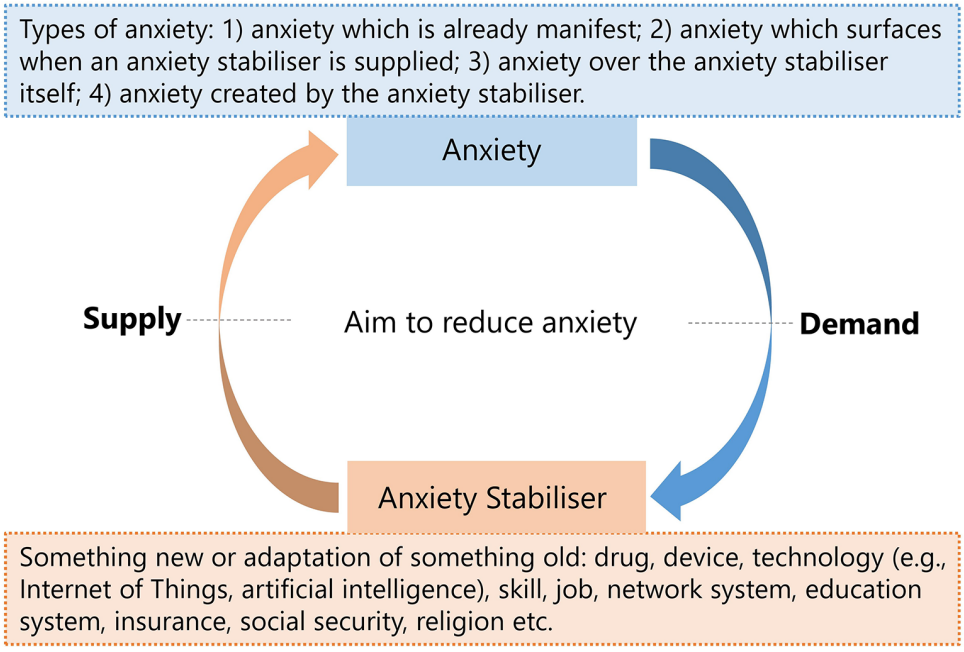

Figure 1 Cyclic cause-and-effect relationship between anxiety and anxiety stabilisers

combination with a smartphone. In 2016, a report was published arguing that the precision of such methods is not as high as that of conventional high-precision gauges.[3] Nevertheless, the use of such easy-to-use, handheld devices is spreading steadily, and these measurements tend to be interpreted out of context, arousing anxiety among a considerable number of patients and users. As a result, medical care professionals have to spend extra time and energy to handle such complaints.

As a generalisation, in order to reduce an explicit or latent anxiety, some new device is developed or some new use/application of an existing device is introduced, which we call an *anxiety stabiliser* (something that mollifies excessive anxiety rather than eliminating it). On the other hand, this novel anxiety stabiliser gives rise to another anxiety, which in turn gives rise to the need for a new anxiety stabiliser, thus repeating the cycle (figure 1).

Attributable to the cyclicality illustrated in figure 1 would be the generally low or unguaranteed precision of measurement using such handheld devices and applications,[4] whose readings are rather difficult to interpret. In general, the devices and applications used in mHealth and healthcare are not legally authorised as 'medical equipment,' and there is no assurance of the accuracy and precision demanded of medical equipment. Yet the use of inexpensive but robust handheld healthcare devices and applications is spreading widely. This has led to a dangerous situation in which users harbour inherently unnecessary anxiety or conversely do not get a due sense of health crisis.

In recent years, the use of popularised, individualised 'medical equipment' and mHealth outside medical facilities (such as pharmacies, convenience stores and homes) has rapidly increased in Japan. As a result, we are now seeing the emergence of entirely new types of anxiety about test results (table 1). It should be noted that the alarm bells over this situation have just started ringing in Japan.[5] Many Japanese tend not to tell doctors that they perform such self-tests and self–measurements, presumably because they are afraid of being criticised by the doctor for 'having their own way.' As a result, quite a number of them resort to the internet, folk therapy or alternative therapy for solutions to their anxieties or answers to their questions.

Table 1 New chief complaints and anxieties induced by individualised medical devices

Technology	New chief complaints and anxieties (examples)
Clinical thermometer	High or low body temperature
Weight scale	Increased or decreased body weight
Body composition analyser	Increased or decreased body fat percentage
Blood pressure gauge (wristwatch-type)	High blood pressure ('having a headache')
Oxygen saturation monitor (fingertip-type, wristwatch-type)	Low oxygen saturation ('having respiratory discomfort')
Blood test (using a handy apparatus)	C reactive protein 1.2 mg/dL (no subjective symptom)
Electrocardiogram (T-shirt-type, wristwatch-type)	Arrhythmia (medically harmless)
Ultrasonography (in conjunction with a smartphone)	Any anomaly? Inflammation? Cancer?
Brainwave measurement (by unipolar induction)	Sleeping disorder? Epilepsy?
Automatic diagnostic software (via the internet)	Cancer? ('Possible causes of your condition are acute gastroenteritis (90%), colon cancer (<0.1%)')

These are examples of complaints and anxieties newly induced by technology: inability to interpret measurement values and fear of possible anomalies or serious diseases.

FUTURE PROSPECTIVE

How to deal with the escalating problem of ageing is a challenge common to many advanced countries. In particular, Japan, where ageing is advancing at the quickest pace, is a focus of world attention with regard to how to safely navigate an overaged society. In Japanese medical practice today, many medical staff work day and night to perform whole-body management and treatment for an increasing number of aged patients. However, one can already see a limit to this labour-intensive system that relies on medical care personnel that are dwindling in number relative to the general population due to the country's continually declining birth rate. This is where technology comes in.[6] In situations like this, which demand some, even partial, change in people's sense of the value of healthcare (eg, view of life and death, and costly medical care), general expectations of technology are high, and excellent, easy-to-use medical technology in particular would be of great help on the medical front.

On the other hand, the proliferation of technology is bound to generate enormous amounts of data and information as people, things and society become increasingly integrated by virtue of the irrepressible Internet of Things, and medical equipment and healthcare devices become more and more individualised. Thus, unless this vast amount of information produced by technology is utilised by the general public and medical staff in an appropriate manner, the use of technology might simply bring confusion to the medical front and to society. In a way, it would be reasonable to expect Japanese medical staff and the general public, with their high level of education and awareness of health, to be in a good position to grasp these diversifying user needs and to *wear* advanced technologies as powered suits (high-grade light equipment) in an appropriate manner, thereby tiding over the unprecedented greying of society. To meet these expectations, we would need to take the following measures: (1) research and development (including precision verification) of medical equipment and healthcare devices with safe, easy-to-realise, easy-to-operate and low-cost networking capabilities; (2) education whereby people can grasp the significant contribution that technology has thus far made to the medical front and society; and (3) construction of a social framework for appropriately converting what has so far been in the territory of medical staff into something that can be handled by ordinary people exploiting individualised technology.

As regards this first measure, we have been pursuing research and development on pocket-sized, handheld ultrasound diagnostic devices (phUS or *Pocket Echo*) and their applications, which have come to be widely used in Japan by nurses and care workers to supplement and enhance the quality of their work. More specifically, in 2016, we started developing a safe, easy-to-operate and low-cost phUS named Miruco® (NIPPON SIGMAX Co., Ltd. Tokyo, Japan). As for education, we have developed and started running a Pocket Echo Life Support course for nurses and other medical staff, which aims to ensure the quality of medical support and to build the foundation for an education system for that purpose.[7] For the social framework, we started to draw up a set of guidelines on the use of phUS for the general public in 2016.[8]

With further technological progress, there will be a sharp increase in the amount of measurement and test data produced automatically or 'unsolicitedly' by individualised medical equipment. Against this backdrop, it is expected that medical and care personnel will be equipped with the right frame of mind to accommodate the anxieties and concerns harboured by patients and the general public seeking their advice, the ability to predict people's future anxieties by considering the cyclic cause-and-effect relationship between anxieties and anxiety stabilisers, and the knowledge and skills required to properly operate the high-grade light equipment used by both medical staff and ordinary people, thereby providing better support for people's lives.

Contributors TK, HM, HK are in agreement to be accountable for all aspects of the work.

Competing interests TK has a patent Miruco licensed to trademark in Japan.

Provenance and peer review Not commissioned; externally peer reviewed.

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BMJ Innov published online August 24, 2017