# Self–management and Type 1 Diabetes
## How Technology Redefines Illness

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**Abstract:** In the last decades, health and illness have been redefined by the technological artefacts. This research explores users' opinions of the potentials and limits of apps related to the self-management of type 1 diabetes. Our research takes the "app" to be a socio-cultural artefact whose meanings and practices are mediated by situated practices and knowledges. The analysis has been conducted on two different kinds of texts: the description provided by the app itself (commercial description) and the reviews provided by app users (customer reviews). Our aim is thus to contribute to the study of how technological tools contribute to the processes of patients empowerment.

**Keywords:** Type 1 diabetes; apps; patient empowerment; commercial description; customer reviews.

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## 1. Introduction

As the digital revolution has emerged in the last decade, opportunities for patients to access and share healthcare information have expanded. Consequently, a new form of 'patient 2.0' (Danholt et al. 2013) emerged and should be analysed.

Technological tools are fundamental in guiding laypeople as they become more aware of, and informed about, their illnesses. Technological tools that redefine our culture of therapy and self-care have proliferated in the health market. These tools can be used in several manners. As suggested by the Green Paper on mobile Health – mHealth – (2014, 1) "mHealth solutions cover various technological solutions that among others, measure vital signs such as heart rate, blood glucose level, blood pressure, body temperature and brain activities. Prominent examples of apps



*TECNOSCIENZA*
*Italian Journal of Science and Technology Studies*
*8 (1) pp. 51–71 – ISSN 2038–3460*
*www.tecnoscienza.net*



T/S TECNOSCIENZA
Italian Journal of Science & Technology Studies

are communications, information and motivation tools, such as medication reminders or tools offering fitness and dietary recommendations". Some claim that in the 2.0 era the patient becomes a sort of self-entrepreneur (Maturo 2015), who can control both the process and the result of the therapy or healthcare. Consequently, as Bruni and Rizzi (2013) point out, in the case of patient 2.0, the production of reliable data is dependent on the patient because s/he wields the technological tool necessary for collecting that data. In addition, as Maturo and Setiffi (2016, 478) observed: "as the sources of medical information shift from those controlled by doctors such as medical records and specialist journals to interactive websites and online communities, it is easier for individuals and patients to find information, get support and share their illness experiences with others with the same condition".

The number of people chronically ill is steadily increasing, which indicates the need for services that ensure continuity of patient care and assistance. About 117 million people suffer from chronic illnesses in the United States, while one out of four adults has two or more chronic health conditions (Center for disease control and prevention 2012). In Europe, those figures are even higher: around 150 million Europeans were chronically ill in 2005 (European Observatory on Health Systems and Policies 2005). Patient self–management is increasingly perceived as a viable alternative to the currently strained health care system (Busse et al. 2005). In this alternative scenario, new technological tools dealing with health would become part of patients daily lives.

## 2. Self-management of Type 1 Diabetes through Mobile Apps

Type 1 diabetes is a chronic disease that occurs when the pancreas does not produce enough insulin or when the body is not able to effectively use insulin. Insulin is the hormone that regulates blood sugar; hyperglycaemia is a common effect of uncontrolled diabetes that causes serious systemic damage, especially to nerves and blood vessels. Diabetes is an important public health problem; it is one of four non-communicable diseases (NCDs) that world leaders have deemed "priority," i.e. prioritized for preventative action (WHO 2016). Globally, an estimated 422 million adults were living with diabetes in 2014, compared to 108 million in 1980.

Type 1 diabetes is known as juvenile, childhood-onset, or insulin-dependent diabetes, as it requires daily administration of insulin in various doses and with varying frequency. The cause of type 1 diabetes is unknown, and the disease is not preventable at our current level of scientific knowledge. According to a 1999 report prepared by the World Health Organization, a healthy way of life, *i.e.* the maintenance of normal body weight accompanied by regular physical activity, can delay or prevent the

onset of type 2 diabetes and, at the same time, help to control type 1 diabetes.

The adoption of self-management practices is a foundational resource in the process of controlling and managing type 1 diabetes and its effects. Routine self-monitoring allows diabetes to exist in the background of the patient's social life by contributing positively to its normalization (Spencer et al. 2013). According to the WHO's latest global report on diabetes (2016), mobile technology can improve the management of diabetes in that it encourages users to adhere to treatment plans meant to manage their disease.

The advent of new technologies such as smart phones, Internet, tablets, as well as of increasingly sophisticated health monitoring devices (glucose meters, blood pressure monitors, oximeter), is accompanied by the miniaturization of those monitoring devices, as nanotechnology continues to develop.

This could result in increased efficiency of health services by adding value and efficiency to a continuum of self-care strategies (Lehocki et al. 2012). The use of mobile devices, which today more than ever affects every sphere of one's social and personal life, may change the face of health care by offering a new avenue for the management of one's disease. Health-related technologies take the place of a personal care assistant who supports a patient in the management and organization of the daily flow measurement and who assists in administration of care and personal data. Recent advances in ICT have enabled the design and development of new patient-centric models for these health-related technologies (Mougiakakou et al. 2009). Self-management of diabetes offers a representative example of intense patient engagement with health management practices and with the organization of health services.

The personal management of type-1 diabetes requires patients to have specific skills, which concern the measurement of their values in relation to the available technological tools. In order to better manage their disease, patients with type-1 diabetes have to develop medical skills. They must take steps to adapt to new habits and even a new lifestyle. Ideally, patients should also learn how to interact with the health technologies they use, thereby achieving a greater sense of responsibility and control in their experience of illness.

At the same time, the patient faces the burden of dealing with the emergence of new pressures and complexities in health management. The emergence of health technologies has completely restructured the form of clinical encounter between doctor and patient. Information about one's health is distributed in a fragmented way and shared over a wide healthcare network. In the centre of this network we find the patient, who is increasingly held responsible both for his or her self-care and for the accuracy of data that is useful for professional supervision of the disease, which he or she measures (Bruni and Rizzi 2013). Clinical encounters that address patients'

mismanagement of measurement technologies offer a clear example of the heavy responsibility assigned to patients.

Such appointments are characterized by two main activities: inspecting the patient's clinical documentation and verifying the relationship between patients and technological tools. The self-management services generally have the following characteristics:

- acquiring patient data communication;
- supporting compliance to treatment;
- visualizing of the state of health;
- educating the user.

Several studies show that the use of mobile technology has a direct impact on the management of chronic diseases (Free et al. 2013). With regard to diabetes in particular, these studies evidence that mobile phone intervention has led to statistically significant improvement in glycaemic control and self–management in diabetes care (Liang et al. 2011).

According to Research2Guidance's annual survey, 76% of mobile health app publishers see diabetes as the self-care area with the highest business potential for mobile health. Currently only 1.2% of people with diabetes who own a smartphone or tablet use apps to manage their condition. Research2Guidance predicts that this percentage will rise to 7.8%, or 24 million people, in 2018.

As mentioned above, digital technologies have expanded opportunities for people to access and share information related to their personal health. In addition, "mHealth solutions support the changing role of patients from a passive to a more participative role, while enhancing their responsibility over their own health through sensors that detect and report vital signs, and mobile apps that encourage them to adhere to diet and medication" (EU 2014, 5). Indeed, many apps have been designed for the health market. The functions and contents of these medical apps provide useful insight into discourses related to illness and chronic conditions. As shown by Lupton (2014), apps are new digital technology tools, but they are also sociocultural products located within pre-established circuits of discourse and meaning. Moreover, these tools are now playing a crucial symbolic role in our social lives; from this perspective, the integration of technological devices with longstanding cultural relationships reflects the dominant place held today by science and technology in our society (Magaudda 2015). Using these technological tools, it is possible to increase doctor-patient interaction (using an app as a medium) and to improve the relationship between the patient and his/her illness (using the app as a memo).

## 3. Methodology

Type 1 diabetes and the apps designed for its sufferers are particularly ripe for analysis for two reasons: first, adolescents' notorious propensity for

new technological tools; and second, the fact that self-management at a young age is even more difficult and challenging than it is for adults. Indeed, measuring blood sugar levels is not always easy, especially on occasions in which having a chronic illness may be stigmatized, as some patients mention in their reviews of health apps. In addition, several studies (Mol and Law 2004; Ho and O'Connor 2014) examine a wide range of psychological issues related to adolescent self-management of disease, including stress, burn-out, depression, peer relationships and diabetes-related family conflict.

This study in based on content analysis of the 5 most downloaded diabetes apps: mySugar Logbook, Diabetic Connect, Diabetes Pilot, Bant, and MyNetDiary. Commercial descriptions and customer reviews have been used to evaluate the strengths and weaknesses of these new technological tools in the managing of type 1 diabetes. Several studies have been conducted through content analysis (Lupton 2014; Lupton and Jutel 2015; Maturo and Setiffi 2016; Maturo, Mori and Moretti 2016). The ways in which apps verbally and visually represent the human body provide insight into contemporary notions of embodiment, health and disease. Examining the words used in the app titles, images and descriptions on the store, including the logo and screenshots employed to illustrate what the app offers potential users, is a way of identifying the tacit assumptions that underpin the apps and their truth and authority claims (Lupton 2014, 612).

These diabetes apps belong to different categories and they were searched in the App Store using the formula "most downloaded diabetes apps" during February 2016.

Specifically, we focused our analysis on the self-tracking possibilities offered by those apps. Four out of five apps offer a standardized method to calculate the level of glucose in blood and offer the possibility of creating a food database in which to check the calories of foods. Although we have considered apps from 3 different categories – Medical, Health & Fitness and Social Networking – all of the apps can be considered helpful in managing self-monitoring as this chronic illness requires. Further, all five apps make use of gamification in order "to increase influence and encourage engagement and activity" (Luminea 2013, 13). We can define gamification as the use of game features in non-game situations (Groh 2012; Maturo 2015). Often, such recreational elements are considered important as means to motivate employees to be more productive or to motivate patients to be more constant and precise with self-monitoring. However, gamification is also becoming widely used to foster consumption among individuals. As far as diabetes apps are concerned, the use of quantification helps people to be more diligent in their self-monitoring.

Commercial descriptions and customer reviews of these apps touch on themes that can be broken down into four main areas, each of which we have analysed: the language used by the app, the app's visual features (design), the services provided by the app, and the app's targeted users.

## 4. Findings

### 4.1 Commercial Descriptions

The first linguistic component of our research investigates the commercial descriptions of diabetes apps, and in particular, which of their characteristics their sellers choose to highlight. Commercial descriptions play a fundamental role in our content analysis because they help us to understand how "digital technologies have been developed within a wider ideological environment, one which has shaped their social evolution both materially and symbolically" (Magaudda 2015, 2). As aforementioned, our content analysis focuses on four main aspects of the apps: the language used by app developers, the app's visual features, the services of the app itself, and the app's target group of users.

Regarding the first aspect – the language used by the App Store – we found that diabetes apps are described in technical terms specifically associated with diabetes; at the same time, these descriptions are simple and clear because they are intended to make sense to customers. According to the commercial description of, e.g., the app MyNetDiary's Diabetes Tracker, it is possible to make a lifestyle change and acquire good habits through:

- checking remaining food calories;
- viewing BG average and next check reminder;
- reviewing daily foods;
- getting tips and recommendations about today's food;
- logging water and weight;
- logging foods-selecting from favourites or dictating searches.

These instructions, presented as a list, are straightforward. Focusing on guidelines for basic components of everyday life (weight, exercise, food and water), this list offers the customer small-scale steps to follow in order to better manage his or her diabetes: apparently, it is enough to follow these clear instructions and the advice listed in the app's description.

The connection between food and illness management ought not go unmentioned: as Mol (2008, 3) points out, "(nutritious) food and (curative) drugs may have similar effects on the body."

The visual features of an app – the second aspect of apps we analysed – prove to be particularly important, because they concern the app's visual impact, and may thereby influence a user's overall perception and use of the app. Indeed, pleasant visual features can encourage monitoring activity, transforming a boring task into a fun and recreational activity (gamification). For instance, the junior version of MySugar LOGBOOK (a version of the app intended particularly for young people) can – according to its commercial description – help one get motivated and involved in his/her diabetes therapy.

It is also worth noting that game design involving personal activity monitors may contribute to youth engagement with self-tracking, health, and identity. The Junior version, for example, makes easier the collection of data through a "monster" (Slimer, see fig. 1), a diabetes avatar.


Fig. 1 – App mySugar Logbook.

This app is particularly intended for children who suffer from type 1 diabetes, because the activity of self-management is turned into something interactive and amusing. Moreover, the app makes it is possible to share data with one (or both) of the child's parents. This app can be used through the registration of the child – name and phone number – and the parent, who must insert several details. The child/user has to manage his/her self-monitoring by selecting different icons that represent physical status – great, good, bad – at different moments throughout the day (before a meal, after a meal, before sports, after sports). In addition, the young user has the task of collecting data (blood glucose level) and of taking pictures of meals. Other important functions concern estimating amounts of carbohydrates and, in the case of injecting insulin, the units of basal and bolus injected; the child can write notes about his/her care management and send them to the parents. Every time the child monitors the relevant metrics of his/her body and sends his/her data successfully, he/she receives a reward (points) that forms a part of the process of his/her self–management. Through this app, it is possible to create graphs and histograms related to the level of blood glucose, using a timetable that involves days, weeks and months. It becomes possible to track and analyse personally relevant data with less effort.

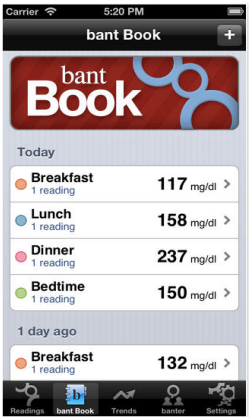


Fig. 2 – App Bant.

The third area we analysed, the services provided by diabetes apps, can – according to their commercial descriptions – improve and facilitate the illness management. Using the app Diabetes Pilot, it is possible to find track trends in 14 categories, among which are blood sugar levels, medications and diet. First and foremost, the patient is tasked with selecting time, the day/hour in which he/she starts with the monitoring, category1 and value in order to start with this tracking. Consequently, the app, on the basis of the precise records entered by the user, draws glucose and weight graphics. The app can also function as a memo/notebook because it allows patients to search past data, to scan barcodes on food packages in order to track food and carbohydrate intake, and to learn about the calories, fat proteins, sodium nutrients and cholesterol in foods. It is also possible to set reminder alerts on any record. Another important feature of the app is the possibility of its calculating the user's insulin-level. Through the app's Data Sharing function, it is possible for a user to save, print and email reports directly from the app. The transfer can be made using an email data file or WiFi Sync. The possibility of data transfer should be seen as a way to simplify medical appointments. These services undoubtedly foster quantification; let us now consider the Bant app (see fig. 2), in order to get a better idea of how these apps can simplify self-management among young patients.

Nowadays, getting medical information through the web seems to be a simple and predictable activity: "consumers are starting to do this individually, in collaboration with health peers, who also have greater prominence now, and in co-care with physicians and other medical professionals" (Swan 2009, 494). However, most of the services require a subscription

[1] Unfiled, imported, breakfast, after breakfast, lunch, after lunch, dinner, after dinner, snack, feeling hypo, sick.

that allows the patient to get all food database updates, unlimited records and unlimited access to all services.

Finally, the reference group consists of all sufferers of type 1 diabetes. Many patients receive their diabetes diagnoses at a young age; interpersonal connection and the exchange of experiences by users are among the main services of these apps in their effort to promote a healthy lifestyle. For someone with the disease, sharing how diabetes affects his or her life can help alleviate the stress and anxiety it provokes. This psychological aspect of having diabetes, as we will see from user reviews of the apps, is particularly delicate. Apps like Diabetic Connect are designed primarily to promote healthy eating habits by way of connecting people so that they can share their feelings and personal experience of the disease. Especially among youth, peer support is considered fundamental to achieve happiness. Through this app, it is possible to get connected with the largest community of diabetes patients on the web (see fig. 3). The app principally offers users the possibility of following discussions while on the go, asking questions, and adding comments to a forum.

Discussions on the app/forum are ranked according their popularity: how many likes and comments they receive. A user can also choose different topics (insulin, stress, type 1 diabetes, oral medications, finances etc.) to read about. To join the community and post a comment or subscribe to a discussion, users create patient profiles.

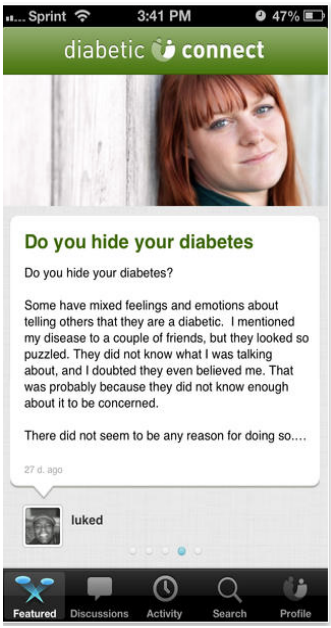


Fig. 3 – App Diabetic Connect.

## 4.2 Customer Reviews

The second linguistic component of our analysis concerns users' customer reviews, i.e. the comments and suggestions they make informed by their use of the diabetes apps. These comments[2] were collected from some of the online forums we identified as the most popular. Here are some examples of the numerous blogs and forums we analysed in the course of our research. First, we considered www.diabetes.co.uk, a digital community that supports people with diabetes in the U.K. and other countries. This is undoubtedly one of the most interesting such forums in terms of its users' access and ability to comment: whereas some blogs and forums require a user to have a special subscription, no such subscription is necessary on this site. Using this forum consists in a user interacting with other members of the forum by answering questions they have posed, or by a user submitting new questions of his/her own. A similarly important webpage is www.childrenwithdiabetes.com, an online space designed for use exclusively by parents of diabetic children. In Italy, the most popular forum is www.diabetando.it, a community which requires some registration but which offers a highly accessible, user-friendly comment section.

Customer reviews of apps give voice to the needs of individual users and bring to light their problems with and suggestions for the latest technological tools intended for diabetics. In addition to the commercial descriptions of the apps, four main components of users' feedback have also been analysed in our research. These four components are: 1) apps language; 2) apps visual features; 3) apps services; 4) apps users.

Regarding the first, the syntax of an app proves important to users. As noted by Berger and Luckmann (1966), language allows us to objectify human expression; understanding language means understanding the reality of everyday life.

> I had a lot of trouble controlling my blood sugar, and my last A1C was 8.5, up a bit from before. The issue was estimating proper insulin based on what I was eating. With the software here, in the last month my estimated A1C is hovering between 6.2 and 6.3.
>
> [Crossfire, diabetes–pilot.iapps4you.com, Diabetes Pilot app)]

Users describe the way diabetes demanded a complete reconstruction of their habits, and further, how apps have played a helpful role in that reconstruction:

> I just joined this forum and it helped answer a lot of questions I had. Especially how to cope emotionally with the diagnosis of a chronic disease. And

[2] Every comment reported is quoted exactly and is publicly available at the websites listed. No registration to the cited forums or private pages was required to access these comments.

> some of the more practical ways to live with changing your lifestyle. I travel a lot for business and will admit it's been a challenge in some ways. I really miss Sonic cherry limeades (LOL).
>
> [Dderm, tudiabetes.org, MySugar LOGBOOK app]

Regarding the second object of our analysis – app design – individuals prefer visually pleasant layouts and features, which can make less rote the process of collecting and recording one's medical or physical data. This gamification of a tedious burden is particularly interesting in that it casts electronic gaming in a new light. Gaming is often considered harmful[3] and is the leading causes of some common diseases among children.

> The chart of my weight helps me see if I'm staying on track.
>
> [Hopester4, iphone.informer.com, MyNetDiary app]

> I'm truly enjoying the design and layout of your website. It's very easy on the eyes which makes it much more enjoyable for me to come here and visit more often. Did you hire out a designer to create your theme? Outstanding work!
>
> [Anonymous, everydayupsanddowns.com.uk, MySugar LOGBOOK app]

The third object of our analysis, namely the services these apps offer their users, is important because the more distinct services an app offers, the more its users interact with one another. Further, the use of these health tracking tools in the management of disease is very important because "the logic of care for diabetes involves the broader process of diagnosing, informing, injecting, encouraging and so forth, a process in which the patient is not only acted upon by medical professionals, but is also a principal actor his or herself. In this sense, caring is "a collective effort of uncertain practices shared by doctors, nurses, patients, relatives and friends, and even technologies" (Turrini 2010, 75).

> I lost over the past 10 months was with the other app, but if I had known about this I would have used it exclusively. It's accuracy with nutrition in relation to diet, exercise, weight, & calories is the best I have seen so far. As a result of this app I better able to manage my tendencies toward diabetes, completely eliminated any cholesterol issue, and better track BP, which as returned to normal […] This app does it all and allows to track your progress in many levels.
>
> [hawk_fam003, mynetdiary.com, MyNetDiary app]

An individual patient's use of an app services can prove indispensable not only for his or her disease management, but also for his or her entire

[3] We refer to the abuse of video games by children that can lead to obesity. For further information, please refer to the study of Vandewater et al. (2004).

medical team. Self-monitoring can, in fact, be essential for successful diabetes management, in that "the relegation of data-collection to patients or caregivers is a part of a therapeutic alliance in which data is used by patients for self–management purposes but is also shared with healthcare providers" (Piras and Miele 2016, 3).

> I highly recommend this application for diabetics and their care givers, not only for the quality of the software but the diligent and quick response I had from the Company when I commented about a concern. The application is extremely useful, inputting of data is quick, far better than flipping through log and carb counting books. I have had a chance to utilize the desktop version and must say that it is a far beyond what I had hoped for when choosing this application. The data syncing is easy to set up and transfers seamlessly to and from each device. Reports are clear and easy to export, print and email to Doctors.
>
> [E. Scarborough, diabetes-pilot.iapps4you.com, Diabetes Pilot app]

Finally, by way of studying user reviews, we analysed which people or populations make use of these apps. As aforementioned, having Type 1 diabetes is a very complicated experience, "particularly for young people for whom diabetes self-management evolves alongside adaptation to developmental changes in association with individual contextual factors and disease course" (Cooper et al. 2007, 474). The effective treatment of diabetes requires more from a patient than the mere acceptance of the problems the disease causes: it also requires the acquisition of particular skills (Bruni and Rizzi 2013). Essentially, a person diagnosed with diabetes must play a highly active role in the reshaping of his or her daily life, a reality interpreted by men and subjectively meaningful to them as a coherent world (Berger and Luckmann 1966). The changes to daily life which diabetes demands can cause patients' psychological stress or denial or cognitive dissonance about what managing their illness requires:

> Ok, so I was diagnosed about 2yrs ago and I hate: the daily testing (actually have not been testing), the 3 times a year A1C, and everything about diabetes. I am really struggling with what I know I should be doing and what I am not doing.
>
> [Practice grandma, diabeticconnect.com Diabetic Connect app]

Another essential aspect of our analysis concerns the use of these forums by the relatives of people with diabetes. In many cases, parents are interested in using technological tools (e.g. apps and forums) in order to help their children in the management of their disease and, more than anything, in having satisfying social lives. In particular, the issue of peer acceptance – notoriously delicate and important during adolescence – is on many relatives' minds.

> So, my little sis, age 17, is a super cool person. But she wants to be so normal that she doesn't take care of her diabetes when she is around friends. I have tried so hard to get her to explain to them how important it is or to try to find friends that will understand that she has to take care of it – but unfortunately she refuses. Any suggestions?
>
> [Eggo sis, diabeticconnect.com Diabetic Connect app]

> My son use to be like that with his friends, but I sat him down and told him that if he wanted to go place and hang out with his friends then he would have to tell them about his diabetes. At first I think he was scared, scared that they would think that he was weird, but after he told them, they understood and even wanted to know more about it. It is so hard on teenager, because they do not want to be different.
>
> [Frustrated mom, diabeticconnect.com Diabetic Connect app]

Finally, in the same vein, we highlight use of forums by romantic partners of diabetics, and in particular, their curiosity about the disease and starting a relationship with a diabetic:

> My boyfriend has type 1 diabetes. He doesn't like taking care of himself when it comes to giving himself insulin. I'm not for sure but most of the I know when he gives himself to much insulin. He gives himself too much a lot and his sugar gets low like 25–30 low and I have to feed him and he never remembers.
>
> [amy12852, diabeticconnect.com Diabetic Connect app]

> Hello, I am not sure if this is the right place to ask this type of question, but I really do not have anyone else that I can ask. Me and this girl have shown interest in each other, we haven't really gotten serious […]. Anyway, my concern is that she has type 1 diabetes, I do not really know too much about diabetes, but just what I've been reading over the past days and I am wondering how this will affect our relationship. Will she have tons and tons of health issues, and is it wrong or insensitive of me to think, maybe I do not want to even get started on it, and end it before things start?
>
> [Anonymous diabeticconnect.com Diabetic Connect app]

It has become evident that patients can influence the outcome of their treatment[4] and health care service. Following a phenomenological approach, medicine, illness and health become real symbolic systems with specific functions, and consist of a set of meanings, values and behavioural norms. Patients' autonomy and self-determination in adhering to medical care and treatment plans have been issues much discussed in recent years – not only in pharmacological terms, but also in terms of instructions for

[4] The concept of compliance becomes a key parameter in the clinical management and evaluation of experimental protocols of medical treatments. The critical factors that influence the level of compliance are the type of disease, the cultural structure of the patient, the physician's role, environmental interference.

the adoption of a lifestyle conducive to making more effective recommended treatment.

## 5. Interpretation

Through content analysis – of both commercial descriptions and customer reviews – it was possible to identify the potential of these applications, as well as the limits to what they can offer. Although further research is necessary, we outline below the strengths and weaknesses of diabetes apps according to our analyses.

### 5.1 Strengths

Self-care can surely benefit from the use of health apps. For instance, the continuous monitoring function of interstitial glucose (CGM[5]), which such technology encourages, can be highly beneficial: according to the Regional Observatory for Innovation in Emilia Romagna (2014, 3), those benefits include "improved glycaemic control, a reduction in hypoglycaemia, and improved measures of physical condition (e.g. weight loss) and quality of life. The improvement in intermediate outcomes should help reduce short and long-term complications". These apps offer a reminder service (alarms), which patients can use to keep track of the tasks they must carry out. Such services are being adopted around the world, especially in the most disadvantaged areas. The Senegalese government, for example, uses mobile technology during Ramadan to improve diabetes management by sending citizens text messages with health tips (e.g. that one should drink 1 litre of water each morning before beginning the day's fast, a list of foods to avoid when breaking a fast in the evening, and information for healthcare providers about medication management during fasts) (WHO 2016).

A second benefit of health apps – following the analysis of Rich and Miah (2014) – is their potential as public pedagogical tools. Indeed, patient education is a crucial component of diabetes management, especially in the case of type 1 diabetes, many of whose patients must learn to manage their disease at a very young age. We can define public pedagogy, in basic terms, as assistance in improving one's self-monitoring offered outside of a formal educational structure (Rich, Miah 2014). The use of health-focused apps may not only may serve a preventive function but may also allow the smoother management of diabetes in the earliest phases of the disease,

[5] Device that allows to obtain frequent measurements of glycemic level and to rebuild the profile of a diabetic patient's blood sugar level with a time resolution of a few minutes. For further information please refer to the Regional Observatory for Innovation in Emilia Romagna (2014) *Innovative medical devices for the management of diabetes. Updating the short report number 6.*

providing new patients with information and therapeutic services. These technological offerings aid patients in adapting to the new lifestyle that diabetes management requires.

A third benefit of these mobile apps is the reduction of the cost of treatment. According to the National Diabetes Statistics Report (2014, United States), the total costs related to diabetes in 2012 were around 245 billion USD, of which 176 billion USD related to direct medical costs (outpatient and emergency care; inpatient hospital care; medications and medical supplies such as injection devices and self–monitoring consumables; and long–term care), while indirect costs (disability, job loss, premature death) accounted for around 69 billion USD. According to the 2016 report of the Italian Society of Diabetology, the International Diabetes Federation (IDF) has estimated global spending on the prevention and treatment of diabetes and its complications for the year 2015 to be 673 billion USD. Projections for the year 2040 estimate an expenditure of over 802 billion USD, an increase of 20%, in contrast to the substantial stability of the expected population in 2040. In Italy, the total expenditure estimated by the IDF for 2015 amounted to 12 million USD, with an expected growth for 2040 of 14.4% which is slightly smaller than that expected at the European level (18%). The use of these applications could alleviate some of these costs by decreasing visits to the doctor through patients' ability to send metrics about their health via email.

Another positive contribution of these apps is their gamification in gathering data, and the related levels of rewards they offer users.

In several contexts, such as health management, game design involving personal activity monitors is highly promising. Accumulating a large number of points, especially in the first app we analysed, shows a high level of adherence to a treatment plan on the part of the patient. However, incentivizing rewards cannot be considered the sole motivation for boosting intense control. Children's autonomy in managing their diabetes is wrapped up with (factors involved in) their acquisition of wider independence from the parents. This practice, in fact, requires much effort. A patient decides to make diligent use of technological tools in managing his or her disease only once he or she recognizes the centrality of his or her role in effective health management (Lehocki et al. 2012).

Finally, we highlight the power of patient-to-patient influence, considering foremost blood sugar-tracking habits. Interpersonal connections made through social networks or forums that involve the exchange of information may promote healthy practices. Our analysis of forums and customer reviews highlighted that most teenagers affected by diabetes can improve the tracking and management of their health metrics by sharing tips and comments with other patients online.

## 5.2 Weaknesses

Let us turn to apps' weaknesses. Although most of them include a warning that the information they offer should not be taken as medical advice, it is worth our considering more specifically the potential risks use of these apps may involve. Recorded glucose, food, medication and other data should be verified with healthcare professionals. This is because resultant insulin dose recommendations will be decided based on both contextual and behavioural factors: "the potential for new risks arising from the use of medication apps is suggested by the withdrawals of a small number of products, including an insulin dose calculator developed by a pharmaceutical company, because of clinically relevant errors" (Huckvale 2015, 2). The health market is growing rapidly and several medical apps are designed to make diagnoses; one of the most discussed debates is to what extent these diagnoses can or should be taken seriously by patients. If apps are becoming widely prescribed by doctors, could they replace traditional physical exams meant to diagnose patients? This seems unlikely: the process of diagnosis requires a more nuanced process of cooperation on many actors' parts in the name of achieving precise information about a patient's condition.

At the same time, technological objects and artefacts become constituent elements of the clinical encounter between doctor and patient 2.0 (Bruni and Rizzi 2013). The patient's load is simultaneously lightened (in that he or she can use technological tools to make self-management easier) and burdened (in that considerable pressure accompanies the responsibility of care being transferred from the doctor to the patient).

In fact, it is not easy to establish if these tools can effectively improve the quality of life of patients with chronic illness, or if they are only a shortcut to reducing the operating costs of care services. Innovation potential, however, is high. It is important to establish and keep in mind that these technological tools and telemedicine services can be useful only if patients are highly motivated to manage their disease in an autonomous and conscious way.

Indeed, "by shifting the load of responsibility from the way in which society organizes public life to the way in which individuals organize their own lives, the neoliberal ethos is carrying out a highly depoliticizing operation" (Maturo, Mori and Moretti 2016, 264).

The last drawback of these technologies that we must consider is their social implication. Self-management and quantification through health apps presupposes a social construction of the body as something that is an enterprise, or rather as an 'embodied enterprise', given that the symptoms of a chronic illness are evaluated and categorized digitally. In this sense "medical technologies provided health care providers with effective tools to coerce others into approved, healthy lifestyles" (Timmermans and Berg 2003, 97). Moreover, surveillance practices are often associated with both care and control (Brighenti 2011). This form of self-monitoring can be

shared on social networks, thus overturning the foucauldian panopticon idea: the subject does not want to watch over everyone; rather, he demands to be monitored and evaluated by everyone. Moreover, he wants not only his external behaviour to be monitored and evaluated, but also his mental states and physiological data. New technological tools increase the visibility of relationships between the individual body and the body of the population, and shed light on the way these two bodies form the two poles of the control itself (Brighenti 2011). Intimacy becomes extimacy; surveillance becomes inter-veillance; the panopticon becomes the endopticon (Maturo, Mori and Moretti 2016).

## 6. Conclusion: An App a Day Keeps the Doctor Away?

It has hard to deny that the growth of technological devices such as apps has created new opportunities for health care and disease management. Moreover, these medical applications increase the amount of low–cost or free information and publicly accessible data about diabetes, facilitating patients' self-management. Alongside these valuable functions, several issues with these tech tools must be noted.

First, in its focus on self-care and self-diagnosis, technology around diabetes plays a large role in the redefinition of the illness; apps and forums like those we have discussed locate the individual patient and his or her identity at the centre of treatment. By way of these apps, self-management of one's disease becomes a playing field of opportunities to reinvent the self: technological devices and services become an integral part of the diabetic lifestyle. In this way, these technology-borne tools seem to aid in satisfying the adoption and management of a new lifestyle required by disease; apps are designed not to force patients to alter their lifestyles (so to adapt to the disease), but rather to make disease-management more adaptable to the lifestyles patients already have.

These turnabout technologies play a crucial role in that they give the patient an additional resource with which to empower him or herself. Nevertheless, focusing on apps as empowering forces in patients' lives diverts attention from the real risks associated with a lack of professional medical care. The doctor, as a mediator between the individual and the disease, should have a central and irreplaceable role in a clinical counter, a role founded on the knowledge he or she possesses and the experience-based expertise that he or she can offer a patient. Still, it may be the case that these apps allow doctors to achieve greater familiarity with their patients; and perhaps the patient's increasing adeptness in self-tracking and new skills in self-management partially erode the boundaries imposed by the professional status of physicians.

Further, the self-management that apps and other technology engender appears to give laypeople more opportunity to monitor their bodies and

health in line with the discourses of healthism and control that pervade contemporary medicine (Lupton and Jutel, 2015). The potential of this innovation to improve self-care is profound. Still, it is important to establish that these technological tools and telemedicine services are useful only if patients are highly motivated to manage their disease in an autonomous and conscious way. The risks associated with simple self-care that is not integrated with other sources of healthcare must be taken into consideration, so to avoid assigning patients disproportionate responsibility for their health and wellness.

In conclusion, our analysis shows that these tools not only promote communication between users in the dimension of patienthood, but also open up a new dialogue between patient and doctor. For the most effective diabetes management, it is important to create a communicative triad of patients, physicians, and caregivers, in which technology facilitates communication, especially about management of the disease. The management of life with the disease affects more than the patient alone. In fact, there are many different actors who should not be overlooked in the creation of new technological tools. This is crucial in the process of ensuring that patient empowerment is more than a mere rhetorical tool for health policies. Health-management technologies must not become an isolated channel through which healthcare enters people's lives: rather, they ought to offer support to patients, so that diabetes (and the challenges it presents) can exist in the background of patients' daily lives.

## Acknowledgements

While this article is the result of several discussions between the authors, Veronica Moretti has written sections 3, 4, and 5.; Barbara Morsello has written sections 1, 2. and 6.

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