WHAT'S THE IMPORTANCE OF PORTABLE TELE-MONITORING DEVICES IN PATIENT THERAPEUTIC ADHERENCE?

Orlando Rodrigues, Tiago Costa, Miguel Castelo-Branco PhD, Pedro Dinis PhD

University of Beira Interior - Faculty of Health Sciences, Portugal

Abstract

In the UK it is estimated the NHS spends almost £100 million every year in unused drugs. In addition, hospital admission costs attributed to patients not taking their prescribed medicine properly was estimated to be between £36m and £197m per year. In the U.S., medication non-adherence is estimated to lead to between $100 and $300 billion of avoidable healthcare costs annually, representing 3–10% of total U.S. healthcare costs. Studies show that improving medication adherence may have a greater influence on the health of the population than the discovery of any new therapy. Effective medicines are available for many conditions and yet patients are non-adherent 50% of the time. This can be critical point in certain disease states, such as asymptomatic conditions like hypertension, where the incidence may approach 80% non-compliance. It is proposed to create a therapeutic adherence monitoring device within a smart blister pack that is coupled to a device with the capacity to collect and send data to a common server. This would allow a clinician to know, with high certainty, if the patient is taking their medication as prescribed and on schedule. This paper gathers information to identify current technology to support integrated monitoring and control of therapeutic adherence.

Keywords: non-adherence; portable devices; Internet of Things; telemonitoring

Introduction

The World Health Organization (WHO) estimated that, in 2001, chronic diseases contributed to approximately 60% of the 56.5 million total reported deaths in the world, and approximately 46% of the global burden of disease. In 2020 this is expected to increase to 57%.[1]

In Portugal, 5.4 million people live with one or more chronic conditions. Additionally, Portuguese women over 65 years have only 6.6 years of healthy life remaining. In contrast, Norwegian women have, on average, have 15.4 years of healthy life remaining. Other countries share this trend, and the increased incidence of chronic disease must be seen as a wake-up call to health services worldwide.[2]

Improving medication adherence may have a greater influence on the health of the population than the discovery of any new therapy. Effective medicines are available for many conditions and yet patients are non-adherent to their medication 50% of the time.[3] Studies report different ranges of adherence - for adult patients 40–60%, and for children 25–75%, but on average only 50% of people take their medicines properly.[4] This has become critical for some asymptomatic diseases such as hypertension, where non-compliance may approach 80%.[5]

Patient adherence to prescribed medication regimens is a complex and multidimensional behaviour, and to understand what is happening the problem must be dissected to identify modifiable factors. To achieve this the reasons for intentional and non-intentional non-adherence must be understood. These have been classified into patient factors, medication factors, health care provider factors, health care system factors, and socioeconomic factors.

Economic and Health Cost of Non-adherence

In the UK, it's estimated that the National Health System (NHS) spends nearly $11 billion each year on medicines, issuing 927 million prescriptions. More than $121 million constitutes unused and returned drugs, which are destroyed. In addition, hospital admission costs attributed to patients not taking their prescribed medicine properly was estimated at between $44-$240 million per year.[4]

In the United States of America (USA), medication non-adherence leads to between $100 and $300 Billion of avoidable healthcare costs annually, or about 3–10% of total USA healthcare costs. Health-related lost productivity costs are 2.3 times higher than the direct

healthcare costs. In contrast, medication adherence in patients with one or more chronic vascular conditions resulted in a reduction of average annual medical spending by $8,881 in congestive heart failure, $4,337 in hypertension, and $4,413 in diabetes. Further, it is estimated that improved adherence to diabetes medication could avert 699,000 emergency department visits and 341,000 hospitalisations annually, amounting to a savings of $4.7 billion.[3]

A recent National Institute for Health Care Management (NIHCM) foundation data brief concluded that the top 1% healthcare spenders in the USA account for more than 20% of the spending, and that the top 5% account for almost 50% of all allocated health resources. Investigating the common conditions of these patients revealed the top five to be uncontrolled hypertension, dyslipidaemia and diabetes mellitus – some of the diseases with the lowest adherence rates.[6]

Potential health losses must be considered also. Therapeutic non-adherence becomes a problem when the only way to prevent certain diseases is by taking prescribed medications. A lack of awareness and motivation for some patients, and for some health problems such as hypertension and high LDL cholesterol (dyslipidaemia), results in inconsistent and inadequate medication intake. In the worst case, complete neglect of prescribed medication usage, the danger may not be appreciated by patients.

As an example, in the case of arterial hypertension a population-based study concluded that non-adherence to antihypertensive medication was associated with a 5.7-fold increase in the odds of a fatal stroke during the year of death, and a 2-fold increased risk of non-fatal stroke.[7] Stroke, only one of hypertension's related complications, causes 11% of all deaths worldwide and is the second most common cause of death after ischemic heart disease[8] with, in 2010, stroke-related disability being the third most common cause of reduced disability-adjusted life-years.[9]

Solutions

Each disease has its own special challenges, and causes of the behaviour must be understood. Many conditions may be aggravated or even fatal without the correct intervention, and it must be assumed that non-adherence cuts across all medical specialties.

The growth in technological solutions has resulted in many gadgets and devices becoming available for practically everything. Some could make a difference with medication adherence. It is important to know "the state of the art" of medication adherence devices, particularly portable ones that function regardless of the location of intake. This is an area with relatively few published articles, and a need for additional research. Furthermore, available systematic reviews reveal small sample sizes and make the conclusions questionable. Also, there is a lack of real-life usage of these technologies since the main market for these devices are clinical drug trials.

For this report two systematic reviews were examined. In the first the authors considered that, although positive effects on adherence were reported, rigorously conducted studies are needed to inform the use of electronic multi-compartment medical devices.[10] The second systematic review addressed simple devices that monitor and store adherence records, and devices that combine digital displays with audible reminder alarms. Of these, electronic medication packaging (EMP) devices appeared most useful for improving adherence, with 1 to 34% of increased adherence, depending on the kind of intervention.[11] At this time it is almost impossible to establish, with a high degree of certainty, the importance of monitoring devices in clinical practice, and its impact on the problem of non-adherence.

However, with growth of the Internet of Things (IoT) and combination with medication adherence technology, circumstances may change. Healthcare today relies on analytic data for almost everything. Yet for medication adherence the only input, besides analytic control by blood sampling, is the patient-reported data on medication intake. Future technological devices that fit within the lifestyle of the average person could be a game-changer in therapeutic non-adherence.

Sensor technology is making the creation of new data much easier. But to be useful, those data need to be communicated, aggregated, and analysed in ways that enable new and more effective action. Several IoT-enabled devices are available to patients and providers to monitor diabetes, heart conditions, and other ailments. However, the devices are rarely set up to export their data to a system that aggregates and shares information with all involved (clinicians and patients).

Therefore the real goal is to interconnect all ambulatory devices to send information to an IoT-based system that allows real-time monitoring by health professionals of patient's biosignals and

adherence behaviour. Such a tool would provide feedback to patients helping them engage and make better health and wellness decisions in real-time, decreasing the need for costly clinician visits, tests, and hospitalisations, and reducing the rate of progression of the disease.[12]

Conclusion

Therapeutic non-adherence is a public health problem that leads to high economic and health losses. Raised awareness amongst health professionals and the general population is needed. As shown above, currently it is impossible to determine the real impact of portable monitoring devices in therapeutic non-adherence in day-to-day clinical practice. A proposed solution is to create a therapeutic adherence monitoring device contained in a smart blister pack, that is coupled to a device which has the capacity to collect (from other medical devices) and send data (medicine time of ingestion, blood pressure and oximetry) to a common server with a real-time monitoring system. This will allow a clinician to know, with high certainty, if the patient is taking their medication as prescribed and as scheduled.

Corresponding author:
Orlando Rodrigues
University of Beira Interior - Faculty of Health Sciences
Av. Infante D. Henrique 6200-506
Covilha
Portugal
e-Mail: orl.pim.rod@gmail.com

Conflict of interest. The author declares no conflict of interest.

References

1. World Health Organization (WHO) Nutrition Health Topics 2002. Available at: http://www.who.int/nutrition/topics/2_background/en/ accessed 20 October 2016.
2. Crisp N, Berwick D, Kickbusch I, et al. Um Futuro para a Saúde – todos temos um papel a desempenhar. In: Fundação Calouste Gulbenkian. Portugal, 2014. Available at: https://gulbenkian.pt/wp-content/uploads/2016/03/PGIS_BrochuraRelatorioCompletoHealthPortugues.pdf accessed 6 March 2017.
3. Brown MT, Bussell J, Dutta S, et al. Medication Adherence: Truth and consequences. *Am J Med Sci* 2016;351(4):387-99.
4. Bowsher, M. The automated pill dispenser project – the right pills at the right time delivering the right outcomes. End project evaluation report. West Midlands [Walsall]: Improvement and Efficiency West Midlands, March 2012. (2012).Available at: http://www.westmidlandsiep.gov.uk/download.php?did=3099 accessed 6 March 2017.
5. Yap AF, Thirumoorthy T, Kwan YH. Medication adherence in the elderly. *J Clin Gerontol Geriatr* 2016;7(2):64-67.
6. Schoenman AJ, Chockley N. The Concentration of Health Care Spending – NIHCM Foundation Data Brief July 2012. Available at: https://www.nihcm.org/pdf/DataBrief3%20Final.pdf accessed 6 March 2017.
7. Herttua K, Tabák AG, Martikainen P, Vahtera J, Kivimäki M. Adherence to antihypertensive therapy prior to the first presentation of stroke in hypertensive adults: population-based study. *Eur Heart J* 2013;34(38):2933-2939.
8. Lozano R, Naghavi M, Foreman K, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2013;380(9859):2095–2128.
9. Murray CJ, Vos T, Lozano R. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2013;380(9895):2197–2223.
10. Paterson M, Kinnear M, Bond C, McKinstry B. A systematic review of electronic multi-compartment medication devices with reminder systems for improving adherence to self-administered medications. *Int J Pharm Pract.* January 2016. Available at: http://onlinelibrary.wiley.com/doi/10.1111/ijpp.12242/full accessed 6 March 2017.
11. Checchi KD, Huybrechts KF, Avorn J, Kesselheim AS. Electronic medication packaging devices and medication adherence: a systematic

review. *JAMA* 2014;312(12):1237-1247.
12. Cousin M, Castillo-Hi T, Snyder GH. Devices and diseases – How the IoT is transforming medtech - The Internet of Things in the medical devices industry. September 2015. Deloitte University Press. Available at: https://dupress.deloitte.com/dup-us-en/focus/internet-of-things/iot-in-medical-devices-industry.html accessed 6 March 2017.