Mobile Technology Driving Better Clinical Care and Empowering People to take Charge of their Health and Wellbeing

Executive Summary

As telemedicine continues to grow and evolve, biometric monitoring-based follow-up care for chronically ill and post-surgical patients will increasingly shift out of hospitals and into homes. The technology that powers this change is beginning to extend well beyond simply monitoring patients, as it is adopted by health-conscious individuals, as a means of tightly monitoring their health status. These technologies provide much-needed insights to assist professional caregivers in making well-informed decisions, and also help patients take on a more active role in their own wellbeing and health care management. The challenge still facing medical technology providers is to present digestible, sharable data to health care providers, to enable them to make better and more informed decisions, and as a result, improve patient outcomes.

Personal, digital health monitoring systems designed to monitor and process key physiological signs, have been gaining popularity, particularly among chronically ill patients and health-conscious individuals. When integrating appropriate algorithms, embedded sensors acquire and filter biosignals and extract meaningful and actionable health information, which is then wirelessly transmitted to a mobile phone-based gateway, through which both patients and physicians can be alerted. Simultaneous collection of an array of parameters by a single vital signs-sensing device, can provide for tight, long-term, low-cost and sharable health status monitoring, with the potential to improve health management and quality of life, promote both early intervention and proactive care and reduce health care expenditures. The benefits of such sensors have been ascribed to heightened compliance and adherence among well-informed patients (1) and to early recognition of clinical deterioration, curbed by timely intervention. Their introduction into the market has empowered clinical data collection in real-world settings and the shift toward exploitation of big data, which are continuously revolutionizing conventional medical practice. The collected information can be easily integrated into cloud-based health-care records, which have been established by several national healthcare programs, providing individuals and caregivers with a comprehensive record of medical status and disease symptoms. Utilizing patient's personal

smartphone as their monitoring gateway, actively involves patients in prevention responsibility by equipping them with accurate, accessible and simple self-management tools.

Vital sign measurement is an integral component of clinical management, where aberrations from the normal range often reflect an underlying pathological state. More specifically, ECG is the main measurable in detecting and monitoring arrhythmia, including atrial fibrillation, and common and often asymptomatic arrhythmia (2). Similarly, hypertension is a key indicator of cardiovascular diseases, while accelerated resting heart rate has been associated with increased mortality rates in a range of patient populations. Thus, it is not surprising that patient-reported outcomes (PRO)-based vital sign monitoring via consumer-facing applications have been considered of clinical value in both preventing and managing chronic diseases. Specifically, smart devices provide a more authentic representation of the manifestations of the health condition basic vitals in an individual's natural setting. Frequent collection of physiological signals, including ECG signals, heart rate and blood pressure, has been implicated in early detection and prevention of hypertension and cardiopulmonary diseases (4-6). Similarly, regular home-based blood pressure monitoring has been associated with improved blood pressure control and treatment adherence in patients with hypertension (7-8), and may be translatable to management of high-risk pregnancies (9-10). Long-term monitoring of blood oxygen saturation has been associated with curbed exacerbation of chronic pulmonary disease and reduced mortality rates among both infants and adults undergoing long-term oxygen therapy (11). In line with these reports, self-monitoring has been associated with overall improved quality of life, care and sense of security, shortened duration of hospital stay and fewer emergency department visits (12). A 50% reduction in hospital admissions and a similar reduction in hospital length of stay were recorded among chronic heart failure patients monitored daily for weight, blood pressure and pulse rate (13). At the same time, self-monitoring can benefit healthy individuals involved in exercise programs or high-altitude sports (14), where the stored information enables tracking of performance progress and adaptation and can alert the user in the event of an anomaly. A group of healthy individuals participating in a moderate-intensity, home-based exercise program and implementing simple self-monitoring strategies on a daily basis completed significantly more training sessions over a 6-month study period as compared to those monitoring their vital signs on a weekly basis (15). Taken together, multimodal sensors tracking health indicators and disease symptoms promise to strengthen personal health surveillance in both healthy and chronically ill populations, as well as potentiate

patient-doctor collaborations. As a result, patients are more likely to adopt lifestyle changes and more personalized treatment regimens can be designed and implemented.

The Prizma medical smartphone jacket was designed to support self-testing of an array of vital signs, with the main goal of promoting health and wellbeing. The device provides for comprehensive, medical-grade acquisition and processing of key vital signs, such as ECG, saturation level and Heart Rate, which can be logged on a cloud and shared with relevant parties at all times. In addition, the simultaneous collection of several parameters eliminates the need for purchase, use and maintenance of several dedicated devices. Compatible with standard mobile phones, the device empowers accessible, personalized surveillance at all times. Among 488 adults responding to an internet-based survey regarding current and projected health care monitoring habits, 60% expressed high interest in the Prizma vital signs monitoring device. The vast majority of responders ranked the device as a tool that can very much assist them on a daily basis (71%) or in cases of emergency (68%) and marked routine follow-up on important health measures (58%) and ability to share information with the physician (56%) as the key motivations for purchase. Particular interest was expressed by the chronically ill fraction of the responders, 53% of whom claimed they would purchase the device. In addition, 77% of the individuals regularly engaging in sports activities expressed interest in the device, where the degree of interest directly correlated with workout intensities. Moreover, interest in the device was significantly higher in the 30-40 year-old age group, and decreased as age advanced. In line with these findings, the Pew Internet Research self-tracking survey, prompting 3014 adults, found that 69% monitored at least one health indicator, 50% of whom reported that recorded data altered their approach to health (16).

In summary, the continuous evolution of mobile healthcare solutions is revolutionizing patient health, level of care and quality of life. The trending deployment of the mobile phone for such medical and health monitoring, has rendered such tools highly accessible and effective. As remote patient monitoring options continue to grow and mature, the burgeoning strain on the healthcare system will decline accordingly. Such advances in telemedicine will save clinicians time and improve workflow efficiencies, while cutting costs, through reduced utilization of health services and improve the quality of patient life through education, self-empowerment and improved self-management of disease.

References

1. Dobkin BH, Dorsch A: The promise of mHealth: daily activity monitoring and outcome assessments by wearable sensors. Neurorehabil Neural Repair. 2011;25(9):788-798.
2. Smith G, Prytherch D, Schmidt P et al Hospital-wide physiological surveillance – a new approach to the early identification and management of the sick patient. Resuscitation 2006;71(1):19–28.
3. Cook C, Togni M, Schaub MS, et al. High heart rate: A cardiovascular risk factor? European Heart J 2006;27(20):2387–2393.
4. Johnson P and Andrews DC. Remote continuous physiological monitoring in the home. J Telemed Telecare 1996;2:107–113.
5. Ton V-K, Martin SS, Blumenthal RS, Blaha MJ. Comparing the new European cardiovascular disease prevention guideline with prior American heart association guidelines: an editorial review. Clin Cardiol. 2013;36:E1-6.
6. de Lusignan S, Althans A, Wells S, et al. A pilot study of radiotelemetry for continuous cardiopulmonary monitoring of patients at home. J Telemed Telecare 2000;6(Suppl 1):S119–S122.
7. Fursse J, Clarke M, Jones R, et al. Early experience in using telemonitoring for the management of chronic disease in primary care. J Telemed Telecare 2008;14:122-124.
8. Green BB, Ralston JD, Fishman PA, et al. Electronic communications and home blood pressure monitoring (e-bp) study: design, delivery, and evaluation framework. Contemp Clin Trials 2008;*29:*376-395.
9. Hailey D, Roine R and Ohinmaa A. Systematic review of evidence for the benefits of telemedicine. J Telemed Telecare 2002;8 (Suppl. 1):1–30
10. Naef RW, Perry KG Jr., Magann EF, et al. Home blood pressure monitoring for pregnant patients with hypertension. J Perinatol 1998;18:226–229.
11. Balfour-Lynn I, Primhak R and Shaw B. Home oxygen for children: who, how and when? Thorax 2005;60(1):76-81.
12. Heidenreich PA, Ruggerio CM and Massie BM. Effect of a home monitoring system on hospitalization and resource use for patients with heart failure. Am Heart J 1999;138:633-40.
13. Morguet AJ, Kühnelt P, Kallel A, et al. Impact of telemedical care and monitoring on morbidity in mild to moderate chronic heart failure. Cardiology 2008;111:134-139.
14. Satava R, Angood PB, Harrett B, et al. The physiologic cipher at altitude: telemedicine and real-time monitoring of climbers on Mount Everest. Telemed J E-Health 2000;6:303–313.
15. King AC, Taylor CB, Haskell WL and Debusk RF. Strategies for increasing early adherence to and long-term maintenance of home-based exercise training in healthy middle-aged men and women. Am J Cardiol 1988;61(8):628-32.
16. Paton C, Hansen M, Fernandez-Luque L, YS L a: Self-Tracking, social media and personal health records for patient empowered self-care. contribution of the IMIA social media working group. Yearb Med Inform. 2012, 7: 16-24.