Personal Health Monitoring System (PHS) for patients with Long Term Conditions

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Oracle Corporation (Oracle), the Institute of Biomedical Engineering at Imperial College London (IBE), and Toumaz Technology Ltd (Toumaz) are collaborating in the development of low-power sensor interfaces and new wireless middleware to create a complete and fully integrated personal health monitoring system for chronic disease management. This collective innovation will result in the pilot implementation of a community care programme for heart failure in the North Western region of London.

Abstract

The project partners will develop an end-to-end information and communications technology (ICT) system enabling citizens to automatically monitor their vital health paramters and to transmit the information to a centralised information repository that can be securely accessed by healthcare professionals nationwide. The project will bring together world leading expertise in the UK in the area of biomedical sensor interfaces, commercial middleware for wireless edge processing, and healthcare systems integration based on health level 7 (HL7) standards and the National Programme for IT (NPfIT). To achieve the aim of a pilot implementation at the conclusion of this project, the partners focused on chronic disease management: particularly heart failure, as advised by the North West Strategic Health Authority (NWSHA) of London. The system will be designed so that it can be readily extended and scaled for other long term conditions.
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Project Overview

This project will conclude in the pilot implementation of a world first of its kind personal health monitoring system (PHS) for citizens, suffering from or vulnerable to chronic diseases, in the UK. The PHS will enable patients to independently and continuously monitor their own chronic conditions without the need of frequent hospital/GP visits, and let healthcare professionals, especially at the primary care level, make timely â€˜real-time â€™medical interventions for the prevention of severe disease degeneration. The PHS will consist of (i) novel biosensors operating in a body area network, (ii) ultra low-power hardware sensor interfaces with real-time and programmable data acquistion, transmitting the data via encrypted low-power short range wireless communication to a PDA or mobile phone, (iii) wireless edge processing software operating on a PDA or mobile phone for local data storage and intelligent processing, with the capability of secure bi-directional transmission over a public area network to a central healthcare information repository and to the body area sensor network for controlling changes in information flow, and (iv) the integration of this information flow into a central healthcare information repository and database system that can be securely accessed by healthcare professionals anywhere anytime.

The creation of such a PHS requires innovation at a system level, in integrating new technologies and business processes, and in the key ingredient technologies. This project will not involve the development of novel biosensors, in which leading research is already being undertaken at IBE. The foci of this project will be on the development of the ultra-low power hardware sensor interfaces in the body area network (IBE, Toumaz), the augmentation of wireless edge processing software (Oracle â€™s MicroEdge Server) with artificial intelligence on the PDA for healthcare applications, a database application based on the Oracle Healthcare Transaction Base (HTB) that conforms with the national health transactional messaging spine for ubiquitous information access to healthcare professionals, and the information protocols for systems integration and interoperability.

The system usability will be tailored for the elderly and technologically naive in their home or community settings, in consultation with healthcare user representatives such as the British Heart Foundation and the Re-beat Patient Support Group.

Although there are other research efforts towards a personal health monitoring system and attempts to address the market need of chronic disease management, they suffer from various shortcomings: the lack of commercial leadership such as in the PHMon project at Karls Ruhe university in Germany, the tendency of most technology vendors to be myopic about their own business niche rather than collaborative development of an end-to-end system infrastructure, or consortia not being focused by the use-cases of a specific clinical need. Oracle, a major commercial stakeholder of UK healthcare information systems, partnering with a leading engineering and medical academic institution (Imperial), and a

promising homegrown high-tech start-up Toumaz will develop the first complete system infrastructure for personal chronic disease management in an actual community care setting. The focus on the specific clinical needs of heart failure will ensure that the system has well defined deliverables, measurable performance criteria, and a speedy timeline for demonstrating practical results.

There is worldwide recognition of the necessity for new and innovative technology solutions in the healthcare marketplace, improving the holistic quality of care to citizens at an affordable price. An increasing trend is towards greater care in the community, reducing the burden on acute care and primary care facilities for chronic disease management. A number of recent studies confirm this need for developing community healthcare capability, especially for heart failure patients for whom medical management represents the mainstay treatment. Currently heart failure management is based around episodes of hospital patient admission and scheduled outpatient clinic appointments. The current system cannot cope with the growing burden of approximately 350, 000 moderate and severe heart failure cases a year in the US and Europe. Healthcare professionals now accept and are indeed strong advocates that the type of technology innovation contemplated in this project is the only foreseeable solution.

With an increasingly ageing population, (number of over 65s will be equal to or greater the number of 16 year olds and younger by 2011 in Western Europe) and the keen interest of healthcare service providers in establishing community healthcare, there is a large and underserved global market for PHS. The technological expertise required to harvest this market is fragmented across universities, start-ups experimenting with new technologies, and large ICT companies with the proven track record of developing and rolling out commercially reliable information systems. In addition, there is the need for close cooperation with a primary care healthcare service organisation and healthcare user groups to ensure that the technology solution is optimised for clinical need and patient usability. The project partners can meet these challenges to deliver a PHS that satisfies clinical need, patient usability preferences, international healthcare standards for the transmission of electronic messages from different systems, such as the HL7 v3 clinical messaging mandated by the NHS, and utilises core database and application server technologies selected for the NPfIT.

The project partners through wideranging discussions have explored the commercial case for the PHS. The market proof of concept is evident from the interest of the NWSHA in starting a pilot implementation as soon as the technology development has been completed. Demand for the PHS exists not only within several primary care trusts in the UK but also the healthcare service providers of other countries have expressed interest in importing this technology to meet the growing burden of chronic disease management on their respective economies: about 70-78 % of healthcare expenditure in the western economies is on chronic disease management and it is even more severe in developing economies.

There is immediate market pull from the local service providers (LSPs) of the NPfIT who are keen to source such PHS technology for the final e-Health phase due in five to seven years. The commercialisation potential of the PHS will extend beyond the LSPs in the UK: chronic disease management has been described by the World Bank as the global challenge of the 21st century and is therefore highly relevant to all ICT systems integrators seeking new opportunities in the healthcare market.

Modern technologies, such as these being proposed, can make a significant contribution both to the welfare of the individual as well as to reducing the overall cost of care delivery, as well as finally realising the dream of patient-centric care.

In terms of improved quality of care, the proposition is that the condition of the patient can be constantly monitored within their home and, through the application of rules processing, alerts and notifications can be generated and forwarded to the appropriate care providers (and optionally to the patient themselves). Intelligent, ultra-low power, embedded sensors can alter their feedback based on the changing condition of the patient, providing more precise data when close monitoring is necessary e.g. ECG trace, and reducing output when the patient condition is stabilised e.g. heart beat/min every hour.

Patients with long term diseases such as hypertension, diabetes, and asthma to name but a few can benefit greatly from continuous monitoring of those key indicators such as blood pressure, blood glucose and other vital signs with automated exception detection and alerts to the patient as well as to care professionals to ensure early warning of adverse symptoms.

In terms of reducing cost, through continuous monitoring and early detection, both short term chronic complications can be avoided thus reducing acute admissions as well as enabling longer term, informed, lifestyle decisions to be made by the clinician in consultation with the patient.

The development of an end-to-end, sensor-based chronic disease monitoring system, as proposed, would demonstrate the highest levels of hardware technology (e.g. low power sensors), software technology (e.g. MicroEdge server), and business innovation (e.g. clinical applications to improve patient care) all working in tandem with each other. This will put the UK at the forefront of pervasive computing within the Healthcare sector worldwide, with great potential for leading the charge in mobility computing.

Conclusion

Key barriers to the adoption of home remote monitoring stem from previously high technology costs. Payback periods have typically been too long, there have been issues in the past with integration of clinical information, and now architectural solutions such as Oracle â€™s Healthcare Tansaction base make this achievable. Oracle is the only Information Technology company still to have developed a clinical repository that meets International messaging standards such as Health Language seven version three (HL7v3).

Companies are waiting for sensor technology to drop in price, thus making it a more affordable investment. The Sensium platform developed buy Toumaz Technologies enables this. Lean information technology budgets mean that new technologies need to demonstrate compelling business cases and short paybacks on investments. Many Companies that were skeptical now realise that given the increasing costs of treating patients in the Hospital that monitoring patients in their home dramatically reduces the cost of care the issue will be one of â€˜who will benefit?â€™ rather than, â€˜is this solutio technically achieveable. â€™The benefits to clinicians who providers this service is that more patients can be monitored at a lower resource cost freeing up bed or clinic utilisation, thus, increasing proctivity and margins. The benefit to the Payor is lower cost and an increase in healthcare benefit. Surely a win win for all.

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