A Concept for a Long-term Scalable Primary Care Model

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Abstract

This paper presents a concept for development of a unified bioengineering framework that consolidates efforts in extending the geographical boundaries and outreach of primary care in Ireland and ensure its long-term scalability. This framework encompasses infrastructures, devices, systems, techniques, materials, engineering practices and socio-technical set-ups for improved access, safety and quality of care at national and global levels. In particular, we address the development of special purpose solutions, technologies and devices for healthcare from a bioengineering perspective, within the wider biotechnology agenda in Ireland.

Keywords: Primary Care, Bioengineering, Information and Communication Technologies, Global Platform.

1 INTRODUCTION

This paper describes the basis for a novel approach to an integrated, widely-accessible primary care model by developing scalable solutions and modules which employs local and global healthcare priorities, cutting-edge information and communication technologies (ICT) and logics as well as the latest advances in the field of bioengineering.

We address the problem at three levels: infrastructural, gateway and community. The infrastructural level represents the basic physical networking and middleware level. Technologies considered at this level are e-infrastructures, media technologies, knowledge management technologies and universal access technologies. The gateway level represents the entry point to the healthcare system. It is accessible by the patients, global primary care network and global primary care team. It incorporates healthcare services, structure, organization/administration, the supporting global legislative framework and features of healthcare portals. The community level represents the global healthcare team and network. The interactions between the global primary care team and the global primary care network are supported by a global infrastructure enabling scalable and novel paradigms of interaction to accomplish critical healthcare missions and ensure continuity and quality of care.

The objectives of our conceptual framework are to: (i) bridge the gap between user-friendly healthcare technologies, computations and data intensive grid-based healthcare solutions; (ii) develop a meta-model of personalized healthcare; (iii) support the collaborative authoring of interactive healthcare digital content; (iv) introduce novel paradigms of interaction among patients, global healthcare team, global healthcare network and healthcare industry; (v) suggest a design model for products and services for global health; and (vi) develop models to incorporate ICT solutions into medical practices, processes and products.

2 BACKGROUND

This paper is motivated by our interest in developing a long term scalable primary care model and in exploring a unified bioengineering[1] framework that consolidates efforts in extending the geographical boundaries and outreach of primary care. A longer term Primary Care model should take into account a global dimension not only a local one. This is reflected in policies, research and development agendas, and Information and Communication Technology ICT support for healthcare:

2.1 Policies

All healthcare and scientific authorities worldwide are realizing the importance of developing global healthcare. The U.S. National Research Council [1] stresses the need to invest in information technology and infrastructure for efficient communication among players in the global health arena. Adopted healthcare models in Australia, Canada, France, Germany, Netherlands, Sweden, U.K and U.S. [2] suggest an added value from adopting an integrated health care model incorporating international healthcare practices. The Irish health policy is influenced by developments at the international level [3] and by the standards set by the World Health Organisation (WHO). In recent times, the Irish health policy has emphasised prevention, healthy living, more active lifestyles and community-based services and noted that these are highly influenced by globalization. In particular, the 2001 Irish government strategy for the development of primary care services [4] proposed a wider availability of General Practitioners (GP) services through teams and GP co-operatives and the establishment of multi-disciplinary primary care teams.

In the wider European arena, the Better Healthcare for Europe [5] is an EU policy and research and development agenda involving eHealth policy development (eHealth Action Plan [6]), the development of the EU public health portal [7], and eHealth interoperability (cross-border interoperability of electronic health records, telemedicine, healthcare and society, eHealth Resolution) [8]. Notably, the eHealth is an integral component of the EU's i2010 policy framework [9] which seeks to promote an open and competitive digital economy. One of the three i2010's pillars is to foster inclusion, better public services and quality of life through ICTs.

2.2 Research

Globalisation is influencing to a large extent social behaviour and fosters a greater diversity of local communities. The adoption of open economies, markets and systems created an unprecedented impact on the culture and practices of individuals including their health practices. Various research studies are undertaken to assess the impact of globalization on healthcare. It is widely recognized that globalization is a complex, multidimensional phenomenon that has already influenced the way in which hospitals operate and will increasingly impact the healthcare landscape and patients experience worldwide [10]. Globalization is a key context for the study of social determinants of health (e.g., the conditions in which people live and work) [11].

2.3 ICT support

The tools of the modern digital world, in conjunction with novel technologies, especially those in the biological and medical sciences [12,13, 14], have dramatically changed the potential for obtaining and using new information. In the field of global health, the benefits can be seen in many ways: how medical research is conducted; how new information is published, stored, retrieved, and used; how scientists and clinicians communicate; how diseases are monitored and tracked; and how medicine is practiced [2]. In regional development agenda, IT solutions for life sciences are considered at a global infrastructural level2 [12, 13, 14]. The challenge 5 of the ICT research under the EU's 7th FP focuses

[1] Bioengineering is an interdisciplinary field in which the techniques, materials, devices and resourcefulness of engineers are used to address problems in biology and healthcare.

[2] EGEE supported project, Health-e-Child, connecting pediatrics healthcare professionals with grid technology, was awarded the ICT 2008 Exhibit Grand Prize.

on three specific aspects: personalised monitoring and point-of-care diagnosis, patient safety and risk assessment and virtual physiological human [15, 16].

2.4 Examples of case studies of ICT support in primary health care

Specific approaches to implementation of ICT in primary care and at community level (e.g. patient's home, etc) may include targeted programmes and initiatives for better health education, promotion and health monitoring. While having been developed and tested mainly at a regional level, these can surely profit from a further expansion and wider implementation through a global, long-term scalable model of primary care, with an ICT platform like our. Two such recent examples of successful programmes are provided below:

- *Case 1: ICT support for self-monitoring and glucose control in primary care.* National Service Framework (NSF) standards 3-6 relate to working with individuals and their support networks to support self-care. However there is evidence that people with diabetes are not maximising the benefit of self-monitoring or the lifestyle changes required to minimise damage from their disease with, for example, over-usage of glucose monitoring without adequate knowledge of how to use the information to improve glucose control [17, 18]. Health promotional activities do take place but are small scale and opt-in rather than opt-out and inevitably do not attract those in greatest need of help and support. For instance, in UK, some of the targets for glucose control were set as follows: (i) improvements in the management of diabetic patients through the roll-out across all general practices of the care plan approach and support for patients to take a greater role; and (ii) as measured in the Quality & Outcomes Framework in general practice, the rates of blood glucose control in primary care increase from 65% in 2007-2008 to 68% in 2010-2011 (i.e., a Primary Care Trust corporate objective).
- *Case 2: ICT in Heart Failure (HF) Management by M-TOMITA model [19] and media-likely-generated messages/profiles.* A conceptual framework, Model Toward Optimal Independence through Technological Adoption (M-TOMITA) [19] was formed based on the Trans-theoretical Model (TTM), social support theory, and a mass communication theory called Uses and Gratification Model. The M-TOMITA works best when individuals are already aware of their chronic conditions and are contemplating doing something to manage their illness but are not sure what to do (the contemplation stage). If someone has little knowledge of their illness and is not aware that changing health behavior may help them, this model may not be effective. The model is an empowerment process that progresses through stages from contemplation, preparation, and action, to maintenance. Using the Internet method, 4 types of support by health care professionals can be provided. Informational support or education of chronic illness and suggested health behaviors is especially important in the initial stage but should continue all the stages. Among the recommended health behaviors, patients will choose an activity to focus on. Once the first activity is successfully implemented, additional activities will be added, one by one. After the decision regarding a particular health behavior is made, an instrumental support should be provided via the Internet. Through the online record-keeping system the participant can track their own vital signs and health behaviors so that they can become aware of a cause (life style) and effect (symptom and general health) relationship.

3 PREVALENT PRIMARY CARE MODELS

Primary health care is essential health care made universally accessible to individuals and families in the community by means acceptable to them, through their full participation and at a cost that the community and country can afford. It forms an integral part both of the country's health system of which it is the nucleus and of the overall social and economic development of the community.

Trotter [20] classified primary care models in two categories: (1) the traditional models; and (2) the newer models including GP vs. PCT (primary care team in Sweden/UK), Community Based Primary Care (polyclinics), CDSMP, Group visit Models, Alternative: Telephone care, Remote Telemedicine.

A good summary of Primary Care [21] concludes with a new vision of primary care focused on the health of populations. Integration of services and practitioners, continuity of care, and a focus on health promotion and disease prevention would all be supported by new facilities and funding mechanisms. Patient navigators and advocates, along with case management and discharge planning would all work towards keeping people healthy and helping them manage their own care. Participants argue that investments in primary care that work towards this vision will yield savings in the long-term.

A comparison of 4 primary care models from Ottawa (Canada) [22] shows clearly that the type of the practice is of importance. How practices are organized and how physicians are remunerated affect the costs associated with providing patient care. According to [22], it is difficult to claim that one type of primary care model dominates. In particular, further research, which better tracks the relationship between the primary care model and the use of other health system resources, is necessary in order to better understand which approach makes the best use of public resources.

4 CHALLENGES FACING THE CONTINUITY OF CARE

Globalization imposes new challenges on healthcare solutions framed as scalability (volume, complexity, heterogeneity), level (need for global infrastructural support), globalisation of processes (simplification, accuracy, quality, timeliness, workflow modelling), security (international legislations and data protection framework) and accessibility (facilitating access for widest local and international community).

Our aim is to develop a Global Platform For Primary Care (GP4PC) to address existing problems at local and global levels in the continuity of care (e.g., transition from primary to secondary care), interactions/relationships within the primary care practice (e.g., doctor-staff) and improved access to care. This involves the exploration, from a bioengineering perspective, of a global framework that encompasses systems, techniques, materials, devices, engineering practices, and socio-technical set ups (involving interaction among doctor-staff-patient-devices-medical networks) for improved access to healthcare at national and global levels. For instance, the solutions of biotechnology problems in Ireland focused on the development of special purpose approaches, technologies and devices for healthcare. Our research complements existing efforts by considering a wider bioengineering framework that takes into consideration: (i) cutting edge information and communication technologies (ICT), (ii) local regional and global healthcare priorities and practices, and (iii) latest advances in bioengineering, media, publicity and marketing developments.

5 RESEARCH METHODOLOGY

We decompose the problem of developing a Global Platform For Primary Care (GP4PC) into three levels (**Figure 1**): the infrastructural, the gateway, and the community levels.

5.1 The infrastructural level

This level represents the basic physical networking and technology level. Technologies considered at this level are e-infrastructures, media technologies, knowledge management technologies, and universal access technologies.

E-infrastructures provide massive distributed computational power and data storage for global sharing and distributed direct access of world computational resources and the collaboration on compute and data intensive experimentations. E-infrastructure technologies include grid technologies. Bioinformatics, medical imaging, and life sciences are pilot grid applications [13].

Media technologies are technologies for authoring, broadcasting and delivering rich content and services through various media delivery channels (web, TV, wireless devices, etc). The use of media technologies in healthcare include: the authoring, broadcasting, and delivery of health care video to raise awareness and promote disease prevention; the indexation and meta modelling of healthcare digital content; the localisation of the healthcare digital content (this include multilingual support and

culture dependent paradigms of interaction); supporting the patient and the primary care team and network in authoring healthcare interactive digital content.

Knowledge management technologies are technologies for capturing – recording – turning into knowledge massive data generated from various application domains. Knowledge management technologies are used in healthcare to support: quality control; the storage, manipulation, and retrieval of healthcare content; the meta modelling of patient records; the mining of patient data for healthcare decision making; and the development of global healthcare benchmarks.

Universal access technologies provide accessibility any time any where of content and services to the wider community including the disabled user. The use of universal access technology in global primary care ensures 24 hours access to healthcare reaching a global community through various media delivery channels (wireless devices; ipod, interactive TV, PDAs); a fair and personalised access to primary care for the elderly, the young and the disabled; and the support of the integration of care.

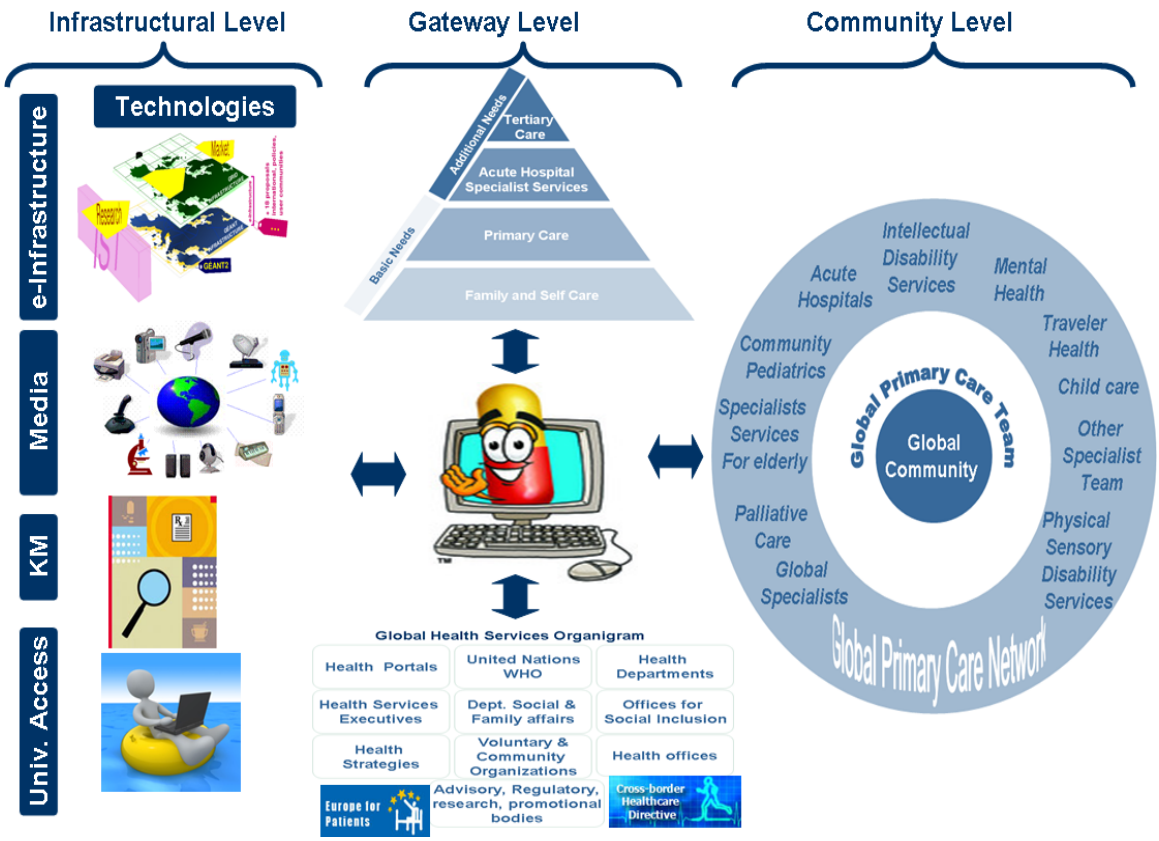

Figure 1. The levels of the Global Platform for Primary Care

5.2 The gateway level

The gateway level represents the entry point to healthcare. It is accessible by patients, the global primary care network and the global primary care team. It incorporate healthcare services; structure, organization, and administration of healthcare; the supporting global legislative framework; features of healthcare portals (e.g. the EU health care portal that acts as a repository of healthcare knowledge to raise awareness and promote disease prevention). It supports interoperability of healthcare. It embraces and extends what is currently referred to as e-health portals, virtual hospitals, and online primary care. It supports decentralised remote primary care on a 24 hours basis delivered to a global community. It supports the integration of care at various levels: tertiary care, acute hospital/specialist services, primary care, and family and self-care.

5.3 The community level

The community level represents the global healthcare team and network. The Irish Healthcare Strategy defines the terms "healthcare team" as "an inter-disciplinary team including GPs, nurses, midwives, health care assistants, home helps, physiotherapists, occupational therapists, social workers and administrative personnel, serving small population groups" and the term "healthcare network" as a "a wider network of health and social care professionals (speech and language therapists, community pharmacists, dieticians, community welfare officers, dentists, chiropodists and psychologists) working with a primary care teams to improve integration of care". We adopt these definitions however we adapt them to a global healthcare context. A global primary care team is more interdisciplinary and serves a wider community. The global primary care network has a wider expertise and specialisation. The interaction between the global primary care team and the global primary care network is supported by a global infrastructure enabling scalable and novel paradigms of interaction to meet critical healthcare mission and ensure continuity of care at a global level.

The development of the global platform for primary care involves the development of bioengineering principles, tools, and techniques for:

- ⇒ bridging the gap between user friendly healthcare technologies (google health [23, 24], HealthVault [25], ICGP [26]) and compute and data intensive grid based healthcare technologies [12, 13, 14];
- ⇒ meta modelling personalized patient centered healthcare services;
- ⇒ supporting the collaborative authoring of interactive healthcare digital content;
- ⇒ Developing novel paradigms of interaction among patients, global healthcare team, global healthcare network, and the healthcare industry;
- ⇒ developing a global healthcare enabling the delivery of healthcare services not only acting as a repository of info;
- ⇒ developing design model for products and services for global health;
- ⇒ developing models to incorporate IT solution into medical products and processes.

6 RESEARCH FOCUS

In the development of the initial prototype for the global platform for primary care we focus on:

- ➢ a target group of patients (e.g. pregnant women, elderly, children);
- ➢ a selected suite of infrastructure technologies (healthcare video database, benchmarks, use a blend of grid and user friendly healthcare applications);
- ➢ a specific set of gateway portal features, systems, legislations and services;
- ➢ specific paradigms of interaction between the patient, the global primary care team, and global primary care network.

The prototype implementation consists of the development of an enabling suite of technologies, processes, and legislation that can be tailored easily to accommodate other target groups and services in the primary care network. It ensures potential scalability to accommodate various target groups, deploy various technologies, incorporate various gateway features, and various paradigms of interaction.

We plan to conduct the test of the prototype implementation at three levels:

- ➢ Industry level: this will involve the selection of a target industry and the exploration of the packaging of this prototype platform to industry:
- ➢ Academic level: this involve the potential of developing a course or a program of study about a global health platform
- ➢ Research level: this involves the exploration of the use of the prototype by other researcher within a broader bioengineering context.

7 PRIMARY CARE MODEL CASE STUDIES

Our aim is to achieve, in a more cost-efficient way, new *solutions* in primary health care that are locally optimal and in the same time, flexible, adaptable, scalable and extendible to a global level. When being optimised, as based on the integration of ICT with a bioengineering framework through our proposed model of GP4PC, such operational solutions in various case studies *(e.g., targeted media-supported promotional personalized communications, health-educational approaches and messages, etc.)*, will have a global participation and impact. Notably, the GP4PC is directed towards generating evidence, building knowledge and capacity, decreasing medical error and increasing patient safety and, at least at regional levels, it will ensure the continuity of care, the improvement of quality of care and will lead to increase of cost-effectiveness and return of investment (ROI) in group and personalized healthcare deliveries, mainly, at individual patient level.

8 CONCLUSION

This paper described an ongoing research work on the development of a *global ICT-bioengineering platform for primary care*. We presented a concept and a bioengineering framework for the development of GP4PC. We described our adopted research methodology and focus. Our research methodology decomposes the problem of the GP4PC development in 3 levels: the infrastructure, the gateway, and the community levels. The initial prototype of the global platform for primary care will focus on a proprietary study case with a target group of patients, technologies and gateway features.

The expected outcome would ultimately widen the scope of the interdisciplinary field of bioengineering and target the global healthcare industry as a member of the global primary care network. This would ensure the incorporation of specialised services in healthcare products and ensure the delivery of high-quality personalised evidence-based primary care (EBPC) services in the general practice, at community level.

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