Next Generation Telehealth
Contribution of the IMIA Telehealth Working Group

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Summary
Objective: Telehealth has long been seen as a means of increasing access and quality of care while decreasing costs and logistical burden for remote health care delivery. Underlying technology to support Telehealth has been developed commercially. However, its widespread adoption has been hindered by numerous clinical, social, political, economic and management factors. This paper examines trends which may help to address this situation.
Methods: First we consider the current status of Telehealth based on some state-of-the-art reviews. Then we present some new future modes of Telehealth services, as described by various prominent authors. From these we identify some common directional themes and fundamental issues affecting the success of future Telehealth innovations.
Results: This position paper advances a view that Telehealth in the future will be much more driven by widespread pressure from two different drivers: more ubiquitous connectivity and related technological capabilities due to greater diversity in *human communication practices,* and new models of care emerging from diverse widespread movements towards *health services reform.*
Conclusion: The IMIA Working Group on Telehealth work agenda will address some specific items within the areas described above.

Keywords
Telehealth, telemedicine, telecare, mhealth, health services

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Introduction

Telehealth (conceptually "health care delivery remotely in location or time") has been widely acknowledged and accepted for several decades as a viable option for increasing access and quality of care, while decreasing costs and logistical burden (e.g. [1]). However, its operational adoption and implementation has not been as widespread or rapid as might be anticipated, due to multiple confounding factors. These include perceived lack of evidence of clinical and economic benefits, reluctance to define operational responsibility and liability policies, poorly developed business models and funding or reimbursement strategies, and difficulties of implementing change management for technology roll-out and user buy-in within the health sector [2]. For instance, a recent study by the World Health Organisation found that more than 50% of countries surveyed sought more information on both economic analysis and clinical evidence for Telehealth [3]. A think-tank study conducted in the USA resulted in a series of white papers dealing with different approaches to address blockage and limitation of Telehealth growth [4]. A recent systematic review [5] considered 1593 review papers, of which 80 were studied in depth, and noted that "21 reviews concluded that telemedicine is effective, 18 found that evidence is promising but incomplete and others that evidence is limited and inconsistent."

The underlying Information and Communication Technologies (ICT) to support conventional instances of Tele-health have largely been developed and are widely available commercially. Indeed, some Telehealth initiatives can be criticised as being driven by "technology push" rather than "clinical need". This position paper advances a view that Telehealth in the future will be much more driven by widespread pressure from two different drivers: more ubiquitous global availability of ICT technological capabilities and infrastructure in everyday life, in response to societal reorientation towards greater diversity in *human communication practices*, and as a consequence of new models of care emerging from diverse widespread movements in many different arenas towards *health services reform*. We will briefly discuss each of these concepts below.

Today's society has a growing expectation that emerging human communication practices will be informal, opportunistic, sporadic, contextual, multi-party and multi-modal. Correspondingly there is a growing reliance on sophisticated hardware and software technologies to provide high levels of connectivity, bandwidth, fidelity and presence. The convergence of communication and computation devices is currently underway, to provide flexible and universal means to support human engagement with this dynamically evolving communications ecosystem. The rapid inception and adoption of new communications mechanisms such as the Internet and wireless broadband

networking, have stimulated the runaway uptake of new services for activities such as social networking and personal messaging. They have largely replaced established telecommunications media such as telephone, radio and to some extent television. Often these services are established on secure or high-grade equipment at health care facilities such as hospitals, practices or clinics, and patients must still travel or book to access them.

Health services reform is a set of approaches which change and extend the ways in which health care is delivered, in order to overcome current and projected mismatch of needs and availability. While the nature of such reforms varies widely in different settings and jurisdictions internationally, there is a unifying theme of change in clinical and operational processes in the health sector, including reorganising and augmentation of existing processes and development of new alternative or complementary processes. Examples of these kinds of changes range from rollout of national Electronic Health Records in regional or national settings of developed countries with sophisticated established health systems (to allow wider sharing of patient health data leading to better clinical decisions), to use of mobile telephones for checking on daily care and medication adherence for rural patients of developing countries (to improve effectiveness of treatment in poor access situations). The overall motivations for such reforms are generic clinical operational needs such as overcoming health workforce limitations, supporting new and extended models of care, dealing with chronic disease management, and implementing widespread prevention and management programs. This is in contrast to the previously promoted attitude that Telehealth interventions must be developed, customised and proven on the basis of specific and usually existing clinical processes, often in isolation from other related or adjunct clinical and operational processes.

In developing this paper, we have reviewed recent publications appearing in the past 5 years to arrive at the above point of view. References to a selection of these sources are provided in the text below. We first discuss the current status of Telehealth, based on some recent state-of-the-art coverage (e.g. [1], [6], [7]). We then consider proposed and apparently imminent new future modes of Telehealth services, as described by various prominent authors (e.g. [8], [9], [10]). We summarise the fundamental blockers and limiting factors which have been identified by experts in those areas (e.g. [4]). We conclude with a summary of the IMIA Working Group on Telehealth work agenda which addresses some specific items within the overall space described above.

Current Status of Telehealth

Since the earliest scholarly research publications of the 1970s, the mainstream view of Telehealth has been focussed on the attractive paradigm of remote consultation. The ability to undertake primary or acute care clinician-patient encounters using ICT infrastructure and devices, when the actors are separated in location and time, provides an immediate benefit in care access and is especially attractive in remote or bottleneck situations. Numerous modes of tele-consultation and related tele-interaction have been explored, including telephone, radio, email, videoconferencing, and Internet. Often these are established on secure or high-grade equipment at health care facilities such as hospitals, practices or clinics, and patients must still travel or book to access them.

Generally these processes as adopted have replicated live consultations where both actors are present and interact in real-time with synchronous behaviour, but increasingly opportunities for delayed or disjoint interaction have been explored using asynchronous behaviour. Some specialities have adopted the approach more widely (e.g. tele-psychiatry, tele-paediatics), often on the basis of a strong cost-benefit model. Some tele-collaboration between clinicians has also been experimented with using this approach, especially when very high levels of expertise are needed (e.g. tele-surgery, tele-emergency-department, tele-intensive-care-unit).

The above approach has also been developed more broadly into remote provision of clinical expertise services such as reporting, through store-and-forward handling of clinical information (e.g. tele-dermatology, tele-opthalmology, tele-radiology, tele-pathology). The approach has furthermore been generalised and extended in various areas of nursing and allied health, especially for roles which replicate clinical activities on a high volume scale (e.g. tele-aged-care, tele-home-visit, tele-wound-care). Numerous regional tele-consultation networks have been established in areas of widely distributed rural populations, with well known examples in USA (e.g. Alaska, Arizona), Canada (e.g. Alberta) and Australia (e.g. Queensland).

Another form of Telehealth which has enjoyed early recognition and adoption is the use of tele-consultation infrastructure for tele-education [11]. This can take the form of Continuing Professional Education for clinicians, upskilling of health workers, sharing of best practice organisational procedures, informing of family and other care team members to help manage patient care, ongoing clinical contact and support for home care team for palliative care patients. This area has been extended to include less acute care situations, such as tele-counselling for patients at risk and tele-coaching for preventative health and wellness promotion purposes. Additionally, the development of online educational material and facilities such as helplines has assisted with general training of patients, carers, and support groups.

A separate mode of Telehealth operations occurs where ICT is used for tele-monitoring of patient health status [12]. Simple wearable medical devices or tabletop telecare devices allow a range of vital signs and observations to be gathered remotely. These signals are then processed by a combination of human agents and computerised algorithms to find patterns and raise alerts when adverse situations are detected. The consequent human intervention required in these situations is often provided by commercial fee-for-service organisations, or by state health agencies which function with different financial models to primary care environments. Patient communications and alarms can also be implemented using such an approach, whether patient-initiated or automatically generated, to deal with situations such as patients with dementia leading to loss of location and situation awareness, and those with high risk of falls or fainting.

It must be accepted that there is a continuing need for growing the evidence base on successful Telehealth interventions, and developing cost-benefit models to support further Telehealth policy development directly. Growing the volume or efficiency of health care delivery by incorporating Telehealth as an adjunct process alongside normal services is an attractive first step. Following Change Management principles the added value is provided by these aspects, rather than by re-engineering the process into a fully end-to-end automated replacement. In the same way as patients accept that Telehealth provides a means to deliver care in situations where it could not previously be obtained, clinicans should appreciate that Telehealth allows their throughput to be increased with limited workload impact if the need for direct clinician-patient presence and interaction can be surrendered.

Unfortunately existing Telehealth services are often limited-scope initiatives which are "sponsored" by local champions, rather than fully analysed and seen as "the best way to do the business" at all levels in the business hierarchy. However, multiple case studies attesting to either economic benefits or improvement of health care outcomes, do provide some level of confidence for further adoptions. Finally, these services are usually based on fairly simple operating environments and logistics, so that the complexity threshold is low and adoption is easy and not time consuming or error prone. In contrast to this situation, designing and implementing large scale comprehensive Telehealth services operating across numerous clinical domains is seen as difficult and without established methodological basis.

Norway provides a good case study for Telehealth adoption in a typical developed country. The first telemedicine projects were initiated in 1987-1988, and gradually tested and pilot clinical services were established in many areas [13]. In 2005-2006, an expert group performed a systematic evaluation of which of the existing telemedicine services in North Norway should be given priority for large-scale implementation. This group identified 282 projects which were further examined. The expert group divided the service in three different groups according to priority and user support, training, research ability, financial incentives and interaction between clinicians and ICT-personnel were used to rank the different telemedicine services [14]. The first priority services include tele-radiology, digital communication and integration of patient records, and education. The second priority services cover tele-dialysis, pre-hospital thrombolysis, tele-psychiatry and tele-dermatology. The third priority services are paediatrics, district medical centres, tele-ophthalmology and tele-otorhinolaryngology.

Future Scope of Telehealth

The immediate horizon for new Telehealth uptake on a wide front is based mostly on new models of care initiatives [15], rather than further advance of primary or acute health services. For instance, Aravind Group of Hospitals in India is succesfully using tele centres for pre operative checkup and post operative care of patients with cataract and other eye diseases. This approach has been successful in replacing camp based eye surgery which had been bedeviled with high complications related to poor infrastructure. Other circumstances requiring new care approaches, including major logistical and management innovations, arise from exceptional health situations such as epidemic outbreaks or natural disasters (e.g. [16]). The range and size of new models of care can vary widely, in different parts of the world and different health systems. Below we will present some categories and examples of this diversity.

Telehealth can easily provide communications and decision support mechanisms for broad based care teams of multiple health professions and non-professional carers (eg family/community carers), and in some cases it is hard to imagine how these could be accomplished without the central use of ICT. A rapidly increasing need for such mechanisms exists in supporting patient-centred care situations (e.g. chronic disease management, post-operative recovery, rehabilitation for injury or stroke patients) [17]. This need can be met by using Telehealth for gathering information via tele-monitoring and smart "ambient-aware" living spaces. The data from these sources would be fed to ICT-enabled care information environments which would provide data integration/merging and decision support services. Such moves would also promote increased focus on self-care tools for stimulating individuals to adopt and maintain a healthy and individual lifestyle, enhanced by health sensor monitoring, interpretation of sensor data, visualization of health-related data, and providing individual custom health care guidance.

Another mode for Telehealth is to strengthen the opportunities for pro-

viding access to healthcare for those isolated from normal care mechanisms by location and time [18]. These are often people in rural or remote settings who cannot take advantage of the "first generation" consultation type Telehealth solutions which are facilities rather than home based. Opportunities being explored include online triage and health call centres based on telephone of Internet access. Supportive multi-party linkages are also being established, such as community/regional care networks connecting a patient with a number of providers, or health hubs where management of multiple care needs for patients can be coordinated. Telehealth is increasingly being proposed to supplement acute and primary care outreach services, such as pre-operative preparations, follow ups, re-assessments and rehabilitations.

A major sector in the patient space needing special care is the aged population [19]. Maintaining independent living is facilitated through Telehealth processes and the management of patients through Telecare and various assistive devices. Adjustment of care plans and customisation of care for individual patients and changing circumstances can be accomplished more easily in this environment than in the conventional longer cycle clinician-patient visit model. Isolation and mental condition issues can be addressed by developing automated forms of interaction and communications with artificial presence. Progress in this area will require the development of automated techniques for processing large amounts of data and assisting in clinical decision making.

It is widely accepted that we are on the threshold of explosive growth in demand for online information resources and decision making tools which empower patients to intervene directly in their own health management. These are seen as a boost to better health promotion and wellness strategies, such as encouragement of physical activity and good nutrition or lifestyle habits. Proliferation of websites which support active programs by participants to address these factors is occurring. One example of this is peer-to-peer network learning environments for group-based motivation and education, in particular for people suffering from chronic or lifestyle-related diseases. Use of advanced social networking and semantic tools in these environments would appear to be very beneficial in building user trust and allegiance, and thereby prolonging compliance.

An explosive increase in proliferation and sophistication of mobile telephony and computing devices such as web-enabled cell phones and wireless-connected PC based tablets has initiated a new sub-field of Telehealth usually called mHealth. These allow universal access by providers and patients to online health resources such as EHR/PHR data and e-documents for healthcare (e.g. reports, referrals, prescriptions). Mobile applications can also support diverse health care professionals who are engaged in the everyday care of patients with chronic diseases, for instance to provide access to and allow update of information on medications or to mange diabetes [20].

While the human communication and health services reform trends are emerging most strongly in the developed world, the solutions and changes that they bring will transfer readily to other less developed arenas in the future. Notwithstanding this benefit, there are other distinct and different needs for health services in the developing world which can be addressed very effectively by making use of "leapfrog" technology adoption [9]. Leveraging wireless connectivity, the capacity for patient-clinician interactions and public/community health support processes will become much greater and these will be delivered much faster and with much more confidence than in the past. Similarly, monitoring of population wide health status and conducting epidemic surveillance will become easier and more inclusive of the wider community.

Fundamental Issues in Advancing Telehealth

There is little reason to suspect that the systemic difficulties experienced with adoption of past and current Telehealth projects on a broader front will be diminished in the short term. There will continue to exist a substantial need for growing the evidence base for successful Telehealth interventions, and developing cost-benefit models to support Telehealth project justification and policy development [21]. Other major contemporary issues in this area as identified in [12] are:

- lack of standards to combine incompatible information systems;
- lack of an evaluation framework considering legal, ethical, organisational, clinical, usability and technical aspects;
- lack of proper guidelines for practical implementation of telehealth solutions.

The realisation of the future scope options described above will depend on some potentially difficult and innovative changes and developments in the health ecosystem. Just as current Telehealth activities have been limited by inflexible health system policies and weak business justifications, a similar challenge exists for future activities, which are more reliant on widespread access to new ICT infrastructure and acceptance of changed and more holistic social practices that are stimulated by it [22]. The emphasis on collaboration between multiple parties, and the personalised (or patient-centric) approach to health care, are two drivers for these kinds of advances [23]. Emphasis will be placed less on Telehealth as a distinctive class of processes in health care, and more on the diversification of existing and new patient services, supported by ICT.

For example, ubiquitous mobile telecommunications and online access will ultimately be achieved by providing efficient multi-layered and integrated

wireless connection systems, but for reasons of cost and energy these will be non-uniform in their performance characteristics. This situation will require online services to be designed and tuned for adaptivity and scaleability, to match variations in bandwidth and quality of service. Similarly, the development of sensor rich ambient awareness local environments will be needed to enable gathering of data for patient living activities and wearable device signals. Both these scenarios will require a much higher level of interoperability and transparency of service between telecommunications service providers as well as health services organisations. They will also require some rationalisation of the current highly restrictive privacy and security environment that is expected for health related transmissions.

A second area for change is towards the management of health data in a far more semantically sophisticated manner. Web based resources for healthcare need to be created with a high degree of semantic interoperability, and customisation to fit a particular user health profile. Linkages and interconnections between online resources for both active human delivered health care processes and future automated processes will be very important to enable seamless delivery of health care. This will lead to the creation of artificial intelligence enabled systems and other surrogates for directly delivered human advice.

A consequence of greater levels of automation is the capacity to undertake individual personalisation of care decisions using learning algorithms, using data derived from patient and cohort histories. This will require more coordination of health data in the form of comprehensive lifelong Electronic Health Records for all citizens, as well as wider public acceptance for secondary use of such data for research purposes than at present. A second benefit of this shift will be an ability to establish more widespread and timely community-based surveillance and public health support mechanisms by dynamic pooling of information in close to real-time. This has positive consequences in both developed and developing world countries, where lifestyle related diseases and infectious diseases are respectively the major sources of burden on the health sector.

Conclusions

We now arrive at the point where we should consider how IMIA might contribute to furthering issues of international interest in this space. Clearly many international agencies (e.g. ITU, WHO) are already involved and are committing major resources to encourage the growth of Telehealth based health care services. Numerous commercial interests (e.g. the Continua Alliance) are also involved with a view to creating generic new business models to fill unoccupied market areas. In the mHealth space, various groups are very active in growing the diversity of applications and building funding models to leverage additional capacity in existing corporate or government services [24]. Many of these endeavours are aimed at revolutionary change and innovation: we suggest that there is considerable scope also for accelerating evolutionary change and that this might be an easier target for a group of diverse cooperating experts of agencies to adopt.

Perhaps IMIA can best serve by addressing niches between the above main trends that might encourage more variety and more participants to join in the Telehealth momentum building. Given IMIAs ability to leverage knowledge from a wide range of experts in industry and research, a primary capability should be the gathering and presenting of information to foster niche engagements. To produce new and effective Telehealth solutions in the future, we need to look into recent past work for instances of promising designs and putative evidence (e.g. [25]). Accordingly we recommend that IMIA should undertake a program to *identify and evaluate (at high level) a range of less conventional Telehealth projects* which have shown or promised success, to provide a range of best case scenarios which could stimulate further Telehealth initiatives in those areas.

One of the most significant global factors in health care is the inequity of quality and access between developed and developing countries. Various aid and philanthropic approaches have been advocated for closing this gap, some involving Telehealth, but recently there have been several initiatives which arose organically in the developing world and demonstrated a more fit-for-purpose and lateral approach. An example is the free use of unfilled portions of SMS messages to deliver health awareness messages in Africa. This principle of "appropriate technology" and "micro-economic models" offers much more opportunity for rapid deployment of new Telehealth based interventions, which can help break the cycle of poverty and systemic political restrictions. At the same time, such innovation offers an opportunity to build capacity and increase educational and informational dissemination in the developing world [9, 10]. To support this process, we recommend a further IMIA work item of *cataloguing various aspects of Telehealth in developing countries* that can be leveraged for both increased access to quality care and educational advancement of the health workforce and indeed the population at large.

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