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INTEGRATING HEALTHCARE, EMPOWERING PATIENTS

Report by the iN2015 Healthcare and Biomedical Sciences Sub-Committee

Singapore: An Intelligent Nation, a Global City, powered by Infocomm

Contents

Preface

Infocomm technology is opening up new possibilities for the healthcare sector, a sector that is heavily reliant on data. The potential is wide-ranging, encompassing how patients can be more effectively cared for; the way patients, doctors and other care givers communicate; monitoring systems that give people greater ability to manage their own health; and intelligent applications that assist doctors in making better medical decisions, and researchers to speed up new discoveries.

At the same time, socio-demographic trends, changing disease patterns, the explosion in biomedical knowledge and rapid advances in medical technology provide a strong impetus for changes in the healthcare system. Many of these will benefit from the innovative use of infocomm technologies.

However, the healthcare sector is a multifaceted and complex one. Although infocomm is a key enabler, it requires strong support for change and leadership from key stakeholders in the healthcare sector to transform healthcare delivery. It also requires concurrent changes in policies, legislations, business models and work processes.

While this report focuses mainly on healthcare, it also considers two major interfaces of biomedical sciences with healthcare namely how infocomm could facilitate the application of new scientific discoveries to clinical medicine; and how healthcare data could support Singapore's biomedical science research thrust.

The report also took into consideration major learning points from infocomm's strategic role in creating value within other business ecosystems, such as the National Library Board, finance and hospitality sectors (refer to Annex A for details). Key lessons drawn from such transformational efforts are:

- A national infrastructure, with data standards, will be necessary to facilitate seamless information exchange among different members of the healthcare network.

- Patients can be better empowered to manage their own health if they have access to their personal health record and other relevant health information.

- Healthcare providers can help improve convenience for patients through better and more interactive information services.

We hope that the iN2015 Healthcare and Biomedical Sciences report will provide insights into how infocomm can support transformation of the healthcare sector and serve as the basis for continued discussions on national efforts to transform the sector.

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Chairman
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Executive Summary

Key Drivers and Implications

Based on a review of our current healthcare system and the major trends in demographics, disease burden and medicine, the following will be key drivers of change in our healthcare sector:

- Ageing population and the increased burden of chronic conditions such as diabetes, hypertension, high cholesterol levels and stroke.
- Rising public expectations of healthcare services.
- The current fragmented and relatively uncoordinated healthcare services.
- Very rapid advances in infocomm, medical science and technologies and biomedical research.

As a result of these drivers, the Sub-Committee foresees a number of likely shifts and changes to our healthcare system, as follows:

- Shift in focus of the healthcare system from treatment of advanced-stage diseases to prevention, health promotion and wellness care.
- Shift from provider-centric, fragmented care delivery to a more integrated and patient-centred system of delivery.
- Shift towards more consistent widespread application of evidence-based medicine.
- Greater role of members of the public in managing their own health.
- Greater facilitation of data flows between healthcare sector and biomedical sciences research sector, to facilitate research that will improve clinical care and outcomes.

iN2015 Goal for Healthcare and Biomedical Sciences

Our infocomm goal for the Healthcare and Biomedical Sciences sectors is:

To accelerate sectoral transformation through an infocomm-enabled personalised healthcare delivery system to achieve high quality clinical care, service excellence, cost-effectiveness and strong clinical research.

This goal will help achieve the following outcomes by 2015:

- **Well-integrated Quality Healthcare**
  Integrated and coordinated care will be enabled by a common information network and appropriate data standards. This will also allow more patients to be treated at the most appropriate point of care. For some patients, where it is cost-effective to do so, remote monitoring can also be used to monitor or administer care while they are at home.

- **Cost-effective Healthcare Services**
  In future, healthcare providers will be assisted by clinical decision support systems to provide a more consistent and evidence-based level of care. Such systems can help reduce duplicate tests and medical errors and, in the future, facilitate the delivery of personalised medicine based on analyses of specific genetic factors which influence susceptibility to, and progression of, disease and response to potential treatments. The adoption of infocomm to enable outsourcing of certain clinical services, e.g. teleradiology, can also help to reduce costs while increasing quality.

- **Greater Ability of Public to Manage their Health**
  In future, home infocomm systems will allow individuals to easily access authoritative and relevant health information. Each person will have an electronic personal health record which captures and stores a pre-defined set of his essential longitudinal health data. The home infocomm system will be able to send appropriate medical alerts to the individual based on information from these records e.g. when to go for recommended regular health screening tests. Interactions with healthcare providers such as the making and changing of appointments can also be made more convenient.

- **Strong Clinical and Health Services Research**
  More effective and efficient linkages between biomedical and healthcare sectors will facilitate the translation of new biomedical discoveries into novel healthcare applications and treatments.

In addition to the above outcomes for the healthcare sector, the transformation of the sector will also generate economic spin-offs for the infocomm, healthcare and biomedical sciences sectors.

iN2015 Strategies and Programmes

To realise the iN2015 goal, the following strategies are recommended:

- Enable integrated healthcare services.
  - Health Information Exchange: e-Enable seamless and secured information exchange in the healthcare value chain.
  - Integrated Healthcare Continuum: e-Enable processes and linkages across the healthcare value chain.
- Enable integration between healthcare and advances in biomedical sciences.
  - Translating Biomedical Research to Healthcare Delivery: Integrate clinical and biomedical research data and make it readily accessible, within a framework that protects patient confidentiality, to the clinical and biomedical sciences research community.

Corresponding to each of the strategies recommended above, the following are key infocomm deliverables:

- One electronic medical record for every patient – A pre-defined set of relevant medical data which is accessible to healthcare providers in the public healthcare system and in much of the private sector. This will facilitate the integration of care for individual patients.

- One electronic personal health record – A pre-defined set of data which each person will have access to. It could include key vaccination and screening data and key diagnoses.

- Clinical decision support systems – Systems that draw information from the electronic medical records and provide assistance, alerts and flags which support healthcare workers to practice evidence-based care delivery and which help reduce medical errors.

- Home monitoring systems – To monitor selected patients suffering from major chronic diseases such as diabetes, hypertension, high cholesterol and stroke, where it is cost-effective to do so. Relevant health-related information can be pushed to and pulled from the home by members of the public, to support health promotion and wellness.

- Clinical databases that strongly support medical research. Linkages between clinical and research databases that facilitate medical research while protecting patient confidentiality.

Critical Challenges

Given the scale and complexity of making transformative changes in the healthcare sector, there is a spectrum of critical challenges to be addressed. This would include infrastructure development, putting in place the necessary regulatory framework, finding the appropriate funding models, ensuring sufficient infocomm manpower and achieving buy-in by the medical/healthcare community and public.

These are by no means trivial challenges. But they are not insurmountable, provided there is leadership from relevant government agencies and healthcare providers to transform the vision into reality.

CHAPTER 1
HEALTHCARE SCENARIOS IN 2015

By 2015, many medical services now possible only in hospitals could be available close to your home, at clinics, other healthcare centres or a nearby central point in the community. In fact, you may not need to even leave home for a number of them.

For instance, instead of going to the hospital for screening tests for certain diseases, you can carry out such tests at home using simple diagnostic kits and equipment. The results of the tests will be captured and combined with your health and medical history in your electronic personal health record. Such testing may eventually be extended to the assessment of your genetic susceptibilities to selected diseases and allow the tailoring of appropriate healthcare treatments.

Infocomm systems with intuitive interfaces, will allow you to conveniently access relevant healthcare information and interact with your healthcare providers. Amongst other things, it can:

- Remind you to carry out recommended screening tests at appropriate intervals.
- Inform your family physician about the test results.
- Provide you with health information relevant to your test results and medical history.
- Help you locate an appropriate specialist if you need one.
- Explain the drugs and treatments that you are receiving.
- Advise you of potential adverse drug interactions based on the medications you are taking or have been prescribed.

For major chronic diseases such as diabetes, hypertension, high cholesterol and stroke, selected patients could be monitored at home through intelligent sensory networks and a system of smart, embedded nano-sensors. This will help to capture real time data on the patient's key clinical parameters and automatically trigger alerts when a reading falls out of a preset range. If necessary, patients can interact with their doctors between clinic visits via this home infocomm system.

A common information infrastructure will be available for the healthcare sector, allowing doctors to share and access medical information on a patient even if they have been captured at home or in different healthcare institutions. These systems will enable a seamless flow of information, so that data travels rather than patients.

Intelligent clinical decision support systems will help physicians analyse the patients' data and present relevant decision-making information as well as the recommended care paths. Point-of-care devices that will carry out analyses for genetic and/or biomarker profiles will facilitate diagnosis, risk-stratification of patients and assist in tailoring of treatments for a selected number of diseases based on pharmacogenetic data.

Infocomm will also alter acute and emergency care. Rapid diagnosis systems coupled with telemetry may make it possible for essential emergency treatment of a number of acute diseases such as heart attacks to be initiated at home by paramedical or ambulance staff, before the patient is brought to a healthcare facility.

For the treatment of acute diseases, infocomm will provide decision support systems that would improve the quality and consistency of care, and reduce medical errors. It would allow for more effective post-acute treatment follow-up of patients.

Telemedicine will enable patients to seek and have access to specialised medical care in different countries. There is also likely to be substantial outsourcing of services to overseas providers, e.g. in teleradiology.

Finally, for infectious disease outbreaks, infocomm will greatly facilitate information collation, storage, analysis and dissemination for more effective and efficient control measures.

CHAPTER 2
KEY DRIVERS AND IMPLICATIONS

There are four developments that will have a profound impact on Singapore's healthcare sector. They are:

Singapore's Rapidly Greying Population

Singapore's population is ageing rapidly with the number of senior citizens forming 8.4 per cent of our population[1] in 2005. 85 per cent of this group will have one or more chronic diseases that will require life-long treatment[2]. With an ageing population comes:

- An increased prevalence of chronic, non-communicable diseases such as diabetes, hypertension, high cholesterol and stroke. There is also an increase in the number of patients with chronic degenerative disorders such as dementia and arthritis.
- A growing need for step-down, nursing and home care. This will put a significant financial burden on both the patient's family and society.
- A higher national healthcare bill.

  In 2003, Singapore spent 3.8 per cent of its GDP, or S$6.3 billion, on healthcare[3].

  The bill is expected to rise because the elderly will require more medical care. New treatments will also become available. These treatments are likely to cost more, and more patients would expect to receive the latest therapeutic drugs.

1 Singapore Department of Statistics
2 "Ministry of Health Budget Speech (Part 3) – The Elderly Chronic Sick", Dr. Balaji Sadasivan, Senior Minister of State for Information, Communication and the Arts and Health, March 2006
3 "Health Manpower & Expenditure", Ministry of Health, April 2006. An earlier study study by the `National University of Singapore projected that Singapore's healthcare costs will hit seven per cent of the country's Gross Domestic Product (GDP) by 2030.

Higher Demands for Relevant and Accurate Health Information

Today, the public and patients are already overwhelmed with large amounts of "information" about health, wellness and diseases. Information overload will be a growing challenge particularly where there is divergent or even wrong or misleading "health information" being provided by different sources. In addition, much of the information generally available is not readily tailored to the individual's specific set of interests, conditions or medical problems.

To facilitate and encourage the public to more proactively manage their health, it is important to provide each individual with easy access to his/her medical history and other relevant health information which can be tailored to specific needs. There is also a need to provide authoritative and trusted health and medical information, e.g. on new drugs and alternative medicine, to provide the necessary balance to the broad range of information sources.

More Fragmented Healthcare

Rapid advances in medical knowledge and technologies have resulted in greater specialisation of healthcare professionals. Patients with chronic diseases typically suffer from multiple medical conditions and have to consult several doctors from different disciplines. They will also be prescribed several medications to deal with all these conditions.

The problem is that there are currently few or no links among doctors from different specialties. Neither is there a central database with all the patient's medical records. So, often, no one doctor has a proper overview of a patient's health.

This greatly increases the potential for poly-pharmacy and adverse drug interactions. To improve the situation, healthcare services need to become much more patient- and disease-centric.

Another layer of complexity may be introduced by the fact that large numbers of patients could opt to have different parts of their care carried out in different countries, e.g. they could have diagnostic or screening tests done in one country, have surgery in another and follow-up treatment in a third. Integration of relevant clinical information and coordination of care for such patients will become a greater challenge.

Advances in Medical Technology and Infocomm

Advances in medical technology and biomedical knowledge hold the promise for more personalised treatments based on a person's medical conditions and genetic profile.

Similarly, advances in infocomm can enable new healthcare delivery models.

For instance, home diagnostics and remote monitoring applications can make it safe and feasible for many patients with chronic illness and/or physical disabilities, to be cared for at home. Many patients and their families are likely to prefer this and it would also ease the pressure on nursing homes and step-down care facilities.

The tremendous speed of advances in medical science and practice make it increasingly challenging for doctors and healthcare professionals to keep abreast of the latest developments. More intelligent clinical decision support systems will also be developed that will help doctors make better decisions by incorporating rapidly growing medical knowledge. Smart computer algorithms working on top of electronic medical records and prescriptions can flag up potential adverse drug interactions and reduce medical errors.

Public Health and Policy Implications

In view of these developments, it is likely that several changes will occur in the healthcare system. They are:

- **Greater Responsibility by the Individual to Proactively Manage his Health**
  Many of the major chronic medical conditions are largely preventable. To achieve this, however, the individual will have to play his part by taking the proper diet, exercising, managing his weight, having appropriate vaccinations and monitoring his health regularly.

  To help encourage him to do so, he should have easy access to his personal health records and other relevant health information. Such an information system can even alert the individual to the need for timely interventions based on his health screening results and medical history.

- **Shift from Treatment of Diseases to Prevention, Health Promotion and Wellness Care**
  More emphasis will have to be placed on preventive care and health promotion.

  Health screening can be made more affordable and accessible to the public. Its results can be made more useful by having appropriate follow-up raised through a properly developed health information system.

  There is also a need to provide authoritative and relevant health and medical information to the individual, for instance, on new drugs and alternative therapies.

  For patients with chronic non-communicable diseases, infocomm can be used to support a well-coordinated process of care which includes better long-term monitoring of test results and screenings and timely follow-up action. This will help prevent the development of serious complications which require complex medical interventions and hospital admissions. Some of these patients could also be monitored from home using remote monitoring technologies.

- **Shift from Provider-centric, Fragmented Care Delivery to a More Integrated and Patient-centred System of Delivery**
  The healthcare system is likely to evolve into a more patient- and disease-centric healthcare delivery model where services are coordinated around the patients' specific needs and problems, particularly if these are multiple and complex. For patients requiring the care of multiple specialists and healthcare teams, infocomm, by integrating different sources of patients' information across the healthcare system, can provide doctors with a complete overview of patients' medical information, reducing the need for duplicate tests and the risks of medical errors and unintended adverse drug interactions. It can also enable the doctors to manage their patients at the right level of care delivery (right-siting). Within hospitals, infocomm systems can play a central role in supporting and facilitating improved processes that can reduce waiting times and improve clinical outcomes and patient satisfaction.

- **Stronger Shift towards Widespread use of Evidence-based Medicine**
  At present, there are significant variations among doctors in care delivery for the same disease and in the management of patients, particularly those with long-term medical conditions. Infocomm systems will be critical to support the consistent delivery of evidence-based medical care for each patient on a long-term basis, through the following functions:

  - Collate, integrate and display relevant medical data and laboratory results for each patient.

  - Deliver relevant point-of-care medical practice data to doctors, e.g. accepted clinical guidelines, drug dosages, drug interactions, alerts, etc.

  - Facilitate the monitoring of clinical outcomes and audit treatment effectiveness to continually improve care delivery.

The use of infocomm for these purposes will help to reduce costly medical errors. In the United Kingdom, a National Audit Office survey of patient safety incidents found that there were around 980,000 reported incidents and near misses in 2004-5[4]. These errors can be largely reduced by providing clinicians with access to timely and accurate information and complementing their decision-making process with clinical decision support systems.

Furthermore, turning to such support systems will become vital as medical knowledge expands dramatically.

- **Greater Integration of Information between Healthcare and Biomedical Sciences**
  Spectacular advances in research technologies have led to rapid growth of medical knowledge. A major challenge however, is to gain a clearer understanding of how these may be related to human health and disease, either directly or through complex interactions with environmental factors. In turn, this could lead to fundamental insights into the genesis and development of diseases, the identification of new diagnostic or prognostic markers, and new treatment approaches.

  To achieve this, we need better ways to discover patterns and connections between human health and disease and changes to specific genes, molecules or processes, and their possible interactions with environmental factors. In this regard, repeated observations of large populations of patients or individuals can provide critical clues and hypotheses. Infocomm in the form of bioinformatics can help clinicians and researchers carry out these tasks more quickly and effectively.

  To this end, extensive, linked and accurate computerised records provide a valuable resource for high quality clinical research through a variety of ways. It allows researchers to look for patterns, form hypotheses, and identify potential study participants. It enables more comprehensive and efficient surveillance for adverse side effects of new drugs, therapies. It also facilitates health services and outcomes research.

Advances in biomedical sciences have raised the prospect of 'personalised medicine' in which treatments are made more effective based on the patient's health and genetic profiles. The most critical step however, is the robust clinical validation of the utility of putative biomarkers of disease, prognosis and response to treatment. To achieve this, a tighter integration between healthcare and biomedical research is necessary in the following manner:

- Greater access to healthcare clinical data for biomedical research purposes.

- Facilitating the translation of biomedical research findings into effective healthcare applications and treatment protocols.

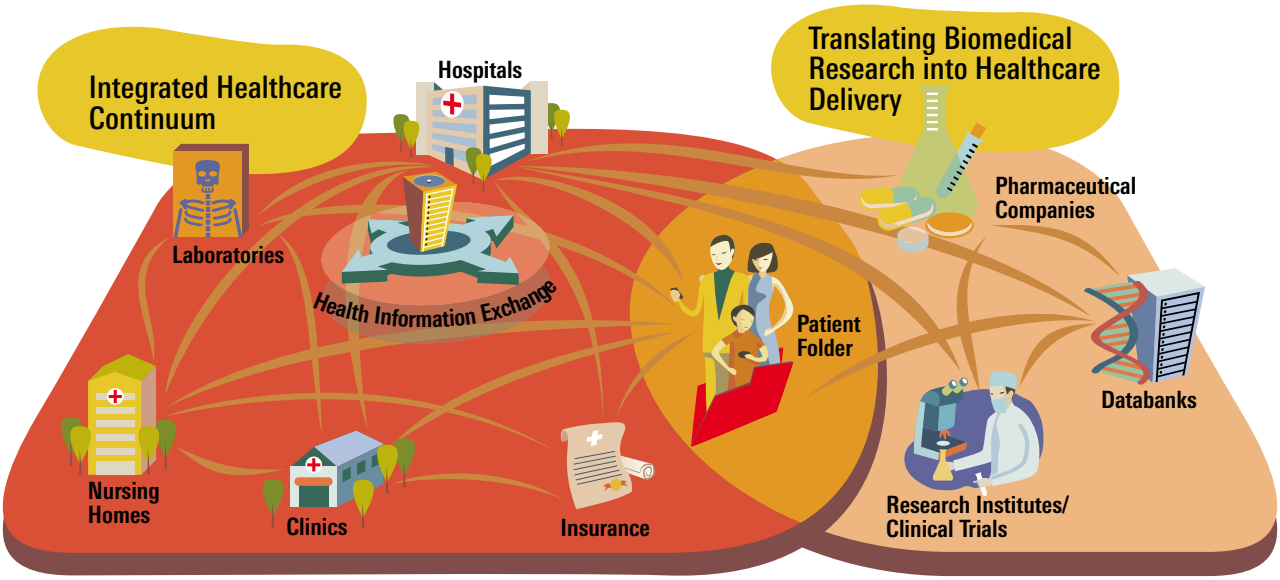
However, it is critical that issues relating to confidentiality and privacy of patients' data are appropriately addressed and adequate safeguards put in place.

4 "A Safer Place for Patients: Learning to Improve Patient Safety", National Audit Office (UK), November 2005

CHAPTER 3
iN2015 GOAL FOR HEALTHCARE AND BIOMEDICAL SCIENCES

Taking into consideration the above drivers and their implications, our infocomm goal for the Healthcare and Biomedical Sciences sectors is:

To accelerate sectoral transformation through an infocomm-enabled personalised healthcare delivery system to achieve high quality clinical care, service excellence, cost-effectiveness and strong clinical research.



This goal will help achieve the following outcomes by 2015 (refer to Annex B for details):

- **Well-integrated Quality Healthcare**
  Infocomm systems that allow access to, and sharing of, patients' clinical and treatment data will enable different healthcare providers to work together in an integrated and coordinated manner.

  With access to patients' complete medical records, doctors can better judge the most appropriate point of care to treat the patients. This will help patients save costs in the long run.

  For a selected group of chronic diseases, remote monitoring services would be available. Patients can continue to receive the necessary medical supervision from home while saving unnecessary hospital bills.

- **Cost-effective Healthcare Services**
  Clinical decision support systems that provide point-of-care clinical practice information can assist doctors and healthcare workers with clinical decision-making. Through these systems, hospitals and clinics will be able to provide consistent and evidence-based care. This will help to reduce prescription and medical errors and improve clinical outcomes.

- **Greater Ability of Public to Manage their Health**
  This will be made possible through simple home infocomm systems that will proactively facilitate health promotion activities and wellness. These systems will allow individuals to search and access healthcare information from healthcare providers' portals and make a significant proportion of interactions with providers more patient-centric and convenient.

  All individuals will have a personal electronic health record which will capture and store a pre-defined set of common longitudinal medical data for each person. This would be made accessible to all healthcare providers treating the individual.

  These health records will also be integrated with the home infocomm systems, thus allowing the systems to alert the individual when there is a need for appropriate medical interventions.

- **Strong Clinical and Health Services Research**
  A conducive regulatory framework should be established to govern the collection and sharing of health data. This would facilitate both biomedical and health services research, while protecting patients' confidentiality.

  Infocomm linkages between biomedical and healthcare databases can then facilitate research and conversion of new biomedical discoveries into more effective treatments. Pharmaceutical companies can also leverage on these databases to develop more effective drugs.

In addition to the above outcomes for the healthcare sector, the transformation of the sector will also have the following economic spin-off benefits:

- **Strengthen Healthcare Infocomm Sector**
  - Accelerate development of exportable healthcare infocomm solutions.
  - Establish Singapore as a thought leader in healthcare infocomm to provide a spring-board for companies to venture overseas.

- **Strengthen Singapore as a Medical Hub**
  - Attract more foreign patients to Singapore through improved healthcare services enabled by infocomm and better information on providers, expertise and key clinical outcomes.
  - Anchor foreign patients through tele-medicine while they are outside of Singapore.

- **Strengthen Singapore as a Biomedical Sciences Hub**
  - Position Singapore as an attractive location to conduct biomedical sciences research through linking biomedical sciences and healthcare infocomm infrastructure.

CHAPTER 4
RECOMMENDED STRATEGIES AND PROGRAMMES

Goal	To accelerate sectoral transformation through an infocomm-enabled personalised healthcare delivery system to achieve high quality clinical care, service excellence, cost-effectiveness and strong clinical research			
Outcomes	Well-integrated quality healthcare	Cost-effective healthcare services	Greater ability of public to manage their health	Strong clinical and health services research
Strategic Thrusts	Enable integrated healthcare services		Enable integration between healthcare and advances in biomedical sciences	
Strategies	Health Information Exchange – e-Enable seamless and secured information exchange in the healthcare value chain	Integrated Healthcare Continuum – e-Enable processes and linkages across the healthcare value chain	Translating Biomedical Research to Healthcare Delivery – Integrate clinical and biomedical research data	

The goal and its corresponding set of objectives can be realised through the following two strategic thrusts (refer to Annex C for proposed project timeline):

Strategic Thrust 1:

Enable Integrated Healthcare Services

This thrust aims to facilitate the integration of care across different segments of the healthcare value chain from health promotion, disease prevention to primary, secondary and step-down care.

In his 2006 budget speech, Minister for Health, Mr Khaw Boon Wan, highlighted Singapore's new concepts in managing chronic diseases – family physicians as the primary care provider, "one Singaporean, one Family Physician", right-siting of care, effective partnership between GPs and specialists, opportunistic health screening, co-operation and compliance by patients. He shared that these concepts can be successfully implemented because Singapore is "small, compact and better organised", but stressed the need to "tear down barriers between public and private, GPs and specialists, hospitals and step-down care homes, and leverage on technology."

As indicated by the Minister's speech above, Singapore's long-term direction is to develop integrated healthcare services for major chronic diseases such as diabetes, hypertension, high cholesterol and stroke. This will be achieved through building effective linkages between different parts of the healthcare value chain.

Infocomm would be used to link up all public hospitals, major community hospitals, all polyclinics, key step-down care facilities and family physicians.

Health Information Exchange
– e-Enable Seamless and Secured Information Exchange in the Healthcare Value Chain

Since April 2004, the Ministry of Health has implemented an Electronic Medical Records Exchange (EMRX) which has facilitated information sharing among the public hospitals. The Sub-Committee recommends that a Health Information Exchange could be built on the EMRX to extend information sharing to all healthcare providers.

With medical records stored across distributed systems, a 'Master Index' in the Health Information Exchange will be necessary to locate relevant data, retrieve them securely and present these to healthcare providers. A personal health record system can also be built within the Exchange based on a defined set of health information. In addition, the Exchange can centrally host patients' critical medical information such as medical alerts and allergies.

Initiatives proposed under the Health Information Exchange include:

Develop Standards and Enable Inter-operability
To enable inter-operability, the first step would be to put in place the necessary standards and mechanisms for exchange of information.

A Health Information Exchange will need to be established to enable and secure flow of information throughout the healthcare ecosystem.

Besides acting as the conduit for information flow, the Exchange will need to have a 'Master Index' that will locate information from different data sources and present relevant information to doctors.

Inter-operability standards are required to support a fully functional Exchange. The minimal data set for healthcare records would be defined as part of the Exchange. An evolutionary approach can be adopted, and automatic translations at the Exchange can bridge the gap, whilst the standards are being adopted in infocomm systems.

The Exchange will also contain the Health Data Dictionary, which maintains the data standards and seamlessly updates new codes into infocomm systems.

In addition, as part of the drive to be a global medical hub and strategic leader in healthcare, Singapore should actively participate and shape the development of international healthcare standards.

Roll Out Personal Health Records
To develop a personal health record for each individual, the minimum data set for the personal health record, security framework and business models will have to be defined. This record must be accessible by each individual. Information in the personal health records could include the following:

- Medical alerts
- Allergies
- Immunisation records
- Disease histories (for important diseases)
- Medication (for a defined period)
- Hospital discharge summaries (for a defined period)
- Results of health screening (for a defined period)
- Status of Medisave claims
- Key laboratory results

Establish the Necessary Medico-legal Framework
Concurrent to defining inter-operability standards, policies are needed to address medico-legal issues which currently impede the sharing of medical information and use of genetic information. These would include data privacy, protection and confidentiality.

Integrated Healthcare Continuum
– e-Enable Processes and Linkages across Healthcare Value Chain

To facilitate the transformation of care processes across the healthcare value chain, it is critical to have infocomm systems that link up the respective entities within the healthcare value chain into an integrated ecosystem. For example, to enable family physicians to be primary coordinators of care within the healthcare ecosystem for major chronic diseases by 2015, infocomm links between them and the rest of the healthcare system would be critical.

Initiatives under the Integrated Healthcare Continuum include:

Enable Right-siting of Care and Chronic Disease Management

Develop infocomm linkages that facilitate different players in the healthcare value chain – hospitals, community hospitals, family physicians, step-down care providers and patients – to work together in an integrated and coordinated manner to provide holistic care and manage chronic diseases. This will be a necessary to enable delivery of healthcare services at the most appropriate level, for example, primary care for simple conditions rather than tertiary hospital care.

Increase Infocomm Adoption by Family Physicians, Step-down Care Institutions

In order for family physicians and step-down care institutions to actively participate in the care of patients within the healthcare ecosystem, active measures would be necessary to encourage a much higher level of infocomm adoption in these facilities. In addition, processes should be streamlined to enable seamless patient referral and handing over between hospitals and these facilities.

Empower the Public to Manage their Health

Building on the personal health record system, applications can be built to push out relevant health information so that individuals can better manage their health.

Remote home monitoring, sensory and tele-consulting systems can be developed to empower the public to manage their health outside of hospitals and other healthcare institutions.

Patients with chronic, non-communicable diseases will be able to manage and monitor themselves largely at home, assisted by appropriate infocomm and monitoring technologies linked remotely to a healthcare provider and family members.

Enable Patient-centric Healthcare Services

Develop infocomm systems that enable information about patients to be available at all points of care. Healthcare professionals will then be able to deliver care based on patients' specific needs and requirements.

Integrating these patient information systems with clinical decision support systems will facilitate consistent delivery of evidence-based care and monitoring of key clinical and service outcomes.

Linkages to insurance and finance sectors can be established to enable straight-through processing of claims and payment.

Patient's experience of healthcare delivery both in terms of convenience to the patient and satisfaction of his personal needs and preferences will also be enhanced.

Strategic Thrust 2:

Enable Integration between Healthcare and Advances in Biomedical Sciences

The spectacular advances in basic medical sciences hold out the promise for fundamental improvements in the diagnosis, treatment and monitoring of patients. To help realise this potential, however, it is critical to greatly strengthen the links between clinical medicine and biomedical research.

Translating Biomedical Research to Healthcare Delivery – Integrate Clinical with Biomedical Research Data

The second thrust aims to facilitate the translation of new discoveries in biomedical research into clinical applications and conversely, to enable clinical data to support and drive biomedical research.

An important factor towards achieving this is the flow of health and clinical information between the healthcare and biomedical sciences research sectors.

Two initiatives are proposed under this thrust:

Develop Excellent Clinical Databases

Excellent clinical databases and Disease Registries can be developed to serve as a major resource for clinical, biomedical and health services research. They should be made accessible to researchers and doctors with proper systems to safeguard individuals' confidentiality and privacy.

Establish Intelligent Systems to Analyse Healthcare and Genetic Data

Intelligent systems can be built to mine and analyse the databases and Disease Registries mentioned above. These applications would help to accelerate clinical and biomedical research. They would also greatly facilitate the regular conduct of data analyses for the purposes of clinical care quality audit and monitoring of outcomes. This would in turn facilitate the translation of biomedical discoveries into new medical treatments.

Based on the above strategic thrusts, the following table depicts a recommended schedule of key milestones.

	3 Years	5 Years	10 Years
Patients	• Patients have access to their own basic personal health information (allergy, HIDS, immunisation, prescription record) • Reduction in duplicate tests • More convenient interaction with healthcare providers	• Healthcare providers in the public sector and some private providers have access to data on patient's medical condition even if they have not managed the patient previously • Patients are provided with comprehensive information and treatment advice tailored to their medical conditions and needs • Patients and the public can navigate the healthcare system more efficiently and effectively • Some patients with specific medical conditions can be monitored outside the hospital	• Citizens can access their basic longitudinal personal health records online • Citizens have ready access to sufficient information to allow them to self-manage their health and wellness
Public/ Private Hospitals/ Institutions	• Healthcare providers see relevant medical records at all points of care within the public healthcare system, and for some functionalities (e.g. test result viewing) across both public and some private institutions • Lower number of medical errors • Lower healthcare cost by reducing duplicate tests and prescriptions • Infocomm systems designed to facilitate nation-wide responses to emergencies • Hospitals pilot treatments that combine genotypic and phenotypic data	• Healthcare providers see relevant medical records at all points of care within the public and private institutions for relevant functionalities (e.g. test result viewing, prescription data) to treat patients holistically • Healthcare providers can provide a consistent and evidence-based level of treatment aided by care path and decision support systems • Better management of selected patient sub-groups through remote monitoring • Research databanks and systems are sufficiently well-developed to support high volume of quality research and healthcare delivery • Tele-medicine systems to extend healthcare services to foreign patients for pre-consultation and follow-up	• All healthcare providers are infocomm-enabled to facilitate coordinated and integrated care at most appropriate level of care in healthcare value chain • Healthcare providers and biomedical researchers can leverage on clinical and research databanks to do research which improves healthcare delivery and outcomes • Singapore hospitals recognised as a world leader in use of infocomm in clinical practice

	3 Years	5 Years	10 Years
Polyclinics	• Healthcare providers see relevant medical records at all points of care within the public healthcare system, and for some functionalities (e.g. test result viewing) across both public and some private institutions • Infocomm systems designed to facilitate nation-wide responses to emergencies	• Healthcare providers see relevant medical records at all points of care within the public and private institutions for relevant functionalities (e.g. test result viewing, prescription data) to treat patients holistically • Healthcare providers can provide a consistent and evidence-based level of treatment aided by care path and decision support systems • Better management of selected patient sub-groups through remote monitoring • Timely and systematic follow-up on health screening for citizens	• All healthcare providers are infocomm-enabled to facilitate coordinated and integrated care at most appropriate level of care in healthcare value chain
GPs/ Small Private Practices/ Step-down Care	• GPs are aware of the progress of patients referred to public hospitals for specialist treatment • Hassle-free handing over of patients for follow-up after treatment in hospitals	• GPs are infocomm-enabled to facilitate referral of patients appropriately back to GPs/step-down care facilities for follow-up care after hospitalisation • Healthcare providers see relevant medical records at all points of care within the public and private institutions for relevant functionalities (e.g. result viewing, prescription data) to treat patients holistically • Timely and systematic follow-up on health screening data for citizens	• All healthcare providers are infocomm-enabled to facilitate provision of coordinated and integrated care at most appropriate point of care in healthcare value chain • Majority of GPs use infocomm systems effectively in the care of patients

CHAPTER 5
CRITICAL CHALLENGES

Given the scale and complexity of making transformative changes in the healthcare sector, there is a spectrum of critical challenges. Taking into consideration the current state of infocomm adoption in the sector (refer to Annex D for more details), these challenges include:

- Developing sector-wide information infrastructure to facilitate seamless exchange of medical information for healthcare delivery and to enhance collaboration between the healthcare and biomedical sciences sectors.

- Establishing minimum healthcare data standards to ensure inter-operability and facilitate research.

- Establishing a conducive regulatory framework to govern the exchange of medical information. This framework will have to address physician liability and medico-legal issues, e.g. when clinicians prescribe treatment through infocomm applications without physically seeing the patient.

- Finding appropriate funding models through which the government, private sector and the public can jointly develop and sustain the national healthcare infocomm infrastructure.

  Appropriate funding models are critical since a major challenge of developing this infrastructure is that a few entities, e.g. public hospitals, are likely to have to bear the bulk of the costs even though the benefits will accrue to many.

  One possibility is that the linkages to facilitate data flow between the healthcare sector and the biomedical sciences research sector, could be largely developed and supported using research funds.

  For the public healthcare system, it may be possible to make a case for the government to provide a significant part of the funding requirement, as there could be overall cost savings from reduced medical errors and unnecessary duplicate tests. These errors can be largely reduced by providing clinicians with access to timely and accurate information and complementing their decision-making process with clinical decision support systems.

  Extension of inter-operable infocomm systems and data exchange into the private healthcare sector will be more challenging. One option that might be considered is to require private practitioners, who are given government subvention for treating certain types of patients, to establish the means in their clinic to participate in data exchange and for the doctors to enter selected data on their patients into the national system.

- Ensuring sufficient availability of proficient healthcare infocomm manpower.

  As healthcare processes are very complex, re-engineering these processes will require infocomm professionals with deep healthcare domain knowledge. Such infocomm manpower is currently lacking in Singapore. This hinders the development of products and services for the healthcare sector as well as the generation of new intellectual property for the infocomm companies.

- Achieving buy-in and leadership by doctors and healthcare providers for process changes.

  Improving the quality and consistency of healthcare services will require healthcare providers to re-engineer many of their care processes and to work more closely together as teams. The buy-in and active leadership of physicians will be critical, to overcome established healthcare/medical practices and resistance to change. A process of engaging and securing the support and buy-in of doctors, health professionals and medical students will be necessary. Part of this may require pilot projects to demonstrate the benefits of process changes. Appropriate incentives and policies will also be needed to facilitate change management.

- Improving public willingness to adopt infocomm for accessing healthcare services.

The proposed goal and strategies will require a higher level of infocomm adoption for infocomm-enabled healthcare services. Success of the programmes will therefore hinge on the level of public infocomm acceptance and savviness. We will therefore have to improve the public's awareness of and proficiency with new healthcare services and applications. At the same time, particular emphasis must be placed on making infocomm interfaces as simple and intuitive as possible. Realistically, however, the process will take a long time as a significant proportion of the population is not adept in and probably uncomfortable with using infocomm. However, generational change will help address this, as the proportion of younger members of family units, to whom infocomm is a way of life, grows.

CHAPTER 6
CONCLUSION

This report outlines a bold, yet realistic, goal in which healthcare delivery models, enabled by infocomm applications, are transformed from what they are today.

The strategies proposed have outlined what needs to be done from the infocomm perspective. Although important, they play only an enabling role and cannot be meaningfully implemented in the absence of support for change and leadership from the relevant government agencies and healthcare providers.

Transforming the healthcare sector will not only help address today's challenges, it will further provide rich developmental opportunities for healthcare infocomm companies, drive excellence in healthcare services and distinguish Singapore as a medical and biomedical sciences hub.

It is therefore our sincere wish that key stakeholders in the healthcare and biomedical sciences sectors will find this report useful as a starting point and, together with the infocomm industry, make the proposed goal a reality.

Annex A: Relevant Perspectives from other Industries

Infocomm often plays a strategic role in creating value within business ecosystems. Hence, lessons can be gleaned from other industries that have used infocomm to transform service delivery. In the paragraphs below, we highlight how infocomm had been applied in transforming the national library system[5], enabling co-opetition in the payments industry, realising a customer-centric banking model and attaining customer satisfaction in the hospitality sector[6].

National Library Board (NLB)

- **Paradigm shifts.** In the early 1990s, technological advances in infocomm were transforming the ways people obtained information and knowledge. Under such a context, the NLB had to fundamentally change the role of library in society and the way it delivered its services. It subsequently underwent a paradigm shift from being a custodian of books to being a service-oriented information provider.

- **Transforming customer experiences.** A major implication of this paradigm shift was to transform customer experiences by significantly reducing hassles (e.g. waiting times) and providing easier access to information. To speed up the time-to-shelf and time to-checkout of books, an RFID-based Electronic Library Management System was implemented to accelerate updating of loan records. Self-service was also made possible by consolidating multiple disparate information systems into one single system through which information about books, loan accounts, etc. was made accessible to users over a variety of channels including borrower enquiry terminals and websites (nlb.gov.sg).

- **Implications for healthcare.** Relevant medical information can be provided through information portals to allow patients to proactively manage their health. Patient experiences can be improved (e.g. reducing waiting times and hassles) through re-engineering of work processes with the aid of infocomm. Disparate medical databases can be integrated for complete overview of patient medical history. This will further enable the practice of patient-centred care.

VISA

- **Enabling co-opetition in the payments industry.** VISA is an instructive example of how technology-enabled collaboration among competitors, coupled with appropriate governing policies, led to increased businesses for all. Before the formation of VISA, card holders could only use their cards at merchants acquired by their issuing banks. Merchants therefore had to incur unnecessary costs maintaining different systems with multiple acquiring banks. Similarly, consumers required multiple cards with different issuing banks in order to use credit with a large network of businesses.

- VISA was subsequently formed to facilitate the exchange of card holder information between the issuing and acquiring banks. Supporting this exchange were common supercomputing infrastructure and high-speed switching networks. Most customer and transaction-related information however continued to reside with the issuing and acquiring banks respectively. With this exchange, the network of merchants available to card holders and vice-versa expanded significantly without much need for increased capital investment. This augmented network subsequently attracted more businesses from merchants and consumers for the banks.

- **Implications for healthcare.** A common infrastructure, with data standards, exchange protocols/applications and federated databases, can be built to enable the exchange of patient information. Patients should own their medical records and hold the key to open access to healthcare providers (e.g. patient health card).

5 "Transforming Singapore's Public Libraries", Roger Hallowell, Carin-Isabel Knoop, Neo Boon Siong, 2001
6 "Business Transformation Through IT: Case Studies", Frost & Sullivan, September 2005

Citibank

- **Customer centricity.** In a mature market like the financial services industry, differentiating through personalised services is key to retaining customers. Citibank implements this paradigm by utilising all data points it knows of a customer to develop an individual profile for each one of them. This allows Citibank to push out customised services and products. At the same time, officers at all touch points (branch, online portal, telephone and ATM) with its customers have the same complete overview to provide a consistent level of service. The latest information is also uploaded into its databases and customers' profile updated accordingly.

- **Implications for healthcare.** A common data infrastructure can be developed to provide a complete overview of patients' medical history at all points of care in the healthcare value chain.

Wynn Resorts

- **Ensuring customer satisfaction and loyalty.** Due to a large number of hotels, casinos, resorts and premium restaurants in Las Vegas, it became increasingly hard for new entrants to make a mark, and hence, to earn revenue. In order to cater to a customer's needs effectively, each hotel staff needs to collect data about his/her behaviour and, at the same time, provide relevant information to them in return. The two-way information exchange results in ensuring customer satisfaction and loyalty.

- Wynn implemented a seamless network where customers and the hotel staff can share information. The exchange would help enhance the visitor's experience and allow the hotel service staff to provide customised services such as a dynamic 'push' capability that enables the hotel to display information, such as guest services, room occupancy status and event information, right on the guest room phones on its in-built browser. The phones are highly interactive devices wherein at the push of a button a directory of phone numbers and services in the hotel can be obtained. Other information such as the opening hours of a certain restaurant or a shopping mall can also be displayed.

- **Implications for healthcare.** Healthcare providers can similarly improve their level of service through interactive information services with their patients, both within and beyond the hospital environment. This will also provide health education as well as reduce patients' uncertainty of the treatment process.

Annex B: iN2015 Outcomes

Well-integrated Quality Healthcare

- Infocomm systems that allow access to, and sharing of, patients' clinical and treatment data that would help drive the integration and coordination of healthcare services.

  - **Coordination among different providers.** The clinics and hospital teams would work together in an integrated and coordinated manner, with an infocomm-enabled process of care and point-of-care clinical practice information that ensures consistent delivery of evidence-based care and which optimises overall patient outcomes. The aim would be for patients to be managed at the right level of provider (e.g. primary care rather than tertiary hospitals). For example, some of the more complex follow-up patients could be managed by their regular health provider and relevant step-down care facilities, with the appropriate support from the specialist.

- For major chronic diseases such as diabetes, hypertension, high cholesterol and stroke, enhanced monitoring and management could be carried out using the home infocomm system.

  - **Remote monitoring for key diseases.** For a small number of selected key diseases, e.g. chronic diseases, the 'home' infocomm system would be augmented with appropriate remote monitoring technologies to allow patients to be monitored at home (e.g. difficult-to-control diabetes; INR for patients on anticoagulation; white cell counts for patients on chemotherapy; telemetry for cardiac diseases) with the results forwarded electronically to the patient's primary care provider and the patient's personal medical data e-docket. The system could provide various alerts to warn the patient and his caregiver to take specific actions or contact his healthcare provider, e.g. when blood sugars are too high/low, if INRs are too high, if blood pressure is too high/low.

Cost-effective Healthcare Services

- Clinical support infocomm systems in hospitals and clinics that provide point-of-care clinical practice information and assist doctors and healthcare workers with clinical decision-making.

  - **Enhancing clinical decision-making.** To help ensure consistent evidence-based medicine practice, each hospital and clinic will have a clinical decision support system that assists with clinical decision-making based on the common health data set of each patient, supplemented by additional relevant information entered by the provider. In the future, this may include a number of gene-based susceptibility or pharmacogenetic test data.

  - **Improving patient monitoring.** The system flags reminders to the care provider on the standard tests necessary for proper monitoring of patients, e.g. timing of regular tests to screen for complications in diabetics, liver function tests.

  - **Improving clinical outcomes.** The system also captures key monitoring data, e.g. serial HbA1c results for diabetics, serial alpha fetoprotein results for patients with chronic liver disease, etc. These data would be very valuable for clinical quality assurance.

  - **Reducing prescription and other medical errors.** The electronic prescription system will flag up potential drug interactions for drugs ordered by individual physicians. The prescription system could also be linked to the drugs listed in the patient's personal medical e-docket and potential adverse interactions with these would also be flagged up. Ideally, there would also be a linkage to the infocomm system at the dispensing site(s) so as to reduce the risk of inadvertent drug interactions through prescriptions being made by different groups of care providers. Simpler means of avoiding unnecessary polypharmacy and unintended drug combinations may become available if RFID or equivalent technologies allow tagging of individual packs of medications. For some categories of patients and drugs the medications could be dispensed in neighbourhood kiosks.

Greater Ability of Public to Manage their Health

- Simple infocomm systems in households that would proactively facilitate health promotion activities and wellness, and make a significant proportion of interactions with healthcare providers more patient-centric and convenient.

  - The 'home' infocomm system could be based on any combination of infocomm technologies, e.g. Internet, TV or mobile.

  - **Enabling proactive self-management of health.** The 'home' infocomm system pushes out and is easily searchable for authoritative, timely and relevant health information. The system must be simple and intuitive to use, interactive, allows monitoring of health progress and is capable of tailoring information to the individual's needs for a number of selected medical conditions.

  - **Enabling effective health screening.** The same infocomm system provides timely reminders about and facilitates cost-effective screening which can be carried out in the home but with the result read remotely and an electronic record created for the person in his/her Personal Medical e-Docket, and pushes the information out to the regular health provider. Potential examples:
    > Faecal occult blood screening done at home but result read remotely.
    > Blood sugar/cholesterol done on home-kits but with the results ported electronically to the Personal Medical e-Docket and the provider's records.
    > Capsule endoscopy carried out at home with the readout sent remotely to a diagnostic site for analysis.

  - **Enhancing patient convenience.** This system should also allow easy navigation of the healthcare system so that individuals can find the appropriate provider (public or private), register, make and change appointments with them through it. After medical consultation and treatment, the patient should be able to order refills for a prescribed range of drugs through his home infocomm system. Simple advice about the drugs and other treatments prescribed could be addressed through the system, which can also monitor and raise alerts about potential drug-drug interactions.

- A defined common longitudinal medical data set is captured and accessible to any health provider treating the individual.

  - **Common medical data set.** A common health data set with standardised definitions should be captured for each individual. The data set could include drug allergies, vaccination history, record of a standard set of screening tests, presence of a defined set of common medical conditions (e.g. diabetes, hypertension, high cholesterol and stroke), short summaries of hospitalisations, drug history.

  - **Accessibility of common data set.** The common health data set for the individual should be readily accessible, with proper safeguards, to any health provider, public or private, who might look after the individual. A smaller subset of these data could be made available to each individual through his/her personal medical data e-docket.

Strong Clinical and Health Services Research

- A conducive regulatory framework.

  - **Facilitates sharing of information.** This regulatory framework should facilitate the collection and sharing of health data for healthcare and research purposes while safeguarding privacy and confidentiality. It should be a robust but not restrictive data and human tissue regulatory framework.

- Infocomm links that facilitate the flow of relevant information between clinical databases and research databases, under conditions that protect patients' confidentiality.

  - **Linking healthcare and biomedical databases.** Links between clinical databases, disease registries and research databases will help maximise the value of the clinical databases to carry out research and to facilitate the translation of new scientific discoveries into useful clinical applications. Conversely, these will also allow clinical data and materials to inform, support and drive basic biomedical research and to focus it on issues of greatest relevance to healthcare.

  - **Improving treatment outcomes.** Infocomm that can integrate the clinical information for specific patients and their family history, and stratify them into accepted risk profile and treatment groups. These can be supplemented by genetic and/or biomarker profiles that can further improve stratification and choice of therapies. In addition, with genetic knowledge of diseases and the person's genetic makeup as well as his medical history, we may be able to predict or anticipate the type of illnesses a person might be susceptible to and hence administer preventive treatment. Besides better treatment outcomes and drug efficacies, infocomm systems can analyse different care paths to identify the most effective treatment protocol.

  - **Enabling more effective and efficient drug development.** Pharmaceutical companies can also leverage on the partnership to generate new drug compounds and develop drugs that are targeted and individualised for the Asian population. In addition, Singapore could leverage on the opportunity to help drug companies reduce their drug development cost. A major portion of these costs are incurred in the form of large-scale clinical trials. The presence of well-defined populations and sub-populations of patients with different disease susceptibilities and medical conditions would be very useful for researchers and drug companies in carrying out clinical studies in more cost-efficient ways.

Annex C: Proposed iN2015 Project Timeline

	Short Term (1 – 3 yrs)	Mid Term (4 – 5 yrs)	Long Term (6 – 10 yrs)
Integrated Health Services	• Develop inter-operability standards • Pilot health ecosystem projects for key chronic diseases, such as diabetes, hypertension, high cholesterol and stroke • Assist healthcare providers to enhance their existing systems or put in place new systems to right-site the patient • Enable patients with access to basic personal health information in order to manage their own health • Pilot home monitoring solutions and sensors to enable patients to be cared for beyond the hospital environment • Develop clinical decision support systems to enable practice of evidence-based medicine in key healthcare institutions	• Develop a patient master index • Enact medico-legal framework governing the sharing of health information • Extend healthcare ecosystem pilot to all public hospitals, major community hospitals, all polyclinics, key step-down care facilities and family physicians • Provide public access to their personal health records • Facilitate development of home monitoring and tele-medicine systems	• Develop integrated, longitudinal personal health record system • Enable coordinated care at the most appropriate setting in all segments of the healthcare value chain for key chronic diseases such as diabetes, hypertension, high cholesterol and stroke through the healthcare ecosystem • Empower public to manage their health and ownership to their medical records
Integration between Healthcare and Advances in Biomedical Sciences	• Develop data-mining and knowledge management systems to integrate genetic and medical data to support healthcare delivery	• Develop next-generation clinical decision support system capable of analysing genetic data • Develop linkages between research databases	• Extend knowledge management system to facilitate access to medical information by researchers in biomedical sciences

Annex D: Overview of Healthcare and Biomedical Sciences Sectors

People

- **Profile of population.** Our population currently stands at 4.3 million, with about 3.6 million Singapore residents. The percentage of Singapore residents aged 65 years and above is projected to rise rapidly from 8.4 per cent of the population in 2005. Average life expectancy of Singaporeans has also steadily increased and is now at 79.7 years. In tandem with increasing affluence, there is a high prevalence of chronic, non-communicable diseases such as diabetes, hypertension, high cholesterol and stroke.

Healthcare Services

- **Structure of healthcare system.** Healthcare services are provided by different types of providers throughout the entire healthcare value chain from primary care to tertiary care through to step-down care.

  - **Primary care.** Primary care includes primary medical treatment, preventive healthcare and health education. These services are provided through a network of 17 government-subsidised outpatient polyclinics and 1,955 private General Practitioners (GPs). The former caters to about 20 per cent of general primary care needs while the GPs provide the remaining 80 per cent.

  - **Tertiary and acute care.** These services are provided by a network of 13 public and 16 private hospitals. The public hospitals are structured into two hospital groups – SingHealth Group and National Healthcare Group – that operate as not-for-profit private companies. Each of these clusters consists of both general hospitals that provide multi-disciplinary healthcare services and specialised hospitals in various disciplines, e.g. obstetrics and gynaecology and ophthalmology. Private healthcare is provided by two main providers – Raffles Medical Group and Parkway Group Healthcare – with similar specialist disciplines and comparable facilities to the public clusters.

  - **Step-down care.** Intermediate and long-term healthcare services for the elderly are mostly run by voluntary welfare organisations (VWOs). Government financial assistance is provided to some of these VWOs. There are six acute hospitals providing geriatric services, four community hospitals, five chronic sick hospitals, 56 nursing homes (including private homes), 33 day rehabilitation and dementia day centres, 10 VWO home medical providers and 17 VWO home nursing providers serving the healthcare needs of the elderly in Singapore.

Biomedical Sciences Research Sector

- **Biomedical sciences research ecosystem.** Singapore's public sector biomedical research and development activities are championed by the Biomedical Research Council, a unit under the Agency for Science, Technology and Research (A*STAR). Currently, there are five research institutes in the biomedical sciences area, namely the Institute of Molecular and Cell Biology, Institute of Bioengineering and Nanotechnology, Genome Institute of Singapore, Bioprocessing Technology Institute and Bioinformatics Institute. A major focus of the research community is how to better make use of clinical databases to advance biomedical sciences research and how to translate their discoveries into more effective healthcare applications and treatments for patients.

Current Status of Infocomm Functionalities in the Healthcare Sector

- While infocomm holds great promise for transforming the healthcare sector, it is generally acknowledged that the sector has historically lagged behind other sectors in the adoption of infocomm for its key processes. Hence, a substantial amount of 'catching up' will be necessary before some of the more novel potential applications can be widely explored.

- In devising a plan to realise the infocomm vision for the sector, it would be necessary to take into account the current status of implementation and to set realistic goals, targets and timelines.

- Adapting the approach used by Kaushal et al[7] the Sub-Committee made rough, non-quantitative estimates of the status of a range of infocomm functionalities among existing healthcare providers in Singapore. Refer to the following table for a summary of the results.

7 "The functional gaps of health information technologies required for a national health information network: exploring policy solutions", Kaushal R, Bates DW, Poon EG, Jha AK, Blumenthal D, Health Aff., 2005

Current State of Infocomm Adoption in Healthcare Sector

		Public hospitals/ Institutions	Private hospitals	Private specialist clinics	Polyclinics	GPs	Step-down care
Result viewing		3	2	2, P	3	2, P	2, P
Core EMR	Inpatient	2, P	0	0	-	0	0-1
	Ambulatory	2, P	0	0-1	2, P	0-1	-
Longitudinal EHR		3, P	0	0	3, P	0	0
Electronic prescribing		2, P	0	0-1	3	0-1	1, P
Computerised physician order entry		1, P	0	0-1	1, P	0-1	0
Patient communication		1, P	1	0-1	1, P	0-1	0
Patient's appointments, transactions		1	0-1	0	0	0	0
Claims		4	4	0	0	0	4

0: Not available
1: Available within the hospital, or within the polyclinic or within the step-down care facility only
2: Available within the public health cluster only
3. Available across clusters in the public health system
4: Available across public and private system
P: Available for some but not all items
F: Available for all appropriate items

Results viewing: Electronic viewing of test results, e.g. laboratory tests, radiology (text or film), pathology results
Core EMR: A standardised, well-defined core set of patient medical records for sharing by infocomm
Longitudinal EHR: Computerised systems that maintain relevant longitudinal health records including vaccination history, selected screening test results
CPOE: An application that allows all medical orders to be entered electronically
Patient comms: Secure email or messaging systems that allow private communications between patients and their healthcare providers
Claims: Electronic claims submissions between provider and third party payors including Ministry of Health

Note: This is a non-quantitative estimate by the Healthcare and Biomedical Sciences Sub-Committee.

Annex E: iN2015 Healthcare and Biomedical Sciences Focus Group Members

Name	Designation
Mr Dennis Ang Keng Leong	Deputy Director Projects School of Information Technology Nanyang Polytechnic
Dr Christopher Chia	Chief Executive Officer Media Development Authority
Mr Lin Cheng Ton	Principal & Chief Executive Officer Nanyang Polytechnic
Dr Gunaretnam Rajagopal	Deputy Executive Director Bioinformatics Institute Agency for Science, Technology & Research
Dr Patrick Tan	Principal Investigator National Cancer Centre Singapore
Mr Teo Chin Seng	Chief Information Officer Singapore Technologies Engineering
Dr Jason Yap	Director Healthcare Services Division Singapore Tourism Board

Annex F: IDA Secretariat for Healthcare and Biomedical Sciences Sub-Committee

Name	Designation
Mr Arthur Lee	Assistant Director Healthcare & Social Cluster Infocomm Development Authority of Singapore
Mr Lee Hoo Wah	Senior Manager Healthcare & Social Cluster Infocomm Development Authority of Singapore
Mr Teo Yi-Wei	Associate Consultant iN2015 Secretariat Infocomm Development Authority of Singapore

Annex G: Glossary

Term	Definition
Acute care	Medical care generally given in a hospital setting for more serious conditions that often arise over a short time frame and are usually of periodic or temporary nature.
Anticoagulation	Treatment that thins blood in order to make a patient's blood less likely to clot.
Bioinformatics	The science of managing and analysing data using advanced computational techniques as applied to biological research.
Chronic disease	A long-term disease that is non-infectious. This kind of diseases often has many causes. Examples include high blood pressure, diabetes and heart disease.
INR	Internationalised Normalised Ratio. A test that reflects how readily blood clots.
Medico-legal	Pertaining to legal aspects of medical practices.
Pathology	The scientific study of the nature of disease and its causes, processes, development, and consequences.
Point of care	Location at which a patient is treated, e.g. the patient's bedside. Also used to mean the part of healthcare value chain where the patient receives care, e.g. acute care hospitals, GP clinics, nursing homes.
Poly-pharmacy	The concurrent administration of multiple drugs resulting in excessive medication and higher risk of unintended interactions and side effects.
Primary care	The type of holistic, basic healthcare that would be delivered by a family physician.
Prognostic markers	Biological parameters (e.g. specific proteins or genes) that are used to indicate susceptibility, presence and stages of progress of diseases.
Step-down care	An intermediate stage of care between hospital and home-based care. It is provided by community-based institutions like nursing homes, rehabilitation centres and community hospitals.
Tele-consulting	Medical consultation that is carried out using telecommunications rather than in person.
Telemetry	Transmission of data collected remotely to a central location over communications links, e.g. satellite.
Teleradiology	Electronic transmission of radiological images, e.g. X-rays, CTs and MRIs to a remote location for interpretation and/or consultation.

Infocomm Development Authority of Singapore
IDA is committed to growing Singapore into a dynamic global Infocomm hub. IDA uses an integrated approach to developing info-communications in Singapore. This involves nurturing a competitive telecoms market as well as a conducive business environment with programmes and schemes for both local and international companies.
For more information, visit ***www.ida.gov.sg***

Singapore Computer Society
SCS, established since 1967, is the premier professional body for IT practitioners and IT users in Singapore. With a membership of over 22,000, it is an invaluable network for its members. SCS administers various certification programmes that help individuals gain professional recognition for career development.
For more information, please visit their website at ***www.scs.org.sg***

Singapore infocomm Technology Federation
SiTF is Singapore's national infocomm industry association. It brings together 500 corporate members from MNCs and local companies, who collectively account for over 80% of the industry revenue. The SiTF assists its members in business development, market intelligence, overseas trade missions, networking and alliances.
For more information, please visit their website ***www.sitf.org.sg***

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