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International Activities in Tele-homecare

Background Paper

Canada

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Office of Health and the Information Highway
Health Canada

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website address: http://www.hc-sc.gc.ca/ohih-bsi

Questions and comments should be addressed to the author Constantine Tikhonov at:
Constantine_Tikhonov@hc-sc.gc.ca.

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INTRODUCTION

> "It is the beginning of a new era in health care, an era distinguished by the home as a centerpiece of the health care delivery system, characterized by patients having greater autonomy, and families and friends being recognized and trained and hopefully celebrated as the primary care givers. Home medical equipment is critical to the success of this new delivery system. And the understanding of the proper place and use of the equipment is essential." (J.Portnow, MD. Foreword to the Case Management Source Book, 1997)

The economic well-being and health of the population are interdependent determinants of the quality of life and prosperity of a nation. The primary goal of health reform is to improve health outcomes. This goal will be reached by finding cost-effective ways of delivering health care and promoting health maintenance. One of the brightest examples of the "new frontier" of health care delivery is tele-homecare.

Tele-homecare can be defined as the use of information and communication technologies to enable effective delivery and management of health services at a patient's residence. The scope of tele-homecare addresses clinical, administrative, and consumer health information applications (Appendix 1).

It is very important to realize that tele-homecare deals with some of the major trends within the health care systems of the industrialized nations:

- Patients are being discharged from hospitals early and often require additional health care services and monitoring of their health status.
- Health care restructuring is oriented on increased utilization of community health care services. The point of care moves closer to the client.
- Chronic illness is on the rise in North America.
- Demographic changes associated with the aging of the "baby boom" (1946-1966) generations. People live longer and, in the last years of their lives, they often require health care and support.
- Telehealth applications are being developed by private companies and provided to patients who are able to pay, therefore creating a potential for expansion of the second tier of health care.
- There is not enough information on management standards, utilization, and costs of community and home care services.

- It is often difficult for patients and caregivers to find necessary and reliable health information on "as needed" basis.

Tele-homecare is a fundamental part of the solution set for many potential problems presented by these trends.

We need to remember, however, that developing tele-homecare as a part of the public health system is not a substitution for any of the already existing services. It complements community health infrastructure, reinforces it and enables it to address complex systemic problems with the matching sophistication of the solution.

ROOTS OF TELE-HOMECARE

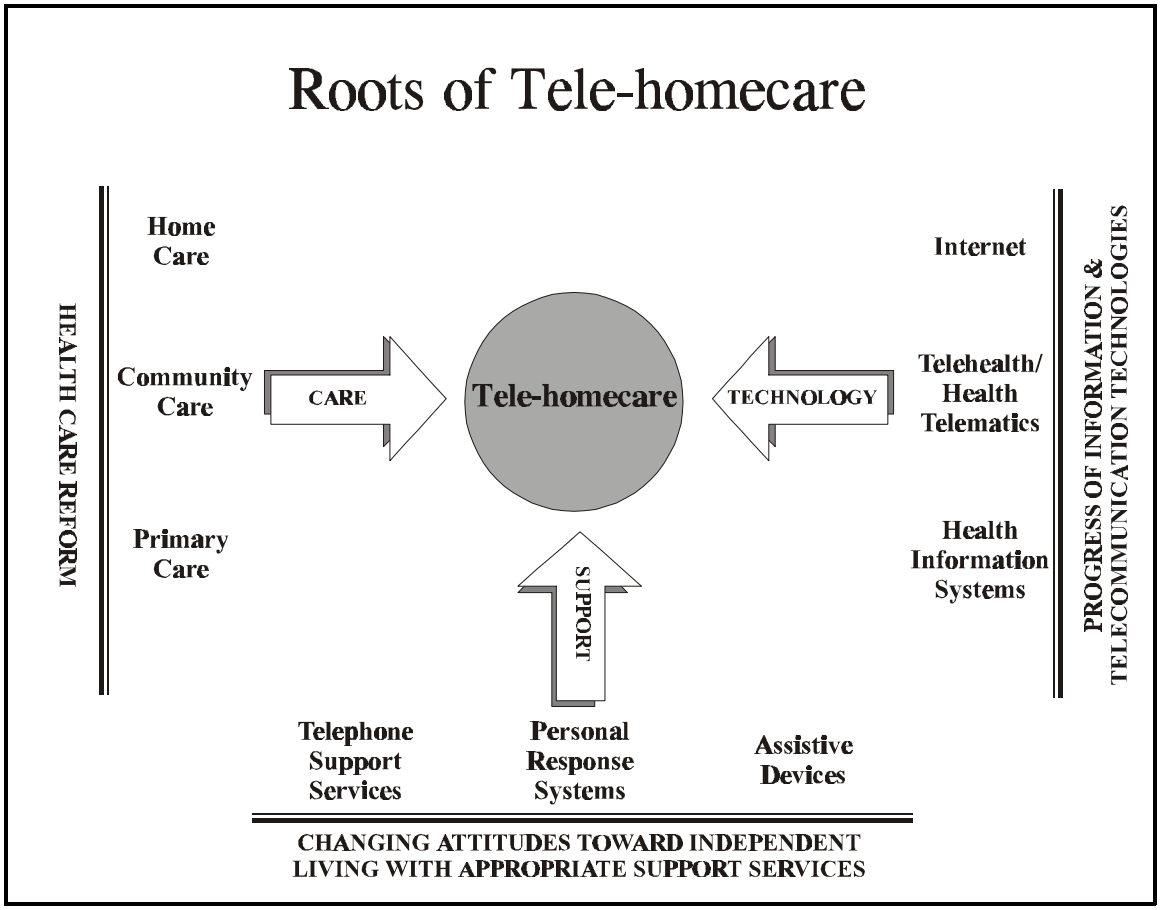

Figure 1: Evolution of tele-homecare through the integration of existing services

Tele-homecare is evolving on a solid foundation of a variety of applications in health care, support services, and information and telecommunication technologies (Figure 1) that now merge under one conceptual umbrella.

Health Care Roots

The health care reform of the last ten years has been incorporating the principles set out by the World Health Organization's notion of primary health care (1978) and the "Health-for-All" strategy. The development of health care toward increasing the role of primary and community care, increasing integration and decreasing institutionalization provides a conceptual foundation for the development of tele-homecare as a component of the Canadian health care system.

Tele-homecare has the capacity to reinforce the four essential characteristics (1) of good primary care: accessibility, comprehensiveness, coordination and continuity of care. As a concept, tele-homecare is built on the foundation of home care, and has the potential to significantly enhance it through improved monitoring, coordination of care, and increased accountability of providers due to improved information systems management.

Support Roots

Telephone support services have been expanding since the invention of the telephone. A study undertaken at McMaster University (2) referred to the first telephone call for medical assistance from Alexander Graham Bell in 1876, when he asked Mr. Watson to come and help with an acid spill on his clothes. The 20th century saw the emerging movement of telephone crisis and suicide prevention counselling, which originated in mid-century in England and spread around the world as a "Life Line" movement. Telephone services are used routinely for medical help. Emergency "9-1-1" calls, telephone referrals, consultations, health surveys and follow-up monitoring are common practices in today's health care. A literature review on the topic (2) found evidence of positive effects of the telephone support for the physically disabled, the elderly and other people for whom travel to a health care facility presented overwhelming difficulty. However, many health care providers viewed telephone support services with caution because of the fear of missing important information without being able to assess visual cues (2).

An **assistive device** is any item, product or piece of equipment that is used to maintain or improve the functional capabilities of people with disabilities. This equipment is used by patients and caregivers to assist in activities of daily living, and also to provide some necessary health care services (e.g., home-based infusion therapy). In the last 25 years, there is a trend toward increasing technical complexity of home care aids. This trend is consistent with the development of remotely controlled equipment.

The **personal response system (PRS)** (3) concept is the most significant predecessor of tele-homecare. Tele-homecare incorporates the idea of PRS as its core motivation (i.e., to provide support and protection to the frail and disabled who need it, when they need it). The technology was developed in the early 1970s, when by using a small portable radio transmitter in their home, people could initiate an automatic call to a help centre. The devices are named differently (e.g., panic buttons, community alarms, medical alert, care phones, emergency response service and personal emergency response service) (3). By 1992, use of the PRS in the world ranged between 1 and 12 percent (UK) of the elderly population. Sweden, Canada and the Netherlands reported that about 3 percent of elderly

people were using the service. A. Dibner, the pioneer of PRS in the United States, suggested that 50 percent of people over 75 may need the service (3).

Technological Roots

The **Internet** is often defined as a network of networks. From the early 1969 military project of the Defence Advanced Research Project Agency (DARPA), it has evolved to become a global electronic information network. The development of dial-up networking enabled any person to connect to the global system and retrieve required information. The Internet has an unlimited capacity for addressing tele-homecare clients' needs for health information.

Telehealth may be defined as an application of information and communication technology to health care delivery and health maintenance. The technological developments of the last 10 years have enabled a range of applications in clinical medicine, from teleradiology and telepathology to telepsychiatry. The clinical aspect of telehealth is often thought of having the most significant impact on the development of tele-homecare, by providing both the methodology and technology for the delivery of clinical care at home.

Health information systems can be defined as an organized combination of people, hardware, software, communication networks and data resources that collect, transform and disseminate information in a health care organization (4). In the last 20 years, computerized health information systems have become a standard for hospital operations. Their primary purpose is to streamline functional activities and to improve resource management. Hospital information systems are built largely on the basis of an organized collection of patient records. The evolution of the relational database design has significantly increased the benefits of the system, allowing the linking of selected financial data with specific diagnostic categories, therefore, enabling evaluation of the resource utilization patterns. Advances in hospital information systems allow managers and providers to understand financial implications of the clinical decisions, as well as clinical implications of specific capital expenditures (5). In the last several years, different community health organizations started to develop their information systems; in general, mirroring hospital models.

This new development can be successful on the premises that the organizational information system will soon be networked, thus, facilitating registration, monitoring and management of the multiple health care interventions from multiple sources.

The philosophy of the new integrated health information system is dictated by the community-oriented health care paradigm and is based on the fundamental premise that a patient is in the centre of the system. Tele-homecare logically emerges as a next step, which would allow integration of health care information systems along the continuum of services, with a patient in the centre of the network design.

REVIEW OF INTERNATIONAL PROJECTS AND INITIATIVES RELATED TO TELE-HOMECARE

European Union

The establishment of the Single European Act in 1987 provided a foundation for a positive breakthrough to a comprehensive, political strategy on technology, addressed by the Second Framework Programme for Research and Technological Development (RTD). The basis of the European technology policy is the Community Framework Programme. It sets goals and outlines a funding envelope for research support in the form of grants over a period of five years (6). European activities in telehealth are coordinated through the European Commission (EC) Directorate-General XIII - Telecommunications, Information Market and Exploitation of Research.

Within the DG XIII, Directorate C and Directorate E are responsible for the Telematics Applications Programme (TAP). Two major areas of TAP are directly related to the development of projects that could be viewed as applications of tele-homecare: Telematics for Healthcare, and Telematics for Disabled and Elderly People. As a result of work done between 1991 and 1994, the EC published a final report of the Third Framework Programme Telematics Systems for Health Care (AIM) (7). From 1994 to 1998, all EC research and technological development (RTD) activities are being conducted under the Fourth Framework Programme. However, a range of strategic planning activities is currently being undertaken to identify priorities for 1998 to 2002 within the Fifth RTD Framework Programme.

Third Framework (1991-1994) Tele-homecare–Related Projects[1]

The development of the Third Framework Programme was driven by the need to complement emerging national initiatives, overcome fragmentation, strengthen European industrial competitiveness, and address new health and social problems associated with the free transborder movement of people within the EC. As a result of cooperation among the member states, a European paradigm for health telematics has been formulated, and the Advanced Informatics in Medicine (AIM 91-94) program has been launched and allocated 105 million ECU[2]. The program's goal was articulated as the:

[1] The description of projects is compiled from the AIM (1991-1994) Final Report (7).

[2] Equivalent to about $175M Canadian

> "Development of harmonised applications of information and communication technologies; development of the European health care information infrastructure; strategies for the use of technologies telematics systems and services and contribution to the definition of common functional specifications; development of telematics technology applied to medicine; validation and integration." (7)

There is a clear trend in the countries of the EU to move point of care closer to the client. Several of the major projects of the third framework have directly addressed applications of advanced information and communication technologies (ICT) in home care.

A2007 - EPIC (European Prototype for Integrated Care) was a 36-month project administered in nine European countries (Ireland, Italy, France, Finland, Greece, Spain, Portugal, Sweden, United Kingdom). The project explored a concept of the integrated primary care solution to support the transition from centralized institutional care toward more decentralized community care. According to the project overview, the main functions of the health and social service providers are the assessment of clients, identification of their problems and needs, and planning, delivery and evaluation of care. EPIC utilized technology-enabling transmission of information from clients' homes to health providers at remote locations.

These tele-homecare applications brought the appropriate technology and services to anyone who needed assistance with healthcare and/or social problems at home. Help was provided in the form of training, information, advice or monitoring. Telemonitoring of alarms, blood pressure and ECG supplied providers with timely information on critical changes in a client's condition at home. These applications supported a clear trend in Europe to provide an increasing number of health and social services in clients' homes rather than in the institutional setting of a hospital or nursing home. EPIC was managed around the shared care database in which each community facility or group of facilities was supported by a local area network (LAN). Each of these LANs was connected over a wide area network (WAN) to a central node, enabling update and access of information between the various service points

A76252 - METROPOLIS (Telecommunications Services for Health Care Added Value: Strategies for telematics systems in metropolitan areas to improve health care delivery) was conducted for nine months in three European countries (France, Sweden and Spain). The study focused on issues of lacking coordination between health care and social services, the growing demand for services among people aged 65 or over, insufficient monitoring of population "risk groups" and inefficient primary and secondary care coordination. All of these issues could be improved by implementing telehealth systems.

Among other conclusions, the study recommended that Telematic Home Assistance Systems [tele-homecare] need to be reinforced. Home health tele-assistance systems could provide a large range of services that would permit the user/patient to remain in his or her normal environment: emergency alarm systems (tele-alarm), post-hospital treatment monitoring, social assistance (24-hour tele-assistance), etc.. These applications potentially represent an increase in service quality by enhancing quality of life and providing cost reductions over traditional services.

A2018- IREP (Integrated Rehabilitation Programme) was a 30-month project conducted by six participating countries (Italy, Finland, Greece, France, Spain, Portugal). Its main goal was to define a uniform conceptual model of rehabilitation protocols and procedures, and to build an information base of existing expertise throughout Europe. The project team aimed at defining a prototype of communication infrastructure and services interconnecting the rehabilitation centres as well as a dedicated workstation for the use of rehabilitation professionals.

The study included analysis of telecommunication services between the patient at home and rehabilitation centres. It was concluded that a workstation for home care must provide, at a reasonable cost, sophisticated user interfaces and facilities for executing rehabilitation exercises, and for assessing their progress and their results.

Fourth Framework (1994-1998) Tele-homecare–Related Projects[3]

The Telematics for Healthcare Sub-programme was built on the analytical foundation of the AIM results. It is focused on facilitating necessary organizational and technical tools for "seamless care" on a local level and, on a national and international level, to provide expedient information about individual patients and aggregated data, as well as to share services across borders (7).

HC 1006 CATCH (Citizens' Advisory System Based on Telematics for Communication and Health) was a 24-month project that started in January 1996. Participants included organizations from Portugal, Germany, Ireland and the Netherlands. The major goal of CATCH is the widespread implementation of health information sources accessible to every European citizen at any time and any place. A variety of health information consumers (e.g., patients, hospital staff, health care providers, clients in their homes) would be able to retrieve health prevention information, and become aware and capable of

[3] Project descriptions are compiled according to the information provided by the EC DG XIII Telematic Application Programme (8, 9)

making independent decisions about their own health. The result of the project will be an implementation of the multimedia, multilingual citizens advisory system.

HC 1008 COCO (Coordination and Continuity in Primary Health Care. The Regional Health Care Network) is a 36-month project aimed at improving the coordination and continuity of health care and social services through the establishment of pilots of Regional Health Care Networks. The participants include eight European countries (United Kingdom, Denmark, Ireland, Spain, Norway, Greece, Italy, the Netherlands) and Prince Edward Island (Canada). There are more than 30 hospitals, 20 health care centres and 12 universities involved in this large pilot. The COCO project includes home care as one of the major components of the regional health network in an attempt to apply advanced ICT to services provided by home care, consultants, laboratories, pharmacies and other professionals. Such integration of the continuum of care corresponds to the concept of tele-homecare, especially in terms of administrative and management applications.

HC 1021 - HERMES (Telematic Healthcare – Remoteness and Mobility Factors in Common European Scenarios) is a 12-month project directed at implementing a prototype network for an "Agreed European Specification for Quality Assured Telemedicine Services" to improve interoperability of the "islands of telemedical activity" and to increase uptake of telemedicine in different European countries. National Telemedicine Access Points will be created to control all communication functions. The range of activities will be conducted on a 24-hour basis, in all clinical specialities, and involves all users and providers in the healthcare environment. The Initial HERMES Services Specification will include the range of urgent response activities that are necessary for 24-hour On-call Services, for Home-based Services and for Ambulatory-Care Services. The project team will also produce a portable vital-signs monitoring system based on previous EU Health Care Telematics work and constructed to meet the requirements for the HERMES Services. The project sites are in the United Kingdom, Greece, Portugal and Germany.

HC 1022 - HOMER-D (Home Rehabilitation Treatment-Dialysis) is a four-country (Greece, Great Britain, France and Germany), 36-month project. The goal of the project is to develop, apply and evaluate telematics monitoring and consultation services for patients with renal failure requiring home haemodialysis (HH). Telematic applications will support isolated patients who need a continuous and uninterrupted HH treatment. Bi-directional communication links between a central control station, which is located in a distant hospital, and remote terminal units in patients' sites, will enable and support the supervision of each HH session and the possible intervention by medical personnel through

a number of operational modes. The adoption of high security levels, special training courses and the interoperability of these services offer more confidence to the patients and radically influence the quality and efficacy of their treatment. Expected results include the improvement of patients' quality of life and their enhanced rehabilitation potential, the flexibility of choosing the optimum haemodialysis session, minimization of transportation costs, drastic reduction of necessary clinical personnel and the corresponding financial costs, as well as the increase of offered medical facilities and services from the specific dialysis centres.

HC1029 ITHACA (Telematics for Integrated Client Centred Community Care) is a 36-month project which aims at improving the quality of care provided to people living in the community through the integration of telematic services. Project sites are located in 10 countries (United Kingdom, Spain, Finland, Portugal, France, Italy, Greece, Sweden, Ireland and Canada). The Canadian project site is located in Regina and supervised by Saskatchewan Health. The project is intended to further develop results of the European Prototype for Integrated Care (EPIC). The professional scope of health care services will be expanded to include mental health and maternal and child health. The users involved in the project are multidisciplinary groups of professionals, including doctors, nurses, social workers, physiotherapists, occupational therapists and managers. The project will create a person-centred community information system, with the integration of a home telecare management system, use of portable data access tools, such as hand-held computers, and executive and geographical information systems.

HC 1047 T-IDDM (Telematic Management of Insulin Dependent Diabetes Mellitus) is a 36-month project conducted in three European countries (Spain, Italy, Finland). About 30 million Europeans have diabetes; 20 percent of them insulin-dependent patients. T-IDDM deals with the design, implementation and testing of a telematic service to assist Insulin-Dependent Diabetes Mellitus (IDDM) patients. The service requires two main components: a patient unit and a medical workstation. The patient unit provides assistance to the patient in the form of teleconsultation. The medical workstation is used for the long-term management of the patient and is assisting the physician in choosing an appropriate treatment protocol. The two modules rely on a bi-directional communication channel to exchange relevant information: the patient unit receives the day-by-day therapeutic strategy to follow and is able to communicate relevant data back to the medical workstation.

ACTION (Assisting Carers using Telematics Interventions to meet Older persons Needs) is a 36-month project, involving Ireland, Portugal, Sweden and the United Kingdom. The primary aim of the project is to maintain the autonomy, independence and quality of life for the frail elderly and disabled persons, and their informal family carers, by the

application of telematic technology. The project intends to demonstrate that, through a combination of familiar technologies, such as the carers own television, remote control units and use of additional technologies (e.g., video reception/transmission, fast computer processors and access to interactive communication), on-line effective care information communication can become a reality for formal and informal carers.

SAFE 21 (Social Alarms for Europe in the 21st Century) is a large project based in five European countries (Great Britain, the Netherlands, Germany, Belgium and Spain). The project is aimed at integration of care and security for elderly European people at home. SAFE 21 is using existing infrastructure to deliver much broader assistive technology and extending availability to users who are currently excluded.

The project addresses four major needs:

1. provide a social alarm that will work from anywhere inside the home, using a neck-worn speech pendant, and outside the home making use of radio cellphone and global positioning technology;
2. provide access to social alarms for deaf users (who are currently excluded);
3. demonstrate how tele-medicine can be incorporated at marginal cost, by exploiting the existing social alarm infrastructure; and
4. demonstrate a monitoring centre that facilitates provision of emergency services and collaboration between medical, welfare and social professionals working together, supporting a broad-based social alarm system.

SAFE 21 can be viewed as a cluster of seven sub-projects: voice pendant, cellphone social alarm, interface for deaf people, ESPRIT home-bus implementation, tele-medicine, multimedia and shared control centre; each of which will concentrate on the development of one or more elements of the social alarm infrastructure, in a coordinated way, so that the entire infrastructure can evolve.

It is expected that the broader and more effective capability of social alarm systems will release many family carers to participate socially and economically in the community. The provision of medical sensors at home will release hospital accommodation. The range of users benefiting from social alarms will be extended. These users will be able to maintain their independence and dignity, and professional users will be able to offer a more cohesive and efficient support service.

MOBCARE (Home/ambulatory health care services based on mobile communications) is an 18-month project involving three European countries (Spain, United Kingdom, and Portugal). Its main goal is to address the key success issues: mobile technology, organizational and professional changes required, range of home health care and ambulatory care services, and service's cost-effectiveness within the health care models throughout Europe. The project is concerned with the concept of home/ambulatory telecare, integrating many diverse services that can be categorized as the following: telealarm services, telemonitoring services, access to health/social-related information, interconnectivity with social/health care information systems (community, hospital/specialities, other organizations), and home environmental remote control.

Fifth Framework Telematics for Health Care: Vision for the Future

The Telematics Application Programme Strategic Requirements Board has published a report on strategic needs and directions for the Fifth Framework Programme. This report (1997) articulated a new vision of "citizen-centred care" as a foundation of the European RTD activities. The vision consists of two components: new innovative services to the citizens, and, networking services and care across organizational boundaries (10).

> "The new paradigm includes the informed citizen caring for his own health and stakeholders responsible for the continuity of health services within a region [Figure 2]. The vision implies a decentralized health care where services with evidence-based effectiveness are accessible to all and are provided in a way that organizational boundaries are invisible to the citizen. Information and communication technologies (ICT) support information distribution and sharing between health promotion, primary health care, hospital services, rehabilitation, home care and other relevant service modalities. ICT supports proximity health services by providing citizens an increasingly direct access to specialised national or European health and medical knowledge." (10)

The vision articulated for the Fifth Framework Programme is fundamentally similar to the philosophy underlying the concept of Canadian tele-homecare.

Germany

Germany is actively involved in all major activities of the European Commission. The country is faced with two major challenges: to reduce operating costs of the health care system, and to address the explosion in medical knowledge and the increasing complexity of health professionals' tasks. Health telematics is believed to have the potential to effectively address these issues (11). Since 1995, there were several major projects conducted in Germany in relation to mobile patient monitoring.

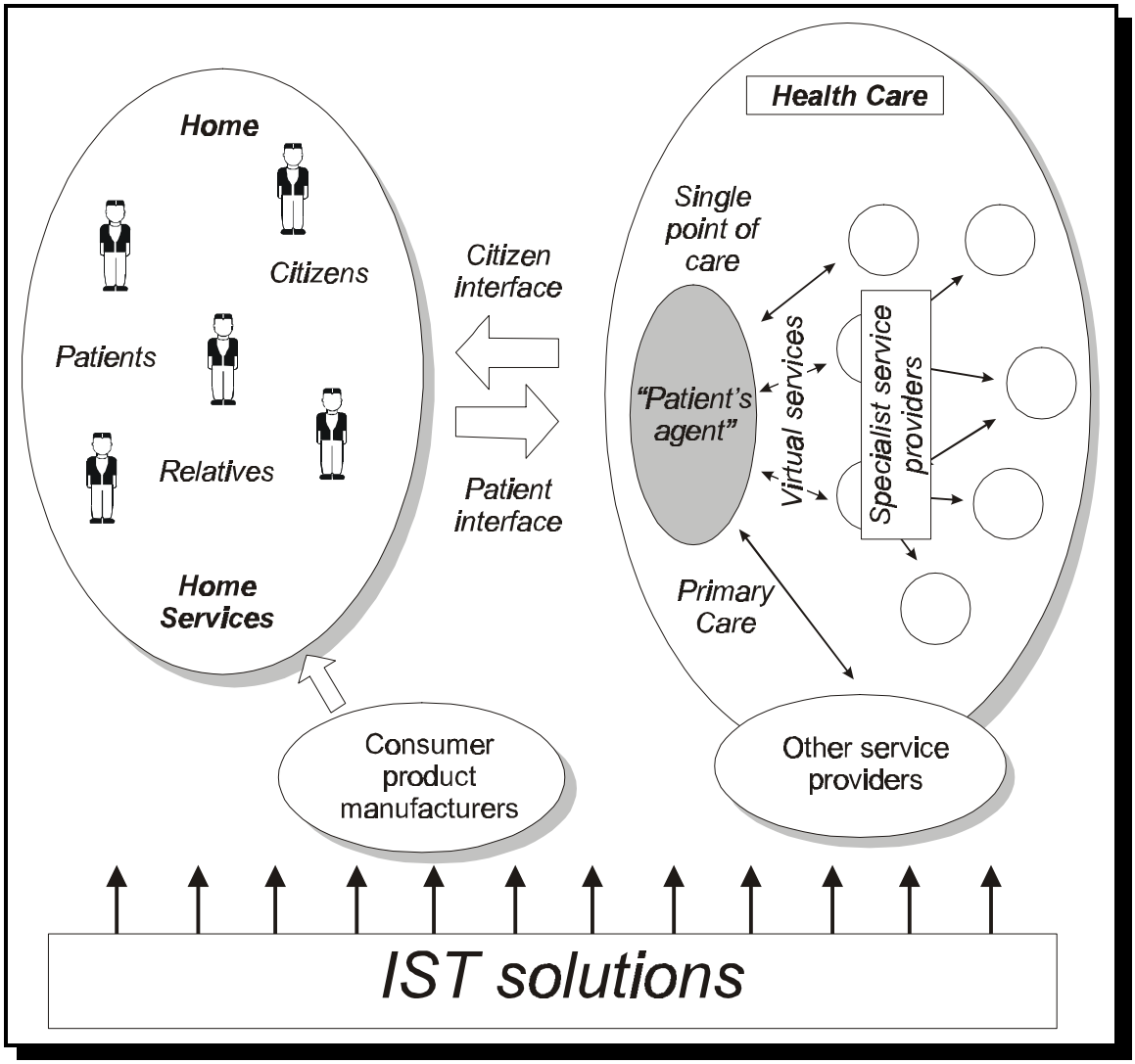

Figure 2: European Vision of Citizen-centred care (reproduced from the Report of the Strategic Requirements Board for Telematics Application Programme in Healthcare Sector, EU DG XIII C/E (10))

These applications were aimed at maintaining the diagnostic contact with the patient who is not limited in his or her mobility and may travel not only around Germany but also to other European countries. Naturally, monitoring of the patient in his or her home is a core component of such an undertaking. There are two projects using remote monitoring that may be mentioned.

The pediatric clinic of Porz/Cologne conducted a pilot project addressing preventive diagnosis of Sudden Infant Death (SID) syndrome, which was named as a leading cause of death in infants between the second and twelfth month of life in Germany (11). According to 1995 statistics, in Germany about 2,500 babies per year die from SIDS (11). The project design included extensive home monitoring of the vital parameters of infants at risk. The project monitored breathing movements, ECG, heart rate and oxygen saturation. In some cases, body temperature and movements were recorded. All sensors were non-invasive and integrated with a baby's pajamas (11). The parents were trained in assessing the physiological status of the child and in emergency intervention measures. Information was also transmitted to the test and research telemedical laboratory for further analysis.

A project conducted at the University of Aachen in 1995 aimed at demonstrating feasibility and diagnostic advantages of the remote home polysomnography[4] for early diagnosis of obstructive sleep apnea[5] in adult patients (11). This project involved monitoring of a complex set of data (e.g., eye movement, electric potential of chin and leg muscles, ECG, respiratory flow, oxygen saturation and body position).

Tele-homecare monitoring is believed to have many advantages: all diagnostic procedures are performed during the night so social functioning of individuals is not disrupted, patients do not need to travel and adapt to a new clinical environment (11), diagnostic quality is significantly higher because of the continuity of monitoring, and the accessibility of the sophisticated diagnostic service in remote areas is improved.

The Netherlands

Population aging is one of the most acute social issues in the Netherlands. Government policy is directed at reducing the number of elderly living in nursing and residential homes, by supporting and promoting advantages and safety of independent living.

One of the areas that seems to be exceptionally well developed in the Netherlands is the use of hand-held computers for electronic case management. After data are collected, it can be immediately transferred, using dial-up networking capacity, from the point of care to the central home care database. Records are regularly updated and are available to different health professionals within the continuum of care (12).

[4] A polysomnography study (or NPSG - Noctural Polysomnography) consists of recording sleep as it happens. Electrodes and respiratory sensors are applied before "light's out" to monitor and record sleep.

[5] Cessation of breathing.

Integration of the PRS with social and medical services started more than 10 years ago. Initially, the process was fragmented due to the insufficient financing. In 1990, the use of PRS in health and social care was financed from the national health services, private medical insurance companies, social security and government funds, and direct contributions by patients (13).

The Netherlands has three models of the service delivery:

- subsidized
- semi-commercial
- commercial (13).

The process started with small agencies providing emergency response and remote monitoring services separately. As government subsidies decreased in the last several years, many agencies merged into large regional organizations to continue providing the services on a more secure financial foundation (16).

The Netherlands' Institute for Rehabilitation Research conducted a variety of studies that address issues of the esthetical design of the monitoring equipment, integration of other (non-emergency) functions within the system, and user satisfaction.

The Netherlands is actively involved in EC studies on the use of the remote monitoring to support independent living policy.

Italy

TeSAN (Tele Soccorso Anziani, or "Tele-help for the elderly") is a for-profit tele-monitoring company, founded in 1987 (14). There are 14 monitoring centres across Italy which serve as primary contact points for the clients. Centres are staffed by non-medical personnel, with two-months' hands-on training in the social, behavioural, biological and information technology aspects of home health care (14). TeSAN offers three main services:

- Personal Emergency Response System (PERS; Telesoccorso)
- Careline Services – proactive telephone monitoring service
- Telemedical/Telemonitoring Services.

These services were established for patients recently discharged from a hospital. The company supplies a variety of portable monitoring equipment to patients. This equipment

can record vital signs taken by the patient or informal caregiver at the patient's home, and then transmit them using telephone to the operator. The operator inputs additional data and transmits it electronically or by fax to the physician. If there are pathological changes, the patient is contacted directly and helped to address the situation.

Sweden

Sweden is one of the pioneer countries in the development and wide implementation of the ERS, which are one of the fundamental predecessors of the tele-homecare concept. In the late 1980s, about 50,000 elderly citizens were equipped by the ERS "Care Phone" system, and the demand for the system was growing at 10,000 units per year (15). In addition, about 80,000 units were installed in assisted living housing units, which operate through the internal network.

In the northern municipality of Umeå, a project entitled "Telemedicine within home health care" has recently been launched. The project is developing tele-consultation services between home and primary care department, as well as secondary care departments, at Umeå University Hospital. Among other projects conducted at the University of Umeå is the development of a so-called "intelligent mattress," which would monitor and transmit vital signs information from patients' homes to the health provider organization (16).

United Kingdom

In the United Kingdom, telecardiology started developing in the 1970s, when the need to monitor the earliest generations of implanted pacemakers evolved into the development of single-lead transtelephonic electrocardiograms (17). The Cardiac Monitoring Centre of the Cardiovascular Research Unit in Edgware, north London, together with the Israel Centre of Telemedicine and Telecare, undertook a study in 1996 to develop a comprehensive non-invasive telecardiology monitoring centre. Patients were closely monitored, using interactive computing and remote consultations, either from their homes or their place of work. The study supported more rational distribution of resources, with general practitioners being able to monitor most patients (17), thus eliminating unnecessary referrals to specialists and excessive hospitalization.

The Maternal Infant Care and Telemonitoring Centre of John Radcliffe Hospital in Oxford established a remote physiological monitoring network to evaluate cardiorespiratory function during sleep in 400 infants in their homes (18). The centre designed and developed portable monitors for continuous measurement of vital signs, which allowed downloading data from monitor memory to the Oxford Centre. This information was then

further analyzed. Researchers were looking at the correlation of cardiovascular disease and maternal and fetal nutrition during pregnancy.

The network was run by community nurses, and had all elements of the primary care clinical service. These characteristics led the study to conclude that, on a larger scale, such telemonitoring design could produce both increase in quality and cost reduction, since the similar hospital-based studies would have been not only at least 10 times as costly, but also "artefactual" because of an "abnormal environment" (18).

In December 1997, the U.K. Department of Health published a White paper which outlined a new direction for the health care system. The U.K. government added an extra £1.5 billion into the health service during 1997-98. The government made a commitment to create a new health care service for homebound citizens, based on a new 24-hour telephone advice line staffed by nurses. This service is being piloted through three care and advice help lines, starting in March 1998. The whole country will be covered by 2000 (19).

The U.K. strategy represents one of the brightest examples of creating a tele-homecare application as part of primary care reform.

In addition to the process of internal reform, different U.K. organizations are actively participating in the development of tele-homecare services within the EC Telematics for Health Programme.

Israel

One of the most remarkable examples of an efficient tele-homecare organization, Shahal Medical Services Ltd., was created in Israel in the early 1990s. Shahal serves over 50,000 cardiac, pulmonary, hypertensive and healthy subscribers in Israel and internationally (20). In addition to 24-hour medical monitoring, the company has its own fleet of Mobile Intensive Care Units (similar to critical care ambulance).

Shahal is involved in providing the following services (21):

- Cardiac Monitoring and Emergency Response System

  The centre is staffed by practising nurses and physicians. New subscribers undergo an initial interview, during which their medical history and a "baseline" ECG are recorded. In a process of a typical patient call, a health professional collects descriptive information about the patient's condition, while simultaneously receiving and recording the 12-lead ECG transmitted by the client-managed portable ECG device. The ECG results are displayed, analysed and compared with previous ECGs using Shahal's proprietary trans-telephonic ECG management software. One of the additional benefits of the service is the increased level of self-confidence of its cardiac patients. According to published data (21), 89 percent of surveyed subscribers reported an improved level of self-confidence, with 54 percent claiming a remarkable improvement.

- Personal Emergency Response System

  The system is based on utilization of the "Home Care Center" (HCC), a hands-free, two-way voice communication device, which can be accessed from any point in the client's residence. The system can also act as a telemedical centre, transmitting data generated by portable diagnostic devices to the remote centre. The system includes pulmonary and blood pressure monitoring systems.

- Emergency Home Entry System

  The so-called "TeleDoor" system enables the unlocking of the subscriber's door from the remote monitoring centre, when he or she is not capable of opening the door for the emergency response team.

- Remote Interactive Video Communication System

  This new system, introduced in 1997 as a "TV phone," is an interactive video communication system that enables two-way visual and audio consultations between health professionals and subscribers.

Shahal is a profit-oriented organization, which charges subscribers $40 to $70, depending on the type of service.

Japan

By 1995, about 3 million people in Japan needed daily personal assistance, and about 15 million had chronic disabilities (22). In order to find a cost-effective model of home health care delivery, the Tokyo Medical and Dental University developed a large ISDN-based tele-home health project. Integrated Switched Digital Network or ISDN services are available throughout Japan. This combination of need and telecommunications infrastructure provided a foundation for a constructive environment for testing tele-home health care applications (22).

At MEDINFO 95, a group of researchers (23) provided an overview of the home care support information system they designed and piloted in Kagawa prefecture for six years. The fundamental significance of this study was in raising the level of awareness about self-health care and promotion of comprehensive medical services in the community (23).

The study used a newly developed telephone terminal with a large screen, which allowed collection and recording of vital signs data.

Singapore

The Straits Times announced in April 1998 that Health Online (http://www.hol.com.sg) was launching a trial video-conferencing medical assistance service. People are able to consult their "neighbourhood" physician for advice on minor medical issues from their homes, using the high-speed SingaporeOne network. The system also offers access to the virtual medical records and remote monitoring of vital signs for patients suffering from asthma and diabetes. The service is provided on commercial basis.

Australia

Telemedicine centres were created at several sites in Australia. State health departments are interested in the potential of telemedicine to assist in home medical situations and to overcome long hospital waiting lists (24).

A group of researchers from the University of New South Wales, led by professor B. Celler, is developing a device capable of collecting, recording and transmitting a variety of clinical data for use both in a physician's office and during a home visit (25). The project team is also designing another device that would enable remote physiological monitoring of patients at their places of residence. The project is guided by a vision that improvement of health care quality and reduction of costs can be achieved by establishing a continuum of patient care.

United States

The development of telemedicine/telehealth programs and applications in the United States is accelerating every year. There are considerable federal investments allocated to finance further advancement of the health care component of the National Information Infrastructure.

According to the study conducted by Telemedicine Today (08/97) and the Association of Telemedicine Service Providers, a total of 339 programs were active in 38 states in 1996, providing 21,000 patient/physician interactions in one year. The total number of telemedicine sites was estimated to be 1,032 in 1996, with a doubling predicted for 1997. The U.S. government is working on resolution of the major policy issues of reimbursement and licensure in regard to the practice of telehealth. The Health Care Financing Administration has described the existing policies in the following excerpts (26):

> Medicaid reimbursement for services furnished through telemedicine applications is available, at the State's option, as a cost-effective alternative to the more traditional ways of providing medical care (e.g., face-to-face consultations or examinations). As described below, at least eleven states are allowing reimbursement for services provided via telemedicine for reasons which include improved access to specialists for rural communities and reduced transportation costs.
>
> Most states that provide payment for services furnished using telemedicine technology do so in the form of a physician consultation. Non-physician practitioners may also be covered depending on their scope of practice under state law.
>
> Federal Medicaid guidelines require all providers to practice within the scope of their state practice act. Some states have enacted legislation which requires providers using telemedicine technology across state lines to have a valid state license in the state where the patient is located. Any such requirements or restrictions placed by the state are binding under current Medicaid rules. Medicare Conditions of Participation (COPs) applicable to settings such as long term care facilities, and hospitals may also impact reimbursement for services provided via telemedicine technology.
>
> Reimbursement for Medicaid-covered services, including those with telemedicine applications, also must satisfy Federal requirements of efficiency, economy, and quality of care. With this in mind, States are encouraged to use the flexibility inherent in Federal law to create innovative payment methodologies for services that incorporate telemedicine technology.

One of the most debated limitations of the U.S. federal telemedical services relates to the compensation for the real-time services only. This leaves out the most cost-effective "store-and-forward" applications.

One of the latest and very powerful trends in the evolution of telemedicine is the development of "home telehealth" or tele-homecare. It has been estimated that tele-

homecare will be the largest area of telehealth to drive the market in the next several years (25).

There are more than a hundred projects conducted around the U.S. aimed at the demonstration and/or implementation of such technology.

This development is also driven by reform of the financing mechanism of the home health care services in the United States toward so-called Prospective Payment System, which will provide a fixed amount of compensation for a patient visit. In such a fiscal environment, implementation of tele-homecare has a well-identified capacity to save up to 50 percent of costs of traditional home care.

The U.S. Balanced Budget Act of 1997 obliged the Secretary of Health and Human Services (HHS) to provide a demonstration project on application of high-capacity computing and advanced telemedical networks to improve primary care and prevent health care complications for Medicare beneficiaries with diabetes mellitus. The project was planned from 1997 to 2001 with the overall budget not exceeding $30 million. One of the major objectives of the projects is:

> Demonstrating the application of advanced technologies, such as video-conferencing from a patient's home, remote monitoring of a patient's medical condition, interventional informatics,[6] and applying individualized, automated care guidelines, to assist primary care providers in assisting patients with diabetes in a home setting (27).

This project will result in evaluation of the impact of advanced information and communication technologies on improving access, decreasing costs and improving the patient's quality of life.

Industry is investing increasing resources in the development of "point-of care" systems. American TeleCare developed a Personal Telemedicine System; H.E.L.P. Innovations is marketing the ResourceLink; HealthTech developed the HANC device (see below), etc. Despite differences in the design and cost of the equipment, all of these applications are increasingly used for the provision of tele-homecare.

The U.S. Food and Drug Administration has approved the first robotic device designed to deliver tele-homecare services. The Home Assisted Nursing Care (HANC) network consists of two units that are placed in the client's home and a central nursing centre (28).

[6] The term 'interventional informatics' was defined by the source as using information technology and virtual reality technology to intervene in patient care.

The device allows video-conferencing, monitoring of vital signs and educating a client in the use of assistive technology and disease management.

A recently published report, *Home Healthcare: Wired and Ready for Telemedicine* (1997) from the U.S. consulting firm Information for Tomorrow, suggests that there are considerable benefits in integrating tele-homecare services horizontally through the creation of networks that extend range of services and delivery areas (28). These benefits could include the following:

- automating service delivery, eliminating duplication and fragmentation;
- extending range of services and delivery areas, using technology that permits data transmission via telephone lines (e.g., remotely controlled automated infusion pumps);
- providing more frequent service to the patients; and
- achieving cost-savings (28).

A variety of published articles report that there is an acceptance of technology by many home care clients, including the elderly. Nevertheless, this technology is provided as a support mechanism for those clients who are clinically stable and have a positive attitude toward the use of tele-homecare. There are estimates suggesting that about 20 to 30 percent of home care patients could effectively use the tele-homecare applications in the United States.

CONCLUSIONS

1. There is a global trend of moving point-of-care closer to the patient and developing the patient-centred model of health care delivery.

2. Tele-homecare is expected to produce better outcomes while reducing costs of home health care services.

3. Many countries all over the world are conducting pilot, trial and demonstration projects to validate the quality outcomes and cost reduction benefits of tele-homecare.

4. Significant activity is under way in the development of the tele-homecare equipment, especially in the United States.

5. Tele-homecare is a logical integration of many existing services under a strategic umbrella aimed at vertical and horizontal integration of health care delivery.

6. Tele-homecare can enable expansion of home health care services into rural areas.

7. The experience of several countries shows that tele-homecare can be successfully incorporated within the primary care reform.

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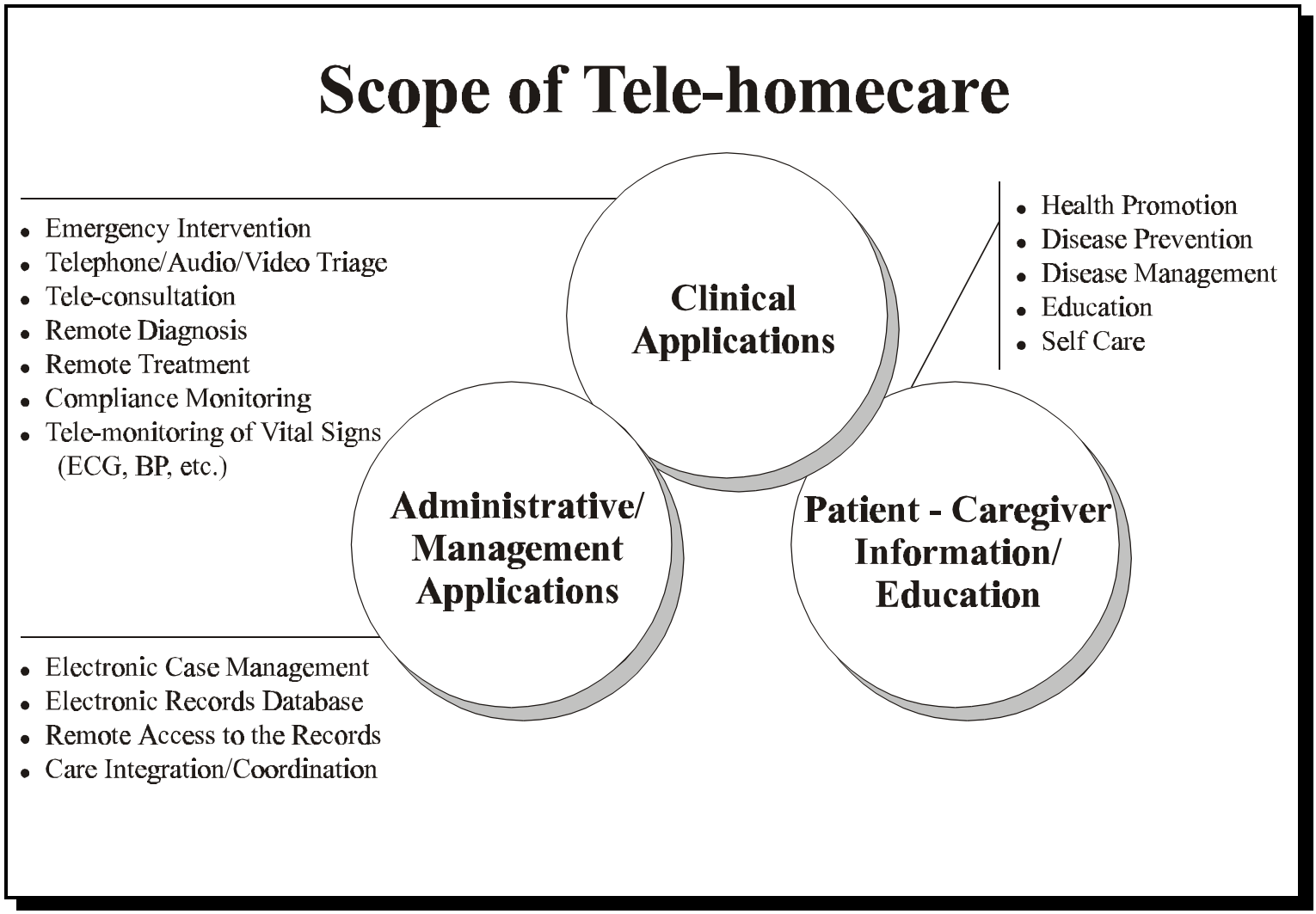
APPENDIX 1


Scope of Tele-homecare
Clinical Applications
Administrative/ Management Applications
Patient - Caregiver Information/ Education
• Emergency Intervention
• Telephone/Audio/Video Triage
• Tele-consultation
• Remote Diagnosis
• Remote Treatment
• Compliance Monitoring
• Tele-monitoring of Vital Signs (ECG, BP, etc.)
• Health Promotion
• Disease Prevention
• Disease Management
• Education
• Self Care
• Electronic Case Management
• Electronic Records Database
• Remote Access to the Records
• Care Integration/Coordination