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Technology Developments Applied to Healthcare/Nursing

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Abstract. Future technology developments as applied to healthcare and particularly nursing were discussed. Emerging technologies such as genetics, small unobtrusive monitoring devices, use of information and communication technologies are as tools to not only facilitate but also promote communication among all parties of the healthcare process. These emerging technologies can be used for ubiquitous healthcare (u-health). The role of nursing in the u-health is fundamental and required for success and growth. Nursing's role will evolve as nurses become 'information-mediators' in a broader-sense than current role. All technologies will ultimately focus on the consumer through 'behind-the-scenes' data collection, which in turn will also allow nurses to analyze these data to improve care. We need to acknowledge an increased presence and or pervasiveness of information technologies as key components of quality healthcare. This sort of acknowledgment will help propel nursing, and healthcare, to increase use of these tools. To develop nurses with these types of skills the nursing education process will require a fundamental change to integrate these technology-sorts of tools as necessary elements for success.

Keywords. Nursing informatics, future, nurse role, emerging technology, u-health

Introduction

Our international group – consisting of nurse leaders in informatics from Norway, USA, New Zealand, Finland, Portugal, and Korea – of International Medical Informatics Association – Nursing Informatics Special Interest Group (IMIA-NI SIG), was charged with examining the potential trends in health informatics focusing on technology and healthcare for the future at the Post Congress of NI 2006 (Ninth International Congress on Nursing Informatics). The continuing rapid developments in technology and the myriad of resulting possibilities prompted the IMIA-NI SIG to look forward to 2020. This report presents a summary of the group 1 discussions and conclusions. The focus was on emerging and future technologies and how these technologies could be utilized to provide healthcare in the future. Technology use will become ubiquitous,

being everywhere and part of everyday life. The changes in technology by 2020 will impact significantly on nursing practice, education, and research. A definition of ubiquitous nursing (U-nursing) is provided, along with discussion of several of the issues and challenges for nurses, the consumers of healthcare services, and the health services themselves, and the place of technology within healthcare.

Background

The Post Congress of NI 2006 was held in Pyung-Chang, Kangwon-do, Korea, in June 2006. The objectives of this meeting were to bring nursing informatics experts from different parts of the world together in a collaborative attempt to define the future nature and scope of nursing informatics.

This paper represents the report from a group charged to consider technology developments applied to healthcare and nursing. Using an analysis of major trends that are already emerging and possible developments over the next 15 years, the group explored technology developments in a broad sense. Here the technology developments are identified and discussed, along with their implications for healthcare and nursing, and the associated opportunities for strategic planning and research.

Technology Developments Applied to Healthcare and Nursing

The group discussed technology developments that will influence nursing services for direct and indirect patient care, disease prevention, and health promotion in both formal care settings and outside the hospital system. These developments included remote (e.g., wireless) monitoring, ubiquitous access to computer networks, lifelong electronic health records, wearable monitoring and treatment devices, and treatment-based genetics medicine. The group addressed questions such as: What effects will these technologies have on the practice of nursing and on nursing informatics? And what implications will they have for nursing education and training, and for organizations, providers, and patients?

Emerging Technologies

Emerging technologies do not automatically directly influence nursing and nursing informatics, but instead have a potential impact on future healthcare and nursing informatics. All healthcare professions now rely on advances in biomedicine and technology that influence the use of informatics in healthcare and nursing. Advances in some professional domains in turn influence other overlapping professions and domains, resulting in opportunities to leverage the

potential progress and development in healthcare informatics, and consequently nursing informatics.

Continuing advances in technologies will influence healthcare and nursing informatics, including advances in genomics, micro electromechanical systems (MEMS) and nanotechnology, wireless radio standards, information and communication technology (ICT), minimally invasive technology, and sensor technology.

1. Genomics

Recent knowledge advancements in genomics have led to a new understanding of genotypes and phenotypes. The methodology used to advance symptom treatment and the goal-oriented therapies to minimize consequences of disease are undergoing change. A new treatment paradigm with the objective of preventing disease before it occurs is based on screening the genetic makeup of population groups by identifying the genotypes and phenotypes of individuals. This will result in a shift to the prescription of therapy and medication based on the genetic makeup of an individual instead of assumptions based on results from similar groups of diseased individuals. This should reduce the occurrence of adverse events from medications and therapies since they will be better tailored to the individual's specific needs [1].

2. MEMS and Nanotechnology

MEMS and nanotechnology allows the dramatic downsizing of biomedical devices and machines. This can facilitate organ-specific parenchyma monitoring, replacing the current indirect monitoring of global parameters (e.g., blood pressure). Technological progress in this area presents the opportunity for introducing new types of biomedical sensors and biosensors. The functional elements of biomedical sensors are divided into four areas: sensors, computational processing units, communication devices, and batteries. All of these elements are undergoing rapid improvements, including reductions in size, which increases the opportunities for their use in clinical applications.

Nanotechnology opens the possibility of developing biomedical devices the size of molecules. This type of technology is still in the development stage, although research on nanotechnology in healthcare-related applications is expanding worldwide. Many risks related to the use of this technology have been identified, but overcoming them will increase the potential for the application of nanotechnology in healthcare [2].

3. Wireless Radio Standards

Wireless networks are based on radio communications at various frequencies. This technology has expanded the use of laptops, tablet computers, and tele-

phones in real-time worldwide communications. Improvements in processor computational power and storage size in personal digital assistants (PDA) and mobile telephones advance their potential applications as medical digital assistants (MDSs) in various clinical settings. Wireless network technologies include wireless local area networks (WLANs), Bluetooth, ZigBee, and radio-frequency identification (RFID) [3].

3.1. WLANs

WLANs operate at open radio frequencies around 2.4 GHz, and have industrial, science, and medical (ISM) uses. WLANs replace the need for physical connections between computers in zones defined by the capacity of the wireless signal routers. However, complex wireless infrastructures covering large areas such as hospitals are commercially available for clinical applications in a variety of fields, including nursing.

3.2. Bluetooth

Bluetooth is a wireless radio standard that also operates in the 2.4 GHz ISM band. Bluetooth was developed to replace wires between close-range electronic devices. Research performed on the implementation of Bluetooth in biomedical devices in clinical settings has produced positive results [4]. Bluetooth allows up to eight wireless devices to operate safely in an uninterruptible ad-hoc network. The cost of Bluetooth is relatively low due to its widespread use, although it has limitations related to power consumption and battery capacity.

3.3. ZigBee

Another wireless radio standard in the 2.4 GHz ISM band is ZigBee, which costs approximately one-tenth of Bluetooth and has a much lower power consumption. In theory ZigBee can handle up to 256 wireless sensors in one network. Moreover, sensors can operate in a “sleeping mode”, waking up to full operation when variables vary from predefined values [5].

3.4. RFID

RFID is another emerging technology with potential uses within healthcare. RFID tags can be placed on biomedical devices, equipment, and medications to keep track of their locations, expiry dates, and replenishment needs [6]. Wireless sensor networks allow large numbers of tiny wireless sensors to communicate in a network. Some claim that the impact of such networks over the next 10 years will be comparable to the impact of the Internet in the 1990s.

4. Information and Communication Technology

Both ICT hardware and software are improving. Computational power continues to increase, and the user-friendliness of human interfaces has improved in a wide variety of software applications due to improvements in their graphical and intuitive features. Combined with progress in wireless technologies, this will lead to new application areas for these technologies as they become increasingly potent, portable, and cheaper.

The Internet has had a major impact over the last 10 years on knowledge distribution within healthcare. This development has been largely driven by governmental institutions, universities, hospitals, and healthcare education providers. The second-generation Internet applications (Web 2.0) [7,8] are changing the traditional ways of communication between humans by reducing physical borders and by facilitating new ways of interaction and the availability of resources, such as newer collaborative Web-based server software applications accessed by browser clients, and blogs, wikis, and forums with content linked to relational databases for dynamic content retrieval [9]. Vendors have been working for decades to develop fully functional electronic patient records (EPRs) for replacing paper-based systems, but many of the current EPR systems are not still fulfilling the needs of clinicians. An important step towards replacing paper-based systems is improving the interoperability between hospital-wide applications, which has been hindered the use of proprietary software applications and the lack of international standards. The availability of structured health data improves interoperability between ICT systems, but the widespread integration of all applications is still a long way off in most hospitals. Hospitals and healthcare institutions are complex organizations, and there are no easy methods for digitizing all their clinical data. The process of information generation is based on data entry, interpretations of these data, and generating knowledge from the data so as to provide the information needed to support clinical decisions.

5. Minimally Invasive Treatment

Over the last 15 years percutaneous coronary interventions (PCI) have been performed on up to 70% of angina pectoris patients as an alternative to open heart surgery. Several procedures can be treated with catheter-based, image-guided radiological, and MRI-guided interventions, thereby reducing the treatment trauma imposed on patients relative to traditional open surgery. Videoscopic, minimally invasive procedures have been introduced in thoracic, orthopedic, gynecologic, and abdominal surgery to replace the traditional open surgery performed with much larger and more traumatizing incisions.

The use of videoscopic procedures not only reduces the length of the actual procedure, but also reduces the level of postoperative levels of pain and dis-

comfort, leading to more rapid mobilization and a shorter hospital stay for large groups of patients undergoing keyhole surgical procedures [10].

6. Sensor Technology

Sensors used in medical applications can be categorized into several groups. The first are biosensors containing biological materials such as enzymes or antibodies used in devices for detecting analyzed substances, which combines a biological component with a physicochemical detector component (see http://en.wikipedia.org/wiki/Biosensor). The development of biosensors for monitoring blood glucose is a growing field fueled by market demand and new areas of application thanks to the implementation of MEMS and nanotechnology.

The second group comprises biomedical sensors designed to measure physiological variables in the body, such as mercury/water-pressure sensors, piezoelectric and piezoresistive sensors, capacitance sensors, and optical sensors for use in near-infrared spectroscopy (NIRS) [11]. NIRS is a relatively new noninvasive optical technique for measuring hemodynamic responses. Biosensors and biomedical sensors have been used for decades for invasive or noninvasive measurements when attached to patients at the point of care, defined as the immediate surroundings of the patient's bed. Point-of-care data are used for patient assessment and decision support. The arterial and venous blood pressures, intracranial pressure, urine bladder pressure, body temperatures, and noninvasive variables such as the ECG and respiratory rate are continuously monitored in critically ill patients to facilitate optimal titration of therapy. Indirect measurements for determining organ-specific functions such as cardiac output or peripheral systemic vascular resistance are obtained using algorithms.

New sensors are smaller, less invasive, and provide data of a higher quality with a higher resolution. Another trend in sensor development is making direct, organ-specific measurements of early markers of severe ischemia and severe disease in vital organs, to replace indirect global parameters. Moreover, multiple sensors can be used to provide the most accurate description of the status of a severely ill patient. A spin-off from this development is the availability of new, high-resolution, and noninvasive sensors for use in home-care settings.

A distinction must be made between the following two major trends or areas in the development of sensors to secure the wellness of an individual: (i) personal biomedical sensors or biosensors attached to the patient or user, and (ii) sensors implemented in the surroundings of the patient or user (e.g., smart house). These two approaches represent very different conceptual and philosophical ways of developing sensors. The new and rapidly growing arena of sensor implementations is in patient homes. Sensors are less intrusive in the home environment when they are mounted in furniture, rooms, and architectural structures, or on other devices in everyday use by the patient. This use of sensors is growing due to market dynamics and potential commercial advantages. Such generic sensors are becoming miniaturized and increasingly inter-

operable with ICTs and wireless sensor networks. The cost of generic sensors for detecting temperature, movement, and pressure is decreasing due to increasing production volumes. When implemented in homes, such sensors can be used for the surveillance of people at risk and for the detection of activities with potential health risks.

The third area of sensor implementation is combining biomedical sensors and biosensors attached to the patient with sensors placed in the surroundings of the patient so as to facilitate optimal monitoring of the patient's health. Combining personal and individual environment sensors might yield the optimal benefits from technologies currently emerging in this field.

Use of Emerging Technologies in Healthcare

1. Health and Wellness Management

Genomics can be applied to prevent a disease in a predisposed individual based on their genetic makeup. Knowledge based on the individual's genotype (genetic makeup) and phenotype (the genetic interaction with the environment) can be used to determine the most appropriate interventions. This implies a shift away from treating symptoms related to disease, which is where the major resources of healthcare are allocated today, towards efforts aimed at preventing disease even before it occurs. Scanning of families identified as predisposed to various forms of chronic syndromes or diseases, or even scanning all individuals to identify their health profiles and risk for chronic disease, opens the possibility of completely new types of healthcare services. This shift of focus from ill patients to healthy people will result in changes in the organization of healthcare as well as to the professional roles in healthcare.

Another example of emerging technology use is the use of step counters with advanced software to provide feedback on energy consumption (e.g., calories), physical parameters progress, and the location or planning of future training activities to improve health. Future versions of such gadgets might include extension to monitoring variables aimed at preserving or even improving the health of consumers. This type of gadget can be utilized not only during physical exercise, but also in daily activities at home, school, and work. An infrastructure in various daily-life settings that facilitates the interoperability with wireless networks will allow the provision of new types of sophisticated healthcare services.

2. U-healthcare System

Unna Huh, president of the Information and Communications University, Korea, reported on the arrival of ubiquitous life (U-life), referring to Mark Weiser from Xerox during her keynote presentation at NI 2006. Weiser defined U-life

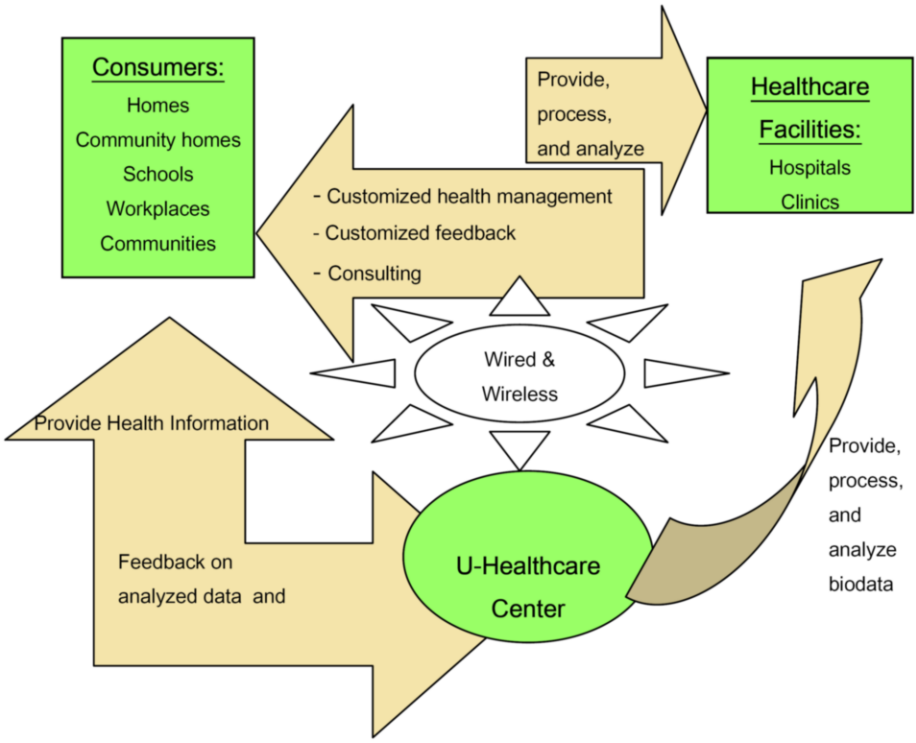

Figure 1. U-healthcare System (modified from Park et al., 2006).

in 1988 as where "anyone or any organizations can utilize an on-line networked computing environment any time, anywhere, through any networks and any devices". Extended use of ubiquitous computing for the wellness of consumers is dependent on planning and creating new business models by several global commercial organizations and industries within telecommunication, ICT, and insurance and governmental organizations at the local, regional, national, and international levels.

The IMIA-NI SIG came up with the model for describing a U-healthcare system illustrated in Fig. 1 based on the work of Park et al. [12]. The system consists of three components: the consumers, the U-healthcare center, and the healthcare facilities. A healthy person can live in a U-healthcare environment at home, at school, in the community, or at work according to where sensors monitor health-related data. Personal health information variables and data are transmitted to the U-healthcare center via the wired or wireless network infrastructure. The data are analyzed, processed, compared with the optimal profile of the individual, and stored at the U-healthcare center, which provides feedback to the individual based on the monitored data. If adverse events occur or symptoms of illness are detected, the consumer is contacted by employees of the U-healthcare center and assisted with correcting any problems. These em-

ployees are healthcare professionals (e.g., nurses) who are trained to assess and develop clinical pathways and individual care plans for consumers. If a consumer turns out to be unable to correct or comply with correctional activities related to illness symptoms, the U-healthcare center refers him or her to a healthcare facility, which can be a hospital, clinic, or other healthcare environment. When the healthcare facility discharges the consumer to their home setting, the individual's data can be monitored by the U-healthcare center until the condition has stabilized. The U-healthcare system thereby provides a closed loop of surveillance, supervision, and treatment, covering consumer needs related to the maintenance of wellness and health.

Scenarios for the Use of Emerging Technology

1. Scenario for Wellness Management at Home

Advances in ubiquitous computing and communication technology have enabled ubiquitous health monitoring at home. Here we consider a scenario involving health monitoring in a smart house that contains a smart toilet, kitchen, living room, and three bedrooms with different sensors measuring biomedical signals, activities, and environmental parameters in Seoul, Korea [13]. In the bedroom, ECG signals, body weight, body movement, and snoring can be measured using sensors in the bed. Activity is monitored using a magnetic switch attached to a door. Communication (via TV and entertainment centers) involving access to the personal EPR is used to establish and evaluate personal health goals. An exercise machine monitors vital signs and communicates with the EPR. RFID tags in the refrigerator are used to monitor the diet, provide nutrition recommendations, and indicate when food supplies need to be replenished. Several environmental parameters such as temperature, humidity, noise, and illumination are monitored continuously.

Unobtrusive health monitoring was possible in this smart house due to the use of a wireless communication infrastructure. A Bluetooth network is used to transfer data from the sensor to the Bluetooth access point, and a WLAN is used from the Bluetooth server to the home server. The WLAN comprises a PDA in each bedroom. In order to monitor several signals automatically and unobtrusively, the sampling rate and duration of measurement is set for each sensor using monitoring software. The ubiquitous-house project team intends in the future to add other sensors to measure body fat measurement, infrared sensors for movement detection, and humidity sensors.

2. Scenario for Illness Care at Home

One of the most promising visions of ubiquitous computing in healthcare is the unobtrusive at-home surveillance of patients with severe chronic disease, reducing the need for face-to-face medical visits or hospitalization. Here we con-

sider a scenario involving a patient with a severe chronic health problem – chronic obstructive pulmonary disease [14]. After the patient is discharged from an acute-care facility, he/she remains under continuous monitoring at home. Telemonitoring pulse oximeters are installed near the bed of the patient, who is instructed to place the oximeter sensor clip on one finger before going to sleep. Arterial oxygen saturation and heart rate are measured twice weekly, and the data are automatically transmitted early in the morning to the hospital's processing center via a normal telephone line, and stored in the patient database. On the same morning, a respiratory physician analyzes the transmitted data using software supplied by the manufacturer, and then telephones the patient to discuss symptoms and changes in prescriptions.

3. Scenario for Ambulatory Care at Hospital

Here we consider a scenario involving a patient visiting the ambulatory-care unit of a ubiquitous hospital (U-hospital). When the patient visits his doctor for hypertension management, he checks in by inserting his RFID card into an information kiosk in the hospital lobby, which provides directions to his doctor's office. When he enters doctor's office for his appointment, the doctor is ready with the patient's electronic medical record on his screen. The doctor examines the patient, orders some laboratory tests, and prescribes medications. Comments concerning possible interactions of a new prescription with an existing one together with some recommendations for an alternative are presented immediately on the screen. The patient exits the doctor's office and inserts his card again into one of kiosks, where he pays for his laboratory tests and medication orders, and makes an appointment for his next visit. He can transmit his medication order to a nearby pharmacist. The kiosk then directs him on where to go for his laboratory tests, and prints a prescription slip and appointment slip. After his test, he can go to a pharmacist, pick up his medication, and go home.

4. Scenario for Inpatient Care at Hospital

Here we consider a scenario involving a patient in a U-hospital. A patient suffering from angina pectoris admitted for a PCI. The patient is waiting for procedure to be performed. A personal-area-network gadget containing sensors is attached to the upper left arm, including an RFID tag for localization. Data from NIRS for monitoring blood glucose, peripheral arterial oxygen saturation and carbon dioxide, pH, electrolytes, ECG, BP, and peripheral temperature obtained ccontinuously from sensors are entered into the EPR. Appropriate data are extracted for decision support and reporting adverse events. A duty cardiologist (who is occupied with another patient) monitors the patient using a wireless MDS, obtaining his or her preferred information (requiring login with an authorization system based on biometrics).

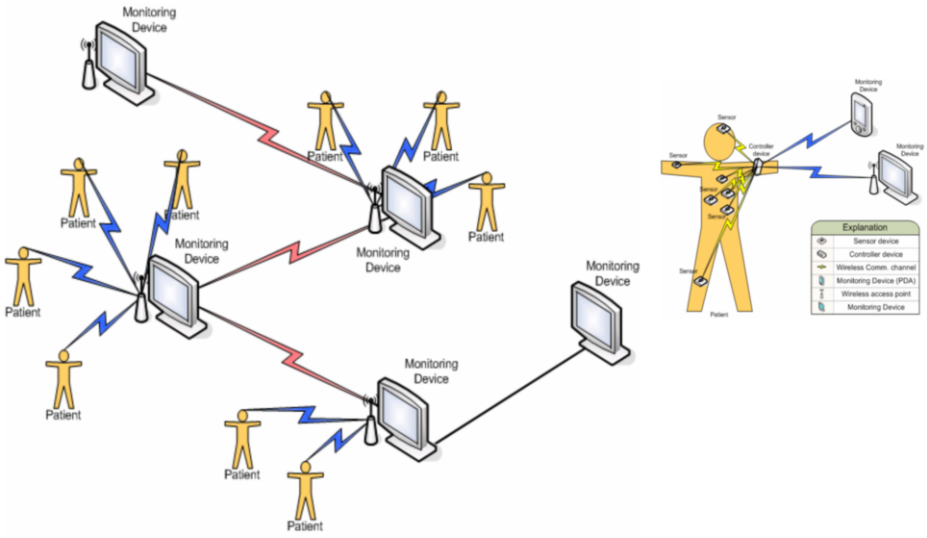

Figure 2. Wireless network infrastructure with sensor devices, controller devices, wireless communication channels, wireless access points, and monitoring devices [15].

Automatic medication, fluid, electrolyte administration (and other …) based on phenotype, genotype, laboratory and other data. All patients in the clinical care facility are monitored using infrastructure based on a wireless sensor network (see Fig. 2).

5. Scenario for Care at a U-healthcare Center

Finally, we consider a scenario involving a patient receiving care from a U-healthcare center. A patient with diabetes is discharged from a clinical care facility after bypass surgery. He lives in a smart house and wears a wristwatch gadget that has NIRS sensors for monitoring blood glucose, peripheral arterial oxygen saturation and carbon dioxide, pH, electrolytes, ECG, BP, and peripheral temperature. Sensors in chest and leg dressings can send message to the U-healthcare center when they need to be changed. An RFID-based medication cabinet monitors the use of prescribed medication and replenishment needs. The daily exercise program and diet is scheduled by a nurse at the U-healthcare center, and teleconferencing can be provided when necessary. Motion detectors that detect falls or the absence of movement will signal the U-healthcare center. The patient can participate in a chronic disease support/education group.

Sensor data transmitted to the U-healthcare center are processed, and any values outside the range are returned to the consumer with correctional suggestions. A communication system (voice-activated videophone) is also provided between the home and U-healthcare center.

Impact of Emerging Technologies on Nursing

1. U-nursing

As stated in Section 1, it is difficult to directly relate the general development of new technologies to progress in nursing and nursing informatics. Instead of new and emerging technologies directly bringing about change, they may influence other domains with their implementations resulting in novel areas of potential development.

Traditionally nurses are crucial to communications with the patient, by arranging the process of care and scheduling treatment from other professionals. Many nurses already use advanced ICT applications, but expanding their use could result in a variety of new outcomes in nursing. A major change has taken place within informatics related to communication, such as involving the Internet and e-mail. The wider use of EPRs and other hospital-wide applications has made nursing documentation even more important for describing the nurse's contribution to patient care, not only to other nurses but also to other healthcare professionals involved in patient treatment.

The group has proposed the following definition of U-nursing: "The provision of nursing for anyone or any organization, anytime, anywhere, through any networks and any devices". The results of an analysis of the possible strengths, weaknesses, opportunities, and threats (SWOT analysis) of U-nursing by the group are presented in Table 1.

The SWOT analysis identified many issues and challenges, and indicates the possible far-reaching consequences of U-nursing. Most significantly, we predict major changes to the traditional roles of nurses, patients, health services, and the place of technology within the healthcare system.

The nurse of the future will play a key role as an information mediator to facilitate the use of technology by consumers. The group has focused on the nurses' role and the education needed to develop the required knowledge and skills. It is recognized that current nursing education will not adequately prepare nurses for the envisioned future. Patients will be redefined as consumers, users, and partners in healthcare. The group agreed that the focus should be on consumers rather than on the technology, with consumers and health priorities driving technology developments. International trends of increasingly aged populations and increasing prevalence of chronic diseases mean that the consumers of the future will be older and more likely to have chronic diseases such as diabetes. Health services will be needed to support these consumers. However, an additional important focus will be on health promotion and maintenance to reduce the burden on the health services. Education and technology support provided to healthy consumers will focus on wellness, examples of which are described in Section, Scenario for Wellness Management at Home. In summary, we suggest that U-nursing will occur within an environment of new consumers, new services, new technologies, and a new understanding of nursing.

Table 1. SWOT analysis of U-nursing

STRENGTHS • Interoperability • Mobility • Portability • Availability of U-technologies • Secure infrastructure • Inclusive • Accessibility of information to consumers and providers of services • Globalization • Facilitate self-care • Customized/personalized care • Increased autonomy of consumers and nurses • Supports advancement of telehealth/telenursing • Provision of e-learning resources • User-friendly • Open source • International standards	**WEAKNESSES** • Lack of control of technology developments • Lack of technological literacy • Lag of educational preparation • Conservative attitudes and work processes in nursing and healthcare environments • Technology-driven • High setup costs • Limited human resources • Lack of standards • Time-consuming • Lack of reimbursement and backup infrastructure
OPPORTUNITIES • New nursing/professional roles • New roles for consumers • Consumer-driven services and technological advances • Improved decision support • Improved collaborations/partnerships – multidisciplinary – between providers and consumers – between nurses – across the continuum of care • New educational paradigms • Shift from disease management to health promotion and disease prevention • Facilitates middleware development • Humanization • Holistic • Facilitates research • Generation of nursing knowledge • Consumer-oriented care across the continuum • Public health surveillance facilitates collection and accuracy of data • Easy dissemination of information • Nurses promoting technology developments	**THREATS** • Poor affordability increasing the digital divide • Viruses and system breakdowns • Loss of privacy • Potential for misuse of information • Socioeconomic status of nurses • Leadership void in nursing • Lack of succession planning • Globalization • Dehumanization • Isolation • Dependency on technology • Intellectual property • Proprietary solutions • Cultural adaptation

2. New Nursing Services

The need for new nursing services is illustrated in Section 3, as exemplified by the U-healthcare system illustrated in Fig. 1. Nurses will be involved in all aspects of the U-healthcare system. The U-nurses will be health professionals running the U-healthcare center, whose role is to care for both healthy and ill consumers living at home. The U-healthcare center represents the linkage between clinical care facilities and consumers. Consumers discharged from a clinical care facility will be followed up by a U-healthcare center. U-nurses will also be employed at clinical care facilities, as they are in current healthcare institutions.

There will be several major changes from the current situation, with a much stronger focus on the consumer. The autonomy and integrity of the consumer will change as the emerging technologies provide new ways of dealing with health and illness. The shift of focus from illness to wellness will be very significant. The application of genomics will emphasize health promotion and disease prevention. This development is still at an early stage, but might lead to a different panorama of chronic disease. Wellness and health management systems involving emerging technologies facilitate new methods of self-care. The management systems will provide direct decision support to consumers in different ways. With a U-healthcare system established at the individual consumer level, wellness and minor symptoms of disease and even chronic disease could be managed by self-care without direct involvement from healthcare professionals. In this setting U-nursing might occur at a supportive, advisory level, more like wellness or illness coaching. Traditionally nurses are information mediators in healthcare, and such as role will not be unfamiliar to U-nurses. The differences relate to the use of technology-based systems for surveillance, observation, and data collection. ICT systems have the capability to act intelligently, in the sense that they can suggest interventions and provide decision support – especially when used with multiple data sets obtained from multiple biomedical sensors and other data sources, computers can provide high-quality clinical knowledge based on evidence-based analyses.

The market penetration, cost, ease of use, and general availability of communication tools have changed dramatically. Young and middle-aged people already have the required computer literacy and are familiar with these technologies, and distance and geographical borders no longer represent major limitations. Moreover, nurses already have professional platforms for handling patient information related to disease prevention and on how to cope with disease and its consequences. A major future challenge for the nursing profession is their involvement in the development of the new types of complex ICT-based services and infrastructures, whether funded by commercial entities or governments.

A fundamental role of nursing is caring for infants and the sick, weak, and old who are not able to secure their basic needs due to impaired or temporary

altered ability for self-care, and this will not change in the U-healthcare system. The manual, physical work associated with preparing, assisting, and compensating for impaired functioning in patients will remain an important component of the care provided.

3. New Nurses

Improvements in ICT and working at U-healthcare centers will require nurses to acquire new skills and knowledge. Indeed, emerging technologies represent a challenge for all healthcare professionals in terms of clinical practice, management, education, and research and development.

In many countries a major challenge in nursing education is recruiting sufficient students, due to the profession being perceived as an unattractive career choice. The theme of caring is not popular in young students when are choosing their studies. Nursing education has to promote why nursing is worth considering and pursuing, which can be aided by addressing the respect for the profession and the salary. Nurse educators are currently not eager to include ICT in their curricula, and there is even fear in the profession about the increasing influence of ICT. In contrast, many nurses are eagerly waiting for new technology solutions to enhance their capabilities. In the future, technology will be used in all healthcare settings (not only in critical care and operating rooms), and therefore all nurses will require technological skills. Nurse educators and expert nurses have a responsibility to help novice nurses to understand the role of ICT in nursing practice. Moreover, the use of ICT and medical technology in nursing practice might make nursing more attractive to students, given that currently nurses are currently restricted to learning how to manage information including evidence-based guidelines and how to apply this information in patient care in their workplaces.

Nurses in different care settings currently need different levels of technological skills, but in the future every nurse will need to be able to use ICT. Nurse managers will also need ICT skills to facilitate the optimal use of information produced by staff nurses. The systematic documentation of nursing activities using international standards is one way to increase the visibility of nursing. ICT will thereby support the work processes of nurses and adding value to nursing practice.

4. Need for Educational Change

The central requirements of nurses in the future are caring skills, nursing knowledge management, and skills to manage change and development[16]. Caring skills represent the core content of nursing, and there will be new emphasis on providing support for consumer self-care and promoting health; however, this aspect of nursing is unlikely to change radically. Nursing information and knowledge management – which covers technological skills and the use

and application of information – will be challenging in the future. The use of technical gadgets requires skills that can be learnt during practical work. The use of ICT must be closely and extensively integrated into the everyday practices of healthcare staff, since this supports the holistic care of patients. ICT will also be used to educate patients and in nursing documentation. Managing changes and developments also requires social and cooperation skills, with the relationship between consumers and nurses becoming more equal as consumers receive more comprehensive information.

Nurses searching for new evidence for use in professional decision-making or when answering consumer questions about information they obtain from the Internet will need to be computer literate. This involves a new role for nurses as facilitators of the use of ICT by consumers. The role of the patient will in future turn to the role of consumer who will be more active and have much more information and knowledge of diseases and related factors than today. Nurses will need more information and new skills when interacting with this type of consumer.

Conclusion

The group has speculated on how emerging and future technologies can be used to provide healthcare in the future. ICT will become ubiquitous in nursing, and the group has considered how developments in technology will affect the practice of nursing and nursing informatics. These developments may influence many aspects of healthcare, including in terms of genomics, MEMS, nanotechnology, wireless radio standards, ICT, minimally invasive technology, and sensor technology.

Emerging technologies will be used for both healthcare and wellness management. A model of a U-healthcare system has been developed that consists of the consumer, the U-healthcare center, and the healthcare facilities. Wellness will be the primary focus at both home and work, with healthcare services for those who are ill being provided at both home and in clinical care facilities.

U-nursing will focus on the provision of nursing for anyone or any organization, anytime, anywhere, through any networks and any devices. A SWOT analysis delineated many issues and challenges of using technologies to support nursing practice. The future role nurses will center on facilitating the use of technology by consumers and supporting information exchange. The need for new nursing services has been discussed with the accompanying need for changes to nursing education. Technology will drive healthcare and nursing, and in turn nursing has the opportunity to channel the technology to provide higher quality, evidence-based healthcare.

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