Impact of Information Technology on Human Resources in Healthcare

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Incorporation of advances in information communications technology (ICT) into the workplace has had a major impact in human resource utilization in sectors of the economy where it has occurred in a substantial manner, such as manufacturing and financial services. While some benefits of ICT have been realized in healthcare, the full impact of its benefits will only be realized if it is incorporated in a systematic form, rather than in the current patchy and uneven manner seen around the province and across the country to date. Furthermore, provincial governments are dedicating significant financial resources in aligning some of these ventures, such as electronic medical records and digital, filmless imaging systems. However, there is significantly more to be done as healthcare finally embraces information technology and recognizes the full force of its impact in the next two decades. For the purpose of this discussion, I analyze the impact of information technology on human resources in healthcare but do not discuss the necessary component of planning for infrastructure, which has to go hand in hand with this conversation.

Advances in technology will likely impact on healthcare human resources on three separate thrusts:

1. Changes in efficiencies brought about at local institutions leading to the removal of some positions and creation of others
2. Changes in types of medical care provided, such as gene therapy and minimally invasive interventions, which will have an impact on shifting of medical healthcare professionals from one subspecialty to others
3. Decentralization of the healthcare delivery system, which will shift significant resources from tertiary care facilities to primary and community care institutions and home healthcare

Each of these areas is discussed in more length below, but clearly a detailed review of changes brought about for further incorporation of advances in information technology to healthcare is outside the scope of this summary.

Efficiencies Brought about at Healthcare Institutions

Most healthcare institutions have already realized some efficiencies by incorporating aspects of ICT, such as institutional electronic health records and picture archiving and communication systems (PACS) for digital imaging. However, in most institutions around the country, ICT is still in its rudimentary stages. Only partial electronic health records exist, and most institutions still rely heavily on paper reports and charts. During the next decade, we will undoubtedly see the development and deployment of comprehensive electronic health information systems incorporating all aspects of in-hospital and out-of-hospital care.

These systems will allow health providers at all levels to access information quickly and share information, improving both patient care outcomes and operational efficiency. Health information technologies that we can expect to see implemented over the next two decades include the following:

- Electronic lifetime health records will store data from many sources (e.g., text and voice notes, medical images, laboratory values) and be accessible from any locale, providing seamless care for patients and reducing expensive duplication.
- PACS will capture, store and provide access to diagnostic images (x-ray films, magnetic resonance images, computed tomography scans) from any location.
- Radio frequency identification (RFID) systems will use radio waves to wirelessly track hospital patients, and microchips to carry information on medications, laboratory tests, imaging studies and medical devices.
- Automated systems will track and manage inventories of pharmaceuticals and other medical and general hospital supplies.
- Decision support systems will give healthcare providers real-time advice on diagnosis and treatment options based on continuously updated information.

As hospitals implement the technologies described above, they will be able to improve the quality of patient care by streamlining processes, reducing duplication and minimizing the risk of medical errors, such as administration of the wrong drug or dosage or even the performance of a wrong surgery. According to a 2003 study of medication errors in pediatric settings, 76% of all errors could potentially be avoided if a computerized provider order entry system were used (Potts et al. 2004). One US hospital that has made the move to a "paperless environment" estimates that they have reduced transcription by 65% and charting by 85%, meaning that healthcare providers have more time for patient care due to lighter administrative loads (Hancock and Groff 2000). Electronic communication between organizations means that health providers will be able to access health records and other data at the point of care, providing patients with more rapid and effective healthcare. Health information databases will also facilitate research by providing a more effective means to collate and evaluate medical data, thus enabling a shift toward evidence-based medical care.

Scenario: A patient is scheduled to have surgery for colon cancer (right hemicolectomy)

Present day: The patient is seen in the preoperative assessment unit, where he undergoes a long list of tests and gives a complete medical history. The only information in his paper chart is what was collected during previous visits to this particular hospital. On the day of surgery, he reports first to pre-assessment and then to day surgery. He is given a paper identification (ID) bracelet with only basic information such as his name and hospital ID number. From there, he is transferred to the holding area and subsequently to the operating room. At each step along the way, someone takes a partial history and reviews and confirms the details in his paper chart. His preoperative and post-operative orders are written out by hand by members of the surgical team and entered into his chart, which must be physically transferred with him each step along the way.

In the future: The patient arrives at the hospital and receives an RFID, which provides a link to his electronic health record containing his complete medical history, including access to all laboratory values and imaging studies, regardless of where they were completed. His history is updated and a limited preoperative assessment is performed (only those tests that need to be updated). Basic tasks (taking temperature, blood pressure, etc.) are performed by semi-automated robotic devices. As the patient moves through the preoperative process, his RFID tracks his location and provides instant access to his electronic health record. There is no need to retake his history or confirm his information at each step along the way. Many of his preoperative and post-operative orders are generated by an automated system based on the information in his health record (including known drug interactions) and are confirmed or approved by the surgical team.

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From a human resources point of view, some of the implications of the above technology will be the following:

- There will be a need for increased training in the use of information technology for all healthcare professionals.
- There will be an elimination of a number of clerical and other "low-tech" positions.
- There will be a dramatically increased need for health informatics specialists (with both medical and non-medical backgrounds) trained specifically to meet the complex ICT needs of healthcare organizations, including (1) the management of electronic databases; (2) the development and maintenance of systems that provide universal standards or access; (3) the development and support of clinical decision support systems; and (4) the supervision of access to data from both a database security standpoint and a medical ethics standpoint

(monitoring access for such purposes as quality assurance, assessment of outcomes and disease surveillance).
- An overall shift will occur within the healthcare industry toward positions requiring more education and training and commanding higher salaries, which will be funded through cost savings made possible by reducing waste, repetition and costly medical errors.

The composition of the healthcare team will also change as ICT plays an ever-increasing role in medical care. It is anticipated that automated systems may obtain and update patient histories and perform certain basic elements of the physical examination. It is also expected that there will be an increased role for non-physician healthcare providers, who will be capable of simple diagnoses and treatments with the aid of clinical decision support systems. They will also likely assume an increasing responsibility for many other functions such as prophylactic care, public health, patient education and patient support. Smaller numbers of physicians will be able to oversee the care of larger numbers of patients with the aid of real-time clinical data and two-way telecommunications systems. Such systems have been used successfully in the intensive care setting, enabling specialists to remotely monitor the status of patients at multiple intensive care units (Breslow et al. 2004). Some experts have speculated that physicians will assume more specialized roles as medical care becomes increasingly dependent on technology, and that patients will only see physicians for "high-tech" specialty care.

Shifting Directions in Medical Care

ICT, together with other advances in medical technology, will undoubtedly have a major impact on the nature of medical care provided for a wide range of medical conditions over the next two decades. Advances in genetics, proteomics, robotics, nanotechnology, biomaterials and biophotonics are expected to dramatically change the ways in which we diagnose and treat illness. The following is a brief summary of some of the major technological advances we can expect within the next 20 years:

- Improved medical and surgical robotic systems that will allow for the performance of more precise and technically challenging procedures, less invasive surgical procedures (smaller and fewer incisions), pre-programmed tasks and real-time intraoperative imaging
- Advanced imaging techniques that will identify pre-cancerous cells, and imaging systems that will be used to target treatments specifically to diseased tissues (e.g., cryotherapy for cancer treatment)
- Implantable or wearable sensors for continuous monitoring of patients with chronic conditions such as diabetes and heart or kidney disease
- Genetics testing, not only for diagnosing disease, but also for identifying individuals at risk for developing diseases, and eventually providing customized genetically based preventive medicine
- Gene therapy – including protein replacement therapy, replacing defective genes with normal genes and introducing genes to increase immunity to a disease (e.g., genes that slow or prevent tumour growth)
- Pharmacogenomics – the use of genetics information to predict adverse drug reactions or to develop targeted drug therapies based on specific gene function
- Novel biomaterials, including tissue substitutes and fully functioning artificial organs (e.g., artificial pancreas for treating diabetes)
- Micro- and eventually nano-scale robots capable of carrying out diagnostic and even surgical procedures within body cavities
- Nanoparticles capable of travelling through the body, detecting disease and targeting cancer cells for drug delivery or repairing damaged tissues

These developments in the way in which diseases are detected and managed are expected to bring significant changes to the healthcare teams of the future. Many of the new technologies described above will create the need for multidisciplinary treatment teams that include experts in bioengineering, biomaterials or genetics technology. For example, the use of novel implants and replacement tissues or organs will require ongoing evaluation of their function using imaging, biosensors and so on. The formulation and dispensing of pharmaceuticals will also become increasingly complex as we move toward the use of drugs that are targeted to specific tissues or customized for each individual patient. Within the operating room, the use of robotics will likely change the operating team by reducing the need for surgical assistants. However, as the use of real-time imaging during surgery and other treatment increases, imaging specialists will become key members of the operating room team and will take on a larger role in patient care. The use of these technologies will also lead to surgical procedures that require smaller and fewer incisions, resulting in a shift away from procedures requiring extended hospital stays toward more short-stay and outpatient procedures. Consequently, we can anticipate that hospital stays following surgery will be shorter, or even non-existent, resulting in changes in human resource requirements within the hospital system. Similarly, the use of remote sensors to monitor patients with chronic diseases, or even to follow those at risk for developing certain medical conditions, may substantially reduce the number of visits to healthcare providers.

The increasing use of genetics technology, both to diagnose diseases and to treat them, will create a need for a variety of experts in this area. It is vital that genetic screening be delivered

to patients as a comprehensive package that includes counselling and support, testing, quality control and surveillance or treatment. As a result, there will be a dramatic increase in the need for geneticists, genetics counsellors and genetics technologists – all highly trained personnel who are currently in short supply. Genetic screening will also create a need for decision support resources, both for healthcare providers who need to understand which tests to offer and for patients who need to decide which tests to undergo. The use of widespread genetic screening for predicting which individuals are likely to develop certain medical conditions will also generate an increased need for professionals to help patients deal with the psychosocial implications of discovering that they have an increased risk of developing a certain disease.

Decentralizing the healthcare system

will create a significantly expanded role for community physicians, nurses and healthcare professionals. By enabling them to do more, we make the jobs more attractive and increase recruitment and retention in the remote parts of the country.

Decentralization of Healthcare

Since the Second World War, provincial and federal governments have actively invested in centralizing healthcare for the specific reason that, with emergence of new capable technologies such as computed tomography and magnetic resonance imaging, there were not adequate resources to make this equipment available in all hospitals. Consequently, it was decided to house these in the large tertiary care hospitals, requiring patients to travel or be transferred for treatment. Secondly, persistent shortages of highly trained specialists also created the need to concentrate these experts in the same tertiary centres. The result of these decisions has been an increasing reliance on tertiary care hospitals to provide advanced medical care to Canadians living in both urban and rural parts of the country. With increasing advances in medical care in all specialties, this has led to a vicious cycle of increasing reliance on tertiary care and a reduced capability of community institutions to offer comprehensive care to local patients. This has resulted in increased wastage of funds through patient transfer between institutions, increased wait times, significant loss of productivity at work and so on.

With full incorporation of information technology, including telecommunications and robotics, we are now at the stage where we can look at decentralizing healthcare and allowing community institutions to offer a wider array of more complex medical and surgical and diagnostic care to their patients (Anvari 2005). In the new model, patient transfer is replaced by the transfer of medical expertise from one centre to another. We have already seen what technology can allow us to do, such as performing delicate surgery on a remote patient in a community hospital using the right marriage of telecommunications and robotics technology (Anvari et al. 2005). While this technology is still at the experimental phase, progress to date shows us a glimpse of what information technology can bring. We can readily envision the following possibilities:

- Nurse practitioners in small communities will be able to do more in diagnostics, medical care and even minor surgical care with assistance of appropriate medical supervision and assistance through telecommunications and robotic connectivity.
- Family doctors will soon be able to perform a variety of minor surgeries, and community surgeons will be able to perform a variety of complex advanced surgeries with the aid of this technology.
- Patients living in rural and remote regions will be able to be treated within their communities, reducing or even eliminating the need for patient transfer, reducing the wait times at tertiary hospitals and shifting the burden of care back to the primary care and community setting.
- Specialized services such as pathology and radiology will become more consolidated at major centres, with specialists providing their expertise to smaller healthcare centres in rural areas through telemedicine programs.
- New sensor technology, in combination with telecommunications technology, will allow patients with chronic conditions to be monitored and even treated from home or from community care centres.
- Easy access to quality medical information and decision support information online will enable patients to take an increased role in maintaining their health and even managing disease.

Decentralizing the healthcare system will create a significantly expanded role for community physicians, nurses and healthcare professionals. By enabling them to do more, we make the jobs more attractive and increase recruitment and retention in the remote parts of the country. We also reduce the increasing burden of care at the tertiary care centres and thus reduce wait times. Without such a major shift in healthcare strategy, we will continue to experience increasing wait times despite spending more and more of our gross national product in healthcare, as this is a vicious cycle fuelled by increasing shifts of reliance on a few tertiary care hospitals.

Conclusion

As healthcare finally embraces information technology in its full scope, we can expect to see significant changes in human resources brought on by efficiencies at the local level, which will

lead to decreased needs in administrative areas and increased needs in medical informatics and other specialized areas. Changes in patient care teams will be seen as a result of dramatic developments in the types of medical care we provide, which will necessitate changes in direction and training. Finally, the shift in where patients receive their care – at home and in the community setting, rather than in big tertiary hospitals – will lead to a geographical shift in healthcare professionals from big cities to community and rural settings, as well as to changes in the roles played by professionals at all levels and in all types of healthcare organizations. HQ

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References

Anvari, M. 2005. "Reaching the Rural World through Robotic Surgical Programs." *European Surgery* 37(5): 284–92.

Anvari, M., C. McKinley and H. Stein. 2005. "Establishment of the World's First Telerobotic Remote Surgical Service: For the Provision of Advanced Laparoscopic Surgery in a Rural Community." *Annals of Surgery* 241(3): 460–64.

Breslow, M.J., B.A. Rosenfeld, M. Doerfler, G. Burke, G. Yates, D.J. Stone, P. Tomaszewicz, R. Hochman and D.W. Plocher. 2004. "Effect of a Multiple-Site Intensive Care Unit Telemedicine Program on Clinical and Economic Outcomes: An Alternative Paradigm for Intensivist Staffing." *Critical Care Medicine* 32(1): 31–8.

Hancock, G. and P. Groff. 2000. *Information Technology, Health and Health Care: A View to the Future* (Discussion Paper No. H/02). Ottawa: Canada Policy Research Networks. <www.cprn.com>.

Potts, A.L., F.E. Barr, D.F. Gregory, L. Wright and N.R. Patel. 2004. "Computerized Physician Order Entry and Medication Errors in a Pediatric Critical Care Unit." *Pediatrics* 112: 59–63.

Bibliography

Davey Smith, G., S. Ebrahim, S. Lewis, A.L. Hansell, L.J. Palmer and P.R. Burton. 2005. "Genetic Epidemiology and Public Health: Hope, Hype, and Future Prospects." *Lancet* 366: 1484–98.

Ellis, D. 2004. "What If … The Consequences of Innovation." *Hospital and Health Networks* 78(8): 38–42.

"Information Technology in Health Care." 2004. In: *Report to the Congress: New Approaches in Medicare.* <www.medpac.com/publications>.

Mohan, J. *Hospitals without Walls.* Paper presented at eHealth Asia 2004. <www.ehealth.org.my>.

US Department of Health and Human Services. 2005. *2020: A New Vision: A Future for Regenerative Medicine.* Washington, DC: Author. <www.hhs.gov/reference/newfuture.shtml>.

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