# IMAGING-1

## IMPACT OF ADVANCES IN IMAGING TECHNOLOGY ON HEALTH CARE

### HISTORY

The first dawning rays appeared quite literally just before the beginning of the 20th century. In 1895 a German physicist named Wilhelm Conrad Roentgen accidentally discovered a form of radiation that could penetrate opaque objects and cast ghostly images on a photographic plate. Roentgen called his discovery X-radiation (the X was for "unknown"), and to prove its existence he took a picture of his wife's hand by exposing it to a beam of its rays. The result showed the bones of her hand and a ring on her finger as dark shadows on the photographic plate. It was the first x-ray image ever deliberately recorded.

The rays were soon identified as a form of electromagnetic radiation with wavelengths very much shorter than those of visible light. The shortness, or high frequency, of these wavelengths accounted for their penetrating power; their ability to delineate internal structure came from the fact that denser materials, such as bone, absorbed more of the rays. An American named William Coolidge soon put all this to practical effect with his 1913 invention of a vacuum tube that conveniently and relatively safely generated X rays. Medical doctors quickly seized on this wonderful new tool that enabled them to see, for example, how a bone was broken, or where a bullet might be lodged, or whether a lung harbored potentially lethal growths. A new field of diagnostic and later therapeutic medicine, radiology, was born. X rays also found their way out of the doctor's office and into the industrial world, where they were used to check for hidden cracks or other flaws in complex machinery and in structures such as bridges.

Medical imaging uses state-of-the-art technology to provide 2- or 3-dimensional images of the living body. Imaging studies can diagnose disease or dysfunction from outside the body, providing information without exploratory surgery or other invasive and possibly dangerous diagnostic techniques. Radiography uses radiation to produce 2-D images (x-rays) or 3-D scans (CT). 3 D Images can be manipulated with software to provide views from any angle. Magnetic resonance imaging (MRI) uses magnetic fields rather than X-rays to produce 3-D images. Ultrasound uses sound waves to produce images of the interior of the body. Nuclear medicine uses the energy from small amounts of radioactive "tracers" that have been introduced into the body to produce both 2-D and 3D images that reveal biological functioning.

## DEVELOPMENT

Imaging has developed as a critical element of patient diagnosis and treatment. Indeed, in many ways, imaging has become the heart of any treatment modality. A look at the evolution of imaging from the traditional imaging department to today's fully digital department reveals major changes in key characteristics of these facilities. The story behind these new sorts of vision and imaging encompasses a wide range of fields, from astronomy to medicine, each with its own century-spanning plot line. Narrative threads intertwine along the way, with discoveries in one field contributing decades later to applications in another. The one common theme is how we turned new knowledge into tools that have improved our lives by changing how we see.

In addition to technology, planning and design of imaging facilities must take into account staffing and patient care. Shortages of qualified physicians, nurses and technologists have heightened the need for health care facilities that aid in recruitment and retention, as well as enhancing productivity.

Both outpatient and inpatient hospitality levels are expected to be higher today than in the past, and there is a growing need for sophisticated diagnostic and treatment services. At the same time, patients are also very educated and have latest knowledge acquired because their hope for a better quantity and quality of life wanders around the corner of every Google search. Patients are becoming conscious health care consumers who demand state-of-the-art care, good communication and a comfortable environment. Facilities are being designed to enhance patient care and comfort at the same time they reduce facility operational costs and improve staff productivity. Facilities must also be planned and designed for maximum flexibility. That is, they must be able to accommodate future changes in patient care models and imaging equipment, both economically and without significant disruption of operations.

Advances in imaging technology and patient care models have had significant impacts on health care facility planning and design. In many ways, radiology and related services are the heart of today's hospital. With capital construction costs a small percentage of a health care facilities' operational costs, planning and designing for maximum flexibility is a must.

These issues have a significant impact on the planning and design of diagnostic imaging facilities. The design should take into account opportunities to geographically consolidate equipment and personnel into one area, while separating inpatient and outpatient traffic. This approach creates space and staffing efficiency, while preserving the optimal environment for infection control and the overall comfort, privacy and well-being of patients. The public side of the diagnostic radiology service is a dedicated registration area, central viewing room and consulting rooms. The outpatient waiting area can be shared with other adjacent services for space or staffing efficiency. A separate dedicated inpatient holding area should be provided to avoid holding patients on gurneys in the hallways, which compromises their privacy, or in recovery areas, where they may become anxious viewing other recovering patients.

Diagnostic imaging procedure rooms should be organized around a central work core that contains digital processors, technical work areas, offices, supply rooms and the like. This area will provide staff access to procedure rooms and back-of-house support areas. The design is derived from a clustered "operating room clean core" concept, in which a central clean and work core is surrounded by radiology procedure rooms, other invasive procedure rooms and operating rooms. Visibility between work areas is essential to support efficiencies and patient safety. A multifunctional pre- and post-procedure unit, or observation unit, should be easily accessible for acutely ill outpatients and those who are being prepped for or recovering from more invasive diagnostic procedures.

Procedure rooms should provide maximum flexibility for various procedures. Standardizing the size and collocating similar rooms offers flexibility with minimal construction costs and downtime. Similarly, soft space should be strategically located so it can easily be converted to procedure rooms if needed.

Radiology rooms have special requirements, including a minimum floor-to-ceiling height of 9 feet (ideally, 9 feet, 6 inches), structural systems designed to carry appropriate equipment loads and appropriate radio-frequency clearances. For example, MRI equipment has special construction requirements, including a path of transport that can handle the load during delivery and installation. Open MRI requires larger radio-frequency clearance. Radio-frequency procedure rooms require proper shielding for radiation protection. Specialty rooms and CT should be equipped for telemetry monitoring. There should also be provision for medical gases for acutely ill patients.

The reading area should be configured to allow for multidisciplinary teamwork, except for angiography and neurology, which have different equipment requirements. High-quality, remote viewing locations should be provided within the service and throughout the facility, including nursing units. Universal access for data and image retrieval is crucial. Indeed, technology is critical for the highest level of patient care and to be as operationally efficient as possible. In fact, it is advantageous to include IT directors in planning.

Facilities also should maintain separate and yet efficient flows of patients, staff, equipment and materials. The first priority is to minimize patient movement by locating high-volume procedure rooms closest to access points. There should be easy patient elevator access into the service area, as well as separate trauma elevators.

There should also be effective, convenient flow of staff and materials from procedure rooms to processing, sorting, viewing and filing areas. Equipment and supply storage areas should be easily accessible to staff. Portable machine and stretcher and wheelchair storage areas should be located so that equipment is secured and convenient for easy transport to and from other areas of the hospital.

Over the last two to three decades, the demand for imaging services has blossomed at an unprecedented rate. New modalities have either been introduced as in magnetic resonance imaging (MRI) and positron emission tomography (PET) or significantly improved as in computed tomography (CT) and ultrasound (US). The increasing sophistication of cross-sectional imaging with very rapid development and integration of interventional radiology into the clinical arena has had a dramatic impact on patient care. The imaging specialist now faces a remarkable transition in his/her work environment.

Digital data and technology have revolutionized the imaging field. The electronic acquisition, interpretation, transmission and storage of image data has not only increased access for patients but also benefits their referring physicians. Imaging interpretations are available earlier and more readily, and there is almost instantaneous access to these examinations on their office computers.

## WORKING & DESCRIPTION OF VARIOUS IMAGING MODALITIES

Due to population aging, over the next 4 to 10 years there will be a marked increase in the number of individuals over 65 years of age. Accordingly, there will be an increase in the number of patients presenting with the three leading causes of death: cardiovascular disease, cerebrovascular diseases and malignant neoplasms. These patients will require imaging for screening, diagnosis, staging and treatment. What follows is a more detailed description of the imaging procedures often used in cardiovascular and cerebrovascular diseases, and the most common cancers.

Cardiovascular diseases: The most important need is the detection of coronary artery atherosclerotic disease revealed as coronary calcifications and coronary artery stenosis, with emphasis on non-invasive procedures such as CT and MRI. Equally important is the study of the impact of coronary occlusive disease on heart perfusion and function as measured by heart contractility and output of blood. Again, the emphasis will be on the use of non-invasive procedures such as ultrasound, MRI and radionuclide imaging (nuclear medicine).

Multi-detector CT now offers high resolution imaging and rapid studies of coronary artery calcifications. Cardiac MR has also progressed significantly over the last few years. Research continues on coronary angiography using contrast administration. At the same time, morphologic and functional evaluation of the myocardium is now possible using MRI, and includes perfusion studies with new contrast agents and the determination of regional and global contractility as well as cardiac output, particularly using machines designed for cardiac applications .

Cerebrovascular diseases: Disease of the blood vessels supplying the brain is associated with high morbidity and large costs to the health care system. Efforts will be directed not only to accurate, non-invasive detection of cerebral occlusive disease but also to early, efficient and safe treatment of this disease. Detection of carotid and vertebral artery occlusive disease will be performed with non-invasive procedures such as Doppler ultrasound and MR angiography. In addition, imaging procedures will be required to assess the effects of chronic cerebrovascular occlusive disease on brain parenchyma with functional MRI procedures such as brain perfusion studies. Results of these studies will be useful for choosing the appropriate revascularization procedure to treat the disease.

Diagnosis and management of stroke is another important and increasing need. Emphasis will be on early detection, speedy diagnosis and triage, followed by treatment with neuroprotective or thrombolytic agents. CT and MRI will be the main imaging procedures in acute stroke and will include both morphological and functional assessment of the brain. Quantification of the amount of reversible and irreversible parenchymal brain damage will be required together with morphological studies of the blood vessels involved.

Cranial MRI is an example of an imaging method now providing a comprehensive evaluation of the brain. Stroke imaging protocols have been developed, including standard pulse sequences, for the evaluation of morphology; diffusion and perfusion pulse sequences to evaluate ischemic penumbra; and MRI angiography to evaluate blood vessel patency. The addition of magnetic resonance spectroscopy (MRS) allows study of brain metabolites in life. Stroke imaging with MRI is an example of a new imaging method that provides added value and with qualitative and quantitative data on morphology and function. It is a consequence of technological innovation and results in improvements in medical treatment and outcomes. Accurate detection of carotid artery stenosis is now possible with MRI following development of new and faster pulse sequences used with contrast injection. Both morphological and functional evaluation of the brain are possible during the same examination with standard diffusion and perfusion pulse sequences.

Neoplasms: The most common malignant neoplasms causing death are those of lung, colorectal, prostate and breast. Diagnosing, staging, and re-staging of cancer, as well as the planning and monitoring of cancer treatment, have traditionally relied heavily on anatomic imaging with computed tomography (CT) or magnetic resonance imaging (MRI). These anatomic imaging modalities provide exquisite anatomic detail and are invaluable, especially for guiding surgical intervention and radiotherapy. However, they do have limitations in their ability to characterize tissue reliably as malignant or benign. Efforts will be directed towards screening of individuals at risk, early detection and staging, as well as monitoring treatment response. Demographic changes will increase the number of individuals at risk for some malignant neoplasms, particularly colorectal cancer. Imaging already has an important role in screening for breast cancer. It will also have a central role in screening for colorectal cancer. Once cancers are detected, imaging will be used for follow-up and to monitor treatment effectiveness. In addition, new treatments, such as cryotherapy and various forms of thermal tissue ablation (laser, radiofrequency, focused ultrasound) are being developed and will use imaging techniques for accurate guidance of the delivery of these tools to destroy cancers 11.

Staging of cancers will rely on CT, MRI and, increasingly, positron emission tomography (PET). Examinations of tumour biology and tumour response will depend upon innovations in radiopharmacy and/or functional MRI .The impact of medical and technological changes on imaging procedures used in screening and treating cardiovascular and cerebrovascular diseases and common malignant neoplasms is substantial. Advances in medicine now require the availability of highly accurate yet non-invasive imaging procedures that will give qualitative and quantitative information on morphology and function. Indeed, as in heart disease, it is often technological change that drives changes in practice.

A long-standing goal of health care is the early detection of disease, when it is more readily treated. But screening tests have to be very sensitive, be performed at low cost and be readily acceptable to patients. Mammography is the only imaging procedure used extensively in this context at present. Image reconstruction methods have been developed to permit virtual bronchoscopy and virtual colonoscopy and similar methods might be applicable elsewhere in the body. Such methods, by replacing physician intensive contrast studies or endoscopy, might be applicable to new screening initiatives. Equally, technical change such as the replacement of chest radiography with spiral CT, subject to cost effectiveness studies, might favourably change the early diagnosis of lung cancer.

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Digital data and technology have revolutionized the imaging field. The electronic acquisition, interpretation, transmission and storage of image data has not only increased access for patients but also benefits their referring physicians. Imaging interpretations are available earlier and more readily, and there is almost instantaneous access to these examinations on their office computers. This, of course, mandates an integrated information enterprise that all Kaiser Permanente (KP) Regions have now or will have soon. Picture archiving and communications systems (PACS), radiology information systems (RIS), and hospital information systems (HIS) all contribute to seamless acquisition of image data through PACS, which, together with information from the RIS and the HIS, result in rapid interpretation available to clinicians together with the original images pulled from archival storage. Thus, images and reports are at the right place at the right time.

Perhaps nowhere else in medicine has there been such rapid advance in technology than in CT scanning. With the advent of multidetector CT (MDCT) five years ago and, more recently volume CT (VCT), a relatively quiet revolution has taken place. CT scanners are now capable of obtaining 128 slices in less than one second. The entire chest, abdomen and pelvis can now be examined with submillimeter imaging in less than 15 seconds. This has led for the first time to true CT volume imaging where image reconstruction can take place in any plane with equal resolution.

We are just beginning to feel the impact of this very valuable tool in such areas as vascular imaging and virtual colonoscopy. The VCT has replaced peripheral diagnostic angiography in many centers and is poised to do the same for diagnostic coronary angiography. In the study of the colon, VCT has been shown to be superior to barium enema, approaching the sensitivity of colonoscopy in the detection of polyps larger than 9 mm.

Advances in software have allowed almost instantaneous display of the images in shaded 3-D representations. This is proving invaluable in preoperative planning. The addition of CT fluoroscopy has allowed rapid, accurate real-time placement of biopsy needles, drainage catheters, and therapy devices. Advances in MRI are equally as remarkable. As the 1.5T technology matures, there is new technology in the form of 3T-fieldstrength magnets that allow for faster, more detailed, and thinner imaging sections than its 1.5T counterpart. MRI is showing that it can compete with CT in noninvasive imaging of the heart. Multiplanar real-time images of the beating heart can now be obtained that allow for full, functional assessment of the heart. With contrast, perfusion studies can also be obtained.

The most recent, MRI, was introduced in the early 1980's. MRI remains the imaging examination of choice for musculoskeletal and neurologic applications and will continue to compete with CT in evaluation of the vascular tree. And many new applications of MRI will spur further growth. For example, in the breast, with the use of gadnolinium contrast agents, MRI is proving to be very sensitive for detection of small breast cancers. Its role in this regard is still being evaluated. When coupled with focused high-energy ultrasound, MRI can be used to guide noninvasive tumor therapies. It has shown its usefulness in treating such tumors and uterine fibroids and in limited applications of other visceral tumors.

It is clear that MR technology is still evolving, mostly along established paths, but now and then a new technique or device is unexpectedly invented. A recent example is the proposal to use hyper-polarized noble gases for MRI3. This opens up new MRI application fields such as examination of the lungs. $^{129}$Xe and $^{3}$He havealready been used for imaging. A specialized field of MR is spectroscopy. With this technique, the concentration of biochemical compounds can be measured, albeit with a rather coarse resolution. Human spectroscopy was begun in the 1980’s, using localized spectroscopy to study metabolic changes and to characterize tissues and pathologies. First attempts concentrated on $^{31}$P which is essential in energy metabolisms. Later, attention shifted to $^{1}$H spectroscopy. The interest also shifted from localized spectroscopy to spectroscopic imaging: images of a specific biochemical compound. An important research field is $^{1}$H spectroscopic imaging of the brain. In many cases, deficiencies could be correlated with certain pathologies.

Spurred on by miniaturization and by advances in computing power, the applications of ultrasound continue to grow. It is now possible to do high-quality ultrasound on devices the size of a laptop computer. Some devices in development are no larger than a PDA; these may indeed be the stethoscopes of the future. Three- and 4-D ultrasound have been further refined and are now being used in fetal imaging and ultrasound contrast imaging. Voice recognition and real-time image optimization (tuning of the image to the patient's own acoustic properties) have improved patient workflow. With the pending approval of ultrasound contrast agents, ultrasound will compete with CT and MRI in the evaluation of the liver.

Interventional radiology continues to grow as procedures migrate from the OR to the IR suite. Stents and stent grafts have dramatically changed the practice of vascular surgery. Vascular surgeons and interventional radiologists have joined forces in many labs with a merging of their two specialties. Percutaneous tumor ablation, stabilization of vertebral body fractures, tumor embolization, venous ablation and recanalization are all procedures now common to the interventional labs.

New flat panel detectors have improved image quality and decreased radiation dose. New rotation angiographic techniques have allowed 3-D vascular image displays. With tube rotation it is now possible through post processing to obtain multislice CT images from the IR equipment.

Digital image acquisition has replaced film throughout the Radiology Department. Digital detectors are now used instead of film to allow immediate image review. This advance has lead to an increase in image quality and a 50% decrease in imaging time. Dual-energy subtraction has allowed improved evaluation of the lungs by subtraction of the bony structures. Additional application of computer-aided diagnosis (CAD) has led to a 10% increase in tumor detection in the chest and breast. This same application is being trialed in CT colonoscopy as well.

Thus several trends are becoming clearer. The earlier and more frequent use of imaging will continue with a shortening of the initial clinical evaluation. As indicated above, the 64-slice CT scanner will allow immediate evaluation of a patient's chest pain, allowing differentiation between a benign situation and the possibility of a heart attack, an aneurysm, or a pulmonary embolism.

Technology will continue to drive care from the hospital. Decreasing cost and size of equipment will allow CT and MRI to devolve outside the hospital Radiology Department into freestanding situations.

The readily available image distribution process ironically will decrease reliance on the radiologist and there will be an enhanced shift to proactive, prophylactic screening in imaging. Computer-assisted detection and diagnosis in the areas of breast, lung, and colon disease are but a harbinger of such use in all clinical areas. Last but not least, functional and metabolic imaging is becoming a reality, and the promise of genetic and molecular marker imaging is not far behind.

## FUTURE PERSPECTIVES:

Major technological breakthroughs have occurred since the development of imaging resulting in markedly improved anatomic and physiologic information about the regions of the body hitherto inaccessible to the available diagnostic modalities. If we take the example of oncology practice also, it is a known fact that oncology being a multidisciplinary specialty requires good communication and coordination between the oncologist and the radiologist and the pathologist as well as the health care deliver staff. The radiologist plays a key role not only in the diagnosis and staging but also in the follow up of patients. The field has witnessed the breakthrough from the anatomic imaging to the molecular imaging.

Molecular imaging is the visualization, characterization, and measurement of biological processes at the molecular and cellular levels in humans and other living systems. Molecular imaging typically includes 2- or 3 dimensional imaging as well as quantification over time. The techniques used include radiotracer imaging/nuclear medicine, MRI/Magnetic Resonance Spectroscopy, optical imaging, ultrasound and others. Molecular imaging includes nuclear medicine and expands the tracer principle to include the use of molecules that report on biological function using light or other detectable signals.

Practical Uses

Molecular imaging has enormous relevance for patient care: it reveals the clinical biology of the disease process; it personalizes patient care by characterizing specific disease processes in different individuals; and it is useful in drug discovery and development, for example, for studying pharmacokinetics and pharmacodynamics. The relevance of molecular imaging to disease are found in the following three examples:

Cardiovascular Disease: Molecular imaging offers unique insights that allow a more personalized approach to evaluation and management of cardiovascular disease conditions such as: ischemic injury, heart failure and left ventricular remodeling, thrombosis, atherosclerosis and vulnerable plaque, angiogenesis, transplant rejection, and arryhthmic substrates.

Cancer: By accurately characterizing tumor properties or biological processes, molecular imaging plays a pivotal role in guiding cancer patient management: detection and diagnosis, staging (extent and location), assessing therapeutic targets, monitoring therapy, evaluating, and prognosis.

Neurological Disease: Molecular imaging is a very important diagnostic tool in the early assessment, risk stratification, evaluation, and follow up of patients with neurological diseases. Molecular imaging is playing an increasingly significant role in neurological conditions such as: tumors, dementias (Alzheimer's and others), movement disorders, seizure disorders, and psychiatric disorders.

Breast MRI is currently a well established clinical apparatus used in both USA and Europe in the pursuit of identifying and detecting early breast cancer, particularly in women in high risk groups.The sensitivity of MRI provides radiologists with a greater chance of breast cancer detection for women in high risk groups, who tend to develop the disease at a younger age.

Molecular imaging is revolutionizing the practice of medicine and is critical to quality health care. Molecular imaging delivers on the promise of "personalized medicine"—it can provide patient-specific information that allows treatment to be tailored to the specific biological attributes of both the disease and the patient.

Molecular imaging shows how specific tissues are functioning, as opposed to conventional diagnostic imaging procedures, which provide anatomical/structural pictures of the body's organs and tissues. It is an invaluable way to obtain medical information that would otherwise require surgery or more expensive diagnostic tests or simply be unavailable. Molecular imaging is making a sweeping impact on health care—paving the way for a new generation of personalized drugs for Alzheimer's disease, heart disease, diabetes, schizophrenia and many other diseases.

With molecular imaging, abnormalities may be detected very early in the progression of a disease, often before medical problems can be detected by other diagnostic tests and even before symptoms occur. Such early detection allows a disease to be treated early when there may be a more successful outcome.

Drugs of the future will be designed for diseases that are defined at the molecular level, and treatment will be based on the detection and monitoring of abnormal molecular processes using biomarkers and imaging. This level of specificity provides critical information not only for initial diagnosis but also to determine the most effective therapy for each particular patient. In addition, molecular imaging will enable physicians to monitor treatment in real time to evaluate exactly how well an intervention is working and if changes are needed. Furthermore, the data provided by molecular imaging will lead to faster, cheaper, and better drugs—providing cost savings and better patient care.

Molecular imaging will make lower cost screening of at-risk populations possible, allowing the most appropriate and effective individual treatment at the optimum time. For example, using molecular imaging to determine cancer's "molecular signature," will allow doctors to select the most effective treatment as early as possible in the course of the disease, ultimately improving a patient's care and outcome.

While all humans are genetically similar, there are tiny differences in our DNA, making us unique in terms of health, disease and how we respond to treatments. The fundamental principle of personalized medicine is that differences among individuals—genetic, environmental, diet, exercise, etc.—play a role in health and disease. These variations are a reason why one drug may work well for one person but not another. They can affect how drugs are absorbed, metabolized, and used by the body.

Personalized medicine uses each person's unique genetic profile in the detection, treatment or prevention of disease. Personalized medicine is possible because new, powerful technologies can analyzes biological events at the molecular level, even before symptoms appear. The promise of personalized medicine is a future where disease is detected at the earliest possible time, and treatments are tailored to an individual patient's genetic profiles.

Personalized medicine will allow for better diagnosis and earlier intervention, facilitate drug development, initiate improved therapies, allow better medication choices, offer safer dosing options and decrease health care costs.

The trend towards less invasive surgery is also very strong. For example, surgeons use endoscopes in laparoscopic procedures to guide and apply small surgical instruments through 'keyhole' apertures into the body. Also, X-ray fluoroscopy is used in the cath. lab. to guide the catheter. A promising addition in the cath. lab. is intravascular ultrasound (IVUS). This provides detailed, 3-D information of the internal condition of the blood vessels which greatly assists in determining the best strategy for catheter insertion. It employs a method of relating the endovascular ultrasound image with the topography of the vascular tree.

A wide range of imaging technologies is required to optimally visualize as much of the wide diversity of anatomical structures, and physiological and pathological processes, as possible. Many imaging technologies (image intensifiers, ultrasound, computed tomography, magnetic resonance) have found wide medical acceptance in the last four decades. The speed of innovation in these modalities remains high. Others imaging techniques, such as positron emission tomography, remain in niche environments. The primary reason for success is a modality's ability to supply new clinical information which is useful for the routine care of large numbers of patients. The demand for more effective and less invasive therapy increases the need for real-time imaging. The choice of an imaging modality for a given procedure is determined by its ability to display both the patient's anatomy and the operator's instruments. Patient access and the safety of both patient and operator are also of major concern. Multi-modality imaging can often enhance medical decisions. At present, this is most commonly done by separately viewing several examinations, and merging results in the physician's head. Combining images in a workstation can facilitate this process to the benefit of the radiologist, referring physician and, ultimately, the patient. The total amount of available information describing an individual patient continues to increase. Information systems facilitate access to images, reports, laboratory values etc. Increased efficiency of information access might simultaneously reduce costs and, more importantly, improve the quality of health care. Managing the efficient use of available medical resources is essential. Medical imaging and medical information management are two of the key technologies which are the indispensable parts of the solution.

Interventional radiology is also one another foci of concern which may be defined as percutaneous radiologic procedure that provides as anatomic, bacteriologic or tissue diagnosis, physiologic data or a therapeutic alternative to conventional management. It represents a more aggressive and invasive approach to the diagnosis and management of the patient. In terms of patient's benefit, interventional radiologic management usually results in reduced morbidity, mortality and lesser financial burden than conventional management techniques. For the radiologist, however it represents an increased responsibility, both for the effects of this treatment and for any complications that may arise. Still the field will witness the advances which will all come up in a big way.