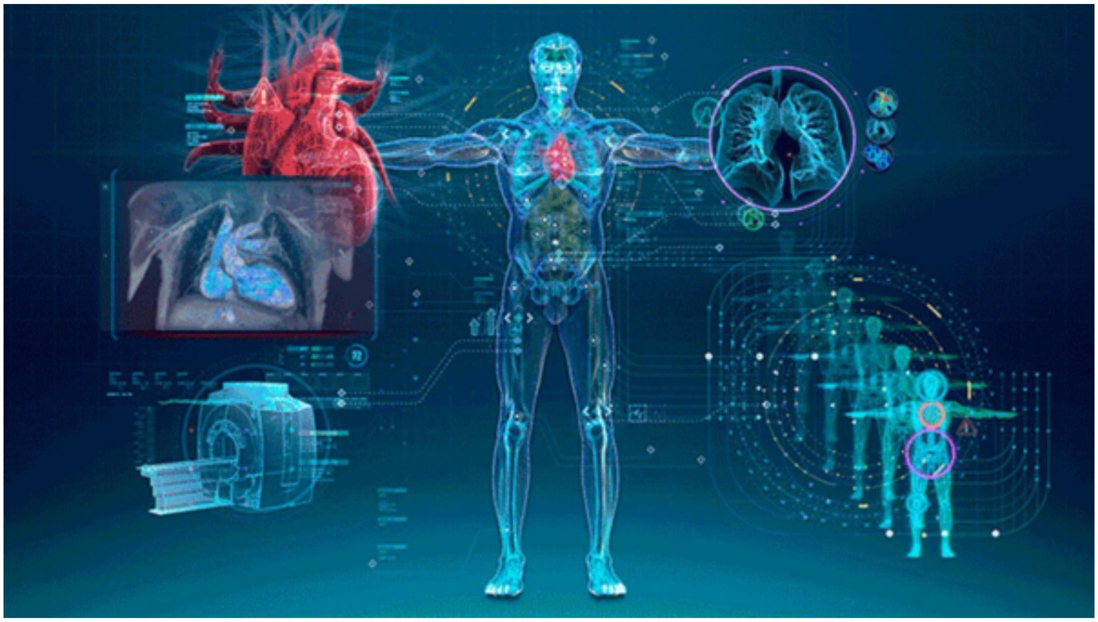
THE FUTURE OF MEDICAL IMAGING



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ABSTRACT

The medical device industry is undergoing rapid change as innovation accelerates, new business models emerge, and artificial intelligence and the Internet create disruptive possibilities in health care. . (Parker L, et al. 2014)On the innovation front, global connectivity has exploded! By 2021, the world will have more than three times as many smart connected devices as people—and more and more medical devices and processes contain integrated sensors. . (Parker L, et al. 2014)In this article, we identify technology clusters with prospects of future growth, look at some cutting edge practices, and consider what the implications may be for our specialty

A FUTURE FOR MEDICAL IMAGING—- WHY?

"If the human mind combines with all the tools AI provides, the results will be magnificent"(Dr Mysler, 2012)

Case study; The 19th century poet Emily Dickinson was reclusive to the point that she would allow a doctor to examine her only from a distance of several feet as she walked past an open door. (Dr Mysler, 2012)If she were alive today, it's likely that she would benefit from advances in medical imaging that could accommodate her standoffishness while still diagnosing the Bright's disease that ended her life at age 55. (Dr Mysler, 2012)

One example of our technologically enabled future is a bathroom mirror with a retinal scanner behind the glass that looks for retinopathy or collects vital signs. In the case of Dickinson, that mirror could have noticed a gradual increase in the puffiness of her face, a symptom of Bright's disease, and alerted her physician.(Dr Mysler, 2012)

This technology also could be a viable way to improve care for patients who are too busy to schedule routine doctor visits. For Iatrophobics , whose fear of doctors has them putting off regular checkups , advances in medical imaging enable a wide variety of noninvasive diagnostic options.(Dr Mysler, 2012)

For health care providers and their patients, these and other advances in medical technology make health care increasingly personal in terms of managing chronic diseases, predicting catastrophic ones and enabling patients to live out their final months or years in the comfort of their homes. These advances also allow health care to become a routine part of daily life.(Dr Mysler, 2012)

Broadly speaking, medical imaging has benefited from these trends more than other parts of the device industry. That is partly because it generates large digitized data sets that can be subjected to advanced analytics and deep learning. (Parker L, et al. 2014)A second reason is that it comprises a full technology stack from hardware to intelligent software, offering ample scope for innovation. Third, improving workflows and the accuracy and speed of diagnostics can deliver measurable benefits in better patient care, reductions in costs and variability, and greater satisfaction for radiologists. . (Parker L, et al. 2014)

In this article we will talk about :

- 1. Various ways in which medical imaging can and will be developed

- 2. Advantages and disadvantages of medical imaging

DEVELOPMENT IN MEDICAL IMAGING

ARTIFICIAL INTELLIGENCE

The primary driver behind the emergence of AI in medical imaging has been the desire for greater efficacy and efficiency in clinical care. . (Parker L, et al. 2014)Radiological imaging data continues to grow at a disproportionate rate when compared with the number of available trained readers, and the decline in imaging reimbursements has forced health-care providers to compensate by increasing productivity. (Parker L, et al. 2014). These factors have contributed to a dramatic increase in radiologists’ workloads. Studies report that, in some cases, an average radiologist must interpret one image every 3–4 seconds in an 8-hour workday to meet workload demands. As radiology involves visual perception as well as decision making under uncertainty, errors are inevitable — especially under such constrained conditions. (Sundaram . B, 2017)

A seamlessly integrated AI component within the imaging workflow would

1. Increase efficiency

2. Reduce errors and

3. Achieve objectives with minimal manual input by providing trained radiologists with pre-screened images and identified features.

There are two classes of AI methods that are in wide use today . The first uses handcrafted engineered features that are defined in terms of mathematical equations (such as tumor texture) and can thus be quantified using computer programs. These features are used as inputs to state-of the -art machine learning models that are trained to classify patients in ways that can support clinical decision making. Although such features are perceived to be discriminative, they rely on expert definition and hence do not necessarily represent the most optimal feature quantification approach for the discrimination task at hand. Moreover, predefined features are often unable to adapt to variations in imaging modalities, such as computed tomography (CT), positron emission tomography (PET) and magnetic resonance imaging (MRI), and their associated signal-to- noise characteristics. . (Parker L, et al. 2014)

3-D Visualization, Virtual Reality, and Image-Guided Intervention.

The 19 start-ups involved in 3-D visualization and virtual reality are among the longest-established companies in our scan. Demand for 3-D printing is increasing in applications such as anatomical models that help with surgical planning (Materialise, Leuven, 2014) and surgical simulation platforms that device sales representatives can use to coach surgeons (ImmersiveTouch, 2012). The technology has also been deployed to make accurate surgical prosthetics, such as middle-ear prosthetics, that improve the accuracy of surgical intervention for patients with conductive hearing loss. (Frantz et al, 2008)

When coupled with newer trends in 3-D printing or integrated into virtual-reality visualization, 3-D visualization helps improve clinicians' understanding of anatomy. (Frantz et al, 2008)A couple of examples serve to illustrate how, with interactive 3-D visualization platforms, surgeons and interventional radiologists will no longer have to rely on 2-D images from a scan when they make incisions, operate, or perform other interventions. (Frantz et al, 2008)Instead, they will be able to see pre-procedural 3-D images overlaid on the patient's body as they operate. New tools that enable clinicians to visualize in three dimensions include advanced monitors for the surgical suite and augmented- reality glasses that allow users to see and manipulate a screen or holograms with hand gestures. These technologies can enhance pre-operative and procedural planning, enable greater accuracy in biopsies, and act as a valuable teaching tool in surgery and other interventions. (Frantz et al, 2008)

Intra-operative Technologies: Imaging is becoming a crucial aspect of intra-operative planning and execution, particularly for applications requiring extensive data acquisition in real time. It can enhance precision during surgical interventions and improve outcomes. Intra-operative techniques , including ultrasound, MRI, and fluoroscopy, and they often require portable capabilities.. (Huang P, 2018)

With real-time, image-guided adaptive radiotherapy, clinicians can improve the targeting and effectiveness of radiotherapy treatment by increasing the dose delivered while minimizing the risk to surrounding tissue. Image- guided adaptive radiotherapy has been around for many years but requires frequent reimaging (typically by CT) of the patient during their course of radiotherapy. The addition of real-time imaging takes the technique to the next level and relies on more data, faster acquisition, and faster image processing. Indications for its use in brain and lung tumors are growing.(Huang P, 2018) Future indications will require further improvements in data acquisition and processing and the use of even more advanced imaging techniques, such as functional MRI and PET/MR, along with AI and ML to automate or speed up adoption.. (Huang P, 2018)

Nuclear Imaging: In nuclear and PET imaging, the introduction of specific ligands allows for better targeting in cancer diagnosis and reduces the need for tissue sampling. (Huang P, 2018) Noninvasive diagnostic techniques will play an increasing role in medicine, especially cancer diagnosis and management. And theranostic platforms, in which the nuclear diagnostic agent is paired with a complementary radiotherapeutic, hold promise for meeting unserved needs in oncology. (Frantz et al, 2008)

As nuclear imaging grows and moves away from metabolic imaging for cancer localization to pathology-specific cancer diagnosis (for instance, the combining of ligands specific to prostate or breast cancer with radio- isotopes for definitive diagnosis), imaging companies will have increasing opportunities to engage in cancer diagnostics, and potentially therapeutics as well. (Huang P, 2018)

OTHER AREAS INCLUDE:

- Connected diagnostic devices such as retinal scanners could be coupled with patients' existing consumer electronics products, such as digital cameras, to provide additional diagnostic and treatment options and make information available to proper medical personnel. (Frantz et al, 2008)

- Sensors in the home could measure how a person is walking to determine if he or she may be a candidate for a medical episode, such as a seizure. This is another example of how health care can be preventative and move deeper into the home without significant trade- offs in quality of care. (Frantz et al, 2008)

- An alarm clock that tells the person it's waking that it's scheduled a doctor's appointment, perhaps based on information collected from other health care devices around the home, such as the retinal scanner embedded in the bathroom mirror. (Frantz et al, 2008)This example brings new meaning to the term “personal area network” (PAN), where multiple devices throughout a home regularly and non invasively monitor and record a person’s vital signs. (Frantz et al, 2008)

- Equipment can be brought into the home and be remotely connected to a caregiver’s network. One example of a product in development is a gyroscope-based device worn by elderly patients to detect whether they have fallen. (Frantz et al, 2008)This device could then connect to the patient’s PAN to send for help. Near-falls, as well as extended sedentary periods (which could be a sign of a developing physical or psychological problem) could also be documented and reported to the patient’s physician. (Frantz et al, 2008)

- Remote surgery, where a world-renowned specialist operates on a hologram that’s used to control a surgical robot thousands of miles away. This approach spreads the best care around the world, allowing patients to be treated by world-renowned specialists without requiring them to travel thousands of miles. ***(Frantz et al, 2008)***

Advantages and Disadvantages

Advantages

There can be enormous benefits to having an imaging study performed. Diagnostic medical imaging provides vital information about your child’s health to their pediatrician, neurologist, emergency room doctor and other physicians.

Potential benefits of imaging studies include:

- Diagnosis of illness, and the severity or benign nature of that process, is made quickly and accurately.
- Invasive diagnostic procedures such as exploratory surgery or angiography or cardiac catheterization may not be necessary.
- When a child has a chronic disease or a form of cancer, medical imaging is essential not only at initial diagnosis, but for monitoring how the disease is responding to treatment or if the disease is progressing, and when a treatment plan might be stopped or adjusted.

Risks/Disadvantages

These are the obstacles to progress in imaging around the world.

1. Access to advances in care, both in terms of geography and funds, to procure equipment are high on the list

2. The limited means patients have to pay for the influx of new technologies.

The continual development of technology and the rapidity with which it occurs means the non-developed countries, such as Argentina, almost always remain in a certain technological backwardness in ability to apply this new knowledge." (FAARDIT, 2014

3. Having an inadequate supply of radiologists who will have received up-to-date training in the most recent advances in

"Radiology is very popular among medical school graduates but due to government restrictions, the number of open positions for training is limited." (SERAH, 2014)