Over the past 30 years, MR imaging has become firmly established as a diagnostic tool in medicine. In the last decade MRI has increasing use as a therapeutic guide. This trend is expected to continue as advances in technology will ultimately allow diagnosis to merge with therapy. MRI’s superior ability to provide soft-tissue contrast has made it the ideal technology to translate from diagnostic into therapeutic domains. This presentation will explore the evolution of intraoperative MRI technology and the necessary parallel development of safe, efficient, and effective MR compatible technologies and processes.

The progress of neurosurgery to a large extent has followed advances in lesion localization. By the mid-1970s, the computer allowed tomographic calculation of slices, enabling computerized tomography, which was joined by positron emission tomography and MRI in the 1980s. These brain-slice imaging technologies allow precise localization within each slice and can be used to show the effects of additive or destructive lesions on brain structure and function. MR technology began to enter operating rooms in the mid-1990s. Magnet systems rapidly progressed from low (0.12 T – 0.5 T) to high field (1.5 T – 3.0 T) due to the desire to obtain more signal to noise and contrast to noise for higher image quality. The advantage of the low field systems is that their open configurations allowed surgery to take place within the magnet. Higher field magnets produce much better images, but their closed configurations require an interruption to surgery while the images are obtained, usually about 30 minutes per imaging section.

Whether the configuration requires the patient be moved to the magnet, or whether the magnet to be moved to the patient, MR imaging disrupts the rhythm of surgery while the image is obtained. Thus MR imaging is generally only used for resection control rather than truly guided surgery. Optimal MR integration into the
operating room requires minimal interruption to surgery. To overcome this limitation, investigators around the globe have begun the process of developing MR compatible robotic technology. These robotic systems have become increasingly more sophisticated as investigators define and incorporate MR compatible materials into structure and function.

Already these robotic systems are partially recreating the sight, sound, and touch of surgery at a remote workstation, or human machine interface (HMI). There is a rapid progression of visual, audio, and haptic technologies that will eventually enhance the surgical environment at the HMI past human capabilities by coupling microscopic images with MR images. Additionally, the HMI interface will connect the surgeon with a global knowledge base.

Medicine, science, and technology are growing exponentially, converging on a remarkable future where therapeutic capabilities will progress beyond what we currently imagine possible. Molecular imaging will provide a powerful matrix for surgeons to maximize resections. HMI will provide an immersive environment where surgeons can operate within a perfect image. Robots will continue to become more dexterous. MRI magnets will improve in quality and drop in cost, enabling the global adoption of MRI-guided therapy.

**Learning Objectives:**

1. To understand the concept and economic implication of merging diagnosis with therapy.
2. To outline the history and ongoing development of iMRI
3. To understand the origin and potential benefits of MRI compatible robots
4. To consider future research directions related to MRI guided therapies