New avenues in diagnosis and therapy are today increasingly being opened up as a result of sophisticated and advanced technology, and at the forefront of this are evolutionary developments in existing technology. Many medical devices and pieces of equipment are developing at lightning speed as a result of digital technologies, which enable new medical concepts, strategies, and visions to be implemented faster than ever before. This means that developments which previously took a decade to implement are now being introduced at a rate of one a year. Technology thus not only has a dynamic interrelationship with medicine; it influences and shapes modern medical science on the basis of new technical possibilities. First-class health care would be inconceivable without progress and innovation in the field of medical technology.

1.1 A Short History

Medicine (from the Latin ars medicina, the art of healing) and technology (from the Greek, meaning skill, craft) have inspired and fascinated mankind since its early beginnings. Technical instruments and devices have always had their place in medicine. Acupuncture needles are known to have been used in Far Eastern medicine since approximately 2500 BC. Hippocrates (460–370 BC), the founder of scientific medicine in the Western world and a prominent doctor of his time, was already using a proctoscope to inspect his patients’ intestines. He also gave descriptions of a variety of instruments and apparatuses for the treatment of wounds. These included, for example, apparatuses with weights and straps which, in the case of an arm fracture, positioned the broken bones in relation to one another, straightened them, and simultaneously immobilized them. As striking evidence from archeological digs in the buried town of Pompeii has shown, sophisticated instruments and devices for surgical interventions were already being used in the Roman Empire (from 63 BC onwards). The vision aids known as glasses, on which many of us rely, are not an achievement of the 20th century but had already been invented by a craftsman at the end of the 13th century.

1.2 Early Breakthroughs of Medical Technology

The first major breakthrough in medical technology and boom in modern medicine took place around the turn of the 20th century with Röntgen’s discovery of x-rays in 1895. Although the nomenclature of the electrocardiograph (ECG) – which is still in use today – had already been decided by Einthoven in 1895, use
of the first clinically viable ECG was not possible until 1903. In 1896, Riva-Rocci introduced the method of noninvasive palpatory measurement for determining blood pressure. The electroencephalogram (EEG) was first recorded in 1924 by Berger using a string galvanometer. Other milestones in medical technology were the invention and introduction of the artificial kidney (1942), the heart–lung machine (1953), hip-joint prostheses (1960), artificial cardiac valves (1961), and the first clinical patient monitoring devices (around 1965). Criteria which had already been used for classification in the USA were developed for measurement and standardization of the ECG according to the Minnesota Code around 1960. In the early 1940s, the construction of the first electronic computer ushered in a new era, and a new technology was born which was to revolutionize medical technology once more: data processing and information technology. This new technology overshadowed all the technological developments which went before it. If a modern calculator were equipped with electronic components (e.g., transistors) from 40 years ago, that calculator would require a power of 6000 W, provided by an electricity supply and emitted to the surroundings as heat. A weight of 50 kg and cube edges approximately 1 m in length would more likely suggest an oven than a calculator.

1.3 Analog to Digital

The radical change in technology from analogue to digital opened up new dimensions in medical technology: the computer tomograph (CT), which generates cross-sectional images of the body, was developed by Hounsfield and Cormack, and a prototype was installed and tested in a hospital in 1971. In 1977, Mansfield found success with a breakthrough for medical applications of magnetic resonance tomography using the magnetic resonance method, and the human thorax was imaged for the first time without the use of x-rays. Unique and sophisticated possibilities in diagnosis were introduced by a large-scale medical technology system which is used in nuclear medicine: the positron emission tomograph (PET). As an imaging system, the PET enhances the diagnostic range because it enables representations of physiological and metabolic processes in the human body to be determined both quantitatively and on a location-dependent basis. Molecular imaging with hybrid PET/CT scanners offers a view of things which had previously not been visible. However, other hybrids such as ultrasound and magnetic resonance imaging also not only have the advantage that they offer an image quality which is much more precise and accurate in every detail when compared with other imaging methods, but they can also be used without any exposure to radiation. It has so far been possible to reduce the radiation dose for a full body scan to as little as 40% compared with older systems.

As a result of the increasing integration of computer-based systems in x-ray technology, imaging methods are being redeveloped in ever shorter time cycles. The rapid growth of the spectrum of clinical applications and the continuous further development and implementation of new technologies have not only led to an altered and extended range of indications for these methods. Furthermore, imaging technologies are increasingly being developed as a complete solution, such as hybrid systems for interventional radiology or integrated IT solutions (picture archiving and communication system (PACS), radiology information system (RIS), etc.) which aim to optimize processes and thus increase efficiency in hospitals. The increasing interconnectedness of technology will change the health system.

To outline the progress and development of all the devices and achievements in medical technology would be to go beyond the scope of this book. Although medical technology is in most cases not original but rather adopts technological developments from fields such as electronics, optics, precision engineering, and plastics technology among others, and these developments are only thought of as being part of medical technology when applied to living creatures, medical technology has nevertheless established itself as a field, and medical care today would be unthinkable without it. This fact reveals the real significance of medical technology:

Medical technology devices and equipment (including in the laboratory and research field) are individual or interlinked instruments, apparatuses, machines, appliances, and auxiliary devices, and any necessary equipment which is used because of its function for the identification (diagnosis), treatment (therapy), observation (monitoring), and prevention (prophylaxis) of illness in humans.