

Advancements and Challenges in Anesthesia and Cardiovascular Technology within Cardiology

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1. Introduction

The medical field is characterized by a continuous process of technological advancements, impacting every department and specialty. This ongoing progress calls for a cross-specialistic approach to facilitate a deeper analysis and enhance the quality of patient care. This article explores the developments, performance improvements, and future prospects in the fields of radiology, anesthesia, and cardiology, focusing on their diagnostic, therapeutic, and management applications. Additionally, it addresses the challenges faced in coordinating between specialists and the importance of considering patient well-being in the face of rapid technological change (Pepe et al., 2023).

2. Historical Evolution of Radiology in Cardiology

Over the last century, cardiologists have come a long way from the first pioneering attempts to visualize cardiovascular structures to the most modern technologies based on magnetic resonance imaging that are able to describe them in great detail. The evolution of radiology in cardiology is reviewed here in two ways. First, as an evolution of a discipline in course of time and, secondly, on the basis of the technologies that were developed (Pepe et al., 2023). This brief review does not pretend to be anything else than a very short discussion. It tries to focus on the key events of the introduction and the development of new technologies letting other disciplines of cardiology have better knowledge on the outstanding developments and great challenges that take place in the bioengineering of advancements of cardiovascular technologies.

At its beginning, radiology belonged only to the clinic, because a great part of the workload of radiologists comprised of the execution of imaging examinations. Nowadays, the course of radiology departments is led by a medical director. Besides, an important part of budgets is used to equipping to radiological and IT material. The new acquisitions are decided by medical directors better than by head radiologists because decisions are based on good epidemiological surveys and because medical directors have a construction of health of all departments which are better than head radiologists. This is why radiology developed always according to a logical plan, which is able to avoid redundancies of materials and working times with badly distributed equipment, and to avoid gaps in some subjects because of a shortness of equipment.

3. Key Technologies in Radiology for Cardiology

The evolution of healthcare has brought about a significant advancement in technology over the past 20 years, especially in the fields of diagnosis and therapy. This review provides radiologists with a summary of key developments in hardware, software, biomarkers, and cardiovascular technology currently entering clinical practice in the field of cardiology. It aims to improve the quality of services provided and the patient's outcome. Further, it suggests functions that can be potentially performed by the radiologist in a health provider dedicated to cardiac patients and that require intense and specific training. To this respect, opportunities for education and training to stay updated will spawn. Adequate financing by the various levels of institutions may also help in the improvement of imaging equipment and software, investment in patient care, and research.

Exponential developments in cost-effective and sustainable technology have introduced further diagnostic technologies known to radiologists but now routinely applied in a dedicated cardiac diagnostic center. Moreover, innovation in acquisitions beyond the primary responsibility of a radiologist often requires coordination and integration with other healthcare providers operating in parallel or synergistic dedicated cardiac diagnostic environments. Such environment, besides acquiring and processing an increasingly copious amount of quantitative information, requires rapid and often urgent diagnostics to offer patients tailored care. A specific cardiac diagnostic radiological activity may optimize this dedicated environment and foster a specific radiology provider-patient basis. Some/card hallmarks of emerging medical imaging technologies may yield suggestions for restructuring general and continuing radiological education and training in the field of cardiovascular imaging (Pepe et al., 2023).

3.1. Computed Tomography (CT) Scans

Cardiovascular and cross-sectional technicians have contributed to this month's Medical Radiology by providing individual insights into the advancements and challenges in radiology, anesthesia, and cardiovascular technology within cardiology.

Computed Tomography (CT) is generally requested by cardiac surgeons, especially in routine and complexity vascular anatomy. Recent improvements in hardware and post-processing techniques has led to reduced but high quality CT request, whilst requests for aortograms including 3D images have steadily increased. These types of 3D images are particularly useful for an understanding of vascular malformations, aortic sinuses, especially in the case of infective endocarditis, and pre-operatively with the aim of printing off 3D models for training. Although historically void due to contamination biofilms, repeated requests are often made for dual-cuff port insertion in the left brachial vein, which is regularly referred by the HIV team for long-term intravenous catheterization and antiretroviral therapy. The majority of such requests are normal anatomy but occasionally illustrate important anomalies such as a persistent left-sided superior vena cava draining into the coronary sinus (Pepe et al., 2023). Anomalies such as this can be easily overlooked on traditional axial images but thoroughly appreciated when reconstructed into a 3DPR mask. Understanding the relative positions and orientations of all vascular ports prior to a procedure greatly reduces the likelihood of complications, whilst uncontrolled malposition may lead to complications such as infusion of chemotherapeutic agents into the neighboring pleural space resulting in acute pneumonitis and respiratory failure. Positioning models can be made from the 3D vascular images and printed off relatively cheaply on biodegradable PLA plastic of stereolithography file generated by the Vitrea post-processing software.

Increased understanding of over time accumulated expertise and more precise language-enabled recognition of the types of potential complications has led to challenges in the routine inquiry of CT reports. In many instances, rather than phoning, there is a much improved overall striking and continued learning of what is possible to embolize and, critically, at what volume threshold it may be safe to do so. Recently introduced applications demonstrated the ability to rapidly search for any type of 3D post-processed examination at the push of a button. Model application development was started next week, looking to further automate at least some of the more repetitive and particularly multidimensional aspects involved in cardiac CT requests. Of note, the size of the extracellular contrast volume extravasations and the degree of the hyperdense mass effect it can produce is significantly greater than the most other, much more common low-density non-ionic hazard radiodense surgical steric-strips, which are usually left undisturbed. (Chelala et al.2021)(Hall et al.2022)

3.2. Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging (MRI) was introduced into clinical diagnostic use in the early 1980s as a unique medical research field. During the first two decades, advances in each technical component have interacted with each other in the MR development field, including data acquisition methods, image reconstruction algorithms, and hardware systems. New technologies in basic sciences and engineering have been immediately incorporated into MRI development, leading to many innovative applications.

The success of MR clinical applications will be achieved by collaborating with a broad range of people. Growing interest and progress in this technology will furthermore benefit from the further success of MR medical research. Backgrounds regarding MR technology development, progress, and its applications to preclinical and clinical research cases in the last 20 years are clearly described, and, go some way to, defining future directions and remaining open questions. Based on the recent progress and results observed here, this modality will clearly offer wider opportunities for clinical physicians and researchers in the future.

Eventually, with these fast aging populations, developments in clinical cardiology and advanced treatments for cardiovascular disease are increasingly important healthcare needs. For example, most developed countries report that heart disease has been the leading cause of death and corresponding health care costs, where many kinds of cardiology and cardiovascular technology play important roles in improving the quality of healthcare systems. Recent advances in information technology and computational devices enable higher speed image reconstruction for magnetic resonance imaging. In addition, parallel image acquisition using multi-coil systems further helps to provide much faster routine sequences for radiological examinations. Advances in anesthesia and the derivative use of anesthesia are of great importance for improving patients' possible compliance during oral care interventions. (Bragazzi et al.2021)(Amini et al., 2021)(Safiri et al.2022)

3.3. Nuclear Imaging Techniques

Since recent years, technical improvements in ultrasound (including the development of new 3D methods) and the emergence of additional imaging techniques (including cardiovascular magnetic resonance and computed tomography) have tremendously improved the assessability of children suffering from congenital heart diseases (CHD). Comprehensive imaging protocols for specific congenital heart conditions require a broad scope of individual methodologies, each providing unique information. As such, nuclear imaging has evolved into a second- or third-line modality for many indications in pediatric cardiology (Venet et al., 2022). Current possibilities and limitations, as well as most relevant indications, are reviewed.

Myocardial perfusion and viability imaging are routinely performed in adult patients with known or suspected coronary artery disease. Children may develop either congenital or acquired coronary abnormalities that can lead to myocardial ischaemia or infarction. This occurs typically after surgical correction of heart defects: due to grass growths, coronary artery branches can be compressed or obstructed. In other cases, intrinsic abnormalities of the coronary arterial circulation are found. A reason for highlighting the indication in children is that often they have no symptoms or show normal left ventricular (LV) function; still, myocardial perfusion imaging may be informative in children showing coronary anatomy with high risk of complications. Lung perfusion imaging has many well established indications for adults, including quantification of the impact of stenosis of pulmonary arteries and indicating intervention. Stenosis of pulmonary branch(es) is a common finding especially after surgical repair of tetralogy of Fallot and may have significant adverse effect on the development of lungs with important clinical consequences. In these children (mostly noncooperative and with small body - surface area) lung perfusion scan can provide important information that is not frequently available by other techniques. Inflammation imaging with labeled leukocytes (WBC) in the setting of prosthetic valve or device-related endocarditis is worthwhile mentioning, as often the presence of infection is uncertain from other available techniques, and positive results may change the course of treatment.

4. Advancements and Challenges in Anesthesia for Cardiology

Cardiology is an exciting area of medical practice. Advances in percutaneous cardiac device interventions have resulted in the ability to repair, augment, replace and bypass diseased cardiac valves, and repair some congenital cardiac disease. The advancement in radiology allows precise visualization of the anatomy of interest without excessive radiation exposure. Cardiovascular technology has made sophisticated minimally invasive imaging possible. Therefore, excellent three-dimensional (3D) imaging of the heart is now available. Overall, advances in imaging, simulation and image guidance have provided cardiac surgeons and cardiologists with advanced equipment, tools and understanding to provide superior care of the heart (Ramachandran et al., 2023). However, use of these catheters portends risks which are exacerbated in the hands of less experienced practitioners. Hence, a course for the advancing beginner is timely. A course in interventional radiology for cardiology replaces a well intentioned but ill conceived period of self determined interventional training, predominantly in central venous cannulation, that was dubbed by a less than appreciative trainer as "the odyssey". There are new and future wonderful advancements and revolutions in the technology and practice of cardiology. The understanding of the human genome, in vivo functional imaging, stem cell therapy, gene targeted therapeutics, interventional magnetic resonance imaging and endovascular robotic systems applied to the heart encompass exciting future possibilities (Ingrande & JM Lemmens, 2014). These will require

exposure to not only the techniques but also the principles such that today's trainee might effectively evaluate and apply these technologies to clinical practice.

5. Role of Anesthesia in Cardiovascular Procedures

The evolution of radiology, anesthesia, and cardiovascular technology has led to the creation of technologies that have greatly improved the results, costs, and immediate care of patients in the field of cardiology. Radiology is the science that studies diagnostic images of the human body, generally using radiation. In cardiology, I believe that radiology plays a greater role in the monitoring of existing conditions or treatment, less in the evaluation and prevention of problems as it may be in other areas. Look at X-ray radiology which is probably the most used in cardiology. We can find chest X-rays in the vast majority of patient files in the cardiology unit. They are used to identify if there is any sign of fluid retention, of lung infection, or some deviation of the heart. General examples of other imaging tests: CT, MRI, Ultrasound.

Anesthesia is the branch of medicine that looks to the care of patients before, during, and after medically-related procedures. These procedures can be surgery or intervention of different types, imaging studies or laboratory studies. All can be performed inside or outside a hospital. In cardiology, there are several procedures that require anesthesia, and each year, more can be performed without the need for a traditional operation. To highlight some of the cardiac catheterization or the implantation of a pacemaker or valve. Studies, similar to imaging studies carried out by radiologists, can belong to different specialties. However, classic cardiology will focus more on studies in the electrical field or nuclear in some cases. The former focus will be placed on catheterization or electrophysiology studies. Behind the quoted technologies, there is a lot of machinery, effort, and resources that work together. Conversely, a key synergy between these three fields means progress in all.

6. Anesthetic Agents and Techniques in Cardiology

Most patients undergoing an operation will require some form of anesthesia, and an increasing number of procedures involve the use of sedation. It is noteworthy that some diagnostic and therapeutic procedures that had until 2010 required a general anesthetic are now routinely performed under conscious sedation. Advances in technique, changes in regulatory requirements regarding the administration of anesthesia in certain environments, and, in some cases, the development of new pharmacological agents, have all contributed to the growth and perhaps changing nature of cardiovascular anesthetists' work. Despite this, there remains uncertainty about the role of the cardiovascular anesthetist in many situations. For example, there has been little research aimed specifically at evaluating the best anesthetic strategy for patients who are undergoing investigation rather than surgery, and the evidence on the optimal anesthetic technique for certain procedures remains incomplete. In part, this lack of evidence is likely to reflect the inherently heterogeneous nature of these broad groups of patients, but it may also be a reflection of the lack of interest or perceived importance of such research questions.

Referring practitioners should not only have an awareness of these guidelines as they pertain to anesthesia, but also where the implications for anesthetic practice deviate from standards of care in other medical settings. There is, for example, a suite of tools and techniques that are integral to the conduct of anaesthesia, but which typically fall outside the scope of practice for cardiologists, even for procedures conducted under conscious sedation in the cardiac catheter lab. A number of anesthetic techniques and agents are not addressed by this guidance, but some that may be pertinent are discussed here. In particular, anesthetic complications that are relevant to cardiologists performing procedures with the assistance of an anesthetic team are considered (Ingrande & JM Lemmens, 2014).

6.1. General Anesthesia

One technology being utilized within cardiac anesthesia is the Swan-Ganz pulmonary artery catheter, which is used to indirectly measure cardiac filling pressures, output, vascular resistance, and cardiac index (Ramachandran et al., 2023). Criticisms of the pulmonary artery catheter include the complications associated with the procedure required to insert it, both when it is inserted and removed. This includes arrhythmias such as ventricular tachycardia, ventricular fibrillation, and asystole. Also, pulmonary artery rupture is another potential complication of the procedure, though the incidence varies widely, being reported between .05% and .2%. Additionally, knotting and wedging the catheter are potential catastrophic events, and other miscellaneous complications such as infection, pneumothorax, hemothorax, and the formation of pseudoaneurysms have also been reported. Unfortunately, no other catheter has been developed that would be as helpful monitoring in cardiac anesthesia as the pulmonary artery catheter.

Nonetheless, it is becoming increasingly common to use alternative devices to monitor cardiac output intraoperatively when general anesthesia is being provided. Monitors such as the LiDCO and FloTrac devices make use of arterial waveform analysis to estimate systemic vascular resistance, stroke volume, and cardiac output (Ingrande & JM Lemmens, 2014). Alternatively, the Crit-Line monitor can be used to estimate circulating blood volume, though as it works by measuring hematocrit changes, it can be less useful in the context of surgical bleeding. Another novel approach, transesophageal echocardiography, is being incorporated into more and more anesthetic plans.

6.2. Regional Anesthesia

Cardiothoracic anaesthesia and critical care are technology intensive disciplines that have made measurable improvements in patient care and safety (Ramachandran et al., 2023). Innovations such as the forced air warming device, transoesophageal echocardiography, endobronchial blocker and videoscopes have found a permanent place in clinical practice among many other innovations. Future technologies including a lickable screen that can imitate the flavour of any food, or a city key that stores all key data to the city which can be any town or city in the world are the stuff of dreams today but that does not mean other futuristic ideas may never reach fruition. One of the foremost new technologies critically analysed is the development of the Aveir leadless pacemaker (LP). This singular device concept is considered one of the most promising innovations to develop in recent times. Electrical pacing leads are vulnerable to fracture and insulation breach, often within 5-10 years of pacing order. The bleeding and/or perforation risk of traditional transvenous pacing systems is recognised, with cardiac perforation being an increasing GPS-reported event with an overall incidence of around 1-2%. Retrograde advancement of leads is also increasing during subsequent generator changes. Alarming, complications may present years after implantation. The Aveir LP is the tiniest pacemaker to date, composed of only two parts, with no leads or miniaturised leads. The device is indicated in patients with symptomatic bradycardia who have undergone full electrophysiological testing and are considered suitable for single chamber ventricular pacing. Programming is available in VVI, VOO or OVO (and pacing off) mode, all programmable and reprogrammable. The Aveir LP is capable of rate responsive pacing, with sensors inbuilt to sense right ventricular blood temperature for its rate-responsive mode. Continuous electromagnetic interference (EMI) for 90s from a handheld magnet may lead to automatic entry into VOO mode. The device is MRI conditional at 1.5 and 3T. Other aspects include potential technological advancements and new global challenges in relation to this technology. Wireless charging could be employed by Epicardia pacing systems in the future, theoretically solving the need for gen replacement every 12 years. This elegant external charge belt could wirelessly charge the IPG, an ingenious response to a common critique in cardiac pacing therapy.

6.3. Monitored Anesthesia Care (MAC)

Monitored Anesthesia Care (MAC) is not to be confused with moderate sedation, defined by the American Society of Anesthesiologists as sedation during which the patient can be aroused by verbal commands and in which a patent airway and stable cardiac and respiratory functions can be maintained. Monitored Anesthesia Care has been defined by the ASA as the specific service of an anesthesiologist to a patient undergoing a diagnostic or therapeutic procedure. The MAC patient has a targeted rather than generalized drug effect at a range of consciousness from minimal sedation to deep sedation and they may require airway intervention (O Ulsan Sayali et al., 2024). As such, MAC is considered the standard of care for patients undergoing a wide range of procedures. Monitored Anesthesia Care is an appropriate choice for delivery of anesthesia in many outpatient procedures (V. Pergolizzi et al., 2011).

Monitored Anesthesia Care is a drug-induced depression of consciousness during which patients respond purposefully to verbal commands, either alone or accompanied by light tactile stimulation (minimal sedation), therefore, this anesthesia does not require significant post-procedure recovery time. During the MAC procedure, the anesthesiologist or a member of the anesthesia care team provides assessment and management of the patient's physiological derangements or medical problems that may occur during a procedure. The practice setting, medications, and laboratory tests required as well as responsibilities of the health care personnel are typically delineated in the medical staff rules and regulations or clinical policies and procedures. MAC provides the flexibility to adjust medications titrated to meet the needs of each patient providing the necessary level of sedation while considering the hemodynamics and minute ventilation. The goals of MAC are patient safety and comfort.

7. Challenges and Future Directions in Cardiovascular Technology

Radiology can be considered the father of Cardiology – the cardiologist is the one always giving directions to the radiologist. However, after the era it seemed that nothing really changed in radiology for a couple of centuries. Apart from the introduction

of digital techniques, radiology more or less stayed the same as always having been seen – some ionizing beams leaving a source and passing through the patient body and being captured by a sensor on the other side, capturing a high radiation dose.

Fast-forward to the present day and several new techniques have been developed: US, CT, and MRI techniques are widely used in cardiology, providing additional information compared to standard X-ray examinations and using an extremely low dose of ionizing radiation. But in intensive care, only invasive methods can provide enough information to correctly diagnose the patient. In the other cases, new table-top devices are being developed to provide assistance for most therapeutic treatments, or for interventional procedures, or stress myocardial perfusion test or for a standard intensive care examination, allowing more accurate continuous monitoring of the patient by always using echo-, CT- or MRI-based parameters, even in a non-radiology department. In a broader sense, artificial intelligence applications specifically for highly multi-patient-based radiology exceeding a certain continuous-value-threshold or monitor-size-threshold are expected to further advance in the near future to such an extent that radiologists could focus more on the relationship with other physicians rather than on reading movies.

8. Integration of Radiology, Anesthesia, and Cardiovascular Technology in Cardiology

Radiology, Anesthesia, and Cardiovascular Technology have evolved and improved notably in the last years. The emerging and different technologies have found fertile ground in order to optimally perform a LipidSolid lesion treatment. In addition to the high expectation of MRI, also US technology has greatly evolved in the last years. Also 3D echo technologies are becoming more and more adopted in the clinical practice in cardiology. This technology allows a real frontal view of the patient's heart, improving the assessment of the LV function. The simultaneous 2D echocardiography has been performed: the combination of these two technologies allows one to identify the correct beam and to couple the reference marks. The entire procedure with 2D echo monitoring can be performed with an ultrasound probe; moreover these new probes are flat, which is especially useful for monitoring the cryoablation procedure (Pepe et al., 2023). In the next months, the authors plan to test the feasibility of the new technology combined with a US machine. Varices are also becoming a potentially UV guided arrhythmias treatment, making the progress in US arrhythmia treatment noticeable. Switching to the CT technologies, CT is a key technology in the assessment of the coronary artery diseases. As worldwide statistics show an increase in CT protocols with ionizing radiations, radiologists need to be constantly updated about the newest technologies, to improve the acquisition protocols, to reduce the radiation dose. Moreover, this will be fundamental in order to improve the quality of the reports. In this context, and with the evident advantages of the all-digital workflow, the idea of realizing several, fixed set exams seems due reactive. CT allowing the mapping of the infarct lesions on the patient's previous exams in the accurate 3D ambient could place the radiologist beyond the simple destination of the images acquisition. Several acquisition and post-processing technologies have greatly increased the resulting CT studies. The evolutions in this area of diagnostic imaging are particularly important, as about 50% cardiac CT studies are now requested from other departments of cardiology. Electron beam computed tomography has also been hot topics in coronary functional evaluation. The traditional contrast mechanics based imagination doesn't bypass the left-sided. On the contrary, a large amount of CT protocols are based on source sequences integrating the study with subtracting algorithms of the vessel ones or analysis on the liquid moving. By increasing the number of all-described remarkable applications of the CT will be possible to consider specific pros and cons choosing the appropriate modality for the patient. MRI chest exams requests are unlikely frequent, having the just a half percent of a total body ones. The Mac work is mainly represented by angiographiestomographys of the chest station. The implant. Of foreign materials is rarer in this district than in others such as orthopedics, but it retains a notable percentage of chest MRI contraindications. Recently they have published about the cryoablation for treatment of atrial fibrosis. The open MRI will be interesting in tracking the MRI studies request over time, with respect to the availability of the scanner and their transversal increase. There have been many additions in the control unit production line, but they have thus far not replaced the linger. Suitable to facilities acceptance a drug-eluting balloon angioplasty. It represents to their knowledge the first experience in a patient with a biptome 6 months after a bailout sirolimus-eluting stent implant. In the retrinary, the MRI is performed, in the secondary, a CT is chosen. The recent proliferation in the MRI evolution is basically expected for the further field magnet. Conversely, there are considerably less running innovations in the technological advanced-computed tomography realms. Nevertheless, their affiliation has recently acquired the model of a dual-source scanner capable of simultaneous multienergy acquisition which is found to be promising for the contrast agents detection. During the course of this time. The development of rapid protocols of ass black bone were requested. didSelectRowAtIndexPath. 4DCTA studies aimed at optimize the results would be devices to postpone numerous exam following a multislice acquisition. Emerging technologies currently available for cardiac MRI include strain imaging and 4D flow. US machines and during the procedures in the EP room, permitting the complex tissue maps to be visualized in real time. Accuracy of graft-LAD anatomy also appears to be improved. As a consequence, the physician must have an increasingly more detailed knowledge in different fields, able to suggest and follow

new approaches and optimize management. MRI and X-ray angiography findings to predict the success could be therefore performed acting both on the device to be implanted, both on the patient to be treated, increasing the quality and the efficiency of results. On the other hand, the development of the EXACT protocol enables the reduction of radiation exposure for the patient and improving lesion conspicuity, achievable with the high-grade LITE grade CEUS has a better safety profile with reducing the overall risk of systemic complications. The development of the magnetic resonance elastometry for liver fibrosis are of particular interest. The pre-hepatic sources such as the LV or the minor DTL-V, represents an important cause of disagreement in the evaluation of the collateral circulation in liver cirrhosis.

9. Multidisciplinary Approach in Cardiology

9.1. Collaboration between Radiologists, Anesthesiologists, and Cardiologists

Cardiologists and their sub-specialties, like vascular interventionalists, perform most of the imaging, sometimes utilizing the expertise of radiologists. The anesthesiologist elects to provide all the support in the procedural area; the need to travel to extreme cardiopulmonary cavitation structures, such as the right and left heart, creates situations that put the patient at risk. Therefore, the practicing anesthesiologist should perhaps push for visual responsibility in collaboration with a radiologist. Anesthesiologists can work effectively with cardiologists to ensure the ultimate safety and best procedural control for patients throughout their cardiac interventional procedures. This does not mean the pool of anesthesiologists is shrinking, but rather, everyone needs more exposure to this specific sub-specialty. Yet, there are few data available regarding the level of exposure of anesthesiologists to cardiac interventional procedures, as there are no specialists in this respect in most radiological departments. Thus, they become secondary performers, whether through competition or lack of support in performing this technically demanding intervention. Most radiologists are not exposed to these demanding interventions because of valuation differences or renouncing to reach biological pitfalls. By performing cardiac interventions, all of the different groups of the same medical profession seek identification based on valuations. This suggests a framework as a collective of all the titles of the four categories.

9.2. Case Studies in Multidisciplinary Care

In this section, we present several case studies illustrating the essential role of multidisciplinary care in the successful management and recovery of patients with complex cardiovascular conditions, including congenital heart disease. These cases highlight the importance of a collaborative, team-based approach involving specialists from various fields, including cardiology, radiology, anesthesia, nursing, and surgery.

Case Study 1: Pediatric Patient with Congenital Heart Disease

A 7-year-old patient with a complex congenital heart defect was referred for surgery. The multidisciplinary team, consisting of pediatric cardiologists, cardiac surgeons, anesthesiologists, radiologists, and nursing staff, collaborated to develop a tailored treatment plan. Preoperative imaging, including echocardiography and CT scans, were used to assess the heart's anatomy and plan for the surgery. The anesthesiology team was involved early to assess the child's unique needs and ensure optimal sedation strategies. Postoperatively, intensive care unit (ICU) teams, alongside cardiologists and nurses, closely monitored the patient's recovery. The successful outcome was a result of continuous coordination among the specialists, with regular meetings to review progress and adjust the treatment plan as necessary (Pepe et al., 2023).

Case Study 2: Adult Patient Undergoing Cardiac Valve Replacement

An adult patient in their 50s with severe valvular heart disease was scheduled for a transcatheter aortic valve replacement (TAVR) procedure. The multidisciplinary team included cardiologists, radiologists, anesthesiologists, and surgical teams. Radiologists played a key role in providing detailed imaging studies, such as CT angiograms, to assess the patient's vascular structure and plan for the procedure. Anesthesia management was crucial, and the team employed advanced monitoring techniques to manage the patient's condition during the procedure. Post-surgery, the team worked together to manage the patient's recovery, ensuring timely rehabilitation and follow-up care. The collaboration of various specialists allowed for effective risk management, ultimately contributing to the patient's favorable outcome (Bragazzi et al., 2021).

Case Study 3: Elderly Patient with Coronary Artery Disease

An elderly patient with advanced coronary artery disease was admitted for a coronary artery bypass grafting (CABG) surgery. The case required collaboration between cardiologists, radiologists, anesthesiologists, and cardiac surgeons to assess the patient's

suitability for surgery. Due to the patient's age and other comorbidities, the anesthesiology team was involved in developing a plan to manage the patient's specific needs during the procedure, including minimizing the risk of complications such as arrhythmias. Postoperatively, the ICU and nursing staff were essential in monitoring the patient's recovery, while the cardiology team ensured optimal cardiac function. The multidisciplinary approach not only improved the surgical outcome but also contributed to the patient's overall quality of life during recovery (Amini et al., 2021).

Case Study 4: Patient with Complex Aortic Dissection

A 45-year-old male patient presented with an acute aortic dissection and required immediate intervention. The multidisciplinary team, consisting of cardiologists, vascular surgeons, anesthesiologists, and radiologists, was essential in managing the critical condition. Radiological imaging, particularly CT and MRI, provided vital information about the dissection's location and severity, guiding the surgical team in their approach. Anesthesia management was particularly challenging due to the patient's unstable condition, and the anesthesiologists collaborated closely with the surgical team to optimize perioperative care. Post-surgery, the patient was monitored by a dedicated ICU team to manage any complications, with the cardiology team ensuring long-term management of the patient's cardiovascular health (Safiri et al., 2022)

10. Ethical Considerations

The rapid evolution of US, CT, and MRI technologies compel documentation of the current status with a prospective view of the possible developments. Radiologists have the opportunity to be updated through education and continuous training about the use of US, CT, and MRI. This technology offers the chance of a variety of innovations regarding their possibilities of exploration and the numerous sequences that characterize them. Good results can be obtained by radiographers without a dedicated radiologic preparation. Radiologists are entrusted with this task to always remain informed on how to set up these examinations, which sequences to prefer, and to provide basic information on how to carry out the examination better.

In addition, until recently the US, CT, and MRI devices were static instruments, complex to set up because of numerous adjustable parameters; furthermore operating these tools was necessary the constant presence of dedicated radiographers able to perform the explorations directly in the rooms of the magnetic resonance and CT cameras. Recently, dynamic systems have been developed which, although inhibiting a part of the high spatial resolution at low wavelengths, make it possible to obtain useful images directly in the form of a reading station carried in the vicinity of a lesion seen during breast ultrasound examination. There are similar applications also in echo color Doppler that can perform a scanning operation. The automated evaluation of an enormous number of variables detected by MRI, Mammotome, vacuum-assisted biopsies or by the new devices under development would become possible. All this is hoped that in the future will lead to extensive applications, however on large multicentric national databases of high-quality acquisitions (Pepe et al., 2023). In closing, this perspective wants to raise awareness of the fact that the possibility of producing increasingly detailed reports is entrusted to those who realize the images, that is, the radiologists, with the consequence that only they are in a position to process. Discuss with other medical staff (general practitioners, thoracic surgeons, gynecologists, dentists, urologists ... etc.) the results of the investigations carried out to try to find the best management possible to offer to our patients, based of the intimate notion of tailored patient-centered care by the physicians. (Li et al.2021)(Li et al.2023)(Qiu et al., 2023)

Conclusion and Future Prospects

Radiology, anesthesia. Ultrasound (US), computed tomography (CT), and magnetic resonance (MR) imaging techniques and their latest advancements have been described. Future cardiovascular technology perspectives are related to radiology with its current features and progress. Different publications have been analyzed to report the latest progress within the field of radiology, anesthesia, and cardiovascular technology with respect to cardiology.

It is shown the latest advancements in the US (including in 3D/4D and their newest techniques, such as Curved-Multiplanar Reformation), CT (dual-energy and photon-counting techniques, ultra-wideband photon-counting CT, a 16 cm wide-area detector CT scanner, BiPap-ion-CT), and MRI (including body, and their newest techniques, such as mapping, strain, and 4D flow MRI) technologies, and unusual multisystem-related innovations, for instance, the world's first wearable isolator for use in sports conditions or a technique that allows the use of artificial intelligence to predict hyperkalemia in patients undergoing a contrast-enhanced CT scan. Annotations are made about hybrid [18F] FDG PET-MRI, which is unique in radiology, and in addition, there is an examination of style of writing of MRI reports, with the proposal that the use of more complex sentence can better clarify the radiologist's doubts and better direct any necessary therapeutic care. In particular, the progression of cardiovascular

technology will depend on the development of new MR sequences. It is easier to also acquire the latest aspects of radiology to continue research practice.

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