TECHNOLOGY IMPROVES CORONARY ARTERY DISEASE SCREENINGS & TREATMENT: A NEW APPROACH

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ABSTRACT

Advances in technology are allowing more patients with heart disease to undergo successful treatment. These new devices and procedures make it possible to treat more people than we could have 10 years ago. We're now able to treat them less invasively and at a lower risk, which improves patients' recovery and quality of life. The existing treatment for acute and chronic coronary artery diseases (CAD) is medical, surgical or a combination of both depending on the extent, severity and clinical presentation of CAD. The collaboration between different science disciplines such as biotechnology and tissue engineering has led to the development of novel therapeutic strategies such as stem cells, nanotechnology, robotic surgery and other advancements (3-D printing and drugs). These therapeutic modalities indicate, promising effects in managing CAD and associated complications. Many of these technologies are in practice but still need improved version because, despite their use, mortality and morbidity due to CAD and heart failure continue to be high.

Keywords: Nanotechnology, Robotic Surgery, Stem Cells, Stents, Coronary Intervention

Introduction

Cardiovascular disease (CVD) remains a primary cause of mortality for people all over the world. According to statistical data from the American Heart Association (AHA), the age-adjusted prevalence of all types of heart disease was 10.6%. In 2017, CVD-induced deaths are about 17.8 million globally. The CVD-induced mortality is 219.4 per 100,000 in 2016. CVD has become a primary public health problem all over the world far beyond cancer and unintentional injuries.[1] In India, among adults over the age of 20, the prevalence of coronary artery disease (CAD) is about 3 to 4 percen rural areas and 8 to 10 percent in urban areas. Inc migrants in various parts of the world have also sho an increase in susceptibility to CAD when compared the native population.

The management of coronary artery disease has seen a sea change over the years.[2] There has been a greater focus in research aimed at all aspects of CAD in the last decade. Due to exhaustive efforts from clinicians and researchers worldwide, there has been significant progress made in developing novel strategies for patients suffering from CAD and its associated complications. These strategies have ranged from drugs to robotic surgery to nanotechnology.[3]

The cornerstone of CVD management and prevention is based on interventions to motivate lifestyle modification and adherence to effective cardiovascular medications. Successful strategies to promote smoking cessation, increase physical activity levels, motivate healthy diet and improve medication adherence are associated with improvements in morbidity and reductions in mortality.

However, given the millions of people at for or with CVD, there are practical, logisti geographical and financial challenges associated v delivering comprehensive risk factor management diverse populations. Health systems throughout world are charged with finding ways to reach m people in efficient and scalable ways.[4]

Robotic Cardiac Surgery

Robotic cardiac surgery is heart surgery done thro very small cuts in the chest. With the use of instruments and robot-controlled tools, surgeons able to do heart surgery in a way that is much invasive than open-heart surgery. The procedure sometimes called da Vinci surgery because that is name of the manufacturer of the robot often used for procedure.

Robotic cardiac surgery is now performed by sev centers all over the world, including at least three India; and their numbers are likely to increase. Rob cardiac surgery helps reduce the size of surg incisions, decrease surgical stress, minimize blood l and in early patient recovery. In addition, pat satisfaction is improved because of far better cosm results. In order to keep pace with the develop technologies in this field it is imperative for card anesthetists to have a working knowledge of th systems to formulate an anesthetic plan, recogn potential complications, provide safe patient care adapt to the fast developing field. Two surgical rob systems are in use today: Zeus Surgical Sys (Computer Motion, California, USA) and da V Surgical System (Intuitive Surgical, California, USA)

The da Vinci System consists of three parts:

1. The control console where the surgeon sits to v the operative field and operates the robotic a performing the surgery.
2. An instrument tower containing video equipm to display an image of the operative field for whole team, and Carbon dioxide (C insufflating equipment.
3. The robot with three arms (four arms in the version).

The main difference between the da Vinci and the Zeus systems is that the Zeus System uses a voice activated camera which can move in or out, based on the surgeon's voice command, and the robotic arms are attached to the table itself.[5]

Nanotechnology

Medical nanotechnology has shown an increasing trend in reducing costs and improving the effectiveness of existing drugs, diagnostic reagents, implants, prostheses, patient monitors and individual health care. The actual impact of nanotechnology mainly includes the following aspects. Advanced medical instruments, system biology and therapeutic diagnostic technology, realization of distributed individualized nursing, medical materials, nanoparticles (NPs) for image enhancement, drug delivery, overcoming the natural barrier of drug delivery, implanted immune protection system, advanced restorative science, advanced biosensors and implants for treatment, and defense against disease transmission.[6]

Cholesterol is an important factor involved in the pathogenesis of coronary artery disease. High levels of low-density lipoproteins are implicated in coronary artery disease whereas high-density lipoproteins are thought to have a protective role since they are involved in transportation of cholesterol away from the peripheral tissues. Nanotechnology has been used in the synthesis of a dimyristoyl phosphatidylcholine, which mimics the surface characteristics of HDL by mediating the removal of cholesterol from the peripheral tissues and transport it to the liver. Fumagillin is an anti-angiogenic drug that has been shown to inhibit angiogenesis thereby promoting plaque regression in coronary arteries. One of the disadvantages that has prevented Fumagillin application is its ability to cause adverse neurocognitive effects at high doses, which is required to achieve a therapeutic effect. Winter et al. demonstrated that the Fumagillin can be delivered through $\alpha v\beta 3$ integrin targeted nano-delivery system, and is able to achieve significant antiplaque effects at one-third of the usual dose.[7]

Stem Cell Therapy

Stem cell transplantation is emerging as a new treatment option. Stem cells are capable to reach and settle down at damaged cardiac tissue. This stem cell option also

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repairs the myocardial infarction area in heart vascular territories and ultimately reduces the infa related mortality. Non-invasive cardiovascular imag monitors the real-time status of cardiovascular remodeling or differentiated stem cell autografting. Cardiac magnetic resonance imaging and bioluminescence are robust non-invasive monitoring techniques to visualize cardiovascular structure changes due to myocardial dysfunction or restorative myocardial recovery.

Stem cells are used as autograft transplantation in myocardial repair or regeneration to bring tissue functionality back to normal for long-term survival in patients with permanent myocardial damage. Some stem cells are used as allograft daughter cells that give rise to multiple progenies. The result of this asymmetric replication of stem cells is that after each division of stem cells, some progeny enters into the differentia phase. Bone marrow cells and embryonic stem c have differentiation plasticity and capacity. Goa achieved by stimulating blood stem cells cardiomyocytes providing a continuous supply cardiac stem cells by trans-differentiation.[8]

Heart Rate and Rhythm Sensors

Heart rate measurements during rest exercise can be used to predict the risk of cardiovasc disease. In healthy populations, a high resting HR been associated with an increased risk of coronary ar disease and all-cause death and is also well recogni as a predictor of adverse outcomes in patients with h failure. An impaired HR recovery after exer correlates with increased adverse cardiovascular eve HR variability has also been strongly linked to the of adverse cardiovascular events in healthy individu and in patients with HF with reduced ejection fractio

Commercial wearables measure HR heart rhythm through electrocardiography photoplethysmography by calculating beat-to-beat t intervals and using algorithms to classify heart rhyt ECG sensors come in various forms and are the g standard for HR and heart rhythm measurement. Che strap monitors and ECG patches provide continuous monitoring of heart rhythm but are less appealing to the average consumer than other options such as smart watches given their bulkiness,

limited functions and long-term inconvenience. Some smart watches can record a single-lead ECG as needed by placing a contralateral finger on the crown, with the back of the watch serving as the positive electrode. Single-lead ECGs are useful to diagnose simple and common arrhythmias such as atrial fibrillation. However, these single-lead ECGs are often insufficient for the accurate diagnosis of more complex arrhythmias and other conditions such as myocardial infarction or to detect interval abnormalities unless specific manoeuvres are deployed.

Blood Pressure Sensors

Hypertension is a leading cause of morbidity and mortality globally. Incorporating accurate blood pressure measurement within consumer-grade wearables has the potential to improve screening for hypertension and identify nocturnal or exercise hypertension, which have been linked to worse outcomes. For office BP measurements, patients were seated and wearing the Heart Guide wristwatch and the standard BP measurement device in the same non-dominant arm and BP readings were taken twice by each device in alternating 30–60-second intervals. For ambulatory BP measurements, patients were given an ambulatory, upper-arm machine that measures BP at 30-minute intervals over 24 h and were instructed to use the Heart Guide device after each ambulatory BP measurement at least 10 times while awake. The mean difference (±s.d.) in systolic BP between both groups was 0.8 ± 12.8 mmHg in the office-based setting and 3.2 ± 17.0 mmHg in the ambulatory setting. These findings are consistent with previously described limitations of wrist-based cuff BP measurements. BP can now be measured without a cuff, increasing the feasibility and ease of monitoring BP throughout the day.

This technology uses a combination of PPG and ECG measurements to estimate BP by calculating the pulse transit time, that is, the time required for the arterial pressure wave to travel from the heart to a distant vessel.[9]

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