Clinical applications

The cardiology care cycle

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Cardiovascular disease (CVD) is the commonest cause of death worldwide [1]. It is estimated that 80% of premature deaths from CVD could be avoided by a healthy lifestyle [2]. The classic heart attack, or acute myocardial infarction (AMI), occurs when blood supply to part of the heart muscle is interrupted. This is usually due to occlusion of a coronary artery following the rupture of vulnerable atherosclerotic plaque in the arterial wall. If left untreated, the resulting ischemia can cause permanent damage to the heart muscle.

The classic symptoms of AMI in men include sudden chest pain (typically radiating to the left arm or left side of the neck), shortness of breath, nausea, palpitations, sweating, and anxiety. In women, the symptoms may be limited to a general feeling of fatigue and indigestion [3]. A heart attack is always a medical emergency, and immediate treatment is essential in order to limit the extent of the damage.

Effective cardiac care depends on a number of factors. These can be summed up in the Cardiology Care Cycle (Figure 1), covering all aspects of patient care from disease prevention to screening and diagnosis through treatment, health management and surveillance.

The different phases of the care cycle are closely linked to the development of the disease. Primary prevention aims at reducing the exposure to risk factors and usually targets the entire population or groups that are at risk of developing cardiac disease. Health promotion, health education and health protection are three main aspects of primary prevention.

Secondary prevention is targeted at (asymptomatic) individuals at risk in order to prevent or delay onset of the disease. Secondary prevention strategies include screening activities and prophylactic treatment. The onset of symptoms marks the transition to clinical disease. The next phases of the care cycle: diagnosis, treatment, management and surveillance, apply to individuals with the clinical disease.

The purpose of these phases is to prevent further impact from the disease by relieving the effects of the disease (e.g. by angioplasty or surgery), retarding further progress of the disease, and tertiary prevention (i.e. prevention of disease recurrence). Depending on the severity of the disease, care may include chronic treatment and surveillance.

The care cycle also offers a useful tool for assessing care delivery, and identifying those areas where cost-effectiveness and quality of care might improve. In addition, it enables industry to identify how products and services can best contribute to improving patient care and lowering cost.

At Philips, Simplifying Cardiac Care through the care cycle approach has led us to focus on four main cardiac themes:

- timely triage
- discovery to treatment
- minimally invasive interventions
- home health care.

The US Department of Health and Human Services and the American Medical Association (AMA) define a care cycle as follows: “The array of health services and care-settings that address health promotion, disease prevention, and the diagnosis, treatment, management, and rehabilitation of a disease, injury, and disability. Included are primary care and specialized clinical services provided in community and primary care settings, hospitals, trauma centers, and rehabilitation and long-term care facilities”.

Figure 1. The Cardiology Care Cycle.
A host of diagnostic and imaging modalities are utilized to triage cardiac patients. Next to cardiography, echocardiography, and cardiac nuclear examinations, advanced imaging techniques such as multidetector CT [4] and cardiac MRI are gaining acceptance for complex cases, when impaired heart function is suspected.

Multi-detector computed tomography (MDCT) scanners have gained increasing clinical acceptance as a non-invasive modality of choice for cardiovascular imaging. The recently introduced Brilliance iCT scanner delivers improvements in speed, power and coverage, alongside enhanced dose reduction capabilities and workflow that provide improved imaging for cardiovascular diseases.

Cardiac magnetic resonance imaging (MRI) now offers methods to investigate the function of the heart in a clinical setting. Its use as a routine method in cardiology is, however, hampered by its relative complexity. Investigations into simplification of procedures, and reductions in the amount of training required, are currently underway, focusing on dedicated task guidance and automation.

The euHeart project

As from August 2008, Philips Healthcare is leading a new European Union funded research project called ‘euHeart’, which is aimed at improving the diagnosis, therapy planning and treatment of cardiovascular disease. The euHeart project complements the Philips Cardiology Care Cycle project by targeting the diagnosis and treatment phases of the care cycles for heart conditions such as heart failure, coronary artery disease, heart rhythm disorders, and congenital heart defects.

The project forms part of the Virtual Physiological Human (VPH) initiative – a collaborative effort that aims to produce a computer model of the entire human body so that it can be investigated as a single complex system (Figure 2). The euHeart consortium comprises public and private partners from 16 research, academic, industrial and medical organizations from six different European countries. The University of Oxford (Oxford, UK) is the scientific coordinator of the project, while King’s College London (London, UK) leads the clinical program.

Discovery to treatment

Reducing time from discovery in the pre-hospital to treatment is critical. In the case of patients presenting with symptoms of an acute myocardial infarction (AMI), a 12-lead ECG is the standard...
diagnostic tool that distinguishes between those cases where the ST segment of the ECG signal is elevated, referred to as ST elevation MI (STEMI) and those where it is not elevated (non-STEMI, or nSTEMI). STEMI is the most dangerous form of AMI and minutes count in determining survival. The care cycle approach for STEMI patients is shown in Figure 3.

If STEMI is detected, whether in the pre-hospital setting by the paramedic, or in the emergency department, it is critical that timely reperfusion treatment is provided. The standard of care for STEMI patients is percutaneous coronary intervention (PCI, angioplasty and stent insertion) in the cath lab, in less than 90 minutes from arrival at the hospital. Scientific evidence suggests that the risk of in-hospital death increases with each 15-minute interval beyond 90 minutes (Figure 4). More recent studies suggest the time be measured from “Discovery” in the pre-hospital setting [5]. In the case of long transport times or other situations where PCI is not available within the 90 minute guideline, thrombolysis is an alternate treatment [6].

There are several ways in which time to treatment can be reduced (Figures 5 and 6). Most of these are related to improving team work across the care cycle: between emergency medical services, the emergency department and the cardiac cath team [7, 8].

Example: A major time saving can be effected by enabling decision making in the ambulance and emergency department (Figure 7). For example, the ECG can be performed while the patient is en route to the hospital, and the results transmitted to the hospital by wireless connection so that they are available when the patient arrives.

The availability of a monitor/defibrillator with 12-lead ECG capability is critical. Specifically designed for use by paramedics, the Philips HeartStart MRx ALS Monitor (Figure 8) combines full 12-lead view with superior diagnostic measurements. If the patient arrests with ventricular fibrillation, the patented SMART Biphasic defibrillation waveform comes into action. The HeartStart MRx Monitor/Defibrillator also allows paramedics to transmit patient data from the ambulance to the hospital’s ER en route. Upon reception of the data at the hospital, clinicians can use the ECG data to begin assessing and preparing for the treatment the incoming patient will need. By allowing a hospital to begin organizing its resources before the patient arrives, the MRx can help reduce the time to treatment.
In addition to transmitting ECG data to the hospital prior to the patients’ arrival, the HeartStart MRx integrates seamlessly with the hospital’s ECG management system TraceMasterVue, enabling critical patient information to be seen where it’s needed – even in the cath lab.

**Minimally invasive interventions**

Coronary surgery is increasingly being replaced by minimally invasive interventions carried out in the intervention cath lab (Figure 9). Percutaneous transluminal angioplasty (PTCA) and stenting are already well-established techniques, but the scope and accuracy of the procedures is increasing with the availability of three-dimensional imaging and image enhancement techniques for better visualization of stent placement [9].

Novel acquisition techniques such as dual axis rotational angiography (XperSwing) provide adequate information for the diagnosis of coronary artery disease with reduced X-ray dose and contrast agent usage [10].

Structural heart disease (SHD) intervention is another area where several novel applications of existing 3D imaging modalities are currently being explored. New 3D ultrasound imaging techniques using live 3D TEE are increasing the understanding of how the heart fills, improving diagnosis and treatment of diastolic dysfunction, including mitral valve repair, avoiding the need for valve replacement.

The EP Navigator fuses 3D CT and fluoroscopy images for navigation. It allows the user to confirm the position of any catheter or lead position with respect to detailed images of the 3D cardiac anatomy, allowing complex EP procedures to be carried out with greater confidence [11].

Several novel applications of existing 3D imaging modalities are currently being explored. These include registration of pre-procedure CTA and MRA 3D data sets with live fluoroscopy, and the application of real-time 3D transesophageal echocardiography (TEE).

**Home health care**

The cardiology care cycle does not end when the patient is discharged from hospital. Managing chronic heart conditions at home is designed to improve the quality of life and may reduce the need for frequent hospitalization [12-14].

Telehealth solutions enable clinicians to remotely monitor patients’ vital signs and other relevant data and send them short surveys about their health status. This combination of objective data and subjective responses enables the clinician to make more timely care decisions and helps prevent unnecessary hospitalizations.

**Remote Patient Monitoring**

Philips Remote Patient Monitoring provides secure, two-way flow of information between remote caregivers and chronically ill patients. The TeleStation is the hub for the transmission and other vital signs data (automatically...
collected from the wireless measurement devices or manually entered) and provides interactive communication between care providers and patients at home.

The TeleStation prompts patients to answer health assessment survey questions—which can be customized to their clinical problem. Every day, patients take their own vital signs measurements as prescribed by their doctor: weight, blood pressure, pulse, glucose level, blood oxygen level and/or ECG rhythm. They also answer survey questions sent by their clinician, which may include general health assessment questions and/or targeted follow-up questions, and enter self-reported data as directed. The information is then automatically transmitted through an ordinary phone line via modem to secure web-based Clinical Review Software. Clinicians can track daily patient measurements, store and retrieve historical data in both tabular and graphical format, and generate reports—promoting faster follow-up and intervention.

The TeleStation will automatically send an AutoCheck survey to follow up on out-of-limit readings. Clinicians can tailor patients’ daily interactions to help reinforce specific topics: signs and symptoms, medication and side effects, diet and lifestyle, and compliance with care protocols.

These automated interactions can streamline clinical workflow by minimizing unnecessary phone calls and by enabling clinicians to contact the highest priority patients—equipped with the data they need for more timely intervention.

**Philips Lifeline**

Philips Lifeline helps seniors and people with mobility problems to live in their own homes, with greater independence and dignity. Lifeline is the preferred provider of medical alert services to members of the Visiting Nurse Associations of America, and to thousands of leading hospitals across the United States.

Lifeline has a large and experienced group of response staff. A simple touch on the Personal Help Button connects the subscriber to a qualified Professional Response Associate at any time of the day or night. The Associate assesses the situation and then notifies the appropriate support and medical response team as required.

**Information technology (IT)**

Information technology has a key role in the Cardiology Care Cycle. In addition to Xcelera Cardiac PACS and departmental IT systems, Philips offers a Cardiovascular Information Management System (CVIS). The CVIS collects and aggregates patient data across all care...
settings involved in cardiac care. All information is integrated into a single, relational database and provides authorized healthcare professionals with quick and easy access to patient information via any standard PC/workstation across the enterprise.

In addition to patient data, the CVIS also provides scheduling, staff and resource management, cost capturing, and the generation of reports and statistical information, thereby supporting the management of a cardiovascular service line.

The CVIS connects with various clinical information systems such as Cath lab workflow management systems (Xper IM), Philips Xcelera PACS and TraceMasterVue ECG management systems, as well as systems from other manufacturers.

Conclusion

The care cycle approach represents a paradigm shift in the provision of healthcare for those patients at risk of cardiac disease. It covers all aspects of patient care from disease prevention to screening and diagnosis through treatment, health management and surveillance.

The care cycle also offers a useful tool for assessing care delivery, and identifying those areas where cost-effectiveness and quality of care might need improvement.

For industry, the care cycle helps to identify how the integration of products and services can create synergies that help improve patient care and reduce costs.

References


