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Process optimization in medical care by technical innovations and digitization

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During the last decades, digitization have made life easier for everone. However, this process is not completed yet but ongoing. Actually, the process of digitization, interoperability and Internet of things have just started. Besides “normal life” and “industry 4.0”, even in medical care technical innovations and disruptive developments will have a major effect on future patient care and treatment. Systems using data mining and artificial intelligence aim to partly substitute physicians, telemedical applications provide “tele-present” specialists, numerous apps and wearable aim to improve the health of us customers. Indeed, technical innovations can optimize processes in medical care including the Emergency Medical Service (EMS), the acute care, the intensive care and the further patient treatment.
Exemplary projects addressing the issues “telemedicine”, “interoperability” and “innovative human-machine-interaction” will be presented that might have a major effect on future medical care. The tele-emergency physician will neither substitute the physician on-scene nor the paramedic on-scene, but will be an additional, meaningful module in EMS to improve quality. Manufacturer-independent data exchange protocols – based on the IEEE 11073 standard family dealing with medical device communication – will provide the precondition to realize an entire device-to-device communication in operating rooms, intensive care units and further hospital divisions. By means of augmented reality, a smart glasses can be applied in various medical fields. Adaptive to the actual context, helpful information, checklists, algorithms and messages can be displayed unobstrusively ensuring a high-quality, guideline-oriented medical treatment, e.g. in the management of mass casuality incidents.

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Experience with two measurement modalities to objectify pulse palpation during cardio-pulmonary resuscitation

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Cardio-pulmonary Resusitation (CPR) is the emergency treatment for patients suffering from a cardiac arrest with the goal of achieving return of spontaneous circulation (ROSC). The most basic approach for the assessment of ROSC is manual palpation, where a rescuer tries to feel the passing of a cardiac pulse by placing one or two fingers on the carotid or femoral artery. Palpation can only be applied during pauses in compressions and has been found to be unreliable, subjective and in particular time-consuming (often 25s or more even for trained people). It has a reported sensitivity of 90% and specificity of 55%. Nevertheless, palpation is a very important technique for the assessment of the need for CPR in an emergency situation and is recommended for Advanced Life Support (ALS) rescuers. Objectified detection of pulse presence is an obvious need in CPR for which a simple, low-cost and reliable sensor is currently missing. Such a sensor can assist rescuers to rapidly recognize a cardiac arrest situation requiring CPR and can help them determine when CPR should be stopped. Various approaches to objectify pulse presence in CPR applications have been investigated. This work presents our experience with two techniques to detect the presence of a spontaneous cardiac pulse: 1.) photoplethysmography (PPG) and 2.) accelerometry (ACC) at the carotid. The PPG approach has been tested in animal studies during automated and manual CPR. The animal studies showed that a spontaneous pulse could be recognized in the PPG signal in few-second pauses. Furthermore, spectral analysis allowed to recognize the spontaneous pulse rate during ongoing compressions and distinguish the spontaneous pulse rate from the compression rate. The ACC approach was initially evaluated in studies with healthy volunteers. Subsequently, ACC data were obtained in head-up tilt table tests and intensive care patients. Promising results with sufficient performance could already be observed for a limited set of clinical ACC data acquired during CPR.

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Cardiac support in emergency situations

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In contrast to a broken leg, the heart cannot be immobilised for functional regeneration in case of a heart failure. Instead, the blood has to be continously pumped through the body. Heart failures typically occur due to an oxygen deficiency caused by an obstruction of coronary vessels, an infection or mechanical/electrical dysfunction mainly resulting in a failure of the heart muscle of the left ventricle which is responsible for pumping the blood into the peripheral system. Hence, currently available therapy devices focus on the support of the left heart, e.g. the so-called LVAD (left ventricular assist devices), IABP (intra-aortic ballon pump) or the Impella® (an intravascular rotary blood pump).
The idea of the application of an Impella® pump is to have a small indwelling size and a short implantation time with the goal to recover the heart function. Therefore, all Impella® pump types are small in diameter (4-7.3 mm), generate blood flow by an impeller (2.5 – 5 L/min), and can be introduced via an artery into the left heart so that the cannula of the pump bridges the aortic valve. Right heart support devices are also available. For monitoring, a sensor measures the blood pressure in the aorta.
Today, the Impella® pumps are mainly used during cardiac interventions such as high-risk PCI (percutaneous coronary intervention) according to guidelines, and in the case of cardiomyopathy and myocardial infarction. A study on the pump efficiency during cardiogenic shock treatment is in progress. In addition, current animal trials focus on CPR support. More than 50.000 patients have already been treated in the U.S. and, for the future, the treatment of more cardiac failure scenarios is in focus. In addition, new pump generations are planned for pediatric and long-term support.