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In-Hospital Cardiac Arrest

*A Study of Education in Cardiopulmonary
Resuscitation and its Effects on Knowledge, Skills
and Attitudes among Healthcare Professionals and
Survival of In-Hospital Cardiac Arrest Patients.*

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Abstract

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This thesis investigated whether outcome after in-hospital cardiac arrest patients could be improved by a cardiopulmonary resuscitation (CPR) educational intervention focusing on all hospital healthcare professionals.

Annually in Sweden, approximately 3000 in-hospital patients suffer a cardiac arrest in which CPR is attempted, and which 900 will survive.

The thesis is based on five papers:

Paper I was a methodological study concluding in a reliable multiple choice questionnaire (MCQ) aimed at measuring CPR knowledge.

Paper II was an intervention study. The intervention consisted of educating 3144 healthcare professionals in CPR. The MCQ from Paper I was answered by the healthcare professionals both before (82% response rate) and after (98% response rate) education. Theoretical knowledge improved in all the different groups of healthcare professionals after the intervention.

Paper III was an observational laboratory study investigating the practical CPR skills of 74 healthcare professionals'. Willingness to use an automated external defibrillator (AED) improved generally after education, and there were no major differences in CPR skills between the different healthcare professions.

Paper IV investigated, by use of a questionnaire, the attitudes to CPR of 2152 healthcare professionals (82% response rate). A majority of healthcare professionals reported a positive attitude to resuscitation.

Paper V was a register study of patients suffering from cardiac arrest. The intervention tended not to reduce the delay to start of treatment or to increase overall survival. However, our results suggested indirect signs of an improved cerebral function among survivors.

In conclusion, CPR education and the introduction of AEDs in-hospital – improved healthcare professionals knowledge, skills, and attitudes – did not improve patients' survival to hospital discharge, but the functional status among survivors improved.

Keywords: cardiac arrest, cardiopulmonary resuscitation, in-hospital, healthcare professionals, education, multiple-choice questions, hjärtstopp, hjärt-lungräddning, sjukhus, sjukvårdspersonal

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”Bara de som sover gör inga misstag”

Ingvar Kamprad

List of papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.

- I Södersved Källestedt ML, Leppert J, Enlund M, Herlitz J. Development of a reliable questionnaire in resuscitation knowledge. American Journal of Emergency Medicine. 2008;26:723-728
- II Södersved Källestedt ML, Rosenblad A, Leppert J, Herlitz J, Enlund M. Hospital employees' theoretical knowledge on what to do in an in-hospital cardiac arrest. Scandinavian Journal of Trauma, Resuscitation and Emergency medicine. 2010, 18:43
- III Södersved Källestedt ML, Berglund A, Thorén AB, Herlitz J, Enlund M. Occupational affiliation does not influence practical skills in cardiopulmonary resuscitation for in-hospital healthcare professionals. Scandinavian Journal of Trauma, Resuscitation and Emergency medicine. 2011, 19:3
- IV Södersved Källestedt ML, Herlitz J, Berglund A, Leppert J, Enlund M. The impact of education on healthcare professionals' attitudes to performing resuscitation. Submitted
- V Södersved Källestedt ML, Berglund A, Enlund M, Herlitz J. In-hospital cardiac arrest characteristics and outcome after defibrillator implementation and education: from one single hospital in Sweden. Submitted

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Abbreviations

ACLS	Advanced Cardiac Life Support
AED	Automated External Defibrillator including Semi-Automated External Defibrillator = SAED
AHA	American Heart Association
AIDS	Acquired Immunodeficiency Syndrome
BLS	Basic Life Support
CABG	Coronary Artery Bypass Grafting
CPC	Cerebral Performance Category Scale
CPR	Cardiopulmonary Resuscitation
D-CPR	Defibrillator Cardiopulmonary Resuscitation
EMS	Emergency Medical Service
ERC	European Resuscitation Council
ESC	European Society of Cardiology
ICD	Implantable Cardioverter Defibrillator
ICN	Internal Council of Nurses
ICU	Intensive Care Unit
HIV	Human Immunodeficiency virus
ILCOR	International Liaison Committee on Resuscitation
IHCA	In-Hospital Cardiac Arrest
MCQs	Multiple Choice Questions
PCI	Percutaneous Coronary Intervention
PEA	Pulseless Electrical Activity
ROSC	Return of Spontaneous Circulation
SARS	Severe Acute Respiratory Syndrome
SSC	Swedish Society of Cardiology
VF	Ventricular Fibrillation
VT	Ventricular Tachycardia

A case

It is early in the morning on an orthopaedic ward. Tommy, 57 years of age, is on his way to the bathroom to prepare himself for hand surgery.

An assistant nurse is on her way to the bathroom with some towels, for Tommy to use. She knocks on the bathroom door and hears a thud from inside the bathroom, she opens the door and sees Tommy lying on the floor. The assistant nurse shouts “help” and controls signs for consciousness and breathing; she believes it is a cardiac arrest. She thinks of when she took part in the cardiopulmonary resuscitation (CPR) education in the hospital. She remembers that the instructor talked about the chain of survival and she starts with chest compressions. The ward nurse arrives and the assistant nurse asks her to alarm the rescue team, and also request the nurse to bring the ward’s automated external defibrillator (AED). The assistant nurse maintains CPR. The nurse connects the AED to Tommy, and the assistant nurse does not interrupt the chest compressions until the AED tells her to do so. Whilst the AED analyses the heart rhythm, the rescue team arrives and prepares to supply oxygen. The medical physician now takes command of the situation. Tommy is defibrillated once and his heart rhythm becomes regular; CPR is performed further until he starts coughing after approximately one minute. The rescue team transports him to the coronary care unit for post- resuscitation care.

Rationale for this thesis

When I was working as a registered nurse in the coronary care unit, cardiac arrest was a possible part of the care. My interest for cardiac arrest patients intensified, and so also did my curiosity about the differing attitudes among my colleagues. When I moved to work at the intensive care unit (ICU) I developed a sense that patients suffering cardiac arrest on other hospital wards received different treatments and/or first response. It seemed to depend on which ward they came from to the ICU. The organisation of resuscitation had somehow faded away in a big reorganisation undertaken at the hospital some years earlier. After the big reorganisation, only the intensive care-, coronary, and emergency departments had regular repetition courses for the hospital's healthcare professionals.

Could it be right that patient outcome after an in-hospital cardiac arrest depended on the ward where the cardiac arrest occurred? My instinctive reaction was that all resuscitation efforts should be initiated with the same standard procedure, independent of the ward where the cardiac arrest started.

1 Introduction

Health care professionals are expected to provide the best possible treatment to patients. According to Swedish law [1], patients are supposed to receive equal care irrespective of where they live in Sweden. Cardiopulmonary resuscitation (CPR) focalises this legal requirement, as it has to be started immediately, and be undertaken in the correct way. Delayed treatment will aggravate patient outcome, as will an incorrectly accomplished procedure. In the worst case, the patient will die. Thus, education and repeated training in CPR are essential factors in our obligations to patients.

1.1 History

Cardiopulmonary resuscitation, as performed by healthcare professionals today, includes ventilation, chest compressions, and the use of a manual or automated external defibrillator (AED). The first reported act of resuscitation was described in biblical times, when the prophet Elisha performed mouth to mouth ventilation on a child [2]. At the introduction of general anaesthesia around 1842, cardiac arrest became a concern of several healthcare professions [2]. Studies on chest compressions were performed on animals, such as cats and dogs, in the late 19th and early 20th centuries. In the year 1904 Keene described that a human was resuscitated with internal chest compressions by a Norwegian surgeon [3]. Thereafter, however, there was a delay in the evolution of CPR until 1960, when the classic study by Kouwenhoven, Jude, and Knickerbocker was published [4]. In that paper, two techniques of chest compression were described: (1) open chest with internal chest compressions and (2) a new method with compressions of a closed chest. The technique with closed chest compressions was similar to today's techniques.

CPR equipment, such as defibrillators, started to evolve in the early 20th century. In 1947, a young boy was successfully defibrillated in an operating room with internal defibrillation [5]. The first closed- chest defibrillation was performed in 1956 [6]. Martin H:son Holmdahl from Uppsala University Hospital worked in the United States between 1960-61. There, he met Kouwenhoven and developed a plan for an alternating current defibrillator. This defibrillator was

introduced by Martin H:son Holmdahl as the first manual defibrillator at Uppsala University Hospital in 1961 [7]. The discovery of lithium batteries was important for the development of automated external defibrillators (AED) [8]. The AED provides advice on what to do, and the rescuer presses the shock button on the AED's advice. The use of AEDs has increased survival after cardiac arrest [9-13]. In Sweden, the general public was introduced and educated to the use of AEDs in 2008. The American Heart Association recommended AEDs in-hospital about 15 years ago. The use of AEDs with the medical services in Sweden started with the Emergency medical services (paramedics) about eleven years ago. The use of AEDs in-hospital in Sweden was recommended during the 1990s. In our county, Västmanland, AEDs were introduced at Köping hospital in 2003 and at the Central Hospital in Västerås in 2007.

The first recommendations regarding CPR in the USA came in 1966. The recommendations were that physicians and other healthcare professionals should be trained in chest compressions according to standards from the American Heart Association (AHA). During 1973, the general public was also included in these recommendations [14]. In Sweden, the first CPR education programme was introduced in 1984. This programme was developed by the Swedish Society of Cardiology (SSC), and was rapidly adopted among healthcare professionals and lay people [15-17]. Views on how best to perform CPR have been a source of research and guidelines development in the USA and Europe. Due to this research, guidelines are changed every fourth to fifth year, with the goal of improving skills among rescuers, and achieving a higher survival rate for patients after cardiac arrest. The guidelines from the year 2000 advise the rescuer to accomplish two ventilations and 15 compressions, with a rate of 100 compressions per minute [18]. The correct placement of the hands when performing chest compressions was decided to be the lower part of the sternum, with a ventilation volume of 800-1200 ml, and defibrillation recommended three times in one sequence. Thereafter, ventilation and compressions should be performed at the same ratio of 2:15, with, as before defibrillation, a rate of 100 compressions per minute. In 2005, the guidelines were changed to initiate CPR with 30 compressions, hand placement at the centre of the sternum, a compression rate of 100 per minute, followed by two ventilations, each with a volume of 500-600 ml [19]. Defibrillation was now recommended to be performed as soon as possible and only once at a time, thereafter a new round with compressions and ventilations with a ratio of 30:2 for two minutes. In 2010, new European guidelines evolved again, now recommending lay people without any education

in CPR to only perform chest compressions [19]. The new guidelines also recommend that healthcare professionals and lay people with CPR education should perform compressions in combination with ventilation in the ratio 30:2, and that defibrillation should be undertaken as soon as possible. More attention was additionally paid to high quality compressions.

1.2 Definition of a cardiac arrest

The embryonic heart already starts to beat in a three- week- old embryo, and it will then keep on beating approximately three billion times during an average lifetime [20]. One of the things we know for sure in life is that death is inevitable. This fact may actually make us wonder: “What exactly is a cardiac arrest”? Following some definitions:

“Cardiac arrest is the cessation of cardiac mechanical activity, confirmed by the absence of a detectable pulse, unresponsiveness, and apnoea (or agonal, gasping, respirations)”
(page 961, Litwin, Eisenberg, Hallstrom and Cummins, 1987) [21]

“Cardiac arrest is the cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation”
(page 214, Socialstyrelsens riktlinjer för hjärtsjukvård, 2004) [22]
(page 236, Jacobs, Nadkarni, Bahr, Berg et al, 2004) [23]

“Sudden cardiac death (SCD) is natural death from cardiac causes, heralded by abrupt loss of consciousness within 1 hour of the onset of acute symptoms. Pre-existing heart disease may or may not have been known to be present, but the time and mode of death are unexpected”.
(page 865, Myerburg, Castellanos, 2005) [24]

As can be seen, there are a number of different definitions of cardiac arrest which have changed over time. One factor influencing this is the duration of the arrest and whether it was witnessed or not [25-27].

1.3 Causes, risk factors and outcome after cardiac arrest

There are some differences in the causes of cardiac arrest between those occurring in- and outside hospital. The cause of cardiac arrest is not always obvious and, furthermore, autopsies are rarely performed today. There are indications that up to 90% of cardiac arrests are caused by ischaemic heart disease [28]. Arrhythmia, not induced by ischaemic heart disease, is the second most common cause of cardiac arrest, followed by hypotension, acute respiratory insufficiency, and acute pulmonary oedema [29]. A study from Sweden indicates that witnessed cardiac arrest is common in hospitals. Over 70% of the cardiac arrests were witnessed at regular wards [30].

The major risk factor for cardiac arrest is, as has been said, ischaemic heart disease, secondary to this is male gender and other hereditary factors. Followed by high age, high blood pressure, high blood lipids, physical inactivity, cigarette smoking, obesity and negative stress at work [31-36]. One third of all in-hospital patients who have had a cardiac arrest have a known history of myocardial infarction, one third have heart failure (cardiac insufficiency), and a major part of the rest has a known history of diabetes [29]. A clinical dilemma is that some of the cardiac arrests occur in individuals who have not been recognised as being at high risk [37]. Non- cardiac causes for in-hospital cardiac arrests are suicide, pulmonary embolism, lung disease, intoxication, electrolyte abnormalities, haemorrhage, and ruptured aortic aneurysm [38].

A report from Sweden indicated that over 80% of all patients who survive a cardiac arrest recover with good cerebral function. Most patients who survive in-hospital cardiac arrests can live almost as before the arrest. Ten percent of cardiac arrest patients suffer from severe cerebral dysfunction, coma, or brain death [38]. Another study indicates that 44% of the cardiac arrest patients suffer from worse cerebral function [39].

In Sweden, approximately 3000 in-hospital patients suffer from a cardiac arrest in which CPR is attempted each year, of which 900 will survive. Conversely a much higher number, 2100, will die, and some interpret this as that resuscitation is meaningless [38]. A good guess, however, is that anyone would greatly appreciate the survival of a close relative who had been given CPR.

1.4 Changes in rhythm and haemodynamics during cardiac arrest and resuscitation

Ventricular fibrillation (VF) or ventricular tachycardia (VT) occurs in about 20-35% of patients as the first recorded arrhythmia in an in-hospital cardiac arrest [40-42].

When the heart beats normally (sinus rhythm), the frequency is between 50-100 beats per minute. Divergence from this is called an arrhythmia. Some authors have found that VF is associated with a better outcome [43, 44]. Other rhythms found in cardiac arrest are VT, asystole and pulse less electrical activity (PEA). Ventricular fibrillation has repeatedly been reported to be associated with a better outcome than asystole and PEA [43, 44]. If CPR has not been initiated during the first few minutes after the onset of VF then, with time, an increasing proportion of cases will convert to asystole. Cardio-pulmonary resuscitation will delay this process [37]. The incidence of VF, as the first recorded arrhythmia in cardiac arrest by the arriving rescue team, is reported to have been decreasing over the last few decades [43, 44].

The electrophysiology of VF has not been completely explained. In fact, there are a number of different theories trying to explain the electrical changes in the heart that precede the onset of VF [37]. The pathological conditions that may constitute the underlying substrate for VF can be divided into four classes: 1) myocardial infarction, 2) myocardial hypertrophy, 3) cardiomyopathy, and 4) structural electrical abnormalities. The majority of structural abnormalities are related to coronary artery disease. Definitive treatment of VF requires timely correction of the arrhythmia by delivery of an electric shock to the heart. This is called defibrillation. The mechanism behind the effect of defibrillation remains obscure [37]. It is uncertain whether the same mechanisms are responsible for atrial versus ventricular arrhythmias. This being said, three predominant theories exist:

- 1) Zipes et al [45] hypothesise that the depolarisation of a critical mass does not allow the remaining muscle mass to maintain a reentrant tachycardia.
- 2) Jones et al [46] believe that defibrillation shocks prolong the myocardial refractoriness during the action potential as well as excite cells during periods of depolarised diastole.
- 3) Shibata et al [47] postulate that a certain amount of current must spread throughout the entire myocardium to prevent reentry arrhythmias.

Overall, there is growing evidence that because arrhythmias (especially tachyarrhythmias) are often the result of reentrant circuits, regional depolarisation in the area of the circuit is sufficient to terminate them [48].

The haemodynamics during a cardiac arrest are complex. Following is a simplified picture of what occurs; at the onset of a cardiac arrest a large pressure gradient exists between the central aorta (mean arterial pressure) and the right side of the heart. Despite cessation of ventricular contraction, this pressure gradient drives antegrade blood flow, and this continues until the pressure gradient is completely eliminated. It has been proposed that arterial and systemic venous pressure should reach equilibrium within 30-50 seconds after the heart has stopped beating. However, in pigs with VF the following has been described [37]: there is an early progressive reduction of aortic pressure reaching a minimum of 20 mm Hg after 30 seconds. Aortic pressure then increases slightly to 25 mm Hg at two minutes, thereafter gradually decreasing to 10 mm Hg over the next five minutes. Right atrial pressure increases gradually after the onset of VF, reaching a peak of 18 mm Hg after two minutes, thereafter it decreases to the approximate aortic pressure during the following seven minutes. During a cardiac arrest the arterial pressure will be transmitted to the venous side of the heart, and this will result in a blown heart, and the left ventricle will be shaped like the letter D.

The pressure that drives blood through the heart, i.e. through the coronary arteries, is the coronary perfusion pressure. It can be calculated by subtracting the right atrial pressure from the mean aortic pressure. Thus, it seems that there is some very minor blood flow through the coronary arteries during the first few minutes after a cardiac arrest [37].

1.5 The chain of survival

Patient survival after in-hospital cardiac arrest depends on a chain of actions that should not be delayed [49]. The “chain of survival” concept was introduced in 1991 by Cummins [50]. The chain was at first used to improve resuscitation strategies in community systems and is now used in-hospital as well. The content of the chain has changed during the years; previously it contained early advanced life support including endotracheal intubation and intravenous medication. Today, this link is removed and replaced by early post resuscitation care.

The content of the chain: early recognition and call for help, early CPR, early defibrillation, and early post-resuscitation care.



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Figure 1. The chain of survival

A short explanation of every link in the chain of survival will follow:

The first link is early recognition and call for help

This means that someone identifies the person who does not feel well at an early stage. The target is to find the person before the cardiac arrest occurs. If cardiac arrest occurs, the alarm system activates, so that individuals with the correct knowledge and skills in CPR will arrive promptly to provide assistance, or rather take command [51].

The second link is early CPR

The initiation of basic CPR by the person who finds the patient in cardiac arrest is important in gaining time until defibrillation can be performed. Only performing chest compressions is better than doing nothing at all [52].

The third link is early defibrillation

The purpose of early defibrillation is to restart the heart to a normal rhythm. Placement of AEDs at hospital wards can be a key to improving the survival rate after in-hospital cardiac arrest [13, 53, 54].

The fourth link is early post-resuscitation care

This last link in the chain of survival describes different methods of further care for the successfully resuscitated patient. The level of evidence for the post- resuscitation methods varies, and it is important to remember that the return of spontaneous circulation is not the end of the resuscitation chain [55]. The goal of this link is to facilitate recovery of the patient and it can be done with mild hypothermia for

comatose survivors [56, 57]. Another method that can be used according to Herlitz et al [58], is to optimise physiology (such as body temperature, which has relatively good evidence [56, 57], blood pressure, glucose-, acid-base-, and electrolyte status). It is further reported that there is a need for reflection on the need for revascularisation (PCI, thrombolysis, and CABG- have some evidence [59, 60]), antiarrhythmic therapy (amiodarone and beta-blocking-agents, which have some evidence [61-63]), ICD, and finally anticonvulsant therapy to prevent seizures. Some believe that this last chain influences outcome the most [64-66].

It is also believed that only medical attention and care can help the patient recover after successful resuscitation, but there is no evidence for this. The status of the patient on admission to hospital will definitely affect outcome [67, 68].

1.6 Automated external defibrillators in-hospital

According to European Resuscitation council (ERC) and American Heart Association (AHA), defibrillation is now a standard cardiac arrest treatment [50, 69, 70]. The first portable AED was introduced in 1979 [71], but it was not until the 1990s when AHA recommended AEDs in public places that the pace of change accelerated [72]. Following European guidelines, AEDs became standard treatment for the Emergency Medical Services (EMS) in 1998 in Europe. There are, however, variations in how hospitals follow the guidelines. In order to legitimise the use of, and training in, AEDs the ESC-ERC panel recommended improved access to in-hospital AEDs [73]. One study shows that there are differences in how regular in-hospital healthcare professionals are able to train and test their CPR skills during a supervised course [74]. At Västerås Central Hospital, the in-hospital healthcare professionals were educated in the use of AEDs for the first time in 2007. At a smaller hospital, located in Köping, the local health service introduced education about, and placement of, AEDs in 2003. At Västerås Central Hospital at the beginning of the current century, CPR knowledge and skills varied between different hospital healthcare professions departments. We were unaware of it at the time, but it was not unlikely that an individual suffering cardiac arrest might have actually received quicker and more adequate assistance outside the hospital, with help from a lay person and the ambulance service, than in-hospital.

An AED, with its in-built instruction program which gives voice prompts to the user, actually renders any knowledge in rhythm

analysis unnecessary. The AED instructs the user to perform defibrillation, by pushing a button, or to perform CPR. An AED's rhythm interpretation is highly accurate, with a VF exclusion specificity of almost 100%, and sensitivity of 90-95% [75-77].

Several studies show that fast access to AEDs and quick action by healthcare professionals enhances survival rates for cardiac arrest patients [78, 79]. It remains, however, that reported in-hospital survival after cardiac arrest is 15-39% [80-82], except for one study reporting an overall survival to discharge of 58% among patients with VF [83]. This is comparable with patients suffering a cardiac arrest in public places such as airports and casinos where reported survival rates are 74-79% [12, 80, 84, 85]. Chretein et al [80] emphasised out that it is important to remember that patients in- and outside hospital are different, with in-hospital patients having a heavier burden of illness, and that this will affect survival rates (a.a.). There are few studies on survival rates among in-hospital cardiac arrest patients in association with AED implementation, education, and training of healthcare professionals [73, 78]. A selection of studies on AEDs in-hospital is presented in Table 1.

Table 1. AED studies of in-hospital cardiac arrest

Author/ Journal/ Year/ Country	Chan et al./ JAMA/ 2010/ USA [86]	Forcina et al./ Crit Care Med/ 2009/ USA [87]	Hanefeld et al./ Resuscitation/ 2005/ Germany [13]	Spearpoint et al./ Resuscitation/ 2000/ UK [79]	Zafari et al./ JACC/ 2004/ USA [54]
No of INHCA	11695	561	38	479	569
Confirmed pulseless VT/VF	2079	87	18	124 Sub-set 15*	24
Return of spontaneous circulation	48.5%	67%	88.9%	19% Sub-set 100%*	-
Rate of hospital discharge	18.1%	18%	55.6%	29% Sub-set 80%*	12.8%
Main findings/ conclusion	1)	2)	3)	4)	5)

1) Use of AEDs did not improve survival after in-hospital cardiac arrest.

2) Use of AEDs did not improve survival rates compared to use of monophasic defibrillators.

3) The concept of first responder AED-defibrillation is supported, but a small sample size cannot give the scientific proof.

4) Use of AEDs did not improve survival rates compared to use of monophasic defibrillators.

5) The use of AEDs improved out-comes in patients with cardiac arrest compared with patients treated with monophasic manual defibrillators.

*A sub-set of 15 patients needed only early defibrillation to restore spontaneous circulation.

1.7 Pedagogy and teaching methods for CPR

Two of the main principles in learning theories is that the ability to learn is native and that every single brain is unique [88, 89]. The learning process involves emotions and conscious- and unconscious processes and improves with challenges and deteriorates with threats. The two cerebral hemispheres complement each other: the left covers logical thinking, it is rational and analytical. The right cerebral hemisphere covers thinking that is intuitive, random, and holistic. The dominant cerebral hemisphere will affect the learning process [90]. Many factors related to storage and retrieval of memories contributes to determine what is remembered and what is forgotten. Some people believe that their memory is like a “library”. However, when information from the memory is needed, no one thinks of how the information is produced, instead the information simply “pops up” in the mind [91]. The capacity of the long-term memory is not completely explained [88], and it is undoubtedly more complex than a library function.

A few studies have, with diverging results, investigated for how long the skills remain after a CPR course. One study found that CPR psychomotor skills may decline as early as two weeks after training [92], whereas another study present results varying from three to six months [93].

Medical learning and education results from a process of socialisation and the culture of medicine. If medical learning is to be effective it needs flexible situation- based learning in realistic simulated scenarios, feedback, and over-learning [90]. Answers to the question of what learning is will vary greatly, depending on who is asked. Many look at knowledge as the process of knowing something about our reality. We may already have some ideas and perhaps experiences about a certain piece of that reality, when we read about it in a book or hear something about it. The effect of the learning process is that we alternate, and innovate our knowledge, and/or change and expand our knowledge about our reality [89]. Experience and interaction between individuals and reality influence the learning process. The learning process aims to find meaning in previously acquired knowledge and a new situation, so that it becomes possible to view things from a new perspective and then change and expand former knowledge. To be able to create meaning in a situation, an understanding of the social environment around the learning process is often valuable [94, 95]. It is not possible to fully impart one’s knowledge to a person during a lecture or a course, but it is possible to establish the conditions for

participants to evolve their own existing knowledge, through the new thing that the participants experience and by making them take part in the lecture or the course [96].

Some studies point out that healthcare organisations have a central role in preparing healthcare professionals by giving them time to evolve the knowledge and skills that they need [97]. Other research indicates that the quality of resuscitation attempt improved after CPR training [98-100]. It has also been shown that the instructor can not be sure of what the healthcare professionals will remember, or what they have learned during CPR training [101, 102].

Guidelines offer a uniform way of teaching CPR [103], and the 2005 guidelines simplified resuscitation techniques [104]. In a teaching situation, the instructor needs to be adaptable and flexible if all the healthcare professionals attending a course are to improve their knowledge. As we know, people learn in different ways, which may explain the diversity of studies in how to train CPR. Some examples of training methods are: self-instruction, using video with or without a manikin [105-108], micro- simulation [109], using voice assistance [110-112] or computers [113], semi-interactive DVD [114], over-learning [111], simulation with video recording [115], traditional, case-based and web-based instructions [116], and regular courses following the guidelines. Nevertheless, one study demonstrates that instructors do not teach in a standardised way, and that poor CPR skills among participants may be learnt from the instructor [117]. Yaeger et al [115] refer to an old proverb:

"I hear and I forget, I see and I remember, I do and I understand". This is important for an instructor to take into consideration.

In an in-hospital setting, healthcare professionals are expected to work together with people they may never have seen before. Helmreich [118] states that many think of an in-hospital CPR situation as a group of people working together as a team. But it is essential that each person in a CPR team can work as an individual with his or her own responsibilities, and still take part in decisions taken at the group level (a.a.). The aircraft industry, for example, was an early starter with simulations and team training, and these methods can also be applied to patient care [119]. Patients are more complex than aircraft, but the teamwork between different healthcare professionals can be practiced in a similar way as in the cock-pit. Healthcare professionals are all expected to be able to communicate and take decisions under pressure. As Jasmeet Soar once said at a congress *"dream teams are made not born"* [120].

1.8 Attitudes and fears to starting CPR

Fear of harming the person with cardiac arrest is one of the most frequent barriers, cited by family members when performing CPR [121]. Fear of harming the patient and/or oneself as a healthcare professional may reduce willingness to initiate CPR. There is a risk of infection transmission during CPR, but the risk for transmission of SARS [122], HIV [122, 123], staphylococcus aureus [124], herpes simplex [125], and salmonella [126] has mostly been reported only in single- case reports. As a summary of previous studies, one may say that the risk of infection is low, but that little is known about the fears and attitudes of healthcare professionals to starting CPR. Bhanji et al [127] suggested that the willingness to perform CPR may be overcome with education. Education, together with strategies for prevention, such as easy access to barrier devices for example pocket masks, might reduce the fear of starting CPR [126, 128, 129].

The aspect of injury to their self is, however, known among healthcare professionals, who developed back pain when they performed CPR [130, 131]. Jones [130] reported that 80% of nurses who performed CPR in-hospital experienced back discomfort, and 56% of them considered that the discomfort was related to carrying out CPR. It is physically demanding to undertake CPR, and there are studies indicating that musculo-skeletal injuries may occur during its performance [132, 133]. The ventilation part of CPR is also physically demanding and can be associated with symptoms of hyperventilation among rescuers, unless they have access to masks and bag materials [134, 135].

One study, reported that nurses positively changed their attitudes in their willingness to use AEDs after education [136]. Some healthcare professionals may find an AED intimidating at first, but during education they should receive information that defibrillation is safe to perform [127]. Attitudes may affect how healthcare professionals are willing to intervene with CPR in a cardiac arrest situation [137].

1.9 Survival after in-hospital cardiac arrest

The true effectiveness of in-hospital resuscitation, as assessed by survival rates, is hard to ascertain. This is, because outcome studies in-hospital cardiac arrests have different designs. They differ regarding the number of patients with cardiac arrest, settings, co-morbid conditions, intervention locations, whether the data were based on witnessed or non-witnessed arrest, or VF/VT arrests only

[138]. Survival rates after cardiac arrest depend on the quality of CPR, alarm to response time, and time to defibrillation [83, 139]. Studies aiming to improve survival from out-of-hospital cardiac arrest started earlier than in-hospital studies. Weaknesses in the chain of survival will affect the survival rate even in hospital. The complete chain must be taken into consideration when evaluating the organisation for resuscitation [49]. As mentioned earlier, there are different survival rates after in- hospital cardiac arrests, 15-39% [80-82], except for one study reporting 58% (only VF patients) [83]. The in-hospital Utstein model was developed to make comparisons between different studies possible, independent of where the studies are carried out. This model recommends four variables to be presented in every in-hospital CPR study: 1) finding of the cardiac arrest patient and initiation of CPR, 2) collapse to first defibrillation, 3) collapse to airway management 4) finding of cardiac arrest patient to administration of medication during CPR [140]. A Finish study [74] indicated that improvements are needed to reach the in-hospital Utstein model [138]. A study from Sweden [141] indicate improvements in the organisation of training in CPR, over a 10-year period. The aim with resuscitation is to bring the patient back to life and, if possible, to the same level of health as before the cardiac arrest. One of the instruments to assess cerebral performance outcomes is the cerebral performance category (CPC). Evaluations according to the CPC score are recommended at hospital discharge, and at six months and one year after the event [138]. The definition of the CPC score is: 1) conscious and alert with normal function or only slight disability, 2) conscious and alert with moderate disability, 3) conscious with severe disability, 4) comatose or persistent vegetative state, 5) brain dead or death from other causes [83, 142]. The CPC score has been criticised for failing to correspond to subjective quality of life assessments [143]. Herlitz et al [144] found a CPC score of 1 among 89% of survivors after inhospital cardiac arrest when they did an follow up after two years.

2 Aims of the thesis

The aim of this thesis was to discover whether the outcome for in-hospital cardiac arrest patients could be influenced by education of all the healthcare professionals at a hospital. Included in this aim was to investigate whether an education intervention among in-hospital healthcare professionals at the Central Hospital in Västerås, Sweden, would affect their CPR knowledge and skills.

Paper I aimed to develop a valid and reliable multiple-choice questionnaire (MCQ) in the subject of cardiopulmonary resuscitation for healthcare professionals.

Paper II aimed to investigate if CPR education among all categories of healthcare professionals would increase their knowledge after education in CPR.

Paper III aimed to investigate potential differences in practical skills between different healthcare professionals before and after education in CPR.

Paper IV aimed to investigate possible changes in attitudes among healthcare professionals to performing CPR after education, and if there were any differences in attitudes between occupational groups.

Paper V aimed to describe the clinical consequences of a systematic education for all hospital healthcare professionals in CPR in combination with AED implementation throughout the hospital, focusing on outcome after in-hospital cardiac arrest.

3 Material and methods

Medical journals place limits on the number of permissible words that authors can use for original scientific articles. Almost every researcher will find out that they have too much data to fit into a standard journal article or research report. The materials and methodology sections in articles are, thus, often shortened [145]. This section will therefore try to explain the implications for the transferability of findings and to justify the statistical and qualitative analyses used.

3.1 Definitions

In-hospital cardiac arrest is defined as any cardiac arrest starting inside a hospital, where healthcare professionals are supposed to intervene. Patients with an already on-going cardiac arrest when arriving at the emergency department are not included.

A healthcare professional is defined as a medically educated person working in a hospital: physicians, nurses (including midwives), other universityeducated staff (including physiotherapists, occupational therapists, social welfare officers, psychologists and biomedical analysts), assistant nurses (including keepers), and finally other remaining occupational groups such as secretaries, kitchen and service staff (if these groups are involved in active patient care). In paper III, the groups were consolidated to physicians, nurses and assistant nurses including keepers, physiotherapists, occupational therapists, social welfare officers, psychologists and biomedical analysts.

Definition of the education program.

In the European education programme, there is a course named *D-CPR* (defibrillator cardiopulmonary resuscitation). It includes theory and practical training in basic CPR and the use of an AED. In the Swedish educational programme, the use of an AED is taught in a slightly expanded version of the European Resuscitation D-programme. The Swedish course takes four hours to accomplish and it includes theory and practical training in basic CPR, the use of oxygen and ventilation with the mouth-to-mask technique, and the use of suction devices for the clearing of airways. This Swedish course is

named S-HLR, which translates as CPR for in-hospital healthcare professionals (in Swedish: hjärt-lungräddning för sjukvårdspersonal).

Attitudes are defined as individual's emotional and cognitive approaches to a subject. A person's attitudes are usually products of their earlier experiences and knowledge, and they are closely connected to behaviour. Attitudes often represent aspects of a person, ranging from positive or negative [146-148].

Intervention is to do something [149]. In our study the word intervention is used in paper II, i.e. the introduction of CPR education programme. The locations used for testing this were an intervention hospital and a control hospital. The healthcare professionals at Västerås Central Hospital were educated in D-CPR for the first time. This is a medium- sized hospital named the intervention hospital in paper II. The control hospital which was Köping hospital, provided repetition courses in D-CPR to its healthcare professionals.

3.2 Technical materials

The healthcare professionals accomplished CPR on a manikin (Laerdal Skillmeter Resusci Anne, from Laerdal Medical AS, Norway). This particular model of manikin includes a software program, the PC Skill Reporting System, for measuring vital functions during simulated CPR situations. The measurements have a tolerance of $\pm 15\%$ for the compression depth and inflation volume variables. A rescue breath of a minimum of 250 ml was detected by the software as "ventilation" and a chest compression of at least 10 mm as "compression". The software program calculates a "compressions without error" variable, which contains compressions with correct hand placement on the sternum, complete release, and a compression depth of 40-50 mm on the manikin. Other variables measured by the program are the number of inflations and chest compressions, average number of compressions per minute, and mistakes performed (such as ventilations with a too short inflation time and compressions with incomplete release). The ventilation measurement starts with the first detected ventilation by the software program and ends with the last detected ventilation in the scenario. This means that the first attempt at chest compressions of at least 10 mm initiates the counting which ended when the researcher tells the participant to stop the scenario. Periods without compressions are, therefore, included.

A training-AED was available for the scenario (Laerdal Heartstart FR2, Laerdal Medical AS, Norway). This AED was placed in a bag with a set of printed instructions, stating: 1) press the green button, 2)

do as the AED instructs you 3) press the red button, if the AED asks you to.

A range of training scenarios was built into the AED. One of the researchers programmed the correct sequence for every scenario. If the healthcare professional chose to use the AED, the first sequence was ventricular fibrillation. Results from this scenario are presented in paper III.

3.3 The national register for in-hospital cardiac arrest

The Swedish cardiac arrest register is an ongoing national survey of all cardiac arrests in Sweden regardless of whether they take place in or outside a hospital. The section of the register which covers all cardiac arrests in-hospital started in 2005, and was web-based from the outset. Today, 54 of the 73 hospitals in Sweden (74%), with an organisation for the treatment of in-hospital cardiac arrest are included in the register. Until December 2010, approximately 7000 patients, having suffered a cardiac arrest in-hospital were recorded in the register. All hospitals receive feedback once a month about their results in relation to the other hospitals in Sweden. All data analyses are made in collaboration with a statistician in Göteborg, where the register is based.

3.4 Statistical methods

All *P*-values in the different studies were considered significant from 0.05 and below, and the tests were two-tailed in all instances. A summary of the statistical methods used is presented in Table 2.

Table 2. Statistical analyses used in study I-V in the thesis

Statistical method	Study I	Study II	Study III	Study IV	Study V
Raw agreement measure	X				
Bootstrap		X			
Fischer's exact test		X			X
Friedman's test			X		
Generalized McNemar's test				X	
Wilcoxon signed rank test			X		
Paired t-test			X		
Chi-square test					X
Logistic regression					X

Data in paper II consists of dependent but un-paired variables, and therefore bootstrap method was used [150]. The disadvantage

with this is that a computer program needs to be extensively programmed in order to optimise the entered data. The program will randomly choose a questionnaire and calculate the proportion of correct answers. This was done first for all the 2402 completed pre-test questionnaires and also then for the 2342 completed post-test questionnaires. The calculation from the real number of completed questionnaires provided the true value. Thereafter, every questionnaire was chosen at random several times, the program actually choosing a questionnaire by chance 10 000 times with both the pre- and post-test values. The proportions of correct answers were calculated for each and every one of the questionnaires separately, pre- and post-test. The proportions of correct answers were then entered into a histogram, followed by the true values. The share of values higher than the true value, divided by the 10 000 times + 1 for the true value, created the *P*-value. The *P*-value obtained from bootstrap analysis is a random variable, with its value being dependent on which questionnaires were selected by random by the computer. As bootstrapped *P*-values have an inherent variability, a value of <0.045 was calculated to be significant, to ensure that the bootstrapped *P*-values did not exceed the 0.05 level. Bootstrap analysis was used to discover if the resulting *P*-values, received from the data analysis, were not a result by chance. A *P*-value can be defined as:

“the probability of having observed our data (or more extreme data) when the null hypothesis is true”.
(page 167, Altman), [151].

Not only quantitative methods were used. In paper I was four healthcare professionals interviewed and in paper IV was five healthcare professionals interviewed in the development of the questionnaires to ensure that the questions were consistently apprehended. In Table 3 is the analysis from two interview questions from paper I demonstrated in a matrix.

Table 3. A matrix viewing examples from the respondent's spontaneous response to specific questions in their own words.

Question	Interview 1	Interview 2	Interview 3	Interview 4
Can anyone use an automated external defibrillator AED?	"I do understand the question, but I don't know the difference between a defibrillator and an AED".	"Yes, I do understand the question, but I don't know the difference in advanced CPR and AED CPR. That makes me unsure if the right alternative needs a written order from a physician".	" I think I understand the question – can all of us working at the hospital use an AED? But I 'm not sure about the answer".	"If you mean anybody, it can be any person who is at the hospital. I think that you mean professionals working at the hospital, that's how I thought about the question".
The electrodes should be placed, where?	"Do you mean the ECG electrode or the defibrillator electrode, as the question is formulated now – I don't know which electrodes you mean".	"I thought of the electrodes from the defibrillator, now when I think about it more – did you mean the ECG electrodes?"	"My answer are under right clavicle and the other electrode 10 cm below left armpit, it was easy to answer, no hard to understand".	"I think you should use the word place instead of put steady because then it doesn't matter what kind of defibrillator electrodes you have".

3.5 Description of intervention and study design of the project

All the papers in this thesis are based on data from real patients and working healthcare professionals from an in-hospital environment.

The study participants in papers I, II and IV were healthcare professionals working at two hospitals in the county of Västmanland. This county consist of approximately 251 000 inhabitants. There are two hospitals, one minor one, which provides one third of the internal medicine care in the county, and one medium- sized general hospital. The number of healthcare professionals working at the two hospitals, was at the start of the intervention, 3144 and increasing to 3165 during the study. There was a staff turnover rate of 8.2% during the study period for paper IV (2006 to 2009). In paper III, the target was to include 90 participating healthcare professionals. This group was supposed to include 30 physicians, 30 nurses and an additional 30 participants consisting of the following professions: assistant nurses, physiotherapists, occupational therapists, social welfare officers, psychologists and biomedical analysts. During the inclusion phase one

registered nurse refused to participate but changed her mind the next day. Consequently, the number of participating nurses was 31.

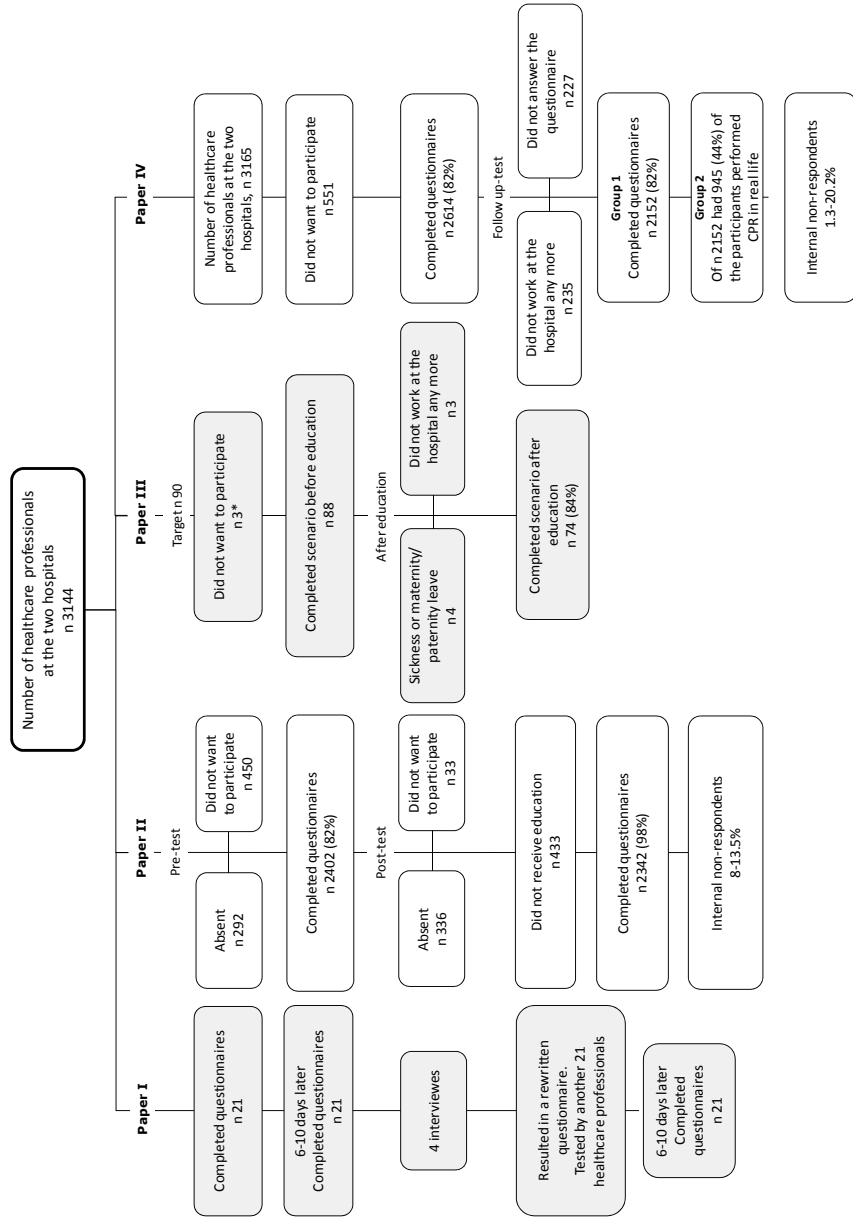
Paper I was a methodological study, including test and test-retest and interviews, aimed at constructing a valid and reliable multiple-choice questionnaire. The population consisted of a sample of healthcare professionals from two hospitals.

Paper II was an intervention study, using the questionnaire from paper I. The intervention consisted of educating healthcare professionals in CPR. All those who were educated answered the questionnaire, both before and after the education. The population consisted of healthcare professionals from two hospitals.

Paper III was an observation study, measuring CPR skills in a simulation scenario both before and after the educational intervention. The population was based on a sample of healthcare professionals from Västerås Central Hospital.

Paper IV was an intervention study. Using a questionnaire it measured changes in attitudes to CPR before and after the educational intervention. The population consisted of healthcare professionals from two hospitals.

Paper V was a register study of patients suffering from cardiac arrest at Västerås Central Hospital, measuring patient survival before and after the educational intervention.



* One registered nurse declined participation. The day after she changed her mind and she agreed to participate. The completed scenarios before education were, therefore, n=88.

Figure 2. Flowchart of the healthcare professionals in papers I-IV.

3.6 Ethical considerations

This chapter describes the ethical decisions we made whilst working with the different papers. Some of the discussions during the research process were methodological, and ethics were discussed at the same time. The ethical committee at Uppsala University, Sweden, approved the entire study (Dnr 2006/201), including all the separate papers. The following reflections conform to the recommendations of the International Council of Nurses (ICN) concerning ethical dilemmas, [152] which will follow below:

Information process and informed consent

The healthcare professionals were informed both verbally by the author and in writing about their freedom to withdraw from the study (papers I, II, III and IV). Informed consent is a metasystematic stage concept [153, 154]; because it links together the system of informing a research subject and the system of obtaining consent from the person. In spite of both verbal and written information, some of the health-care professionals participating in paper III must have misunderstood that they were expected to participate in a CPR education and an additional evaluation. This misunderstanding appeared when they were called to the CPR education. Consequently, they were informed again about the study approach and about the freedom to withdraw from the study. The conclusion should be, therefore, that the ethical rules and regulations were carried out according to the Helsinki declaration [152] despite the misapprehension.

The cardiac arrest patients taking part in the Swedish national register of in-hospital cardiac arrests were informed about their participation in the register. The survivors received information about the content of the register, the type of included information, and how to withdraw themselves.

Confidentiality

The healthcare professionals participating in paper I were easily recruited. Consequently, the participants were informed that one of the researchers would identify and know their answers. They were guaranteed that their answers would be anonymous when presented. In paper II, the questionnaire was anonymous. We assumed it might be embarrassing for the participants to answer questions concerning a subject they are supposed to know – in an examination-like situation. However, this led to the fact that all the participants were reminded

that some of them had not yet answered the questionnaire. We found it ethically acceptable to remind the participants to answer the questionnaire three times and also at the same time express our gratitude to those participants who already had answered the questionnaire. Some participants sent emails informing us that they had answered the questionnaire and we were able to thank them in a more personal way. We believe that the gratitude that we showed may have smoothed any sharp ethical corners. From an ethical point of view, therefore, it may, at worst, have been annoying, rather than unethical to repeatedly urge them to answer the questionnaire.

In paper IV, the questionnaire was provided with an identification number, because the same participants answering the questionnaire would be able to answer the same questions approximately two years later. Only two authorised individuals were able to match the decoded number to the full name. All study data were safely stored to protect the participants identities. Data from studies II, IV and V were analysed and reported without identifying the participants in the analyses. All healthcare professionals participating in study III were informed about the video recording and its aims. They were also informed that three individuals would analyse the videotapes and that their participation would be completely anonymous in the manuscript.

Ethical aspects of the methods

Interviews were accomplished during the development of the questionnaires (papers I and IV). None of the healthcare professionals taking part expressed any psychological distress or other negative emotions during their interviews.

In connection with the video recording during study III, some of the healthcare professionals expressed feelings of discomfort when seeing the video recorder in a corner of the room. Every participant who expressed such a feeling was given the opportunity to view the recording afterwards. They were, however, only allowed to look at their own scenario. In this way we believe that the risk of causing upset during the video recording process was minimised. Several participants expressed a feeling of physical exhaustion after participation in the scenario. It is well known that even a short administration of CPR demands a strong physical effort [155]. To experience this should, however, be regarded more as a good pedagogical experience than as an ethical failure.

During the inclusion of participants to the study for paper III, it was considered unethical to deny participation to nurses who felt

ambivalent, although the decided number of participants had already been achieved (see methods).

Use of ethical principles and regulations

It is important for the researcher to reach out with the new findings, and the research process should always rely on honesty and sincerity [156]. This thesis aims to conform to those principles. Paper V involved patient data and the Swedish law on personal integrity was carefully followed, as it was all the data concerning healthcare professionals in the other papers [157]. The researchers worked according to the Declaration of Helsinki and the ICN code of ethics for nurses [152, 153].

Ethical rationale for the study

This thesis has clinical implications in its ambitions to investigate whether education may influence outcome for patients with cardiac arrest. During the studies the hospital CPR organisation at Västerås was reconstructed and able to develop and, obviously, individual healthcare professionals obtained deeper knowledge of CPR.

The American Heart Association demands studies focusing on healthcare professionals' abilities to integrate their knowledge into their clinical skills, and whether this influences patient outcome [127]. In our study, presented in paper V, many factors might have affected the outcome. We believe that it is important to relate our findings to the experiences of others within the same area of research.

Fair participant selection method

As we aimed to study the knowledge, skills, and attitudes of healthcare professionals to CPR, four out of the five papers only included this group of individuals. For data credibility we included all the different types of occupational healthcare professions. We also invited all healthcare professionals from both hospitals in the county to participate, as taking part in the study could be beneficial for them. In paper III, a random sample of healthcare professionals was asked to participate. A study with all the different occupations represented was then carried out. Lack of time, human resources, and economy, however, limited the number of healthcare professionals that could be included. This unfortunate reality diminishes, but does not eliminate, the conclusions made and therefore a certain acceptable ethical level was reached.

In paper V, which concerned patient outcome, we used epidemiological tools, i.e. patients were observed at group level, not individually. Using registers for research, a strategy confirmed by the

regional ethics committee should be regarded as a fair patient selection method.

Patients included in the register had a cardiac arrest where resuscitation was started. The decision to start, or not to start CPR should have been documented in the patients' medical record. In such a situation, the physician in charge needs to take several factors in attention when decision making. If no decision is made, the healthcare professional will start resuscitation even if the resuscitation in itself would be meaningless, and by extension an unethical action. The ERC guidelines recommend that do not resuscitate decisions are made for every patient at a hospital [51].

4 Summary of results

4.1 Paper I

A short multiple-choice questionnaire was designed to retrieve information about healthcare professionals' theoretical knowledge in CPR. The questionnaire has high face validity, and during the pilot test-retesting the participants answered the questions with good equivalence. The following questions were finally included, along with their correct answers according to the Swedish national guidelines [152]:

1. What is the first thing you should do if you see a person collapse in the waiting room of the hospital where you work?
Correct answer: check for response, breathing and pulse
2. How long a time (in seconds) should your inspection of a patient with suspected cardiac arrest take?
Correct answer: 30 seconds
3. What first aid equipment should you prioritise if you are unable to obtain all the necessary first aid equipment immediately?
Correct answer: defibrillator
4. Can health care professionals working at the hospital use an automatic external defibrillator?
Correct answer: yes but only individuals who have passed a CPR course with an AED
5. A-D. At which arrhythmia should you defibrillate during ongoing CPR?
Correct answer: ventricular fibrillation and pulse less ventricular tachycardia
6. Where should you place the defibrillator electrodes on the patient during CPR?
Correct answer: one below the right clavicle and the other 10 cm below the left armpit

7. The patient is soaking wet with cold sweat, what should you do to be able to defibrillate?
Correct answer: dry the area where the electrode plates should be placed and the area between the plates
8. How many times in one sequence can you defibrillate during ongoing CPR?
Correct answer: maximum one defibrillation at a time, then you have to perform CPR
9. The patient has ventricular fibrillation at the first rhythm section. How soon should you defibrillate according to the existing guidelines?
Correct answer: within 3 minutes
10. In connection with CPR, what should you do when you give breaths or ventilate?
Correct answer: breathe/ventilate slowly
11. How do you know that the breaths or the ventilation are effective?
Correct answer: you see the chest rising
12. With which frequency (minutes) should you perform chest compressions?
Correct answer: 100 compressions/ minute

See the Appendix for complete answer alternatives in Swedish.

4.2 Paper II

Overall theoretical knowledge increased after training in CPR. The healthcare professionals at the intervention hospital presented better results post-test compared with pre-test. Comparing the two hospitals, the staff at the control hospital presented a higher level of knowledge pre-test, whereas at the intervention hospital, staff performed significantly better post-test.

In the findings from a staff category perspective, the physicians presented the highest number of correct pre-test answers, but they did not significantly increase their results. At post-test, physicians and nurses had equal results. The group of other university-educated staff (including physiotherapists, occupational therapists, social welfare officers, psychologists and biomedical analysts) increased their number of correct answers more than any other group from pre- to post-testing (Table 4).

Table 4. Percentage of correct answers at the intervention hospital according to medical profession, pre- and post-test, and bootstrapped p-values. P-values less than 0.045 were considered significant.

Q	Physicians			Nurses			Assistant Nurses			Other university- educated staff			Other occupational groups			Total		
	Pre%	Post%	P	Pre%	Post%	P	Pre%	Post%	P	Pre%	Post%	P	Pre%	Post%	P	Pre%	Post%	P
1	92	93	0.718	89	94	0.040	86	94	0.013	80	95	0.025	78	88	0.208	87	94	<0.001
2	18	39	0.015	19	49	<0.001	13	49	<0.001	10	45	<0.001	18	29	0.221	16	46	<0.001
3	64	87	0.005	44	87	<0.001	36	88	<0.001	22	91	<0.001	24	71	<0.001	41	86	<0.001
4	60	62	0.701	76	85	0.014	65	84	<0.001	40	72	0.009	35	60	0.056	65	80	<0.001
5A	97	92	0.138	59	76	<0.001	33	63	<0.001	18	44	0.021	16	26	0.246	50	69	<0.001
5B	50	61	0.193	27	43	0.001	11	32	<0.001	2	9	0.150	6	8	0.519	22	38	<0.001
5C	72	83	0.127	48	65	0.002	38	60	0.001	17	49	0.007	18	37	0.101	44	63	<0.001
5D	56	54	0.631	24	27	0.271	7	15	0.057	3	5	0.491	2	7	0.299	20	24	0.135
6	86	93	0.170	52	90	<0.001	38	92	<0.001	18	97	<0.001	15	65	<0.001	47	90	<0.001
7	68	81	0.099	61	90	<0.001	54	92	<0.001	20	89	<0.001	34	57	0.069	54	87	<0.001
8	64	79	0.082	36	79	<0.001	29	80	<0.001	7	76	<0.001	15	41	0.024	33	76	<0.001
9	4	13	0.071	4	29	<0.001	4	30	<0.001	0	15	<0.001	4	9	0.284	4	26	<0.001
10	46	58	0.155	53	66	0.009	47	62	0.014	41	58	0.120	42	58	0.174	49	63	<0.001
11	100	99	NA	99	99	0.765	97	99	0.037	90	100	0.001	92	96	0.342	97	99	0.020
12	76	88	0.088	77	91	<0.001	69	89	<0.001	52	86	0.001	60	84	0.038	71	89	<0.001
≥50%	86	90	0.306	45	88	<0.001	27	86	<0.001	10	80	<0.001	15	47	0.005	39	84	<0.001
≥80%	18	36	0.033	12	37	<0.001	3	26	<0.001	0	1	<0.001	2	7	0.204	8	30	<0.001
100%	0	0	NA	0.0088	3.4	0.037	0	0	NA	0	0	NA	0	0	NA	0.003	0.018	0.009

Q = Question

NA = Not Available

Pre% = Percentage points correct answers before training

Post%= Percentage points correct answers after training

≥50%= the percentage of participants having more than eight correct answers

≥80%= the percentage of participants having more than twelve correct answers

4.3 Paper III

There were no major differences in CPR skills performance among different healthcare professionals. The nurses were the group of healthcare professionals who improved the number of compressions per minute the most. The compression depths were under or at the lower part of the recommendation, but the total improvement was significant (Table 5). A satisfying result was that 96% of the participants used the AED after education.

4.4 Paper IV

Overall, there was a significant improvement in 10 out of 11 items, reflecting various aspects of attitudes to CPR (Table 6).

The concern about being infected, when performing mouth- to- mouth ventilation, was reduced in all categories, with the most marked reduction in physicians (75%; $P < 0.001$) and the least reduction in “other health care providers” (including physiotherapists, occupational therapists, social welfare officers, psychologists and biomedical analysts) (33%; NS). There were some non-significant differences in attitudes after CPR education among the healthcare professionals who had performed CPR in real life. A tendency of reduced mental discomfort was noticed.

See the Appendix for the questionnaire in Swedish.

4.5 Paper V

An intervention in terms of a systematic CPR education for all healthcare professionals within one single hospital in combination with the implementation of 18 AEDs all over the hospital did not shorten the delay time to delivery of treatment, including defibrillation. Neither was survival to hospital discharge affected. However, estimated cerebral function among survivors improved (Table 7).

The mechanisms behind this finding remain speculative, as the results rely on a small sample size.

Table 5. Assessment of ventilations, chest compressions, and the use of the AED among all healthcare professionals before and after intervention.

Variables	Physicians (n = 23)			Nurses (n = 26)			Other healthcare professionals ¹ (n = 25)			Total (n = 74)		p
	Before	After	p	Before	After	p	Before	After	p	Before	After	
Number using the AED, n (%)	14 (61)	22 (97)	0.005	12 (46)	25 (96)	<0.001	4 (16)	24 (96)	<0.001	30 (41)	71 (96)	<0.001
Ventilations												
Ventilation volume ml, median (q1-q3)	321 (0-635)	670 (465-890)	0.006	735 (621-826)	656 (563-898)	NS	441 (0-920)	726 (415-1081)	0.031	621 (0-815)	666 (444-928)	0.009
Correct ventilations with correct volume according to guidelines, %	3 (13.0)	3 (13.0)	NS	5 (19.2)	4 (15.4)	NS	8 (32.0)	1 (4.0)	0.020	16 (21.6)	8 (10.8)	NS
Compressions												
Compressions per minute, mean (sd)	98 (27)	105 (16)	0.09	105 (21)	117 (10)	<0.001	83 (34)	104 (19)	<0.001	95 (29)	109 (16)	<0.001
Compressions with no errors *, median (q1-q3)	24 (0-32)	39 (6-143)	0.012	27 (0-52)	76 (21-99)	0.009	1 (0-37)	24 (5-77)	0.024	18 (0-42)	55 (13-99)	<0.001
Compression depth mm, mean (sd)	39 (10)	41 (8)	0.151	35 (9)	39 (7)	0.075	33 (13)	40 (7)	0.004	35 (11)	40 (7)	0.000

¹. Other healthcare professionals includes: assistant nurse, physiotherapists and occupational therapists.

q1-q3 = interquartile range (25% – 75%)

* Compressions with no errors includes correct placement of hands and adequate depth

sd = standard deviation

n = number of observations

Table 6. Differences in attitudes after CPR education by all healthcare professions (Group 1).

Question ¹	Physicians (n=226)			Nurses (n=956)			Assistant nurses (n=742)			Others ² (n=228)			Total (n=2152)		
	%	Diff.	P	%	Diff.	P	%	Diff.	P	%	Diff.	P	%	Diff.	P
Sure how to react	74	+10	0.03	67	+9	<0.001	60	+13	<0.001	30	+5	NS	60	+10	<0.001
Not nervous	53	-5	NS	54	+3	0.01	53	+8	<0.001	21	+2	NS	49	+4	<0.001
Duty to intervene	98	+3	NS	97	-2	NS	96	+3	NS	92	+4	NS	96	+0	NS
Secure in CPR knowledge	70	+18	<0.001	71	+14	<0.001	68	+19	<0.001	31	+7	0.04	65	+16	<0.001
Not anxious	69	+0	NS	65	+10	<0.001	64	+13	<0.001	29	0.0	NS	60	+9	<0.001
Know what to do if cardiac arrests occur	90	+5	NS	90	+7	<0.001	88	+12	<0.001	67	+5	NS	86	+8	<0.001
Act instinctively	73	+10	NS	76	+5	0.02	72	+5	NS	49	+5	NS	71	+5	<0.001
Chance to help	87	+4	NS	91	+3	NS	92	+5	0.006	72	+9	NS	88	+4	<0.001
Need to have things under control	62	+0	NS	67	+4	NS	51	+1	NS	49	+9	0.04	58	+3	<0.001
Manage to take control of the situation	89	+4	NS	68	+8	<0.001	43	+14	<0.001	38	+7	NS	57	+10	<0.001
Important to use gloves	43	+8	NS	32	-0	NS	27	+5	0.008	9	-0.0	NS	28	+2	<0.001

¹ See the appendix for the complete questions

² Other university educated staff, including physiotherapists, occupational therapists, social welfare officers, psychologists and biomedical analysts

% Proportion of participants with the respective attitude after education?

Diff. change in proportion of participants before and after education in CPR

NS not significant

Table 7. Outcome.

	Calendar Period		
	Before	After	P
	intervention	intervention	
	n (%)	n (%)	
Status on admission of the rescue team			
Conscious	10 (14)	26 (21)	0.25
Breathing	23 (33)	42 (34)	0.88
Palpable pulse	23 (33)	44 (36)	0.75
Initial results of CPR			
ROSC at any time	42 (58)	94 (72)	0.06
Alive after termination of CPR	33 (45)	80 (60)	0.04
Long- term results			
Alive at discharge from hospital	18 (26)	39 (32)	0.51
Alive after 30 days	18 (25)	43 (32)	0.27
CPC score* among survivors			
1	9 (50)	37 (95)	<0.0001
2	5 (28)	2 (5)	
3	3 (17)	0 (0)	
4	1 (6)	0 (0)	
5	0 (0)	0 (0)	

* CPC score definition:

- 1 conscious and alert with normal function or only slight disability
- 2 conscious and alert with moderate disability
- 3 conscious with severe disability
- 4 comatose or persistent vegetative state
- 5 brain dead or death from other causes

5 Discussion

The starting point for this thesis was that the organisation for CPR training disappeared during a major reorganisation (2004-2005) at the Central Hospital in Västerås, Sweden. During the restoration of this organisation we found it valuable to investigate whether the restoration itself would have any impact on outcome among cardiac arrest patients, and if the knowledge of CPR among healthcare professionals would improve. We did find out that the knowledge, skills and attitudes in the subject CPR did improve. This might have affected the functional status among cardiac arrest patients in a positive way. This section will discuss methods, results and other matters that have appeared during the research process.

5.1 Paper I

Own findings in relation to available knowledge

The European Resuscitation Council has developed an education programme [158] and two MCQs [159] in English for their advanced life support course. Unfortunately, it was not feasible for us to assimilate the European Resuscitation Councils development and evaluation process of their MCQs, at the time of our developmental work with our MCQs. In Sweden there were no instructors educated according to the ERC at the time (there are now). We are, therefore, unable to compare our questions with others.

Interpretation of our own results in an overall perspective

Even if the tested MCQs in paper I were tested on a small sample size, important information were collected during the test- retest and interviews. We do believe that it was better to develop and test existing questions, rather than just use the questions from the education programme without any test. We found no studies which present their questions used to measure theoretical knowledge in relation to education in CPR [158-160].

5.2 Paper II

The questionnaire served its purpose in investigating whether theoretical knowledge of CPR would increase among all categories of healthcare professionals before and after education. The use of the questionnaire indicated a lack of knowledge at pre-test. With education knowledge increased significantly.

Own findings in relation to available knowledge

One of the purposes of using MCQs as evaluation tools is to determine the areas where participants in a course need more information and help [94]. We consider it important for healthcare professionals to understand the chain of survival concept. Therefore, we estimated the following questions to be important: “what is the first thing you do if you see a person collapse in the waiting room at the hospital where you work”, “with which frequency (in minutes) should you perform chest compressions” and “how do you know that the breaths/ventilation are effective?” Another important question for the healthcare professionals to answer and understand is which first aid equipment to prioritise. If the healthcare professionals can answer these questions, they might be able to organise and start resuscitation according to the chain of survival concept. There might be an association between resuscitation knowledge and CPR performance [161, 162]. If we assume that a healthcare professional has never performed CPR in reality or on a manikin, it will be quite hard to perform CPR without knowing anything about how and why it should be performed. With theoretical knowledge, a healthcare professional may be able to perform CPR sufficiently.

Rodgers et al [163] indicated the opposite, however, as the results in their study do not show any correlation between the results from written test and skills in a scenario. They state that an isolated written test would not be enough to determine practical CPR skills. Our intention was not to design a questionnaire and recommend it as the single point in order to obtain good resuscitation knowledge among healthcare professionals. Instead, our intention was to design a questionnaire that was easy to use and to obtain an understanding of whether the healthcare professionals would comprehend the chain of survival concept.

The study population was representative, as all types of healthcare professionals were represented. The hospitals in Västerås and Köping represent a medium- and a minor-sized hospital, respectively. It is not certain that our findings may be able to generalise to major hospitals or to hospitals outside of Sweden. Different nations have different

organisations for resuscitation, and differences in the hierarchy between healthcare professionals might also influence outcome [78, 164]. Since we cannot completely rule out that other factors than the intervention may have affected patient outcome, we need to be cautious in our interpretation of the results.

Interpretation of our own results in an overall perspective

It was disappointing that only 30 percent of all healthcare professionals had more than 80 percent correct answers post-test. This result makes it hard to see any association between change in knowledge and better outcome among patients with cardiac arrest. On the other hand, almost all groups reached 90 percent post-test correct answers on the question “what is the first thing you do if you see a person collapse in the waiting room at the hospital were you work”. The same was found with regard to the questions on “which equipment to give priority to”, “how many times in one sequence to defibrillate”, and “at which frequency to perform chest compressions”. With this in mind we think that our intervention might have influenced the outcome for cardiac arrest patients. In the study by Rodgers et al [163], the participants got on average 89% correct answers, and in a study by Nadel et al [165] the mean score of correct answers of 12 questions was 60%. Moule et al suggest a change in the criteria of passing the test from 50 to 70% [160], and the European Resuscitation Council has a limit of 80% correct answers for passing the test.

5.3 Paper III

In this paper, we aimed at evaluating practical CPR skills among the full spectrum of healthcare professionals. There are not many studies [166] in which physicians are included; mostly the target group is medical students [92, 107] or nurses [167, 168].

Own findings in relation to available knowledge

We were unable to see any major differences in the CPR skills between the different groups of healthcare professionals in our study. This would indicate that it does not matter which category of healthcare professional that performs CPR. Likewise, Napier et al [166] did not find any differences in CPR skills between nurses and physicians.

In our study, 96% of the participants used the AED after education. Previous studies indicate that healthcare professionals who have been trained in the use of an AED, are quicker than those who are untrained

[169]. The time from VF to defibrillation is important, as survival decreases with every passing minute without defibrillation [41].

Interpretation of own results in an overall perspective

Other studies indicate that the performance of good chest compressions and ventilations influence the outcome after cardiac arrest in a positive way [170, 171]. In our study, the nurses improved the number of compressions per minute most of all the healthcare professionals. Another element of CPR is leadership. Training in leadership has been shown to improve CPR performance and change behavior among course participants [172]. We support the importance of having a good leader in a resuscitation situation, and that different healthcare professionals should work together as a team [172-174]. However, our study looked at single rescuer CPR only, and we did not address the associations between good team leadership and outcome after resuscitation.

The skills in CPR performance among the healthcare professionals participating in our study improved. But unfortunately the skills were still insufficient. Other studies also indicate poor resuscitation skills among healthcare professionals and they therefore suggest frequent repetition courses in CPR [175, 176].

5.4 Paper IV

There is an overall lack of knowledge about attitudes to CPR and the potential impact of those attitudes on the performance of CPR and on outcome after a cardiac arrest. Although not proven, it is not unlikely that the attitude of healthcare professionals to CPR may be one of the most important factors for outcome after a cardiac arrest.

Own findings in relation to available knowledge

There might be an association between attitudes and willingness to perform CPR. If healthcare professionals are scared of using an AED, it might affect their willingness to use one. Delayed defibrillation can reduce the chances that a ventricular fibrillation is successfully defibrillated [177]. During education healthcare professionals are assured that defibrillation can be safely performed by the rescuer [178]. Similarly, if the healthcare professionals have a frightened attitude to infection transmission during CPR it might reduce their willingness to perform mouth-to-mouth ventilation. A study by Odegaard et al [137] indicated that ambulance personnel had an attitude of knowing better than Guidelines how to perform chest compressions. So even if the healthcare professionals know

theoretically how to perform CPR, they still are affected by their own attitudes of what is best for the patient.

Interpretation of own results in an overall perspective

The willingness to perform CPR may be facilitated by education [127] in combination with strategies for easy access to barrier devices, such as a pocket mask [126, 128, 129]. Having said that, it is important for healthcare professionals to regularly participate in CPR courses and update their knowledge, including how to use barrier devices. The answers from the healthcare professionals in our study indicated that education made them feel safe, and the worry of becoming infected while performing mouth-to-mouth ventilation was significantly reduced. If healthcare professionals would change their attitudes, so that they would be willing to start mouth-to-mouth ventilation, it could improve the outcome for a cardiac arrest patient. A study from Japan indicated that a high number of healthcare professionals (70%) do not want to perform chest compressions and ventilations [179]. Physical discomfort, such as back pain, was reported to occur among the rescuers [130]. In our study, the healthcare professionals were asked about physical discomfort and 26% stated that they had some kind of physical discomfort. This is surprisingly low, since CPR is like an aerobic effort [180]. The patient with cardiac arrest is dependent on the received efforts by the rescuers.

5.5 Paper V

Own findings in relation to available knowledge

Cardiac arrests were more frequently witnessed after intervention and results indicated that chest compressions were started more frequently prior to arrival of the rescue team after the intervention in wards outside the intensive care unit. This might have affected the functional outcome among the cardiac arrest patients. According to Kaye et al [102], the effect of CPR depends on how quickly it is started and on the quality of the resuscitation efforts performed. When the healthcare professionals were tested about their theoretical CPR knowledge, their improvements were evident in the three questions concerning “the first thing to do when a person collapses”, “how many times in one sequence to defibrillate”, and “the frequency at which chest compressions should be performed”. Such knowledge may have contributed to the increase in estimated functional outcome after the intervention. Functional status appeared to vary among the resuscitated patients [144, 181, 182]. Studies [183-185] showing reduced time to compressions in connection with defibrillation indicated better outcome after cardiac arrest. Chan et al [186]

indicated that delayed defibrillation was associated with worse outcome, in terms of survival, after in-hospital cardiac arrest. There is also a strong relationship between the time to defibrillation and survival after in-hospital cardiac arrest [38, 42, 83, 186]. It was not possible to adequately address the impact of our intervention on the delay time from cardiac arrest to defibrillation due to the following reasons: prior to the intervention very few patients were defibrillated in wards outside the intensive care unit. In contrast, and most likely due to the intervention, a relatively large number of patients were defibrillated outside the intensive care unit after the intervention. Thus, when comparing delay to defibrillation before and after the intervention we included “intensive care only” before and “intensive care plus other wards” after intervention. Such a comparison is quite meaningless. Even if the time to defibrillation was not reduced there was a positive trend towards that the chain of survival concept apparently being followed. It might be that this way of working positively affected patient outcome. Estimated functional outcome was improved among those patients who survived cardiac arrest. Other studies that followed the implementation of AEDs did not see improved survival [79, 86, 87]. These studies report how many healthcare professionals they educated, but do not indicate how they adapted the CPR course. These studies have, to the best of our knowledge, not tested healthcare professionals’ CPR knowledge. Kromann et al [187] pointed out that testing skills increased the learning outcome, compared with the same time spent on practicing CPR skills. We may speculate that our intervention increased activity after a cardiac arrest outside the intensive care unit, perhaps due to changes in attitudes and theoretical knowledge. Thus, more patients had chest compressions started prior to arrival of the rescue team and more patients were found in ventricular fibrillation and were therefore defibrillated, prior to arrival of the rescue team.

On the other hand, studies indicating improved survival after AED implementation did not control healthcare professionals’ knowledge [13, 54]. The difference of our study from the two studies with improved outcome is that the authors write of the importance for the healthcare professionals to have hands on training during the CPR course and that they should focus on early use of the AED before the rescue team arrives (a.a.). To our knowledge there are no studies investigating if education in CPR for in-hospital healthcare professionals might affect outcome among in-hospital cardiac arrest patients. Another important element that affects outcome is do not resuscitate orders (DNR).

It is important to make a decision about when not to continue resuscitation. DNR orders affect a hospital’s outcome statistics for

patients with cardiac arrest. A DNR order should be made for every patient at a hospital, exactly as all other treatments are considered during a hospital stay [188]. Our study did not indicate that the number of CPR attempts changed after the intervention.

Interpretation of own results in an overall perspective

Our study indicates that an education effort aimed at all healthcare professionals' affects outcome among in-hospital cardiac arrest patients in a positive way. This indicates that future studies need to focus on the healthcare professionals CPR knowledge in combination with patient outcome. Another important element is to study the classification of the CPC score. How well do judgments from medical journals agree with the real patient function?

5.6 Methodological considerations

The methodological considerations are presented here in a separate part of the thesis, paper by paper.

Paper I

This paper concerned a methodological study. To be able to investigate the healthcare professionals' theoretical knowledge in CPR we wanted to test not only the reliability of the questions, but also to consider their validity. Data collection in questionnaires is usually relatively quick to complete. However, inappropriate questions may lead to poor quality data and misleading conclusions, so it is recommended to use previously validated and published questionnaire [189]. As, to the best of our knowledge, there was no valid and reliable questionnaire available and a questionnaire had to be constructed. It was decided to use multiple-choice questions (MCQs).

There are studies which provide recommendations on how to design, format and examine the development process of MCQs, regardless of the subjects studied [190, 191].

The conventional format of MCQs has three components: the question, the correct answer, and several incorrect, but plausible answers or distractors. Considine et al [190] argue for only one correct answer for each multiple-choice question. The location of the correct answers should be evenly distributed throughout the test to avoid "placement bias", and both the correct answer and the distractor should be similar in terms of grammatical form, style and length [190].

There is no statement in the literature regarding the optimum number of distractors for multiple-choice test items. Catts states that the

performance of distractors is more important than their number. While there is some evidence that it is an advantage to have a greater number of options per question, this is only true if each distractor is presented appropriately [192, 193]. Haladyna and Downing [194] argue for the use of three- option MCQs, as a limitation to three will reduce the time to construct and to complete, and also the probability of inclusion of weak distractors will be reduced. However, as Nunnally and Bernstein [195] stated that the probability of guessing correct answers is 25% with four alternatives and 20% with five, we decided that our MCQs would have four to seven alternatives.

In order to keep validity and reliability high, the questionnaire also needed to be piloted and administrated under conditions that were similar to the intended use of the MCQs [190]. Our questionnaire was piloted under the same conditions concerning time as those we wished to use in paper II. A major critical point was that we should have used a higher number of participants in paper I.

Reliability is the degree to which an instrument produces the same results with repeated administration [196]. Paper I had a pre-test/post-test design, and according to Polit, Gravetter and Wallnau a high level of reliability is particularly important when the effect of an intervention on knowledge is measured. Reliability can be measured using correlation coefficients or reliability coefficients, for example Cohen's kappa, Cronbach's alpha, Kendall's tau or Spearman's rho [196, 197]. Due to the small sample size of the pilot study in paper I, and the fact that all the answers in the MCQ in the same paper were not chosen by the respondents, it appeared that a kappa analysis could not be undertaken. A problem was also the nominal character of data and a high number of response alternatives. Therefore, the response alternatives were transformed into dichotomous dummy variables and then the kappa analysis was made. For example, the correct response answers were coded as 1 and the wrong/distracted answers were coded as 0. This analysis presented kappa variations between 0.640 – 0.774.

Transformation from original variables was not possible as the questionnaire developed had too many distractors/response alternatives in relation to the number of answers, chosen by the respondents. We discovered after the pilot testing that the number of participants in the pilot study was too small for using statistical methods such as kappa analysis or Cronbach's alpha. After statistical consideration of the rate of correct responses the statistical method known as raw agreement measure was used. This method illustrates the agreement between the two test versions. Due to the small sample

size an influence by chance cannot be excluded. The study should have had at least 30 respondents in each group. Therefore our study ended up with the design of a pilot study.

Stability of single MCQs is established using test- retest correlation and there is no evidence regarding the ideal interval between testing and retesting [195, 196]. During the test and retest, the MCQs were administered to the same group of participants on two occasions with 6-10 days in between. Four interviews were performed in between the two groups of healthcare professionals' participating in the test-retest.

Validity consists of both face and construct validity. The validity of each of these elements needs to be determined to establish the overall validity of the MCQs [196]. Face validity ascertains whether the MCQs are relevant, appropriate and representative of the construct being examined. It is hard to obtain a quantitative measure for face validity, but one way is to measure it in a subjective manner with an expert group. Therefore, the questions from an education programme, developed by an expert panel from the Swedish Society of Cardiology, were used [198].

Further on, to establish face validity, clarity, and reliability, four participants were interviewed to ensure that the questions were consistently understood and to identify errors in spelling and grammar. Nilsson stated that things that are barely discerned or disclosed in a questionnaire might appear in an interview situation [199]. The reason is that verbal and emotional expression provides a deeper and more complex understanding of the phenomenon (a.a.). According to Boyton et al participants might be offended when they are asked questions about age, sex, and socio-economic status [200]. In our study, the interviews paid attention to the question about a participant's age and all four participants expressed a feeling of being offended. This question was therefore not included in the final questionnaire.

The MCQs construct validity is related to whether or not the questions measure the domain of knowledge being examined. We wanted to examine healthcare professionals' theoretical knowledge in CPR. The construct validity of MCQs should be established by using an expert panel, and this is what we did. The expert panel will control if the correct answer to the multiple-choice question is actually correct and it will also ensure that there is no more than one answer that may be correct [189]. The construct validity in our study must be considered good, as basically both phenomena, cardiac arrest and CPR, are

well-known among hospital staff. Thus, both the questions and the participants are strongly related to a theoretical framework.

Paper II

Several factors are shown to increase response rates: that the questionnaire is clearly designed, that it has a simple lay out, that it has been tested, that participants will be notified about the study in advance with a personal invitation, that the aim of the study is clearly explained, that full anonymity will be guaranteed for all participants, and that a researcher will be available to answer questions and to collect the completed questionnaire [145]. Several of these factors were achieved in paper II. Our decision to protect participants' anonymity affected the possibility to choose the statistical method. We believed that it could be delicate for participants to answer questions about a subject that they were supposed to know – in an examination-like situation. We therefore let the questionnaire be completely anonymous, aiming for good co-operation and a high response rate. This made the pre- and post-test answers correlated without being paired and the *P*-values were obtained from bootstrapping [150].

Theoretically, there may be a selection bias in the study. If the healthcare professionals who did not participate had inferior knowledge, then we would present falsely high contents of CPR knowledge among the participating healthcare professionals. There were no indications for such bias, since it was a low percentage of correct answers in the pre-test. Moreover, the rate of participation was high. Our questionnaire, measuring knowledge, may be further improved by being used at other hospitals. We can then, when questions have been used in different environments, be sure that the questions are correctly understood. The questionnaire used to measure resuscitation knowledge is short. This fact may be a limitation since there is just one question for each aspect of CPR being covered. Another critical point was that the educational intervention, involving all healthcare professionals at the hospital, should have taken place during a shorter time. Then other factors that might possibly affect the intervention would have had less time to interfere.

Paper III

Not only lack of time, resources, and economy limited the number of healthcare professionals to be included in the present study. It was also anticipated that physicians would dislike participating. These realities, and the number of participants used in previous studies [201-205] were a guide for the sample size estimation.

The healthcare professionals were selected by their working managers and each one was contacted personally by one of the researchers to provide study information and ask for participation. The time and place for participation was agreed upon between the participant and the researcher. Many of the physicians did not arrive at the appointed time or place. They were called by telephone or bleeper, and a new time or place was established. Despite all the difficulties it became a realistic proposition to include 30 physicians in the study.

The ultimate strategy would have been to use a power analysis. A power analysis is used to calculate the lowest number of participants needed to detect a certain minimum difference or effect for a decided level of significance, provided it exists in the collected data set [151].

Not all aspects of CPR were registered by the software program during the scenario. Therefore, the scenarios were video recorded. Three experienced instructors evaluated the videotapes of the participants performing defibrillator cardiopulmonary resuscitation (D-CPR). The evaluation was accomplished according to the Cardiff test protocol [152, 206]. The Cardiff test offers a way to retrospectively and in a standardised manner, evaluate performances during a video- recorded scenario. Whitfield et al [206] state that the reliability of this test is less acceptable for variables such as checking for responsiveness, initial check of the airway, and checking for signs of circulation. The instructors in our study evaluated the scenarios in different ways, despite the efforts made to standardise the evaluation. The unacceptably high inter-observer variation made it impossible to analyse the data as recommended. Further studies on how to find a uniform way to evaluate practical skills are required.

Since the software program does not cover all aspects of CPR training on a manikin, video recording is a necessary complement. Such a video recording is proposed as an objective quality control of a training scenario. Also, by using manikins and programs for evaluating the CPR training healthcare professionals may receive objective information about how they performed CPR [94]. There are recommendations for outcome measurements during a CPR course for healthcare professionals, according to an ILCOR Advisory Statement [94].

A methodological disturbance was that the guidelines for CPR changed from the ratio 2:15 to the new 30:2 during the study period. Thus the new guidelines were not implemented before the

intervention. Consequently, guidelines 2000 [207] were used before the intervention and the guidelines 2005 [104] were used afterwards.

Paper IV

Paper IV is based on a questionnaire for healthcare professionals regarding their attitudes to CPR before and after an educational intervention. A consideration of concern was when the participants should be asked to answer the same questionnaire once more. It was decided that they should answer it again after approximately two years. This estimate was basically made for practical reasons. All participants at the two hospitals should have received CPR education and the inquiry was designed to not collide with other practical and/or time consuming events at the hospitals. The latter was important for getting a high response rate.

We used the generalised McNemar's test, as we did not want to make any assumptions about the reply alternative "do not know". If we had used the standard McNemar's test we would have had to categorise the answer "do not know" to either yes or no. We considered it unethical to do this, since we believe the answer "do not know" was given for a reason.

The instrument could be further improved if it is used on several healthcare professionals who have performed CPR. When the questionnaire is used in other studies it will be possible to compare different target groups and also to determine if all participants understand the questions in the same way [191]. Such a further improved questionnaire might, in combination with interviews, provide a deeper understanding of the association between attitudes and the willingness to perform CPR and it might also influence outcome for cardiac arrest patients.

Paper V

The CPC score has been criticized for failure to correspond to subjective quality of life assessments and also to cerebral function [143]. Thus, both the fact that the method suffers from a limited validity and the fact that the estimation was made retrospectively based on limited information from medical records, suggests caution in the interpretation of these data. A strength with regard to the overall data was that data were controlled by an external audit. This was made possible due to participation in The National Registry of in-hospital Cardiac Arrest in Sweden.

A limited number of multiple statistical analyses were used in this paper, and adjustments could have been performed, e.g. by Bonferroni corrections. The Bonferroni correction is a method to avoid Type I errors, but it may increase the risk of Type II errors [208]. Some researchers argue against the use of Bonferroni corrections [208, 209]. The sample size was small, therefore we can hardly consider our data as confirmatory, but rather as hypothesis generating.

5.7 Implications

In the future I would like some of the research of CPR in Sweden and, hopefully, also in Europe, to focus on investigating healthcare professionals' theoretical knowledge and attitudes. It was possible for us to develop multiple-choice questions as an instrument to assess the theoretical knowledge of CPR. It is likely, and desirable, that the multiple-choice questions can be evolved further.

An educational intervention appeared to increase health care professionals' theoretical knowledge of CPR. But the study also indicated that there are still deficiencies in this knowledge. This means that there is a need for regular repetition courses among healthcare professionals to preserve and improve CPR knowledge [210]. The educational intervention also appeared to increase CPR practical skills among healthcare professionals. Unfortunately, despite the training there were still serious shortcomings in skill performances. Further studies should therefore be conducted with the aim of improving education and developing a system of regular scheduled repetition training, in which all healthcare professionals should be involved. We do believe that it is important to train in teams involving different occupations. According to Hunziker et al, the training also needs to be focused on educating the leader of the rescue team [211].

Our study indicated that physicians have good theoretical knowledge. With this in mind, there is a suggestion to re-design the CPR education for physicians. They might have a shortened course focusing on the practical skills, on training in leadership, and on discussions about the decision whether to resuscitate or not. If that is to be managed, there is a need for several physicians to be instructors in CPR and to take an active part in the repetition courses for colleagues.

Presenting a shortened course may make it easier to attract physicians to repetition courses.

There were no differences in skill performances between the different professions. The nurses, assistant nurses and all other healthcare professionals might need to focus on the first link in the chain of survival. It is important to find the patient early, before the cardiac arrest has occurred. To achieve this goal, education in early warning scores and communication might be the right paths to take [212, 213]. The CPR education of other healthcare professions (physiotherapists, occupational therapists, social welfare officers, psychologists and biomedical analysts) needs to focus on how to use barrier devices and the safety of the rescuer and the patient as well as on early warning signs and communication.

An educational intervention appeared to change healthcare professionals' attitudes to CPR in a positive way. However, we still know too little about the importance of this group of individuals' attitudes to CPR. Future research must focus more on the significance of this poorly documented subject and how it affects the patient outcome. Future studies might focus on how and why healthcare professionals are willing to change their attitudes to CPR. Feedback after CPR efforts in real life and other types of feedback during resuscitation training may be a way to approach the problem [214].

We could not prove that training combined with the deployment of AEDs shortened the time to defibrillation. This calls for further documentation. It is important that hospital directors closely follow the clinical consequences of the introduction of the AEDs in wards with respect to time- to- defibrillation and survival.

The share of patients who survived with good cerebral function appeared to increase after an educational intervention among healthcare professionals in the study. This supports the value of an optimal CPR organisation which takes responsibility for all regular and repetition training of the healthcare professionals. We do not recommend hospital managers to reduce the time and money spent on resuscitation education of healthcare professionals. Until proven otherwise, the better functional status found in cardiac arrest patients after education in basic life support for healthcare professionals will continue to be a good argument for keeping up education and training. To be able to avoid mishaps, near incidents, and incidents in patient care, healthcare professionals need regular repetition courses in for example CPR, in order to check, test and improve their knowledge and skills. This is a corner stone for safe patient care.

6 Conclusion

This thesis presents findings from five papers which taken together conclude that:

- It is possible to create a short reliable multiple- choice questionnaire to evaluate healthcare professionals' knowledge in cardiopulmonary resuscitation (CPR).
- The theoretical knowledge improved among all groups of healthcare professionals after an educational intervention.
- The willingness to use the automated external defibrillator improved generally after education, and there were no major differences in the CPR skills between the different healthcare professions.
- The intervention changed the approach to CPR and attitude when performing it, thus, several healthcare professionals received a positive attitude to resuscitation.
- The improvement in knowledge and attitude might have resulted in an improvement in the quality of resuscitation performed at real cardiac arrest patients. The functional status among surviving cardiac arrest patients improved. With respect to the small sample size and with possible effects from other factors in mind, the results from our cardiac arrest patients were important hypothesis generating findings.

7 Summary in Swedish/Sammanfattning på svenska

Titel: Hjärtstopp på sjukhus.

En utbildningsintervention i hjärt- och lungräddning bland sjukvårdspersonal och dess effekter på kunskaper, färdigheter, attityder samt överlevnaden hos patienter.

Sjukvårdspersonal förväntas ge bästa möjliga vård och behandling. Enligt den svenska hälso- och sjukvårdslagen väntas patienterna erbjudas likadan vård oavsett var i Sverige de uppsöker vård. Hjärt- och lungräddning (HLR) och återupplivningsförsök ställer angelägenheten kring att erbjuda likadan vård på sin spets. Detta eftersom HLR är något som måste påbörjas omedelbart och på rätt sätt när behovet uppstår. Idén till denna avhandling uppstod då organisationen för HLR försvann i samband med en större omorganisation inom Centrallasarettet i Västerås under år 2004-2005 (förutom vid vissa specialistvårdsavdelningar). Förlusten av HLR-organisationen medförde att patienterna upplevdes få olika vårdinsatser vid ett hjärtstopp, beroende på var inom sjukhuset de vårdades. Kunde det vara så att brist på kunskap i HLR påverkade utfallet efter hjärtstopp för patienterna?

Historiskt startade hjärt- och lungräddning för århundranden sedan, men det dröjde ända till år 1960 innan det klassiska manuskriptet av Kouwenhoven, Jude, och Knickerbocker publicerades. Där beskrevs två olika tekniker för att utföra HLR: 1) kompressioner direkt på hjärtat med öppen bröstkorg 2) en ny metod med bröstkompressioner på en stängd bröstkorg. Metoden med stängd bröstkorg liknar den metod för HLR som rekommenderas och utförs idag. Dagens rekommendation är att utföra 30 bröstkompressioner med takten 100/minut och därefter 2 inblåsningar, samt att snarast möjligt hämta en hjärtstartare/defibrillator till platsen för hjärtstoppet.

Konceptet ”kedjan som räddar liv” introducerades 1991 och rekommenderar: tidigt larm, tidig HLR, tidig defibrillering samt den sista länken med eftervård vid hjärtstopp. Patienternas överlevnad beror på hur sjukvårdspersonal påbörjar länkarna i ”kedjan som räddar liv”. Ungefär 90 procent av alla hjärtstopp orsakas av ischemisk

hjärtsjukdom, och arytmier är den näst vanligaste orsaken. Två arytmier som kan uppstå vid ett hjärtstopp är ventrikelflimmer (VF) eller ventrikulär takykardi (VT). Vid dessa två arytmier är hjärtstartaren ett mycket gott hjälpmedel.

Rädsla för att skada patienten eller sig själv har bland sjukvårdspersonal visat sig vara en förklaring till minskad villighet att starta HLR. Studier har visat att en del sjukvårdspersonal är rädda för att smittas av infektioner i samband med HLR. Detta trots att riskerna för smitta av exempelvis SARS, HIV, staphylococcus aureus, herpes simplex och salmonella har visats vara låga. Personalen vid ett hjärtstopp förväntas arbeta tillsammans med människor som de sällan eller aldrig har träffat tidigare, och målet är att de skall arbeta tillsammans som ett team. Varje enskild person i teamet ska kunna arbeta individuellt med eget ansvar och ändå vara en del i dess gemensamma beslut. Flygindustrin var tidig med simuleringsövningar för sina team, och delar av dessa tankegångar bör vara tillämpliga även inom vården.

Om läroprocessen skall bli effektiv krävs flexibilitet, situationsbaserat lärande, simulering, återkoppling och överträning. När något nytt skall läras, så förnyas och utvecklas kunskapen i förhållande till den kunskap som fanns från början. Läroprocessen tar sin utgångspunkt i tidigare kunskap och den nya situationen. Det finns ett ordspråk som instruktörer i hjärt- och lungräddning kan ha nytta av:

”jag hör och jag glömmer, jag ser och jag kommer ihåg, jag gör och jag förstår”.

Effektiviteten av utförd återupplivning på sjukhus, mätt i överlevnad är svår att beräkna. Tidigare studier har bland annat baserats på olika antal patienter, olika miljöer, bevittnade eller obevittnade hjärtstopp och om beräkningarna är utförda på alla hjärtstopp eller bara på de med VT/VF. Överlevnaden vid hjärtstopp inom sjukhusmiljön varierar mellan 15-59 procent i olika studier. Syftet med återupplivningsförsök är att föra tillbaka patienten till livet i det hälsotillstånd som fanns före hjärtstoppet. Ett sätt att mäta hälsotillståndet efter hjärtstopp är att mäta funktionen med ”cerebral performance scale” (CPC). CPC-skalan graderar patientens funktion från ett till fem, där siffran ett innebär god funktion och siffran fem är lika med hjärndöd. Önskvärt är att denna utvärdering sker när patienten skrivs ut från sjukhuset, efter sex månader och ett år efter hjärtstoppet. Inom detta område finns möjligheter för Centrallasarettet i Västerås att utvecklas.

Alla återupplivningsförsök borde påbörjas likadant oavsett var på sjukhuset hjärtstoppet sker. Om patienten svarar på behandlingen, som är startad på avdelningen, ska avancerad vård, det vill säga intensivvård, övervägas. Denna avhandling är en klinisk studie som syftar till att undersöka om en utbildningsintervention till sjukvårdspersonal på sjukhus kan påverka deras kunskap och färdigheter i HLR. I förlängningen är det främsta syftet att undersöka om utbildning och reorganisation kan påverka utfallet för patienter med hjärtstopp på Centrallasarettet i Västerås.

För att kartlägga sjukvårdspersonalens kunskaper utvecklades ett frågeformulär. Frågorna kom ursprungligen från utbildningsprogrammet för D-HLR (Defibrillerings HLR), framtaget av svenska HLR-rådet. Frågorna omarbetades, testades och validerades (delstudie I). Frågorna täcker in följande områden inom HLR: 1) utvärdering av medvetslös patient, 2) utvärdering av misstänkt hjärtstopp, 3) bröstkompressioner, 4) mun-till-mun andning, 5) vem får defibrillera, 6) indikation för defibrillering, 7) tid för optimal defibrillering, 8) praktisk procedur vid defibrillering och 9) hur gör jag om problem uppstår.

I delstudie II användes dessa frågor för att ta reda på sjukvårdspersonalens kunskaper före och efter utbildning i S-HLR (HLR för sjukvårdspersonal). Sjukvårdspersonalen vid Köpings närsjukhus, med en befintlig HLR organisation, hade högre kunskap innan utbildningen i jämförelse med sjukvårdspersonal vid Centrallasarettet i Västerås. Däremot hade sjukvårdspersonalen vid Centrallasarettet signifikant höjt kunskapsnivån efter utbildningen i jämförelse med personalen från Köpings närsjukhus. När materialet analyserades ur ett yrkesperspektiv framkom att läkarna hade högst kunskap från början, och att de därmed inte heller ökade sina kunskaper signifikant. Sjuksköterskorna ökade sina kunskaper efter utbildningen, till en kunskapsnivå likvärdig läkarna. Den grupp av sjukvårdspersonal som ökade sina kunskaper mest var gruppen "övrig universitetsutbildad personal" (vilken inkluderade sjukgymnaster, arbetsterapeuter, kuratorer, psykologer och biomedicinska analytiker).

Delstudie III visade att det inte har någon betydelse vilken yrkesgrupp på sjukhuset som utför HLR. Alla yrkesgrupper lärde sig att använda hjärtstartaren. Dessutom förbättrade alla yrkesgrupper sina praktiska färdigheter. Emellertid var kompressionsdjupet under eller precis i nivå med de nationella riktlinjerna rekommenderade djupet.

Attityderna till HLR förändrades i positiv riktning. Rädslan för att bli smittad vid mun-till-mun andning minskade bland alla yrkesgrupper.

Läkarna var den yrkesgrupp som minskade denna rädsla mest (75%; $P < 0.001$), medan gruppen "övrig universitetsutbildad personal" var de som minskade sin oro minst (33%; NS). Det fanns några områden där sjukvårdspersonalen inte förändrade sina attityder till HLR. Det gällde en redan från början låg rädsla för att bli smittad av någon sjukdom i samband med utövande av HLR samt oro för att skada sig själv eller patienten. Dessutom fanns det en tendens till reducerat psykiskt lidande generellt bland deltagarna i studien (NS.)

Införandet av 18 hjärtstartare och återuppbyggnaden av HLR-organisationen medförde att bröstkompressionerna startades tidigare, medan tiden till defibrillering och övrig behandling inte förändrades. Överlevnaden vid utskrivning från sjukhus förändrades inte heller, men de som överlevde gjorde det med gott funktionellt status (CPC 1; $P < 0.001$). Att förklara varför patienterna förbättrats i sin funktionella status blir spekulativt, då studien baserats på ett begränsat antal patienter.

Det är av yttersta vikt att beslut är taget för varje enskild patient inom sjukhuset gällande om HLR skall påbörjas eller ej. Om beslut inte är taget kommer HLR att påbörjas, trots att syftet med HLR saknar mening, och i förlängningen blir en oetisk handling. Förutom den etiska aspekten och missbruket av resurser, leder utsiktslös HLR till låg överlevnad vilket ger negativ återkoppling för HLR-organisationen. Detta kan på sikt bli demoraliserande för verksamheten. Dessa svåra beslut om HLR eller ej, påverkar således utfallet av överlevnad efter hjärtstopp negativt.

Slutligen vill vi påminna om att HLR-kunskap är färskvara och behöver övas regelbundet för att det ska undvikas missförstånd och incidenter i patientvården. Därtill krävs det övning i grupp med flera yrkeskategorier för att sjukvårdspersonalen skall kunna bibehålla och förbättra kunskaper och färdigheter. Detta ger möjlighet till förbättrad patientsäkerhet och ökat funktionellt status efter hjärtstopp.

Nyckelord: hjärtstopp, hjärt-lungräddning, sjukhus, sjukvårdspersonal,

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9 Appendix

Multiple- choice questions used in paper II/ Enkät med kunskapsfrågor i hjärtlungräddning

Skulle Du känna dig säker på din uppgift, om du träffar en livlös person med hjärtstopp under ditt arbetspass imorgon?

Hjärtlungräddning är en del i vårt arbete, som utförs sällan, men när det utförs har det stor betydelse för den drabbades överlevnad. Med anledning av detta tillfrågas Du att besvara denna enkät som är en del i en kartläggning av vårdpersonalens kunskaper i hjärtlungräddning inom sjukvården, psykiatrin och tandvården på Västerås Centrallasarettet samt sjukvården på Köpings sjukhus i landstinget Västmanland.

Du har troligen besvarat denna enkät tidigare och vi vill att du besvarar den igen. På detta sätt bidrar du till utveckling inom hjärtlungräddningsområdet. Det innebär att där kunskaper saknas är vår ambition att erbjuda kompletterande utbildningsinsatser.

Samtlig vårdpersonal som har någon form av patientkontakt kommer att besvara denna enkät.

Besvara enkäten individuellt utifrån de kunskaper Du har idag, ta inte hjälp av böcker eller andra hjälpmedel.

Dina svar kommer att databearbetas tillsammans med alla andra som besvarar enkäten.

Dina svar kommer att behandlas konfidentiellt, det vill säga inga uppgifter som insamlas kan spåras tillbaka till Dig i forskningsrapporten. Enkäten är sekretesskyddad och inga obehöriga får ta del av enkätens uppgifter om den enskilde (enl. paragraf 3, sekretesslagen). Ansvarig myndighet är Landstinget Västmanland, Sjukhusstyrelsen, Centrallasarettet, 721 89 Västerås, telefon 021-17 30 00.

Ditt deltagande i studien är helt frivilligt, men det är viktigt för undersökningens kvalitet, att alla som får enkäten besvarar den. Därför är det angeläget att Du försöker svara så fullständigt som möjligt på frågorna. Enkäten är en delstudie för en doktorsavhandling vid Centrum för Klinisk Forskning i Västerås.

Trots att vi förorsakar dig ett visst besvär, hoppas vi att Du vill hjälpa oss att utveckla hjärtlungräddningen på sjukhusen i Västerås och Köping. Denna utveckling kan förhoppningsvis förbättra insatserna då en medmänniska drabbas av ett hjärtstopp.

Tack på förhand för Din medverkan!

Har Du några frågor angående studien eller enkäten kontakta någon av undertecknad.

Med vänliga hälsningar



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Enkät med kunskapsfrågor i hjärtlungräddning (HLR)

Besvara frågorna nedan enskilt och utifrån Dina egna kunskaper.

Sätt bara ett kryss per fråga där inget annat anges, använd kulspetspenna och kryssa i rutan. På de ställen där Du ska fylla i text eller siffror ska du skriva på linjen. Det är bra om Du textar tydligt !

1. Vad är det första du gör om du kommer fram till en person som ramlat omkull i ett väntrum på sjukhuset där du jobbar?

- ☐ Läger personen i stabilt sidoläge
- ☐ Kontrollerar medvetande, andning, puls
- ☐ Ger två inblåsningar så fort som möjligt
- ☐ Kontrollerar medvetande och andning
- ☐ Vet inte

2. Hur lång tid (i sekunder) får din undersökning högst ta av patient med misstänkt hjärtstopp?

- ☐ 10-15
- ☐ 20
- ☐ 30
- ☐ 60
- ☐ Vet inte

Följande frågor handlar om en situation där patienten har fått ett hjärtstopp. Hjärtlungräddning med inblåsningar och bröstkompressioner är påbörjad.

3. Om du inte kan hämta alla hjälpmedel på en gång, vilket hjälpmedel skall du i första hand prioritera?

Sätt bara ett kryss per fråga.

- ☐ Defibrillator
- ☐ Hjärtbräda
- ☐ Sug
- ☐ EKG-apparat
- ☐ Syrgasutrustning
- ☐ Andningsmask
- ☐ Vet inte

4. Får personal som arbetar på sjukhuset använda en halvautomatisk defibrillator?

- ☐ Ja, alla får det
- ☐ Ja, men bara personal som gått kurs i HLR och blivit godkänd
- ☐ Ja, men bara personal som blivit godkänd i HLR för sjukvårdspersonal (S-HLR) och fått en delegering av läkare
- ☐ Vet inte

5. Vid vilken/vilka arytm(er) ska man defibrillera under ett pågående hjärtstopp?

	JA	NEJ	Vet inte
a) Ventrikelflimmer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b) Asystoli	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c) Ventrikeltakykardi (pulslös)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d) Pulslös elektrisk aktivitet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6. Var ska elektrodplattorna från defibrillatorn placeras på patienten vid hjärtstopp?

- ☐ Båda två mitt emellan bröstvårtorna
- ☐ Den ena under höger nyckelben och den andra 10 cm nedanför vänster armhåla
- ☐ Den ena på bröstet och den andra på ryggen
- ☐ En på var sida av bröstkorgen
- ☐ Vet inte

7. Patienten är genomvåt av kallsvett. Vad ska du göra för att kunna defibrillera?

- ☐ Inte något speciellt
- ☐ Låt honom behålla kläderna på
- ☐ Läger torrt papper på huden och sätter fast elektroderna från defibrillatorn ovanpå
- ☐ Torkar av området där elektrodplattorna från defibrillatorn ska placeras samt området mellan plattorna
- ☐ Vet inte

8. Hur många gånger i följd kan du defibrillera under pågående hjärtlungräddning?

- ☐ Högst en defibrillering åt gången, sedan måste man göra HLR
- ☐ Två gånger, sedan måste man göra HLR
- ☐ Tre gånger, sedan måste man göra HLR
- ☐ Ingen begränsning
- ☐ Vet inte

9. Patienten har kammarflimmer vid första rytmregistreringen. Hur snart bör du defibrillera, enligt gällande riktlinjer?

- ☐ Inom 1 minut
- ☐ Inom 2 minuter
- ☐ Inom 3 minuter
- ☐ Inom 4 minuter
- ☐ Inom 5 minuter
- ☐ Vet inte

10. När du gör inblåsningar/ventilerar patienten i samband med hjärtlungräddning skall du

- ☐ Blåsa/ventilera långsamt
- ☐ Blåsa/ventilera kraftigt
- ☐ Blåsa/ventilera snabbt
- ☐ Vet inte

11. Hur kan du vara säker på att en inblåsning är effektiv?

- ☐ Genom att du kan känna att luften kommer tillbaka genom munnen
- ☐ Genom att du känner att luften försvinner in i patienten
- ☐ Genom att du ser att bröstkorgen höjer sig
- ☐ Genom att du kan höra ett väsande ljud
- ☐ Vet inte

12. Med vilken frekvens (per minut) ska man göra bröstkompressioner?

- ☐ 60 ☐ 80 ☐ 100 ☐ Mer än 100 ☐ Vet inte

13. Sätt ett kryss i rutan för vilken yrkeskategori du tillhör

- ☐ Undersköterska, skötare
- ☐ Sjuksköterska, barnmorska
- ☐ Biomedicinsk analytiker
- ☐ Sjukgymnast
- ☐ Arbetsterapeut
- ☐ Audionom
- ☐ Läkare
- ☐ Annan yrkeskategori, vänligen specificera _____

14. Hur länge har du sammantaget arbetat inom vården

--	--

 år

Här kan du skriva kommentarer om du vill

Tack för din medverkan

Questions used in paper IV

Hjärtlungräddningsformulär

Du ombeds besvara ett frågeformulär som handlar om dina tankar och upplevelser i samband med hjärtlungräddning. Hur arbetsmiljön ser ut för vårdpersonalen i samband med hjärtlungräddning är knappt undersökt tidigare. En del frågor kan upplevas likartade, det är dock av stor vikt att du besvarar alla frågor ändå. Även om du sällan eller aldrig deltagit som vårdpersonal vid ett hjärtstopp är det av betydelse att du besvarar formuläret.

Dina svar kommer att databearbetas och skannas in av en dator. Sätt därför dina kryss tydligt i rutan ☒ för att markera ditt svar. Det gör inget om delar av krysset hamnar utanför bara skärningen på krysset finns innanför. Använd svart eller blå kulspetspenna. Om du kommer på att du kryssat i fel ruta, så fyll hela rutan som blev fel och gör ett kryss i den ruta du vill ha ditt svar i. Det tar ca 15 minuter att besvara formuläret. Om det är någon fråga du anser omöjlig att besvara så ange detta hellre än att kassera hela enkäten.

Formuläret ingår i en delstudie som genomförs för att undersöka vårdpersonalens arbetsmiljö och kunskaper inom HLR. Studierna ingår i en doktorsavhandling vid centrum för klinisk forskning Västerås.

Överst på formuläret finns ett löpnummer som gör det möjligt att skicka påminnelse till den som eventuellt inte svarat. Så snart ett formulär kommit in förstörs detta nummer. Dina svar kommer att data-bearbetas tillsammans med alla andra som besvarar formuläret. Det Du svarat går ej att urskilja i sammanställningen av formuläret. **Ditt deltagande i studien är helt frivilligt och Dina svar kommer att behandlas konfidentiellt**, dvs. inga uppgifter som insamlas kan spåras tillbaka till Dig i forskningsrapporten. En uppföljning kommer att ske efter ca två år, du kommer då att erbjudas deltagande igen.

Tacksam om du vill skicka in den ifyllda enkäten i det bifogade svarskuvertet **inom 10 dagar**. Har Du några frågor angående studien kontakta någon av undertecknad.

Tack på förhand för Din medverkan!

Med vänliga hälsningar;
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Hjärtlungräddningsformulär

Sätt ett kryss per fråga om inte annan möjlighet anges i frågan. Använd kulspeppenna och kryssa i rutan.

På de ställen där Du ska fylla i text eller siffror ska du skriva på linjen. Det är bra om Du textar tydligt!

1. Sätt ett kryss i rutan för vilken yrkeskategori du tillhör

- ☐ Undersköterska
☐ Sjuksköterska, barnmorska
☐ Biomedicinsk analytiker
☐ Sjukgymnast
☐ Arbetsterapeut
☐ Audionom
☐ Läkare
☐ Annan yrkeskategori, vänligen specificera

2. Din ålder är år

3. Hur länge har du arbetat inom yrket år

Tänk dig att du är på väg till jobbet och du vet att det för tillfället kommer att vara några hjärtsjuka patienter på din arbetsplats. Det är stor risk att någon av dessa patienter får ett hjärtstopp och du kommer att behöva utföra HLR, vad känner du inför detta?

	Ja	Nej	Vet ej
4. jag skulle känna mig osäker på hur jag skulle reagera	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. jag skulle känna mig nervös inför denna situation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. jag skulle känna det som min plikt att ingripa om så behövdes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. jag skulle känna mig trygg i mina HLR kunskaper	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. jag skulle känna mig ängslig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. jag skulle veta vad jag skulle göra om ett hjärtstopp inträffar	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. jag skulle handla instinktivt	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. jag skulle se det som en möjlighet att hjälpa till	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. jag skulle ha ett behov av att ha saker och ting under kontroll	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. om så behövs skulle jag klara av att ta kommandot över situationen	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. Anser du att du med bestämdhet behärskar att använda defibrillatorn?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

15. Har du någon gång utfört HLR på barn (ventilation eller kompression eller läkemedelshantering)

☐

Ja

☐

Nej

16. Har du någon gång utfört HLR på vuxen (ventilation eller kompression eller läkemedelshantering)

☐

Ja

☐

Nej

Om du svarat Nej på både fråga 15 och 16 tackar jag för din medverkan.

Om du tänker tillbaka på den senaste gången du deltog i en hjärtlungräddningssituation, kände du då ...

		Ja, stort obehag	Ja, litet obehag	Nej	Minns ej
17.	något fysiskt obehag	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18.	något psykiskt obehag	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19.	en oro för att bli smittad av någon sjukdom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20.	en oro för att sticka dig på läkemedels- ampull, uppdragningskanyl eller venflon	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21.	en oro för att göra fel och orsaka komplikationer för den drabbade	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22.	en oro för att bli smittad av någon	Utfördes ej	Ja, stort obehag	Ja, litet obehag	Nej
	sjukdom när du				
	utförde mun till	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	mun andning				

Här kan Du skriva kommentarer

.....

.....

Här är formuläret slut.

Jag ber dig läsa igenom det en gång till,
för att se efter att alla frågor som ska besvaras är besvarade.

TACK FÖR DIN MEDVERKAN!

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De vilda flyger.*

Elmer Diktonius

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