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Telemedicine at the Emergency Site –
Evaluated by emergency team members in simulated scenarios

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1 Hypothesis and Background

Emergency medicine plays an important role in anaesthesiology and intensive care medicine. The continuous development of the existing medical emergency system is of major scientific and public health concern.

1.1 Hypothesis

This study aims to examine the following hypothesis:
Emergency medicine can benefit from telemedicine, whenever paramedics at a remote emergency site request consultation or mentoring by a distant emergency doctor.

Prior to application in the existing medical emergency system, this hypothesis is to be tested in the setting of a medical simulation centre. Paramedics encounter standardized simulated emergency case scenarios and are connected for teleconsultation and telementoring with emergency doctors by video- and audio link. The core device of this telemedical link is a newly developed real-time high definition video system called *LiveCity camera*.

In detail the items of the hypothesis are as follows:
1.) Emergency team members encounter situations at the emergency site, in which they would like to get help by a more experienced colleague.
2.) The telemedical contact to an emergency doctor makes paramedics feel more secure.
3.) A sufficient telemedical system needs transmission of vital signs as well as audio- and video-connection.
4.) The *LiveCity camera* is an effective telemedical tool.
5.) Emergency team members perceive that telemedicine improves the quality of patient care.

A prerequisite for the evaluation of the hypothesis is that the simulated scenarios are realistic and relevant for studying an emergency situation and are taken seriously by paramedics and doctors.

The hypothesis is in line with the expectations of the European Union Research and Innovation Programmes, and the study is part of the Seventh Framework Programme (FP7) for 2007-2013.

1.2 EU-Project *LiveCity*

Among the main goals of the European Union are the reduction of disparities and the sustainable gain of equal opportunities across borders and over geographical distances. The European Union funded research project *LiveCity* ("Live Video-to-Video Supporting Interactive City Infrastructure")[1] is part of the appropriate programs of FP7. *LiveCity* contributes to achieve and improve the technical and structural basis of live communication between individuals or groups of individuals in distant places by using high definition (HD) video communication in real time [1].
Such a concept is expected to positively contribute to the quality of life of citizens and communities within the European Union in various situations; some of them are to be examined representatively in the *LiveCity* Project [2].

1.3 Emergency Use Case of *LiveCity* Project

An integral part of the *LiveCity* Project is the *Emergency Use Case* represented in the *LiveCity Grant Agreement* in *Work Package 2*. For this part of the project, project-partners from Portugal, Greece and Ireland developed a special camera, called "*LiveCity camera*"[2] [3]. The concept of the *Emergency Use Case* is to connect

[1] FP7; CIP-ICT-PSP-2011-5 / Pilot Type B; Objective 5.1: Open Innovation for future Internet-enabled Services in "smart" Cities; Grant Agreement No.297291

[2] *LiveCity* partners: Luis Cordeiro and Joao Goncalves (OneSource Consultoria Informatica LDA, Portugal), Ioannis Chochliouros and Evangelos Sfakianakis (Hellenic Communications Organization S.A. (OTE), Greece), Eleni Patouni and Nikolaos Bompetsis (National and Kapodistrian University of Athens, Greece), Donal Morris (RedZinc Services Ltd., Ireland)

paramedics, who are treating an emergency patient, with an emergency doctor located at a hospital by use of the *LiveCity camera*. The paramedics are enabled to demonstrate the emergency situation and vital signs of the patient to the emergency doctor. Thus, the emergency doctor is able to assess the emergency situation and advise the paramedics at the emergency site.

Particularly in emergency medicine, time is critical and even a small delay of appropriate handling at the emergency site can lead to a significant harm of the patient and therefore to increased morbidity and mortality. The hypothesis of the *Emergency Use Case* is that a real-time high quality video connection between paramedics at the emergency site and emergency doctors at a distant hospital might increase the quality of patient care and potentially save lives.

The *Emergency Use Case* is realised in two interconnected sub-projects, taking place in Greifswald (Germany) and Dublin (Ireland). The sub-project at Greifswald University Medicine investigated the *LiveCity camera* video link in a medical simulation centre without actual patients. The sub-project at the Beaumont Hospital in Dublin in cooperation with the Royal College of Surgeons in Ireland is in charge of transferring the experiences gained in Greifswald to real emergency sites outside the simulation centre[3].

The findings of the *Emergency Use Case* will be analysed in synopsis with the other *LiveCity* Use Cases regarding key performance indicators and potential political implications by the partners at Brunel University, London, Great Britain[4].

[3] *LiveCity* partners: Peadar Gilligan and Ahjoku Amadi-Obi (Royal College of Surgeons in Ireland, Ireland)

[4] *LiveCity* partners: Vishanth Weerakkody and Ramzi El-Haddadeh (Brunel University London, United Kingdom)

1.4 Medical Emergency Systems

To evaluate the potential impact of telemedicine and especially *LiveCity camera* based communication at the emergency site, the background of medical emergency systems has to be considered. Medical emergency systems are different constitutively or to some extent in every country worldwide. Sometimes even within one country there are different emergency systems. For example, China had seven different emergency systems in 2007 [4] and in some countries the urban areas can provide a higher developed system than rural areas [5].

1.4.1 Medical Emergency Systems worldwide

To categorize the variety of medical emergency systems worldwide, four different types might be differentiated: (a) no organized structure; (b) basic life support; (c) advanced life support with paramedics; and (d) advanced life support with physicians [6].

(a) Many developing countries in Sub-Saharan Africa or parts of Asia have no organized pre-hospital emergency system [7]. However in line with population growth, urbanization and industrialization there is an ongoing shift from infectious diseases towards medical conditions like cardiovascular diseases and vehicle accidents. Due to medical reasons this calls for a higher need of medical emergency systems [8-10]. One approach to improve the quality of emergency medicine in those countries is to teach high quality first aid to volunteers of the community [11].

(b) Basic life support works without trained medical professionals at the emergency site and focuses on fast transport to a hospital and keeping the patient alive during transport, which is, for instance, the case in Zimbabwe [12]. In comparison, advanced life support systems work on a more sophisticated level of care at the emergency site and during the transport to a hospital, but depend upon well-educated and medically qualified providers [6].

(c) Advanced life support with paramedics as single providers at the emergency site is also called “the Anglo-American model” [13]. It was developed in the United States

of America [14]and is also used e.g. in Ireland [15], the United Kingdom [16], Canada [17], Australia [18], New Zealand [19], Singapore [20], South Africa [21], and the Netherlands [22].

(d) Advanced life support with paramedics working together with physicians at the emergency site is called “the Franco-German model”[13]. It is for example used in France [23], Germany [24], Greece [25],Spain [26], Denmark [27], Israel [28], Brazil [29], and in the urban areas of Portugal [30] and Lithuania [5].

The main difference between the two models of advanced life support is that the Anglo-American model brings the patient to the doctor and in the Franco-German model the doctor is brought to the patient [31].

1.4.2 Medical Emergency System in Germany

The German medical emergency system as an example of the Franco-German model is a dual system with two partners, i.e. paramedics and emergency doctors [32]. Paramedics receive a one- to three-year education in handling emergency situations [33]. Emergency doctors are medical doctors with a special training and qualification in emergency medicine [34].

Already in 1938 the German surgeon KIRSCHNER stated, that in emergency situations the physician should be brought to the patient [35], and this is still the philosophy of the German medical emergency system.

*Figure 1*shows the pathway of a patient, who experiences an emergency and alerts the medical emergency system. This diagram is based on the concept “Rettungskette” (chain of survival), developed in 1960 by AHNEFELD to illustrate, how the different partners work together like links in a chain in a life-threatening emergency case beginning with first aiders and ending in hospital [36, 37].

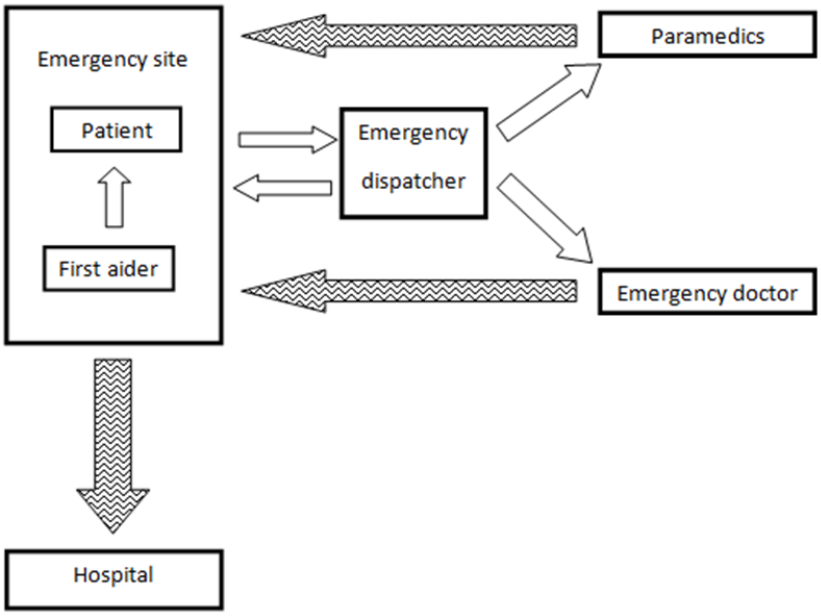


Figure 1: Pathway of medical emergency system in Germany

The first and prerequisite step is that either the patient or a first-aider, which might be a relative, friend or bystander observing the situation, calls for help. The number to call is “112”, the European emergency number, which can be dialled free of charge in case of a medical emergency in all EU countries, Switzerland, Montenegro, Turkey and South Africa [38]. The 112 call in Germany will be answered in 95% within 20 seconds and the 112 operator can identify the local position of the caller within 70 seconds [38] .

The 112 call is answered by the emergency dispatcher, who is a paramedic with a special training. The emergency dispatcher will assess all relevant details and will ask the caller for further information, if necessary. The emergency dispatcher will rank the emergency into the categories “emergency doctor required” or “no emergency doctor required” , based on a so-called “Notarztindikationskatalog”, an index of urgent necessity [39]. An emergency doctor is required in situations, which seem to be life-threatening or potentially life-threatening [40]. Hence in those cases the emergency dispatcher will alert the emergency doctor. A team of two paramedics will be sent to the emergency site in all emergency cases. Approximately, only one out of three to one out of four emergency situations require an emergency doctor [24].

Because the paramedics are alerted in every emergency, there are more paramedics than emergency doctors. This allows a wider geographical spread of paramedics, which places the paramedics closer to potential sites of emergencies.
Historically the paramedics and emergency doctors drove to the emergency site in the same vehicle. This is called “the stationary system” [41]. In the “rendezvous system” the paramedics and emergency doctors drive in different vehicles and arrive independently at the emergency site, where they meet. The rendezvous system has been established as the main procedure and is used in 99.1% [42, 43]. The rendezvous system allows a high flexibility and leads to a substantial decrease in the time it takes for the first team of emergency personnel to arrive at the emergency site [44, 45]. The time between the alerting of the emergency system and the arrival of the first members of the emergency personnel at the site is called “Hilfsfrist” (“period to help”) [46, 47]. Every federal state government in Germany is obliged by law to organise the required infrastructure for the emergency personnel to arrive within a predefined time [33, 48]. On average, the paramedics in Germany arrive at the emergency site after 8.7 minutes and the emergency doctor after 12.3 minutes [42].

At the emergency site, the emergency doctor and paramedics establish a preliminary diagnosis and start the treatment. The treatment could be either completed at the emergency site, so that the patient can be left at home, which is the case in approximately 5%, or the patient has to be brought to the hospital [42]. Depending on the kind of emergency and surrounding circumstances (e.g. distance to hospital) either the main part of the treatment is done at the emergency site (“stay and play”), or during transport (“scoop and play”) or at the hospital (“scoop and run”) [49-51]. The transport of the patient to the hospital is done together by the paramedics and the emergency doctor. Once the patient is in the hospital, the hospital staff will continue the diagnostics and treatment. The paramedics and emergency doctor return to their different bases becoming available for the next emergency patient.

1.5 Telemedicine

Telemedicine are ICTs (information and communication technologies) in medicine enabling diagnostics and treatment of diseases over geographical distances [52, 53]. The term “telemedicine” is a hybrid word of the Greek “tele” meaning “at a distance” and the Latin word “medicina” for “healing arts”. It was first used by Bird in the 1970s and although more than 100 peer-reviewed descriptions exist, there is still no unitarily accepted definition [54-56].

Telemedicine is an important topic as described in the “Global Observatory for eHealth” by the World Health Organization (WHO), and the implementation of telemedicine is one of the goals of the European Union [52, 57].

Telemedicine offers an opportunity to balance uneven allocation of infrastructure and resources including human resources [56]. Therefore, it is used in many different medical disciplines and areas. One goal of telemedicine is to reduce hospital admissions and to provide medical care to a patient in his familiar surroundings [58]. Another goal is to treat urgent worsening of chronic diseases or emergencies [59, 60]. Telemedicine has huge advantages in emergency medicine, where the transfer of knowledge in short time is critical and potentially lifesaving, as illustrated by the *LiveCity* partners from RCSI and the Beaumont Hospital in Ireland [61].

There are two “dimensions” of communication in telemedicine: horizontal and vertical. Based on the concepts of internal communication within business companies, the horizontal communication happens between partners of the same level in the hierarchy, while the vertical communication is between partners of different levels in the hierarchy [62, 63]. Hierarchy in this sense is defined by level of knowledge, competence and responsibility. The horizontal communication can be for example between medical doctors in different hospitals. The vertical communication can take place between a medical expert and a patient. For instance a nurse can support a patient with his daily treatment of diabetes or doctors can support cancer patients at their homes [64-66].

The vertical communication is also possible between two healthcare-providers with different levels of medical expertise, e.g. an emergency doctor and paramedics. Thus, telemedicine offers the opportunity to have a medical supervisor. This use of telemedicine is called teleconsultation and telementoring and allows guidance by an advisor in situations, which the advisee has not - or has seldom- experienced before [67]. For example, in the field of surgery telementoring could often be implemented successfully and led to a reduced complication rate [68, 69]. Telementoring is also of great value in non-surgical treatment as shown in a study done in a paediatric hospital in Somalia [70]. The research project *PrimCareIT* (part-financed by the European Union Baltic Sea Region Programme 2007-2013) studies how teleconsultation and telementoring can be implemented in rural areas of the Baltic Sea Region [71].
The *Emergency Use Case* of the *LiveCity* Project examines telementoring and teleconsultation in the area of pre-hospital emergency medicine.

1.5.1 Concept of Tele-Emergency Doctor

There are some special situations, in which the rendezvous system of the medical emergency system in Germany could benefit from support by telemedicine. A tele-emergency doctor could provide teleconsultation and telementoring in these situations.

Figure 2 is introducing a tele-emergency doctor as an auxiliary partner into the well-established "Rettungskette" as shown before in *Figure 1*. The tele-emergency doctor is an emergency doctor with special training, who works from a central dispatch place distant from the emergency site. The paramedics can get in contact with the doctor via telemedicine and ask for help.

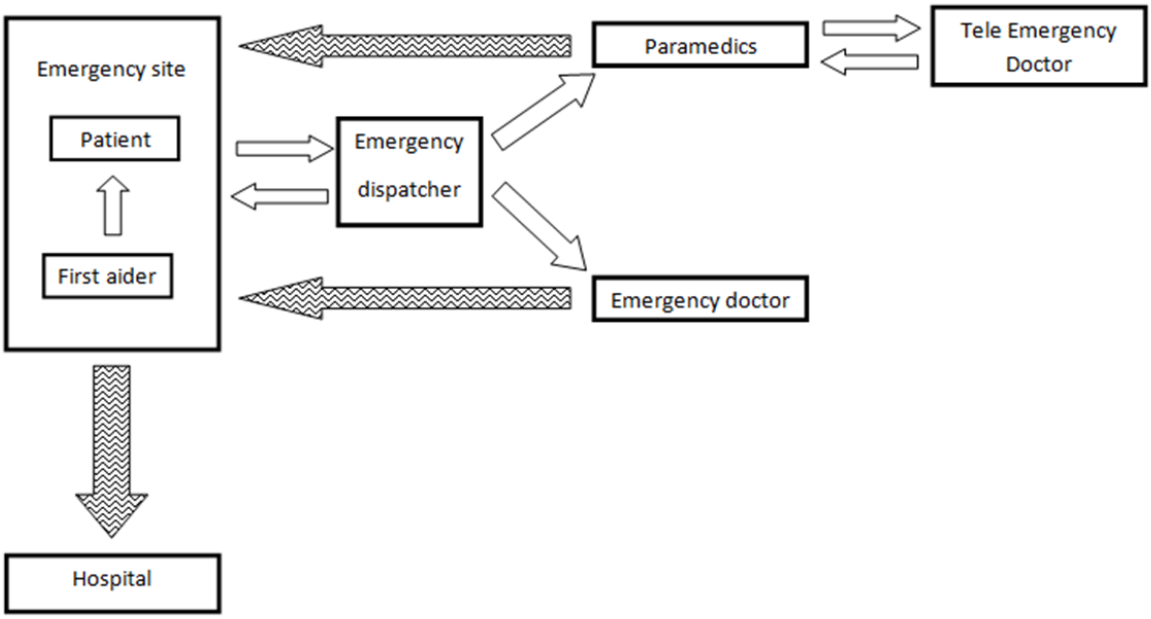


Figure 2: Pathway of medical emergency system in Germany with addition of a tele-emergency doctor

Telemedicine looks especially promising and supportive, when paramedics are without an emergency doctor at the emergency site but would like to consult one. The absence of the emergency doctor could have several reasons. For example, as mentioned above, in general the emergency doctor arrives at the emergency site some minutes after the paramedics. Although in most cases this time is short, in life-threatening situations these early minutes are especially crucial. Another reason for the absence of the doctor might be that in the initial assessment the severe extent of the emergency was not identifiable, so that the emergency dispatcher only alerted the paramedics. And in some emergencies the situation can worsen very quickly and unexpectedly, so that it develops into a situation, where an emergency doctor would be needed. Additionally, there are emergencies, which are not life-threatening, but in which paramedics would like to have guidance by an emergency doctor. Those situations might be, for example, rare diseases or special circumstances, e.g. difficulties during pregnancy.

In all situations, in which paramedics are without an emergency doctor at the emergency site, but would like to consult one, telemedicine might be the solution. The

prerequisite for that is that there is a real time connection for live communication between the paramedics and the tele-emergency doctor.

For this contact to be efficient, helpful and according to legal regulations in medicine, the distant consultation has to transport more information than a mere telephone call can perform. The “Model Professional Code for Physicians in Germany” obligates physicians to an individual and direct treatment of patients also in telemedicine [72, 73]. This could be achieved, for instance, by transmission of the patient’s vital signs. Vital signs include blood pressure, heart rate and oxygen saturation and allow a dynamic evaluation of the current status of the patient. On the basis of the vital signs and the description of the situation and further information by the paramedics, the tele-emergency doctor is now able to assist the paramedics in diagnostics and therapy.

The prerequisite for telemedicine is that two persons or groups of persons are connected with each other by the means of a communication technology. Often this connection is built beforehand during a face-to-face meeting when both partners apportion the communication devices. When using telemedicine in emergency medicine, there is no possibility to meet beforehand and establish a connection. If an emergency patient is not already part of a telemedicine project, the connection has to be newly created and the devices to build the connection have to be brought to the patient. In the *LiveCity* Project this communication device, the *LiveCity camera*, was brought to the emergency site by the approaching paramedics. *Table 1* shows the advantages and disadvantages of such a procedure.

Table 1: Advantages and disadvantages of establishing a video connection with a device brought by approaching paramedics

Advantages	Disadvantages
• Fast establishment of connection • No additional burden for patient • No maintenance by patient • Patient needs no qualification • Device can be used for several patients → cost reduction	• Establishment of connection only after arrival of paramedics • Additional burden for paramedics

Because the paramedics are instructed and practised in the use of the device, the telemedicine connection can be quickly established. However, the connection can only be established after the paramedics arrived at the emergency site. The time between calling “112” and the arrival of the paramedics is still unused. Patients and relatives are in an exceptional situation. For different reasons, their thoughts and actions are focused and reduced to the essential. Because of pain, anxiety and different levels of consciousness the operation of a new device might be difficult or not possible. Therefore, it is of great value, if the paramedics establish the telemedicine connection, even if it is an additional burden for the paramedics. Another advantage is that the paramedics can integrate the maintenance of the device into their daily routine and therefore keep a high level of quality. Independent from the socioeconomic status of the emergency patient, this telemedicine connection is accessible for all citizens. The patient does not need to have any prior knowledge in the use of computers or of similar equipment. This is especially important for elderly people, who form one of the main groups of emergency patients [74, 75]. Because the device can be used for several emergency patients, this concept also has the economic advantage of cost reduction [76].

1.5.2 Evaluation of different existing concepts of video-communication in emergency medicine

Several different concepts of video-communication in emergency medicine are currently under study or already implemented.

TemRas, based on the project *Med-on-@ix* (Aachen, Germany), developed a monitor, which automatically sends the vital signs of a patient in real time to a tele-emergency doctor, who is stationed at the emergency dispatch centre. Additionally, the ambulance car is equipped with a video camera, which sends high-definition videos in real time to the tele-emergency doctor. The remote emergency doctor can operate this camera, which is located at the ceiling of the ambulance car. For instance, the emergency doctor can zoom to analyze small details. This concept is a successful addition to the "Rettungskette" and was implemented as part of the emergency medical system in the city of Aachen in April 2014 [77-80].

The *FACT Study* (*Feasibility of AmbulanCe-based Telemedicine*) (Brussels, Belgium), part of the *PreSSUB Project*, has a similar approach using real-time video connection between the ambulance car and a teleconsultant. In patients with suspected stroke, the teleconsultant examines the patient according to a standardized protocol, asking questions and evaluating for example movements of facial muscles. It could be demonstrated that remote stroke assessment in moving ambulances is possible and reliable [81, 82].

The *Tucson ER-link Project* (Tucson, USA) combined a video link from inside an ambulance car with additional videos taken by cameras attached to the outside of the ambulance car and the existing highway cameras. The advantages of this approach lies especially in trauma management, when the emergency doctor can also look at the accident scene [83, 84]. Unfortunately, this project was terminated due to a shortage of funding.

One of the limitations of this Aachen-system and Brussels-system for telemedical consultation is, that the video camera is fixed on the ceiling of the ambulance car [81, 85]. That way, the first video connection between paramedics and tele-emergency doctor is not possible before the paramedics and the patient enter the ambulance car. For some emergency situations this is too late. In a patient with a severe bleeding, with shock or coma, the blood circulation of the patient has to be stabilized or the airway secured, e.g. by endotracheal intubation, before it is possible to start transportation [86-88]. It could be shown, that paramedics not always perform endotracheal intubation in situations, where it is strongly recommended, because

they are not practiced enough [89]. This stabilization and the airway management can be difficult and in a meta-analysis it has been shown that emergency doctors have a significant higher success rate in emergency endotracheal intubation than paramedics [90]. So a video based assistance by a tele-emergency doctor for those tasks could be helpful. Thus, the *Tucson ER-link Project* already integrated videolaryngoscopes into their prehospital telemedicine network [91].

Another lack of benefit when using a video camera system mounted on the ambulance car occurs at the other end of the emergency spectrum, where there are also situations, in which a video consultation before entering the ambulance car might be helpful. The decision, whether a patient has to be treated in a hospital or can be left at home, is a complex decision requiring consideration of a lot of additional surrounding facts, like age of the patient, living situation, accessibility of family, friends and neighbours. It is especially difficult to make a decision regarding hospital admission in cases of allergies and anaphylaxis and altered level of consciousness [92]. So it is a decision many paramedics want to be made by the emergency doctor. ROBERTS and co-workers have presented data, showing that emergency doctors are more confident than paramedics in deciding not to transport a patient to a hospital [93]. The moment a patient has been carried into the ambulance car just for video consultation, the emergency doctor and the paramedics will become reluctant to tell the patient, that he can be treated at home and can leave the ambulance car again. This could lead to a higher rate of patients admitted to hospital, which in consequence increases the work load and costs in the health system [94].

In all situations mentioned above, patients would benefit from a mobile camera that can build a video connection and can be brought directly to the emergency site. That way, the tele-emergency doctor can get visual information about the patient earlier. In a pilot feasibility study, WU and co-workers tested a video camera attached to the stretcher, with which the patient can be transported in a lying position from the emergency site and the ambulance car to the hospital. They concluded that prehospital stroke evaluation using this camera was feasible and reliable [95]. To further enhance the chance to obtain essential information, it might be important to see the surroundings of the emergency site and thus get a better picture of what might be the reason for the emergency. This requires a mobile camera, which is

directed by the paramedics. Nonetheless, it is essential that the camera should not restrict the work of the paramedic, keeping both hands free to work. Such a kind of mobile video camera is google glass, which is at the moment extensively tested in numerous projects in different scientific areas. Among others, PORTER and co-workers test at the Rhode Island Hospital in Providence, USA, the use of google glass for a dermatology examination in the emergency department and HRONG and colleagues test a modified version of google glass in the emergency department at Beth Israel Deaconess Medical Center in Boston, USA [96, 97]. Also, first trials in emergency medicine outside a hospital are made with google glass [98].

Because of the wide distribution of mobile phones with the ability to do video calls, the idea often arose, that telemedicine could be realized with commercial off-the-shelf products. Moreover, especially in emergency medicine, the idea seems appealing, that the patient or the first-aider calling the emergency dispatcher uses a mobile phone video call and thus increases the amount of information the emergency dispatcher gets. For example, dispatcher-assisted cardio-pulmonary resuscitation with video-conference via mobile phones could be shown to be superior to audio-connection [99, 100]. However, off-the-shelf products are not designed for this purpose and often technical issues regarding for instance light and audio-quality limit the success of such projects [101, 102].

Furthermore, the internet connection needs to transport a high amount of data within a short time in a stable and high quality, which limits the successful implementation of some telemedicine projects with off-the-shelf products [103]. Additionally, the telemedicine connection has to meet the high standards regarding security of vulnerable patient data. Concerns about failures in data security are one of the main obstacles in telemedicine [104]. Therefore, individual devices with specially designed software and hardware for the specific purposes have to be developed. The *LiveCity camera* was built to meet those challenges.

2 Aim

The *Emergency Use Case* of the *LiveCity* Project is realised in two interconnected sub-projects based on the *European Union Grant Agreement 297291.*As the first step, the *LiveCity camera* will be investigated in realistic emergency scenarios by paramedics and emergency doctors in a medical simulation centre. The experiences gained under simulated conditions will be evaluated and the *LiveCity camera* adapted accordingly. As the second step, the *LiveCity camera* might then be tested outside the simulation centre. The first step is the sub-project of the Greifswald University group. The general aim therefore is to prepare the second step: tests with real patients at real emergency sites.

The key questions covering the aim of this study are:

- How valid is the emergency site simulated in this project?
- How much and what kind of support is needed at the emergency site?
- How is a tele-emergency doctor perceived in general?
- How do propositi feel during communication via the *LiveCity camera*?
- What kind of data needs to be transmitted from the emergency site?
- How are the technical aspects of the *LiveCity camera* evaluated?
- How is the concept of a tele-emergency doctor evaluated?
- Does the tele-emergency doctor improve the quality of patient care?

3 Material and Methods

The telemedicine core device in this study is the *LiveCity camera* (*Section 3.1*). The emergency site is modelled in the medical simulation centre of the Department of Anaesthesiology at Greifswald University Medicine (*Section 3.2*). The emergency patient is simulated using the Laerdal mannequin Resusci Anne® (*Section 3.3*). The emergency cases are ten standardised scenarios and two additional training scenarios (*Section 3.4*). The emergency team consists of 2 paramedics and 1 emergency doctor recruited out of a pool of 21 paramedics and 10 emergency doctors as propositi (*Section 3.5*). The emergency action is taking place following a protocol with phases A, B and C, the latter with the *LiveCity camera* in use (*Section 3.6*). The individual appraisal of telementoring in emergency medicine is assessed with the use of questionnaires (*Section 3.7*).The impact of the tele-emergency doctor on the quality of patient care is assessed with checklists based on medical guidelines (*Section 3.8*).

3.1 Telemedicine core device: the *LiveCity camera*

The core device of this study is the *LiveCity camera*, enabling a real-time high definition video connection between paramedics at the emergency site and a remote expert. The hardware and software of the camera were newly developed by the *LiveCity* partners in Ireland, Portugal and Greece[5] [3, 105].

The *LiveCity camera* enables a real-time video connection by a micro-PC. One of the essentials of good telementoring is a real-time connection [106]. Even a small time lag leads to a disturbance in the communication in telementoring [107]. The emergency doctor gives instructions based on all the information he gets, observes the realisation of the instructions, evaluates the actions and improves them, if needed. Hence, a time lag is a huge hindrance and can result in such a poor

[5]An integral part of the *LiveCity* Project were multiple telephone-conferences regarding technical challenges and the implementation of the camera. During the whole simulation work of phase C, there was a continuous web conference, so that the partner from Portugal could monitor the technical part of the simulation work, help with technical issues and receive feedback by the propositi.

communication, that no meaningful assistance by the emergency doctor is possible. At the same time, the high legal standards regarding data security have to be met. In the *LiveCity camera* complex encryption methods were used to ensure confidentiality of all patient data [3].

The *LiveCity camera* - as shown in *Figure 3* - consists of: (i) the video-camera itself, worn with a headband above the right ear; (ii) a headphone with mouthpiece to enable audio connection in both ways; and (iii) the micro-PC, which builds the internet connection. The position of the camera above the right ear was chosen to transmit the same perspective the paramedic has to the emergency doctor. Since the emergency doctor observes the emergency “through the eyes” of the paramedic, he is able to access all relevant information needed to evaluate the situation and can then guide even manual activities. The transmitted video is dynamic and follows the head movements of the paramedics. The camera location imitates a usual angle of view and therefore makes it easier for the emergency doctor to orient himself in the video. Another advantage of the camera position is that the paramedic still has both hands free to work, which is of great importance in emergency medicine. In the first prototype the micro-PC was located in a belt, but since the work of paramedics requires a lot of bending and kneeling (see *Figure 4*), the micro-PC is now placed in a backpack to enable work without hindrance.

Figure 3: Paramedic wearing the LiveCity camera

Figure 4: The work of paramedics often requires bending and kneeling

As explained before in *Section* "*1.5.1 Concept of Tele-Emergency Doctor*", there are a lot of advantages in establishing the video connection by the paramedics. However,

this leads to an additional burden for the paramedics, which should be reduced to a minimum. In the development of the *LiveCity camera*, huge emphasis was put on making the operation of the *LiveCity camera* as easy as possible. Thus, the paramedics just have to take two steps to start the video connection. The *LiveCity camera* is powered on by pressing the black button on the right strap of the backpack (see *Figure 5*) and the button at the back of the video camera itself. This starts the boot up process of the micro-PC and can be done before entering the emergency site. The moment the paramedics want to start the video connection to the tele-emergency doctor, they have to take the second step by merely pressing the red button on the left strap (see *Figure 6*). This initiates the video call.

Figure 5: Powering on the LiveCity camera by pressing the black button on the right strap

Figure 6: Starting the video connection by pressing the red button on the left strap

The transmitted video is received by the remote emergency doctor at a laptop provided with special software (*Figure 7*).

Figure 7: Tele-emergency doctor in a remote office receiving video at a laptop

This software allows the emergency doctor to adapt the transmitted video according to the particular needs, e.g. regarding light, contrast and sound level. Another notable function is the “snapshot” feature. A snapshot can be taken by the emergency doctor at any time. The snapshot is a high definition photo transmitted independently from the video. Because of the high pixel count, it allows the emergency doctor to analyse certain aspects in detail. This is, for example, very useful for the interpretation of a 12-lead-ECG (see *Figure 8*), where tiny elevations of lines can indicate a myocardial infarction. Because the interpretation of 12-lead-ECG is sometimes very challenging and needs a lot of experience, some authors state, that physicians have a higher success rate in detecting e.g. a heart attack than paramedics have [108]. Therefore the snapshot feature was an integral part of the camera development (see *Figures 9*).

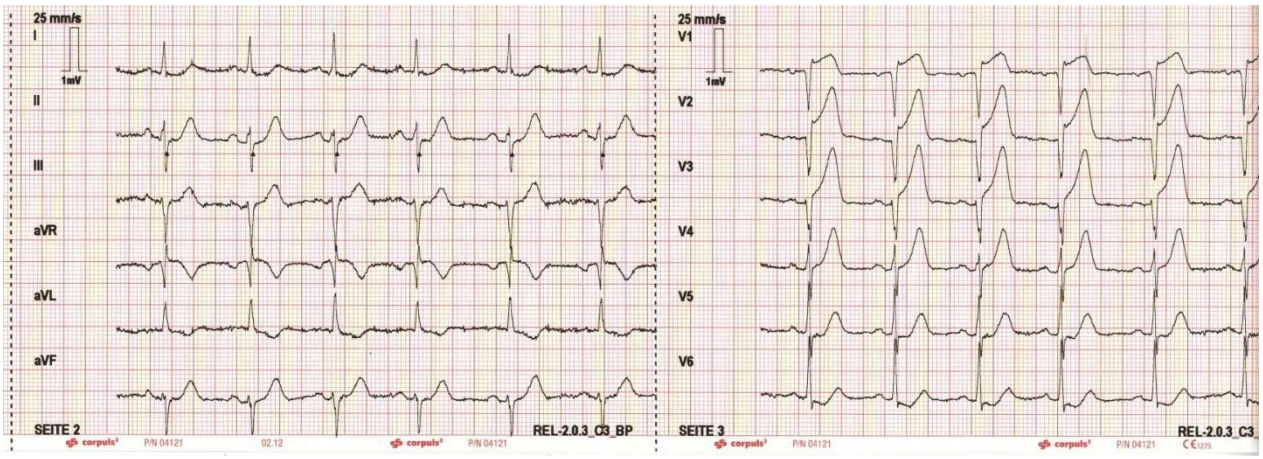


Figure 8: A 12-lead-ECG of a myocardial infarction

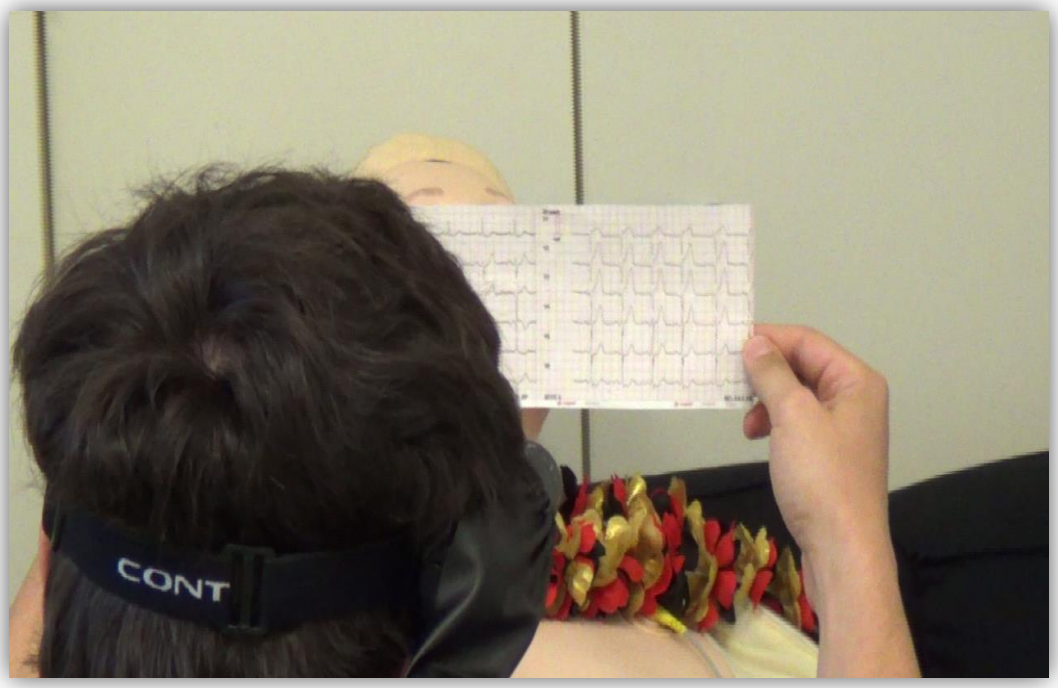


Figure 9: Paramedic presenting 12-lead-ECG via the LiveCity camera to the emergency doctor

3.2 Emergency site: the Medical Simulation Centre

The aim of this work is to assess the impact of video communication on emergency medicine. To prevent potential harm for individuals it is performed in the fully equipped high fidelity medical simulation centre of the Department of Anaesthesiology at Greifswald University Medicine (*Figure 10*).

Figure 10: Paramedics working in the state-of-the-art full-scale patient simulator of Greifswald University

As AMMENWERTH and co-workers have explained [109], there are three ways of testing a new health information technology. The first way is to evaluate it in a laboratory, but the results are limited by a low external validity. The second way is a field evaluation test, but for this, both software and hardware have to be sufficiently mature to not possibly harm any person. So the solution is often the third way: a study in a simulation centre, which combines good internal and external validity [109]. Usability studies in medical simulation centres are ideal for objective, structured analysis of new technical devices [110].

A simulation centre uses computer-operated mannequins to dynamically create realistic routine or emergency scenarios [111]. Medical simulation, as explained by GREDLER, are dynamic situations, in which participants respond to the conditions and problems that occur and see and feel the consequences of their individual actions [112].Medical simulation is very established, especially in emergency medicine [113, 114]. It is widely and successfully used in training at all stages of medical education and in research [102, 115]. It offers the opportunity to standardise while minimizing negative consequences of potential errors [114]. It can be used for both individual settings and group settings [116].

3.3 Emergency patient: the Laerdal mannequin Resusci Anne

Simulation studies offer the opportunity to conduct experimental cross-over trials with high internal validity. The external validity depends on how realistic the simulated scenarios are. The perception of how realistic a scenario in a simulation centre is, is influenced by three different aspects: the equipment fidelity, the environment fidelity and the psychological fidelity [117]. The equipment fidelity is characterised by the used hardware and software. For this objective, the Laerdal mannequin Resusci Anne® (Laerdal Medical GmbH, Puchheim, Germany) was used and the vital signs were dynamically simulated with the monitor iSimulate ALSi® (Skillqube GmbH, Wiesloch, Germany). The Laerdal Resusci Anne is globally used in education and research [118-120].In *Figure 11* this mannequin is depicted sitting on a sofa with the iSimulate monitor showing the simulated vital signs. The environment fidelity is mostly created by the appropriate surrounding for every scenario. In the *LiveCity* Project every scenario had different characteristic accessories, e.g. in one case of simulated heart attack, a patient was watching sports sitting on a sofa with a football flag while eating potato crisps (see *Section "3.4.4 Myocardial Infarction: STEMI"). Figures 12* to *16*show exemplarily pictures of different emergency scenarios. Psychological fidelity is the ability of the individual participant to immerse into the simulated situation. Psychological fidelity can be increased by enhancing equipment and environment fidelity [121].

Figure 11:LaerdalResusci Anne Mannequin with iSimulate monitor showing vital signs

3.4 Emergency cases: ten scenarios

Ten typical emergency scenarios were prepared from five different categories: “Stroke”, “Myocardial infarction”, “Trauma”, “Rare diseases” and “Complications during pregnancy”.

All scenarios were structured to be handled according to the worldwide used “ABCDE”-approach to rapidly evaluate the emergency situation:“A” for airway, “B” for breathing, “C” for circulation, “D” for disability, “E” for exposure. Relevant details of the case have been included to be recognised by “SAMPLE”-history: “S” for symptoms, “A” for allergies, “M” for medication, “P” for past medical history, “L” for last oral intake and “E” for events leading to the illness/injury [122, 123].

When paramedics and emergency doctors are alerted by the emergency dispatcher, they are provided with information about the location of the emergency, age and gender of the patient and the “Einsatzstichwort” (operation key word). The operation key word is based on the callers description of the emergency and indicates the kind

of emergency [44, 124]. For all 10 scenarios in the *LiveCity* Project operation key words were developed.

In general, every scenario followed this pattern:

The paramedics were presented with the operation key words and age and gender of the patient. After that, they entered the simulation room, where the mannequin was postured with additional props, to illustrate the specific emergency scenario. The paramedics then started to ask the mannequin questions regarding the emergency, took the medical history, measured the vital signs and examined the patient. According to the predefined case description, which was developed specifically for every scenario, questions were answered and the vital signs and findings in the physical examination shown. They were dynamically adjusted according to the actions of the paramedics. In the simulation cases with the tele-emergency doctor, the paramedics could decide at which point during the simulation they wanted to start the video consultation. Depending on features of the emergency case (for instance the severeness and the urgency to start the treatment) and on traits of the paramedic (like level of experience and wish for reassurance) the consultation could start either right after hearing the operation key word or after finishing the diagnostics and initial treatment just for confirmation or at any given moment between that, as would be the case after the implementation of the tele-emergency system. All the scenarios ended, when the paramedics decided to start the transport to the hospital. That endpoint was chosen, because before the beginning of the transport, all major decisions regarding diagnostics and treatment have to be made. If the paramedics did not start transport within 27 minutes, the scenarios were terminated. This time limit was set, because in Germany in 95% the emergency doctor reaches the emergency site within 26.6 minutes [42]. Thus, in the majority of cases there would be an emergency doctor at the emergency site in person after 27 minutes to take over from the tele-emergency doctor.

For the simulation in this study, the equipment of the paramedics contained all medical devices, that are statutory for an ambulance car in Germany according to DIN EN 1789 Typ C [125, 126]. These are, for instance, monitor of medical parameters (including body temperature, blood sugar level and 12-lead-ECG) and

defibrillator, ventilator machine, medical suction machine, stiff neck and medical bag with drugs, dressing and devices to secure the airway and blood circulation.

The ten different emergency situations and two additional training scenarios are outlined below. The original descriptions in German of all case scenarios are attached in the Annex.

3.4.1 Stroke: with paralysis

- Operation key word: “67 year old male patient with acute paralysis of his right arm”
- Stage setting: mannequin sitting on a sofa with open newspaper lying aside
- Case history: A 67 years old man cannot move his right arm after waking up in the morning. The situation did not improve over the last 40 minutes. The patient assumes, he dislocated his shoulder during the night.
- Vital signs: blood pressure 180/100mmHg, heart rate: 72bpm, oxygen saturation: 95%
- Pre-existing illness: none known (patient hasn’t been at a doctor’s office for years)
- Current medication: none
- Physical examination: paralysis of the right arm
- Diagnose: stroke with paralysis
- Therapy: fast admission to hospital with CT scan and stroke unit [127, 128].

3.4.2 Stroke: with anaesthesia

- Operation key word: “30 year old female patient with sensory disturbance”
- Stage setting: mannequin sitting on a sofa with a magazine, a box of skin cream and makeup lying aside *(see Figure 12)*
- Case history: A 30 year old woman cannot feel her left arm and the left part of her face. She discovered that while applying skin cream and makeup after taking a bath.
- Vital signs: blood pressure 150/90mmHg, heart rate: 95bpm, oxygen saturation: 100%
- Pre-existing illness: obesity, smoker, in 2009: deep vein thrombosis in right leg
- Current medication: contraceptive

- Physical examination: anaesthesia of the left arm and left face
- Diagnose: stroke with anaesthesia
- Therapy: fast admission to hospital with CT scan and stroke unit [127, 128].

Figure 12: Stroke scenario with young women having a sensory disturbance in her left arm

3.4.3 Myocardial infarction: NSTEMI

- Operation key word: “72 year old female with acute coronary syndrome”
- Stage setting: mannequin sitting on a sofa with broom lying aside
- Case history: A 72 year old woman suffers severe chest pain and shortness of breath. These symptoms occurred after she cleaned the staircase vigorously while being annoyed about the children next door, who made the staircase so dirty.
- Vital signs: blood pressure 190/85 mmHg, heart rate: 93 bpm, oxygen saturation: 95%
- Pre-existing illness: obesity, hypertension, diabetes mellitus, smoker, hyperlipidaemia
- Current medication: drugs to lower blood sugar level, blood pressure and lipid level
- Physical examination: paleness, shortness of breath

- 12-lead-ECG: nothing abnormal detected
- Diagnose: acute coronary syndrome, most probably myocardial infarction (NSTEMI)
- Therapy: fast admission to hospital with cardiac catheterization laboratory; drugs according to guideline of European Society of Cardiology [129].

3.4.4 Myocardial infarction: STEMI

- Operation key word: “54 year old male patient with acute abdomen”
- Stage setting: mannequin sitting on a sofa with a flag and potato crisps lying aside
- Case history: A 54 years old man was watching football and eating crisps. After a goal made by the opposing team, he got a sudden feeling of sickness and strong pain in his upper abdomen. The patient thinks it is food poising caused by potato crisps. During the scenario he develops pain in his chest and shortness of breath. (*see Figure 13*)
- Vital signs: blood pressure 140/95mmHg, heart rate: 80bpm, oxygen saturation: 94%
- Pre-existing illness: hypertension, hyperlipidaemia, smoker
- Current medication: drugs to lower blood pressure and lipid level
- Physical examination: paleness, shortness of breath
- 12-lead-ECG: STEMI
- Diagnose: myocardial infarction (STEMI)
- Therapy: fast admission to hospital with cardiac catheterization laboratory; drugs according to guideline of European Society of Cardiology [129].

Figure 13: Heart attack scenario with patient anxiously watching the national football team

3.4.5 Trauma: tension pneumothorax

- Operation key word: “male patient, car accident”
- Stage setting: mannequin lying on the ground outside the car next to hazard warning triangle
- Case history: 21 year old male patient crashed car into tree and hit chest into car wheel. No other person involved. Bystanders rescued patient from car and laid him on the ground. Patient suffers severe shortness of breath and answers every question with “Air!”. The condition and vital signs of the patient rapidly worsen and patient stops speaking.
- Initial vital signs: blood pressure 70/52mmHg, heart rate: 152bpm, oxygen saturation: 85%
- Pre-existing illness: unknown
- Current medication: unknown
- Physical examination: cyanosis, enlargement of neck veins, deviation of trachea to left side, no movement of the right chest, instability of right ribs 6-8, skin emphysema, in auscultation: no ventilation of right chest, hypersonic sound above right lung

- Diagnose: tension pneumothorax right lung
- Therapy: oxygen, small catheter insertion into right chest, analgesics, stiff neck, then fast admission to hospital with trauma centre [130, 131].

3.4.6 Trauma: blunt abdominal trauma

- Operation key word: “22 year old male with bicycle accident”
- Stage setting: mannequin lying on the ground wearing a bicycle helmet*(see Figure 14)*
- Case history: A 22 year old man had a bike accident while driving 20km/h and impressed handlebar into abdomen while falling down. He suffers from severe abdominal pain, is pale and has cold sweat.
- Vital signs: blood pressure 79/48mmHg, heart rate: 167bpm, oxygen saturation: 95%
- Pre-existing illness: haemophilia A
- Current medication: none
- Physical examination: road burn at temple, arms and legs; abdominal examination: hard; sparse movement of the bowel
- Diagnose: blunt abdominal trauma
- Therapy: fast admission to hospital with trauma centre, oxygen, fluids, analgesics, stabilisation of circulation [130].

Figure 14: Trauma scenario with young patient after a bike accident

3.4.7 Rare disease: paracetamol intoxication

- Operation key word: “21 year old female with acute abdomen”
- Stage setting: mannequin sitting on a sofa with magazine and package of paracetamol hidden under the magazine
- Case history: A 21 year old woman felt nauseous since the morning and had to vomit several times. She reports pain in her upper abdomen and feels sleepy. Upon request she reports, she had a severe migraine attack three days ago, which she treated with paracetamol. She reluctantly admits she took multiple paracetamol tablets multiple times, but cannot recall how many in total.
- Vital signs: blood pressure 100/60 mmHg, heart rate: 63 bpm, oxygen saturation: 97%
- Pre-existing illness: migraine
- Current medication: paracetamol as needed
- Physical examination: scleral jaundice (yellow eyes),under examination increase of pain in upper right abdomen
- Diagnose: paracetamol intoxication
- Therapy: admission to hospital with intensive care unit, evaluation of administration of antidote [132-134].

3.4.8 Rare disease: snake bite

- Operation key word: “53 year old female tourist with snake bite at isle of Ruegen”
- Stage setting: mannequin sitting on a bench with hiking map and mobile phone lying aside *(see Figure 15)*
- Case history: A 53 year old female tourist was hiking at the isle of Ruegen, when she was bitten by a snake in her right leg. She felt a strong pain in her leg and nausea and reported an attack of sweating. When the paramedics reach her 20 minutes after the snake bite, she still has some pain in her leg, but no nausea or sweating. She couldn’t identify the snake, but took a photo of the snake with her smart phone.
- Vital signs: blood pressure 150/90mmHg, heart rate: 110bpm, oxygen saturation: 98%
- Pre-existing illness: hypertension
- Current medication: drug to lower blood pressure
- Physical examination: right leg: fang marks, swollen and reddened
- Diagnose: snake bite by European viper
- Therapy: disinfection, immobilization and elevation of leg, no manipulation; admission to hospital; evaluation of need for immunotherapy [135-138].

Figure 15: Rare diseases scenario: Picture of the snake taken by the patient

3.4.9 Complications during pregnancy: aortocaval compression syndrome

- Operation key word: “23 year old female with unconsciousness during pregnancy”
- Stage setting: mannequin lying on a sofa with pregnancy record book on a side table
- Case history: Husband called 112, because 23 year old pregnant wife did not respond, when he tried to wake her up. When paramedics enter apartment, patient has awaken and reports, she lied down to rest after lunch. After lying down, she felt dizzy, faint, palpitation and then drifted off. Husband reports, he tried to wake her up. When she didn’t respond, he turned her around, so she was now facing him. Patient is still in this position with her left side lying lower than her right. No abnormalities in pregnancy record book. Week of pregnancy: 35+6.
- Vital signs: blood pressure 100/70 mmHg, heart rate: 62 bpm, oxygen saturation: 98%
- Pre-existing illness: none
- Current medication: none
- Physical examination: auscultation of heart rate of fetus: normal rhythm and frequency
- Diagnose: aortocaval compression syndrome
- Therapy: admission to hospital with obstetrics, transport in left lateral tilt position [139, 140].

3.4.10 Complications during pregnancy: preeclampsia

- Operation key word: “35 year old female with pain in upper abdomen during pregnancy”
- Stage setting: mannequin sitting on a sofa with pregnancy record book lying on side table *(see Figure 16)*
- Case history: A 35 year old pregnant woman complains about strong pain in the upper abdomen and nausea and vomiting since the morning. She had problems with morning sickness in the first trimester, but not in the second or third. She additionally develops a severe headache and reports flickering in her eyes. As documented in pregnancy record book, she developed diabetes mellitus and hypertension during pregnancy. Week of pregnancy: 37+4

- Vital signs: blood pressure 190/110mmHg, heart rate: 90bpm, oxygen saturation: 98%
- Pre-existing illness: detection of diabetes mellitus and hypertension during pregnancy
- Current medication: none
- Physical examination: oedema in face and ankles, under examination: increase of pain in upper right abdomen
- Diagnose: preeclampsia
- Therapy: create calm and quiet atmosphere, administer magnesium, admission to hospital with obstetrics, transport in left lateral tilt position without siren and lights [141-143].

Figure 16: Scenario with young women experiencing difficulties during pregnancy

3.4.11 Training scenario: severe attack of bronchial asthma

- Operation key word: “24 year old female with shortness of breath”
- Stage setting: mannequin sitting on a sofa with magazine lying aside
- Case history: A 24 year old woman reports an asthma attack with unusual severity. Her prescribed anti-asthmatic drugs brought no release. She speaks breathless and breathes in a high frequency. Wheezing is detectable.

- Vital signs: blood pressure 147/85mmHg, heart rate: 138bpm, oxygen saturation: 92%
- Pre-existing illness: bronchial asthma
- Current medication: asthma inhaler, contraceptive
- Physical examination: wheezing, high breathing rate
- Diagnose: asthma attack
- Therapy: oxygen, anti-asthmatic drugs [144].

3.4.12 Training scenario: acute limb ischemia

- Operation key word: “76 year old male with pain in his leg”
- Stage setting: mannequin sitting on a sofa with newspaper lying aside
- Case history: A 76 year old man reports, he suddenly had severe pain in his right leg and is afraid, his leg has to be amputated.
- Vital signs: blood pressure 158/95mmHg, heart rate: 126bpm, oxygen saturation: 98%
- Pre-existing illness: diabetes, hypertension, coronary heart disease, peripheral artery occlusive disease, kidney insufficiency, alcohol-toxic liver cirrhosis, smoker
- Current medication: drugs to lower blood sugar level and blood pressure
- Physical examination: right leg: cold, pulseless, pale, swollen
- Diagnose: acute limb ischemia right leg
- Therapy: oxygen, heparin, analgesics, fast admission to hospital [145].

3.5 Emergency team: emergency doctors and paramedics as propositi

Emergency doctors and paramedics were recruited with the following inclusion and exclusion criteria.

Both paramedics and emergency doctors had to be qualified members of the medical emergency system and had to be actively working in emergency medicine. Emergency doctors had to be experienced in the field of anaesthesiology for at least two years and had to be working as medical doctors for at least four years.

Additionally, knowledge and routine in education of medical students, young colleagues or paramedics was required. This inclusion criterion was chosen because telementoring and teleconsultation requires skills and experience in the field of education to successfully help with theoretical and practical/manual tasks.

Paramedics who were studying medicine or dentistry after the first medical state examination were excluded from the study. This exclusion criterion was chosen because knowledge and manual skills would exceed the paramedic training and thus resulting in a bias regarding the efficiency and need of a tele-emergency doctor.

A total of 10 emergency doctors and 21 paramedics took part.

Of the ten emergency doctors, three were female and seven male. Of the twenty one paramedics, eight were female and thirteen male. No special emphasis was put on the gender distribution, because emergency medicine is still a male-dominated area.

Table 2 shows the distribution of age of the paramedics and emergency doctors participating. The propositi reflect almost all age groups working in emergency medicine. Because of the long education needed, emergency doctors usually get the qualification after the age of 30 years.

Table 2: Age Distribution of propositi

Years of Age	Paramedics	Emergency Doctors
18-25	12	0
26-30	3	0
31-35	1	2
36-40	2	2
41-45	3	4
46-50	0	2

Table 3 shows the distribution of the years the paramedics and emergency doctors had been working in their respective position. In concordance with the age distribution

of the paramedics, there is a tendency towards paramedics working less than 6 years. The emergency doctors' working years were homogenous distributed.

Table 3: Years working in this position in emergency medicine

Years working in this position in emergency medicine	Paramedics	Emergency Doctors
<1	4	0
1-5	10	3
6-10	1	2
11-15	3	2
> 15	1	3
no answer	2	0

The paramedics were asked to rate, how experienced in emergency medicine they felt. 10 of 21 paramedics rated themselves as partly inexperienced and 11 of 21 paramedics rated themselves as partly experienced (8) or experienced (3). No paramedic felt inexperienced. This suggests an equal distribution of experience.

All propositi were asked to rate the following sentence on a four point Likert scale from "disagree" to "agree": "I am open-minded about new information technologies." Of the 10 emergency doctors the majority agreed (8 agreed, 2 partly agreed, no one disagreed or partly disagreed). Of the 21 paramedics the majority also agreed (15 agreed, 5 partly agreed, 1 partly disagreed, no one disagreed). Thus it could be assumed that most would have an open and positive attitude towards a video telemedicine device like the *LiveCity camera*. This might be caused by a potential recruitment bias, because people who are not interested in new information technologies are less likely to take part in a study like this. This could be discussed as a weak point for the generalisation of the study results [146].

To enhance the generalisation of the study results, paramedics from the whole of Germany were recruited. One-third of the paramedics work in the town and the surrounding area of Greifswald and two-thirds are working in other parts of Germany

between the island of Amrum in the north and Konstanz in south and between Berlin in the east and Muenster in the west. *Figure 17* shows the different areas of Germany in which the paramedics are usually working.

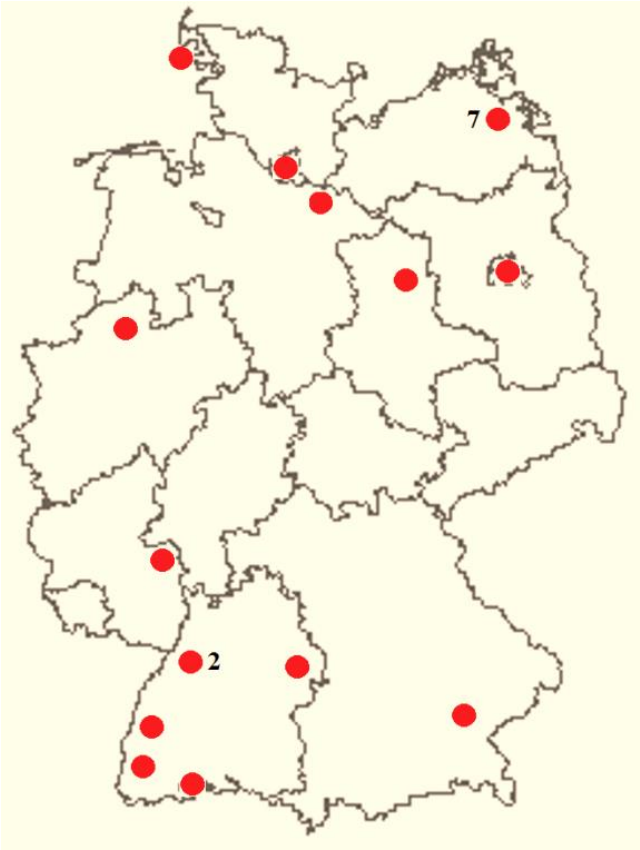


Figure 17: Regional distribution of places of work of the 21 paramedics

As part of the principle of subsidiarity, the German emergency system differs to some extent from county to county [44]. Every county can decide on specific equipment and medication and can assign different tasks to paramedics. The daily work flow and decision making is also influenced by geographical and infrastructural characteristics of the local area. For instance, paramedics working at the island of Amrum in the North Sea have to face the challenge of longer transportation time to the next hospital influenced by weather conditions, day time and tide. While paramedics working in a city like Berlin or Hamburg have a large number of hospitals they can approach within a short time, but have to consider the specific infrastructure of the hospital.

3.6 Emergency site procedure: phases and protocol

To allow a detailed evaluation of the *LiveCity camera*, a 3-step-study design with phases A, B and C was chosen[6].

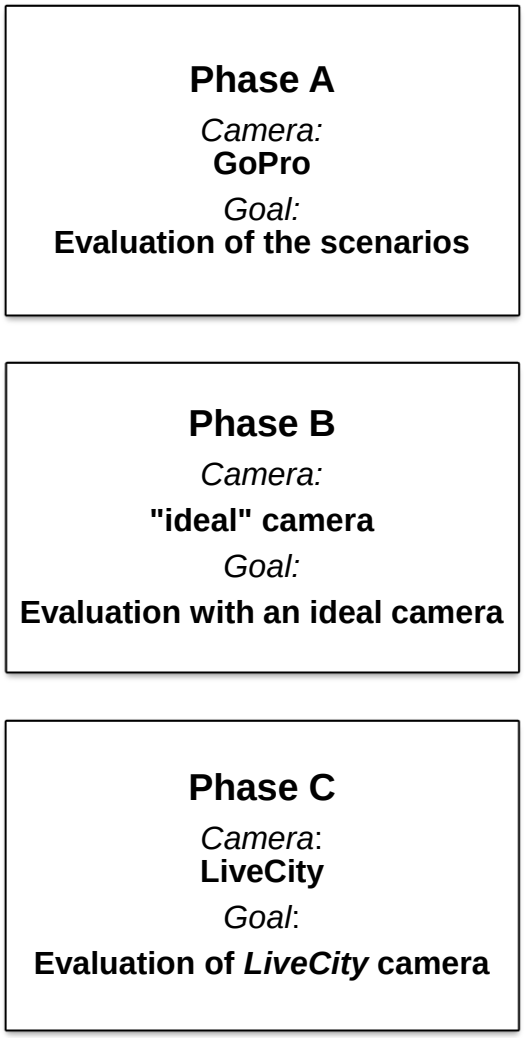
The main difference between the three phases in terms of study protocol is the way the information by sight and voice travels between paramedics and doctors. Phase A is investigating the quality of communication when paramedics and doctor are linked by an off-the-shelf camera. In this study the camera GoPro Hero 3® was chosen. Phase B is investigating the quality of communication when paramedics and doctor are linked without transmission technology but by direct optical and audio contact, as an imitation of an "ideal" camera. Phase C is investigating the quality of communication when paramedics and doctor are linked by the *LiveCity camera*.

The main difference in terms of study purpose is the intention of the three phases. Phase A is intended to benchmark the lowest quality of communication and to test the developed scenarios for suitability. Phase B is intended to benchmark the optimal quality of communication, as given by an "ideal" camera. Phase C is intended to find out about the specific quality of communication via the *LiveCity camera* video link.

*Table*4 summarises the three phases with their different links of communication and their different goals. Phase A is basis for phase B, that gives basis for phase C.

[6]Formal approval of the study has been obtained by the Ethics Commission of Greifswald University Medicine, December 17th2013 (internal number BB 148/13). Written informed consent was obtained from all propositi.

Table 4: Phases A to C



The ten standardized emergency scenarios were surveyed in phase A. After acceptance for usability for this study, those ten scenarios were then used in phases B and C in a cross-over design.

To evaluate the co-operation of paramedics and doctors “close to reality”, ten typical emergency scenarios from five different categories were prepared for a randomized two-armed protocol. These categories are: “Stroke”, ”Myocardial Infarction”, “Trauma”, “Rare diseases”, and “Complications during pregnancy”. For each category two cases with similar level of difficulty in terms of diagnosis and treatment were created to allow a cross-over design. Cross-over design was achieved by comparing the results and opinions of paramedics in action at the simulated emergency site: (a) without doctor’s support, and (b) the same paramedics in corresponding cases another time with video-based consultation and contact to a tele-emergency doctor.

Two additional training scenarios were developed, so that the paramedics could familiarize with the simulation centre, the equipment, the other team members and the *LiveCity camera*.

According to usual guidelines in German emergency medicine two paramedics worked together as a team. Together they handled ten scenarios, five of them with a tele-emergency doctor and five of them without. The sequence of the case scenarios and the assignment to the two cross-over categories was randomized.

3.6.1 Communication via off-the-shelf camera (Phase A)

Phase A was intended to benchmark the lowest quality of communication. Paramedics and doctor were linked by the off-the-shelf camera GoPro Hero 3®.

In phase A, all ten developed scenarios were tested and evaluated with a focus on practicability by paramedics and medical doctors. All scenarios were additionally evaluated concerning textual coherency, comprehensibility and coefficient of difficulty, which are very important aspects in medical simulation [114]. The GoPro Hero 3 can be worn with a headband and was mainly developed for filming sports activities. Therefore, it incorporates many advanced features, which are important in emergency situations as well, like e.g. resistance to water and robustness. However, based on the primary intention to make short video sequences and send them by WiFi, this GoPro camera cannot receive signals. Therefore, an additional handheld transceiver was used during simulation in order to achieve a bidirectional conversation between the paramedics and the emergency doctor, as can be seen in *Figure 18*. Further it has to be noted, that the GoPro Hero 3 had a time latency of up to 10 seconds. As explained in *Section "3.1.Telemedicine core device: the LiveCity camera"* time latency has to be kept at a minimum. These features make the GoPro Hero 3 unsuitable for the use as a telemedicine device in emergency medicine.

As a result of phase A, all ten emergency scenarios were accepted after minor revision.

Figure 18: Paramedic wearing GoPro-camera Hero 3 using a handheld transceiver during simulation phase A

3.6.2 Communication via “ideal” camera (Phase B)

Phase B was investigating the quality of communication when paramedics and doctors are linked without transmission technology but by direct optical and audio contact, as an imitation of an “ideal” camera. Only in comparison to an “ideal” camera it is possible to evaluate the *LiveCity camera* meticulously.

There are different demands towards an “ideal” camera from the emergency doctor’s point of view and from the paramedic’s point of view. The emergency doctor requires optimal picture quality, e.g. colour, pixel size, focus, angle, including wide-angle plus optimal audio quality, e.g. sound intensity, clarity, tone pitch and additionally absence of latency, interruption, distortion and motion artefact. For instance, a slight alteration of colours may lead to severe harm, if the emergency doctor does not detect a cyanosis, which is a bluish skin caused by lack of oxygen. Apart from that, the paramedics have supplementary requests, which are of same importance, like no hindrance while working, good wearing comfort, no additional weight or heat production. Because there is no “ideal” camera existing yet, the emergency doctor used no camera at all during phase B and stayed in the same room in which the simulation took part. Hence, he was able to see and hear everything in optimal quality

from his desk (*Figure 19*). He was not allowed to touch the patient or to give manual help and he had to wait until the paramedics called him to help orally. So he had to work under the same conditions as the emergency doctors have to work while using the camera to help paramedics at a remote place.

In this setting the emergency doctor didn't depend on the movement of the paramedics but could determine on his own where to look. Furthermore, both paramedics were able to communicate with the emergency doctor. Hence, there was no need for the paramedic talking to the emergency doctor, to echo everything the emergency doctor had said to him to the other paramedic, resulting in less danger of loss of information and loss of time.

Figure 19: Emergency doctor's view from his desk towards the mannequin/ patient during phase B

3.6.3 Communication via *LiveCity camera* (Phase C)

The purpose of phase C was to investigate the quality of communication when paramedics and doctor are linked via the *LiveCity camera*. In phase C the same ten scenarios were simulated under equal conditions as in phase B with the exception that in phase C the *LiveCity*-camera was used (see *Figure 20* and *Figure 21*).

Figure 20: Paramedic showing vital signs on the monitor via the LiveCity camera

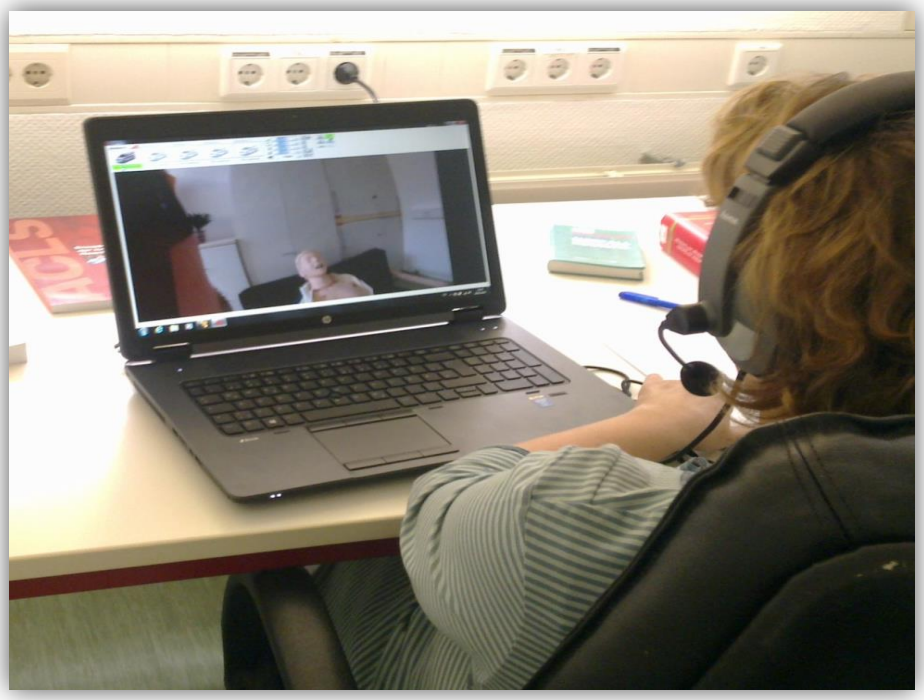


Figure 21: Emergency doctor's view through the LiveCity camera in phase C

3.7 Emergency site experience: personal appraisal

To assess the outcome in practical, technical and psychological aspects, paramedics and doctors were interviewed by use of semi-structured questionnaires developed together with the Department of Medical Psychology, Greifswald University Medicine[7].

Seven different questionnaires were constructed, which were handed out to the paramedics and emergency doctors during different stages of the simulation. Apart from the demographics, the attitude towards computer and telemedicine in emergency medicine was assessed before starting the simulation. The same questions regarding the attitude towards telemedicine in emergency medicine were repeated after finishing the simulation work. After each simulated emergency case, the paramedics and emergency doctors were independently asked to rate the work of the paramedics and whether the tele-emergency doctor had *-or would have-* improved diagnostics and treatment in this particular case. More than 350 questionnaires were completed.

3.8 Emergency site experience: professional performance

The quality of medical treatment goes along with the adherence to guidelines. To assess, whether an intervention applying a high-quality video-link in real time from the emergency site to a remote emergency doctor is influencing the professional performance of paramedics, the adherence to guidelines was tested in a cross-over design.

The adherence to guidelines was measured with checklists, developed for each emergency case[8]. These checklists were based on current German and international guidelines.

[7]The original questionnaires in German are attached in the Annex.

[8]The original checklists in German are attached in the Annex.

On the basis of these checklists the performance of the paramedics was reviewed by points for (i) quality in diagnostics, (ii) finding the correct diagnosis and (iii) guideline-adherent therapy. The quality of diagnostics and of therapy was rated between 1 and 3 points. The diagnosis was either correct (1 point) or wrong (0 points) (*Table 5*). Two physicians judged all checklists independently. After that, for each team of paramedics the points were aggregated (*Table 6*).

Table 5: Review scale regarding adherence to guidelines

	0 points	1 point	2 points	3 points
Quality of Diagnostics		poor	mediocre	good
Diagnosis	wrong	correct		
Quality of Therapy		poor	mediocre	good

Table 6: Minimum and maximum of possible aggregated points

	Minimum of Possible Points	Maximum of Possible Points
Quality of Diagnostics	5	15
Diagnosis	0	5
Quality of Therapy	5	15

4 Results

The task of Greifswald University Medicine in the *Emergency Use Case* of the *LiveCity* Project is to evaluate the *LiveCity camera* under simulated emergency conditions. This feasibility study in Greifswald aimed to asses practical, technical and psychological aspects through questionnaires and also in direct conversations with the propositi during all stages of the simulation. Additionally, the influence of telementoring on guideline-adherence was investigated.

To get an analysis as detailed as possible, every paramedic and emergency doctor worked with the *LiveCity camera* in several different emergency cases covering the broad spectrum of emergency medicine. Thus, the propositi could get acquainted with the *LiveCity camera* and were more likely to detect small differences in the potential and impact of such a camera system in different emergency situations. Therefore, this study design was constructed allowing a thorough investigation of the *LiveCity camera* with a limited number of propositi. Inevitably this leads to a small number of comparable data, which do not allow statistical significance testing.

Before entering and after having accomplished every scenario in a total of 110 simulated emergency scenarios, all the participating emergency doctors (n=10) and paramedics (n=31) were asked to complete questionnaires for gaining their comments and reflections. All data have been categorised and structured by use of SPSS (SPSS statistics version 22.0, Chicago, IL, USA) for trends.
This thesis presents the results to those items of the questionnaire, in which a trend concerning the amount of agreement is observable.

The following tables are reporting the items as expression of collected experience on how valid the emergency site is simulated in this project (*Section 4.1*), how much and what kind of support is needed at the emergency site (*Section 4.2*), how a tele-emergency doctor is perceived in general(*Section 4.3*), how the propositi feel during the communication via the *LiveCity camera* (*Section 4.4*), what kind of data needs to be transmitted from the emergency site (*Section 4.5*), how the technical aspects of the *LiveCity camera* are evaluated (*Section 4.6*), and how the concept of a tele-

emergency doctor is evaluated (*Section 4.7*).*Section 4.8* shows, how the tele-emergency doctor influences guideline-adherence. *Section 4.9* presents a selection of verbal feedback by the propositi.

4.1 How valid is the emergency site simulated in this project?

This item of the study is featured by the following sentences of the questionnaires, requesting a comment from both emergency doctors and paramedics: “The scenarios were realistic.", “The scenarios were relevant.” and “I took the simulation work serious.”

4.1.1 Realistic

Table 7 shows how doctors and paramedics rated the statement “The scenarios were realistic."

Table 7:“The scenarios were realistic.”

	Agree	Partly agree	Partly disagree	Disagree
Doctors (10)	4	5	1	0
Paramedics (21)	9	11	1	0

Considering the total number of 10 emergency doctors, 1 partly disagreed, 5 partly agreed, 4 agreed. Considering the total number of 21 paramedics, 1 partly disagreed, 11 partly agreed and 9 agreed. No emergency doctor or paramedic disagreed.

4.1.2 Relevant

Table 8 shows how doctors and paramedics rated the statement “The scenarios were relevant."

Table 8:“The scenarios were relevant.”

	Agree	Partly agree	Partly disagree	Disagree
Doctors (10)	7	3	0	0
Paramedics (21)	14	7	0	0

Considering the total number of 10 emergency doctors 3 partly agreed, 7 agreed. Considering the total number of 21 paramedics, 7 partly agreed and 14 agreed. No emergency doctor or paramedic disagreed or partly disagreed.

4.1.3 Take simulation work seriously

Table 9 shows how doctors and paramedics rated the statement “I took the simulation work seriously.”

Table 9:“I took the simulation work seriously.”

	Agree	Partly agree	Partly disagree	Disagree
Doctors (10)	6	4	0	0
Paramedics (21)	18	3	0	0

Considering the total number of 10 emergency doctors 4 partly agreed, 6 agreed. Considering the total number of 21 paramedics, 3 partly agreed and 18 agreed. No emergency doctor or paramedic disagreed or partly disagreed.

4.2 How much and what kind of support is needed at the emergency site?

This item of the study is featured by the following sentences of the questionnaires “I encounter situations, in which I would like to get help by a more experienced colleague.”, requesting a comment from both emergency doctors and paramedics, and the question “What kind of support would you especially like to get in an emergency situation?”, to be answered by paramedics only.

4.2.1 Quantity of need

Table 10 shows how doctors and paramedics rated the statement “I encounter situations, in which I would like to get help by a more experienced colleague.”

Table 10:"I encounter situations, in which I would like to get help by a more experienced colleague."

	Often	Sometimes	Rarely	Disagree
Doctors (10)	0	6	4	0
Paramedics (21)	7	10	1	3

Considering the total number of 10 emergency doctors, 4 stated "rarely", 6 stated "sometimes". No emergency doctor answered with "disagree" or "often". Considering the total number of 21 paramedics, 3 disagreed, 1 stated "rarely", 10 stated "sometimes" and 7 stated "often".

4.2.2 Quality of need

Table 11 shows how paramedics rated the statement "What kind of support would you especially like to get in an emergency situation?"

Table 11: "What kind of support would you especially like to get in an emergency situation?"

	Diagnostics/Treatment	Practical/Manual	Undecided
Paramedics (21)	13	6	2

The 21 paramedics were asked to choose between "help with practical and manual skills" or "help with diagnostics and treatment". 6 of 21 wished for practical or manual help; 13 of 21 wished for help with diagnostics and treatment; 2 paramedics could not decide.

4.3 How is a tele-emergency doctor perceived in general?

This item of the study is featured by the following sentences of the questionnaires, "I consider the tele-emergency doctor as helpful." requesting a comment from paramedics, "As a tele-emergency doctor I considered myself as helpful." and "As a tele-emergency doctor I could improve the situation.", requesting a comment from doctors, and "A tele-emergency doctor improves the quality of patient care.", to be assessed by doctors as well as paramedics.

4.3.1 Helpful

Table 12 shows how paramedics rated the statement “I consider the tele-emergency doctor as helpful.”

Table 12: “I consider the tele-emergency doctor as helpful.”

	Agree	Partly agree	Partly disagree	Disagree
Paramedics (21)	15	6	0	0

Considering the total number of 21 paramedics, 6 partly agreed and 15 agreed. No paramedic disagreed or partly disagreed.

Table 13 regards the same aspect from the doctor´s point of view: “As a tele-emergency doctor I considered myself as helpful.”

Table 13: “As a tele-emergency doctor I considered myself as helpful.”

	Agree	Partly agree	Partly disagree	Disagree
Doctors (10)	4	6	0	0

Considering the total number of 10 emergency doctors, 6 partly agreed and 4 agreed. No one disagreed or partly disagreed.

4.3.2 Improving the situation

Table 14 shows how doctors rated the statement "As a tele-emergency doctor I could improve the situation.”

Table 14: “As a tele-emergency doctor I could improve the situation.”

	Agree	Partly agree	Partly disagree	Disagree
Doctors (10)	3	7	0	0

Considering the total number of 10 emergency doctors, 7 partly agreed and 3 agreed. No one disagreed or partly disagreed.

4.3.3 Improving care

Table 15 shows how doctors and paramedics rated the statement “A tele-emergency doctor improves the quality of patient care.”

Table 15: “A tele-emergency doctor improves the quality of patient care.”

	Agree	Partly agree	Partly disagree	Disagree
Doctors (10)	3	7	0	0
Paramedics (21)	13	8	0	0

Considering the total number of 10 emergency doctors, 7 partly agreed and 3 agreed. Considering the total number of 21 paramedics, 8 partly agreed and 13 agreed. No emergency doctor or paramedic disagreed or partly disagreed.

4.4 How do propositi feel during communication via *LiveCity camera*?

This item of the study is featured by11 sentences of the questionnaires,8 of them requesting comments by paramedics, "I felt confirmed in my work by the tele-emergency doctor.”, “The tele-emergency doctor made me feel more secure.”, "The tele-emergency doctor made me feel more secure in legal aspects.”, "I felt controlled by the tele-emergency doctor.”, “I felt like a puppet on a string directed by the tele-emergency doctor.”, “The tele-emergency doctor deranged my relationship to the patient.”, “I perceived the tele-emergency doctor as an interferer.” and "The tele-emergency doctor disrupts my course of action.”Another 3 sentences requested comments from doctors, “As a tele-emergency doctor I felt like a puppet master.”, "As a tele-emergency doctor I continued feeling like a doctor.” and “As a tele-emergency doctor I perceived myself as an interferer.”

4.4.1 Confirming

Table 16 shows how paramedics rated the statement "I felt confirmed in my work by the tele-emergency doctor.”

Table 16: "I felt confirmed in my work by the tele-emergency doctor."

	Agree	Partly agree	Partly disagree	Disagree
Paramedics (21)	9	11	1	0

Considering the total number of 21 paramedics, 1 partly disagreed, 11 partly agreed and 9 agreed. No one disagreed.

4.4.2 Secure in general

Table 17 shows how paramedics rated the statement "The tele-emergency doctor made me feel more secure."

Table 17: "The tele-emergency doctor made me feel more secure."

	Agree	Partly agree	Partly disagree	Disagree
Paramedics (21)	12	6	3	0

Considering the total number of 21 paramedics, 3 partly disagreed, 6 partly agreed and 12 agreed. No one disagreed.

4.4.3 Legally secure

Table 18 shows how paramedics rated the statement "The tele-emergency doctor made me feel more secure in legal aspects."

Table 18: "The tele-emergency doctor made me feel more secure in legal aspects."

	Agree	Partly agree	Partly disagree	Disagree
Paramedics (21)	13	6	2	0

Considering the total number of 21 paramedics, 2 partly disagreed, 6 partly agreed and 13 agreed. No one disagreed.

4.4.4 Feeling controlled

Table 19 shows how paramedics rated the statement "I felt controlled by the tele-emergency doctor."

Table 19: "I felt controlled by the tele-emergency doctor."

	Agree	Partly agree	Partly disagree	Disagree
Paramedics (21)	0	2	10	9

Considering the total number of 21 paramedics, 2 partly agreed, 10 partly disagreed and 9 disagreed. No one agreed.

4.4.5 Feeling of puppet-on-a-string

Table 20 shows how paramedics rated the statement "I felt like a puppet on a string directed by the tele-emergency doctor."

Table 20: "I felt like a puppet on a string directed by the tele-emergency doctor."

	Agree	Partly agree	Partly disagree	Disagree
Paramedics (21)	0	1	6	14

Considering the total number of 21 paramedics, 1 partly agreed, 6 partly disagreed and 14 disagreed. No one agreed.

Table 21 addresses the same aspect from the doctor´s point of view.

Table 21: "As a tele-emergency doctor I felt like a puppet master."

	Agree	Partly agree	Partly disagree	Disagree
Doctors (10)	0	0	6	4

Considering the total number of 10 emergency doctors, 6 partly disagreed and 4 disagreed. No one agreed or partly agreed.

4.4.6 Professional identity

Table 22 shows how doctors rated the statement "As a tele-emergency doctor I continued feeling like a doctor."

Table 22: "As a tele-emergency doctor I continued feeling like a doctor."

	Agree	Partly agree	Partly disagree	Disagree
Doctors (10)	5	5	0	0

Considering the total number of 10 emergency doctors, 5 partly agreed and 5 agreed. No one disagreed or partly disagreed.

4.4.6 Relationship to patients

Table 23 shows how paramedics rated the statement "The tele-emergency doctor deranged my relationship to the patient."

Table 23: "The tele-emergency doctor deranged my relationship to the patient."

	Agree	Partly agree	Partly disagree	Disagree
Paramedics (21)	0	2	15	4

Considering the total number of 21 paramedics, 2 partly agreed, 15 partly disagreed and 4 disagreed. No one agreed.

4.4.7 Interferer

Table 24 shows how paramedics rated the statement "I perceived the tele-emergency doctor as an interferer."

Table 24: "I perceived the tele-emergency doctor as an interferer."

	Agree	Partly agree	Partly disagree	Disagree
Paramedics (21)	0	0	6	15

Considering the total number of 21 paramedics, 6 partly disagreed and 15 disagreed. No one agreed or partly agreed.

Table 25 regards the same aspect from the doctor´s point of view, "As a tele-emergency doctor I perceived myself as an interferer."

Table 25: "As a tele-emergency doctor I perceived myself as an interferer."

	Agree	Partly agree	Partly disagree	Disagree
Doctors (10)	0	0	6	4

Considering the total number of 10 emergency doctors, 6 partly disagreed and 4 disagreed. No one agreed or partly agreed.

4.4.8 Disrupting

Table 26 shows how paramedics rated the statement "The tele-emergency doctor disrupts my course of action."

Table 26: "The tele-emergency doctor disrupts my course of action."

	Agree	Partly agree	Partly disagree	Disagree
Paramedics (21)	0	3	6	12

Considering the total number of 21 paramedics, 3 partly agreed, 6 partly disagreed and 12 disagreed. No one agreed.

4.5 What kind of data needs to be transmitted from the emergency site?

This item of the study is featured by the following questions to be answered by doctors, "Is transmission of the vital signs without audio or video connection sufficient?" and "Is transmission of the vital signs with additional audio connection sufficient?".

4.5.1 Transmission of vital signs

Table 27 shows how doctors answered the question "Is a transmission of the vital signs **without** audio or video connection sufficient?"

Table 27: "Is a transmission of the vital signs without audio or video connection sufficient?"

	Yes	No
Doctors (10)	2	8

Only emergency doctors were asked, 8 of 10 answering "no" and 2 of 10 "yes".

4.5.2 Transmission of vital signs and audio connection

Table 28 shows how doctors answered the question “Is a transmission of the vital signs with additional audio connection sufficient?”

Table 28: "Is a transmission of the vital signs with additional audio connection sufficient?”

	Yes	No
Doctors (10)	2	8

Again only emergency doctors were asked, and again 8 of 10 answered "no" and 2 of 10 "yes".

4.6 How are the technical aspects of the *LiveCity camera* evaluated?

This item of the study has been investigated in a group of 12 paramedics and 5 emergency doctors using the *LiveCity camera* in study phase C.

The following sentences from the questionnaires had to be answered by paramedics to collect their initial experience.“Because of the *LiveCity camera* the tele-emergency doctor got additional information.”, “Operating the *LiveCity camera* was an additional burden for me.”, “The *LiveCity camera* was too heavy.”, “Filming the emergency scene was easy for me.”, “I could show the tele-emergency doctor everything I wanted to show.”, “My own field of vision was restricted by the *LiveCity camera*” ,“The audio quality was good.”, “I could tell the tele-emergency doctor everything I wanted

to tell.", "The technology was easy to operate." and "The technology was very failure-prone."
The following sentences had to be answered by doctors, "The paramedic could show me everything I wanted to see.", "I could easily orient myself in the picture on the screen.", "The audio quality was good." and "The technology was very failure-prone."

The sentence "The tele-emergency doctor deranged the communication with my colleague at the emergency site." was answered by paramedics of phase B and phase C and the results are presented in two tables.

4.6.1 Adding information

Table 29 shows how paramedics rated the statement "Because of the *LiveCity camera* the tele-emergency doctor got additional information."

Table 29:"Because of the LiveCity camera the tele-emergency doctor got additional information."

	Agreed	Partly agreed	Partly disagreed	Disagreed	No answer
Paramedics (12)	5	5	0	0	2

Of the 12 paramedics, who worked with the *LiveCity camera*, 5 partly agreed, 5 agreed and 2 did not answer. No one disagreed or partly disagreed.

4.6.2 Adding burden

Table 30 shows how paramedics rated the statement "Operating the *LiveCity camera* was an additional burden for me."

Table 30: "Operating the LiveCity camera was an additional burden for me."

	Agree	Partly agree	Partly disagree	Disagree
Paramedics (12)	0	3	4	5

Of the 12 paramedics, who worked with the *LiveCity camera*, 5 disagreed and 4 partly disagreed, 3 partly agreed and no paramedic agreed.

4.6.3 Adding weight

Table 31 shows how paramedics rated the statement “The *LiveCity camera* was too heavy.”

Table 31: “The LiveCity camera was too heavy.”

	Yes	No
Paramedics (12)	4	8

Of the 12 paramedics, who worked with the *LiveCity* camera, 8 answered “no” and 4 answered “yes”.

4.6.4 Easy filming

Table 32 shows how paramedics rated the statement “Filming the emergency scene was easy for me.”

Table 32: “Filming the emergency scene was easy for me.”

	Agree	Partly agree	Partly disagree	Disagree	No answer
Paramedics (12)	4	5	1	0	2

Of the 12 paramedics, who worked with the *LiveCity*, 4 agreed, 5 partly agreed, 1 partly disagreed and 2 did not answer. No paramedic disagreed.

4.6.5 Demonstrate everything

Table 33 shows how paramedics rated the statement ”I could show the tele-emergency doctor everything I wanted to show.”

Table 33: “I could show the tele-emergency doctor everything I wanted to show.”

	Agree	Partly agree	Partly disagree	Disagree	No answer
Paramedics (12)	4	5	1	0	2

Of the 12 paramedics, who worked with the *LiveCity camera*, 1 partly disagreed, 5 partly agreed, 4 agreed and 2 did not answer. No paramedic disagreed.

Table 34 regards the same aspect from the doctor´s point of view, ”The paramedic could show me everything I wanted to see.”

Table 34: “The paramedic could show me everything I wanted to see. “

	Agree	Partly agree	Partly disagree	Disagree
Doctors (5)	2	3	0	0

Of the 5 emergency doctors, who worked with the *LiveCity camera*, 3 partly agreed and 2 agreed. No one disagreed or partly disagreed.

4.6.6 Easy on-screen orientation

Table 35 shows how doctors rated the statement “I could easily orient myself in the picture on the screen.”

Table 35: “I could easily orient myself in the picture on the screen.”

	Agree	Partly agree	Partly disagree	Disagree
Doctors (5)	2	2	1	0

Of the 5 emergency doctors, who worked with the *LiveCity camera*, 1 partly disagreed, 2 partly agreed and 2 agreed. No one disagreed.

4.6.7 No vision restriction

Table 36 shows how paramedics rated the statement “My own field of vision was restricted by the *LiveCity camera*”

Table 36: “My own field of vision was restricted by the LiveCity camera”

	Yes	No
Paramedics (12)	2	10

Of the 12 paramedics, who worked with the *LiveCity camera*, 10 answered “no” and 2 answered “yes”.

4.6.8 Audio quality

Table 37 shows how doctors and paramedics rated the statement “The audio quality was good.”

Table 37:“The audio quality was good.”

	Agree	Partly agree	Partly disagree	Disagree
Doctors (5)	2	2	1	0
Paramedics (12)	7	4	1	0

Of the 12 paramedics, who worked with the *LiveCity camera* in phase C, 1 partly disagreed, 4 partly agreed and 7 agreed. Of the 5 emergency doctors 1 partly disagreed, 2 partly agreed and 2 agreed. No one disagreed.

4.6.9 Tell everything

Table 38 shows how paramedics rated the statement “I could tell the tele-emergency doctor everything I wanted to tell.”

Table 38: “I could tell the tele-emergency doctor everything I wanted to tell.”

	Agree	Partly agree	Partly disagree	Disagree
Paramedics (12)	10	1	1	0

Of the 12 paramedics, who worked with the *LiveCity camera*, 1 partly disagreed, 1 partly agreed and 10 agreed. No one disagreed.

4.6.10 Easy operating

Table 39 shows how paramedics rated the statement “The technology was easy to operate.”

Table 39: "The technology was easy to operate."

	Agree	Partly agree	Partly disagree	Disagree
Paramedics (12)	3	1	5	3

Of the 12 paramedics, who worked with the *LiveCity camera*, 3 disagreed, 5 partly disagreed, 1 partly agreed and 3 agreed.

4.6.11 Failure-prone

Table 40 shows how doctors and paramedics rated the statement "The technology was very failure-prone."

Table 40:"The technology was very failure-prone."

	Agree	Partly agree	Partly disagree	Disagree
Doctors (5)	3	2	0	0
Paramedics (12)	10	2	0	0

Of the 12 paramedics, who worked with the *LiveCity camera*, 10 agreed and 2 partly agreed. Of the 5 emergency doctors, who worked with the *LiveCity camera*, 3 agreed and 2 partly agreed. No paramedic or emergency doctor partly disagreed or disagreed.

4.6.12 Deranged communication

Table 41 shows how paramedics working with the *LiveCity camera* in phase C rated the statement "The tele-emergency doctor deranged the communication with my colleague at the emergency site."

Table 41:Phase C: "The tele-emergency doctor deranged the communication with my colleague at the emergency site."

	Agree	Partly agree	Partly disagree	Disagree
Paramedics (12)	3	3	2	4

Of the 12 paramedics, who worked with the *LiveCity camera* in phase C, 3 agreed, 3 partly agreed, 2 partly disagreed and 4 disagreed.

Table 42 regards the same statement and summarizes the answers of paramedics working with the “ideal” camera in phase B.

Table 42: Phase B: “The tele-emergency doctor deranged the communication with my colleague at the emergency site.”

	Agree	Partly agree	Partly disagree	Disagree	No answer
Paramedics (9)	0	2	1	5	1

Of the 9 paramedics working with the “ideal” camera in phase B, 2 partly agreed, 1 partly disagreed and 5 disagreed. 1 paramedic did not answer.

4.7 How is the concept of a tele-emergency doctor evaluated?

This item of the study is featured by “Would you call a tele-emergency doctor in cases you wouldn’t normally call an emergency doctor?”,“I perceive that the tele-emergency doctor leads to a faster start of the therapy.”, “I perceive the tele-emergency doctor system as useful.” and “I can imagine working in a tele-emergency doctor system.", requesting a comment from both emergency doctors and paramedics.

4.7.1 Additional calling

Table 43 shows how paramedics answered the question “Would you call a tele-emergency doctor in cases you wouldn’t normally call an emergency doctor?”

Table 43: “Would you call a tele-emergency doctor in cases you wouldn’t normally call an emergency doctor?”

	Yes	No
Paramedics (21)	14	7

Considering the total number of 21 paramedics, 14 answered "yes" and 7 answered "no".

4.7.2 Faster start of therapy

Table 44 shows how doctors and paramedics rated the statement “I perceive that the tele-emergency doctor leads to a faster start of the therapy.”

Table 44:“I perceive that the tele-emergency doctor leads to a faster start of the therapy.”

	Agree	Partly agree	Partly disagree	Disagree
Doctors (10)	3	6	1	0
Paramedics (21)	11	9	1	0

Considering the total number of 10 emergency doctors, 1 partly disagreed, 6 partly agreed, 3 agreed. Considering the total number of 21 paramedics, 1 partly disagreed, 9 partly agreed, 11 agreed. No emergency doctor or paramedic disagreed.

4.7.3 Useful system

Table 45 regards the statement “I perceive the tele-emergency doctor system as useful.” and demonstrates a dynamic evaluation of the usefulness of the tele-emergency doctor system. The propositi had to answer this question twice: First, after the initial explanation of the concept and idea behind the tele-emergency system before starting work at the simulation centre and for a second time after completing all scenarios.

Table 45: "I perceive the tele-emergency doctor system as useful."

Phase B	**After simulation**				
Before simulation		Disagree	Partly disagree	Partly agree	Agree
	Disagree	0	1	0	0
	Partly disagree	0	0	1	0
	Partly agree	0	0	3	6
	Agree	0	0	1	2

Phase C	**After simulation**				
Before simulation		Disagree	Partly disagree	Partly agree	Agree
	Disagree	0	0	0	0
	Partly disagree	0	0	1	0
	Partly agree	0	0	5	2
	Agree	0	0	0	9

Table 45 shows the answers allocated to the group working with the "ideal camera" in phase B and the group working with the *LiveCity camera* in phase C. The grey fields indicate "no difference" between the first and the second evaluation. While the fields on the left side of the diagonal line show a decline in the opinion, the right side shows an incline in the opinion regarding the usefulness of a tele-emergency doctor system.

4.7.4 Commitment

Table 46 shows how doctors and paramedics rated the statement “I can imagine working in a tele-emergency doctor system."

Table 46: “I can imagine working in a tele-emergency doctor system."

	Agree	Partly agree	Partly disagree	Disagree
Doctors (10)	4	5	1	0
Paramedics (21)	16	4	1	0

Considering the total number of 10 emergency doctors, 1 partly disagreed, 5 partly agreed, 4 agreed to the summarizing sentence of the study. Considering the total number of 21 paramedics, 1 partly disagreed, 4 partly agreed, 16 agreed to the summarizing sentence of the study. No emergency doctor or paramedic disagreed.

4.8 Does the tele-emergency doctor improve the quality of patient care?

4.8.1 Adherence to guidelines for diagnostics

Figure 22 depicts the aggregated points as a measurement of performance for each team of paramedics and emergency doctors.

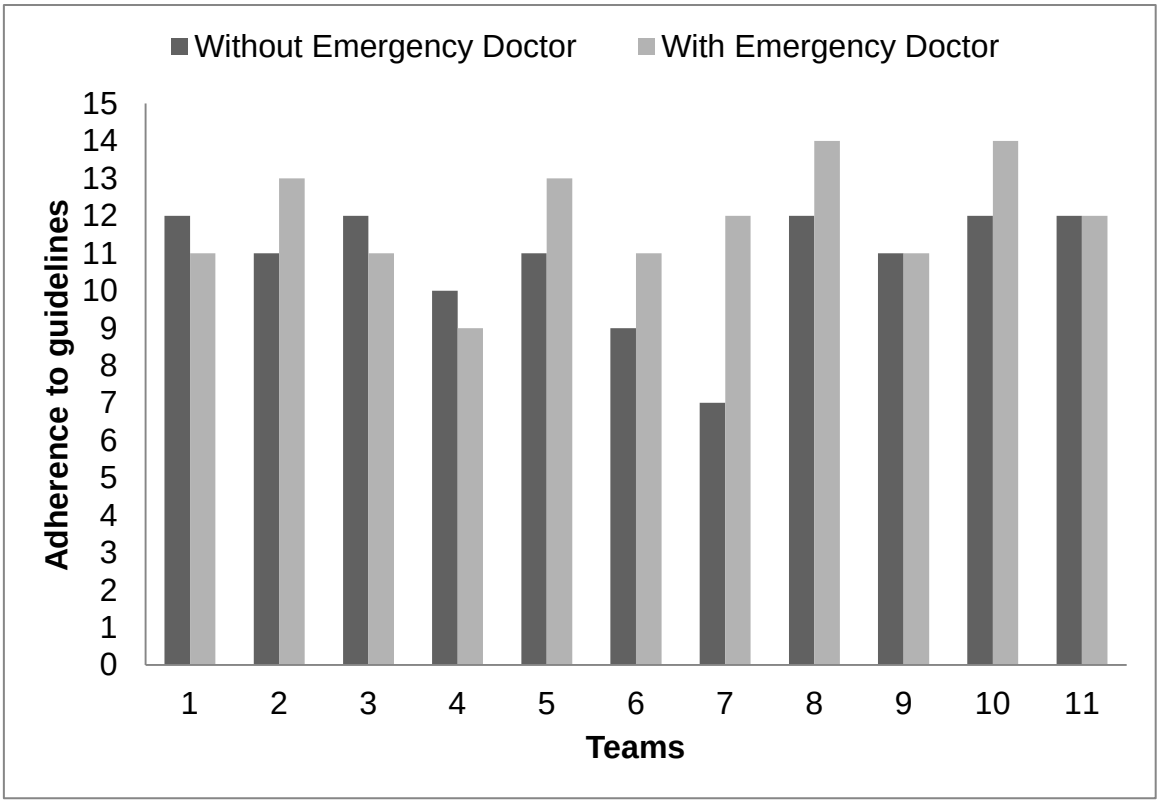


Figure 22: Adherence to guidelines regarding diagnostics

The quality of diagnostics for each team of paramedics is shown in *Figure 22* as points aggregated from all 5 emergency categories. The blue columns depict the cases the paramedics treated without the help of an emergency doctor. And the red columns depict the cases, where the paramedics got help by a tele-emergency doctor. Team 2, 5, 6, 7, 8 and 10 had a better adherence to the guidelines in diagnostics, when they were connected to an emergency doctor. Team 9 and 11 showed no difference. And team 1, 3 and 4 had a decreased adherence when working with an emergency doctor.

Table 47 presents the median, minimum and maximum of the teams' aggregated points, subdivided into the cases without and with an emergency doctor.

Table 47: Adherence to guidelines regarding diagnostics

	Number of Teams	Median	Minimum	Maximum	Total Sum
Without Emergency Doctor	11	11	7	12	119
With Emergency Doctor	11	12	9	14	131
All	22	11,5	7	14	250

Table 47 displays that the median as well as the minimum, maximum and total score of diagnostics were higher in cases with support by an emergency doctor compared with the cases without an emergency doctor.

4.8.2 Correctness of diagnosis

Figure 23 depicts the evaluation of correctness of diagnosis by paramedics without and with support by an emergency doctor.

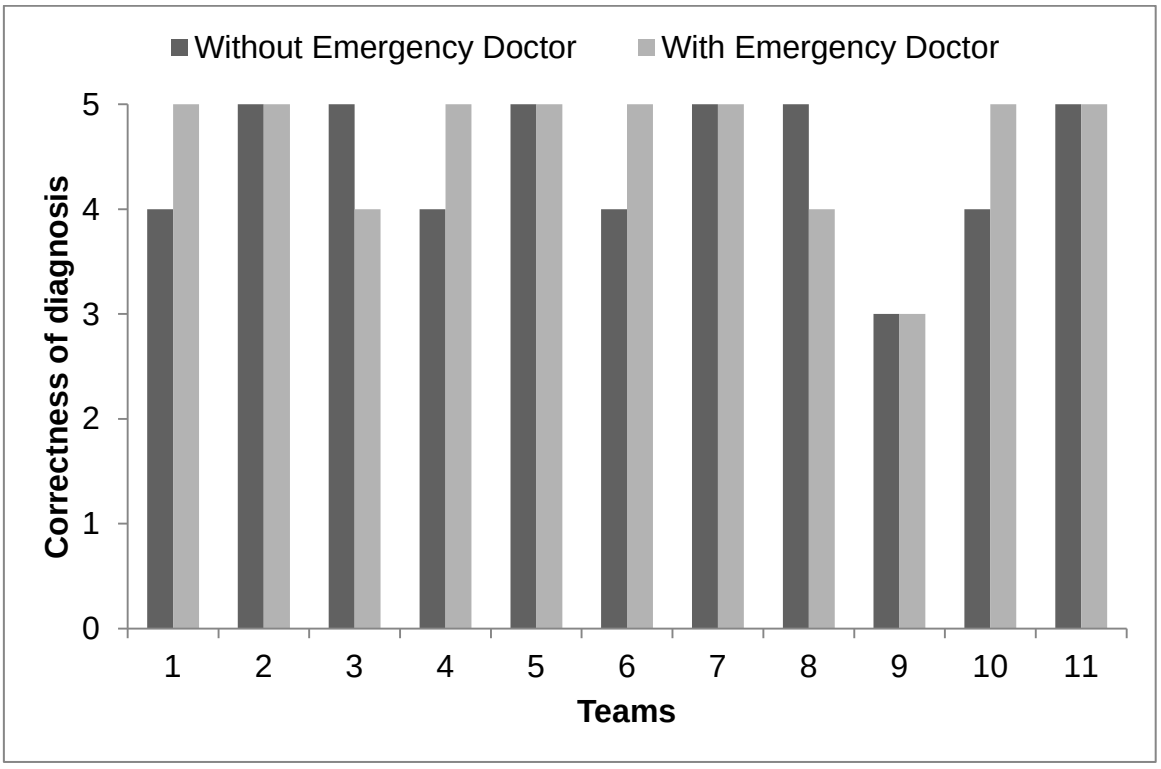


Figure 23: Correctness of diagnosis

The number of correct diagnoses each team gained is shown in *Figure 23*. Again, the blue columns depict the cases the paramedics treated without the help of an emergency doctor. And the red columns depict the cases, where the paramedics got help by a remote emergency doctor. Team 1, 4, 6 and 10 had more correct diagnoses, when connected to an emergency doctor. Team 2, 5, 7, 9 and 11 showed no difference. And team 3 and 8 had less correct diagnoses when working with an emergency doctor.

Table 48 presents the median, minimum and maximum of the teams' aggregated points, subdivided into the cases without and with an emergency doctor.

Table 48: Correctness of diagnosis

	Number of Teams	Median	Minimum	Maximum	Total Sum
Without Emergency Doctor	11	5	3	5	49
With Emergency Doctor	11	5	3	5	51
All	22	5	3	5	100

Table 48 displays that the median as well as the minimum and maximum do not differ for correct diagnosis in the cases with support by an emergency doctor compared with the cases without an emergency doctor. But the total score of correct diagnoses is higher in the cases with an emergency doctor.

4.8.3 Adherence to guidelines for therapy

Figure 24 depicts the evaluation of adherence to guidelines regarding therapy.

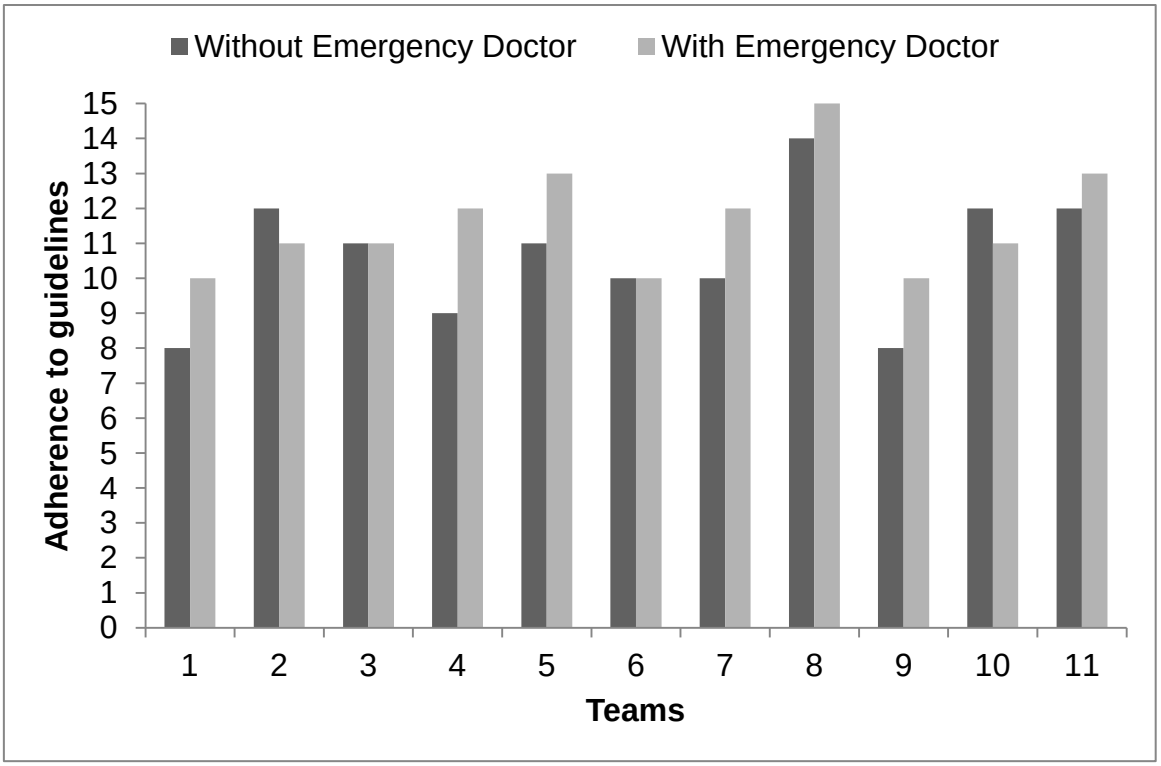


Figure 24: Adherence to guidelines regarding therapy

The quality of therapy for each team is shown in *Figure 24* as points aggregated from all 5 emergency categories. Again, the blue columns depict the cases the paramedics treated without the help of an emergency doctor. And the red columns depict the cases, where the paramedics got help by a remote emergency doctor. Team 1, 4, 5, 7, 8, 9 and 11 had a better adherence to the guidelines in therapy, when they were connected to an emergency doctor. Team 3 and 6 showed no difference. And team 2 and 10 had a decreased adherence when working with an emergency doctor.

Table 49 presents the median, minimum and maximum of the teams' aggregated points, subdivided into the cases without and with an emergency doctor.

Table 49: Adherence to guidelines regarding therapy

	Number of Teams	Median	Minimum	Maximum	Total Sum
Without Emergency Doctor	11	11	8	14	117
With Emergency Doctor	11	11	10	15	128
All	22	11	8	15	245

Table 49 displays that the median for therapy does not differ in cases with an emergency doctor compared with the cases without an emergency doctor. But the minimum, maximum and total score of adherence to guidelines in therapy are higher in the cases with an emergency doctor.

4.9 Feedback by propositi

To assess the appraisal of the concept, real-time high quality video connection from the emergency site to a remote expert, the propositi as representatives of the future users of the *LiveCity camera*, were asked to give feedback. The feedback was given via the semi-structured questionnaire and in informal conversations during the simulation. Although some propositi were initially sceptic, most paramedics and emergency doctors got more and more enthusiastic during the simulation work. Most propositi tried to contribute to the *LiveCity* concept and *LiveCity camera* by offering helpful ideas and trying to solve some problems, which might arose in the implementation phase of the *LiveCity camera*. Together with the paramedics and emergency doctors there were long and detailed conversations, about how the *LiveCity camera* could be further improved and later implemented into the existing medical emergency system.

Below some comments by the paramedics and emergency doctors are quoted:

- *"This [concept] has a huge potential."*
- *"I would like to work as a tele-emergency doctor."*
- *"It is such a help to have a tele-emergency doctor – I would have never thought so."*
- *"It really is reassuring to have help just a video-call away."*
- *"When is it going to be implemented in our city?"*
- *"The quality of the snapshot is incredibly good. One can really analyze an ECG."*
- *"The hardware and software have to be very robust to be used in emergency medicine."*
- *"The hardware and software are at this point not ready for usage."*
- *"The computer in the backpack seems to be too hot. Constant restart was necessary."*
- *"Further improvement of the technology is necessary."*

In conclusion, after taking part in the simulation, both paramedics and emergency doctors appreciated the idea of live video connection in high quality from the emergency site to a remote tele-emergency doctor to receive support and reassurance for their work. However, before the *LiveCity camera* can be implemented into the existing emergency system, the remaining technical problems have to be solved.

5 Discussion

The results presented in this thesis illustrate a variety of practical, technical and psychological experiences. To increase comprehensibility, the items will be first discussed seriatim and then reflected in the broader spectrum regarding potential impact and further need of development

5.1 Seriatim discussion of experiences

5.1.1 Is the simulated emergency site providing a valid test condition?

For the *Emergency Use Case*, the *LiveCity* consortium agreed to select three target populations of emergencies to be tested in the medical simulation centre and outside the simulation centre: stroke, myocardial infarction and trauma. These emergencies belong to the "First Hour Quintet". This term was coined by the sixth European Resuscitation Council Meeting in Florence, Italy, in 2002 and describes five emergencies, which are life-threatening diseases in which fast treatment reduces morbidity and mortality [147, 148]. Stroke, myocardial infarction and trauma are also among the main causes of death in Europe [149]. Worldwide, they belonged to the group of top 10 leading causes of death in 2004 and prognosis for 2030 predicts them to be within the top 5 leading causes of death worldwide [150]. Thus, there are many approaches to improve the therapy of these emergencies, e.g. by telemedicine. The implementation of telemedicine in stroke treatment was recommended by the American Heart Association and American Stroke Association in 2009 [151].

To reflect the broad spectrum of emergencies, which paramedics and emergency doctors encounter, two additional emergency categories were developed: rare diseases and complications during pregnancy. Rare diseases and complications during pregnancy are special challenges in medicine. Often there are no standard operating procedures and the paramedics might not have encountered a similar situation before, which increases the stress level. Another aspect in pregnancy is that the unborn child has to be considered, too, e.g. in the application of drugs to manage the emergency. There are only a limited number of medications, for which it could be proven, that they can be administered during pregnancy without teratogenic or

negative long-term effects for the unborn child [152]. Additionally, pregnancy changes many physiological parameters in women, which have to be kept in mind. Therefore, a video consultation of a tele-emergency doctor might be helpful.

The majority of both emergency doctors and paramedics confirmed that the simulation of the scenarios was realistic. They also acknowledged that the chosen scenarios were relevant examples of emergency situations. All paramedics and emergency doctors agreed or partly agreed that they took the simulation work seriously. This means, that the chosen method is estimated as valid, which is a fundamental prerequisite for further evaluation of the following findings.

5.1.2 Is there a request for telemedicine at the emergency site?

To assess the need for teleconsultation and telementoring at the emergency site, paramedics and emergency doctors were asked, whether they encounter situations in their daily work, in which they would like to get help by an experienced colleague. The majority of paramedics stated that they sometimes or even often face those situations, while the emergency doctors meet those situations rarely or sometimes. Thus, the paramedics experience the need for additional help at the emergency site. When asked what kind of help they wished for, the majority wanted help with diagnostics and treatment. Thus, there seems to be a higher need for knowledge transport than for manual help. Teleconsultation and telementoring enable such a transfer of knowledge over a geographical distance.

5.1.3 How is the tele-emergency doctor perceived?

After completing all scenarios all paramedics agreed (at least partly), that the tele-emergency doctor is helpful. And all emergency doctors rated themselves as tele-emergency doctors as helpful and being able to improve the situation. Emergency doctors and paramedics stated, the tele-emergency doctor improved the quality of patient care. Hence, a tele-emergency doctor might be the answer to the wish for additional help at the emergency site.

5.1.4 What do we learn about the psychological aspects of telementoring?

One of the goals of telementoring and teleconsultation is to help the mentee by confirming him in his knowledge and work, when correct and thus making him feel

more secure. The majority of paramedics agreed (partly) that the tele-emergency doctor confirmed their work and made them feel more secure in general and in legal aspects. At the same time it is important that the mentee does not feel controlled by the mentor or like a puppet on a string. Most paramedics felt neither controlled nor like a puppet on a string. The emergency doctors denied the feeling of being a puppet master and still felt like a doctor. Since the concept of a tele-emergency doctor brings an additional person into the situation at the emergency site, it is important to examine, if the relationship between the patient and the paramedics changes. The majority partly disagreed, that the tele-emergency doctor deranged the relationship to the patient. Neither the emergency doctors nor the paramedics perceived the tele-emergency doctor as an interferer at the emergency site. And the paramedics stated that the tele-emergency doctor did not disrupt their course of action.

5.1.5 What are the requirements for a telemedicine device?

To evaluate what kind of telemedicine device is needed to meet the requirements, paramedics and emergency doctors were asked what kind of data should be transmitted. The majority of emergency doctors stated the transmission of vital signs alone or vital signs plus audio connection would not have been enough. And the majority of paramedics confirmed, that the *LiveCity camera* transmitted additional information, the tele-emergency doctor would not have received without it.

5.1.6 How did the propositi evaluate the *LiveCity camera* as a device?

In *Section "3.6.2. Communication via "ideal" camera (Phase B)"* the characteristics of an "ideal" camera are described. The *LiveCity* members strived to develop the *LiveCity camera* as close as possible to the "ideal" camera. One fundamental aspect was that operating the *LiveCity camera* is no additional burden. The paramedics who worked with the camera in phase C mostly denied or partly denied an additional burden and the majority answered, that the *LiveCity camera* was not too heavy. Although the propositi only got a short introduction into operating the *LiveCity camera*, most paramedics agreed, that filming was easy for them.

Yet, the majority of paramedics disagreed or partly disagreed, that the general operation of the technology was easy. Furthermore, all paramedics and all emergency doctors, who worked with the *LiveCity camera*, agreed or partly agreed

that the current version of the *LiveCity camera* was very failure-prone. In most cases, the steadiness of the internet connection was limited, which resulted in connectivity problems. These findings were reported back to the developers of the *LiveCity camera*.

The position of the camera was chosen above the right ear to create the same perspective for the emergency doctor, the paramedic has. Most paramedics and every emergency doctor agreed or partly agreed that this goal was achieved and that the paramedics could show the tele-emergency doctor everything he wanted to see. Additionally, this position in comparison to an unusual angle has the advantage of making it easier for the tele-emergency doctor to orient himself in the picture on the screen. The majority of emergency doctors agreed or partly agreed that they could find orientation easily. Simultaneously, it is important that the field of vision of the paramedic wearing the *LiveCity camera* was not restricted. Nearly all paramedics agreed that they experienced no limitations in their field of vision.

As described above, a good audio quality is a prerequisite for a good oral communication via telemedicine. The majority of paramedics and emergency doctors agreed or partly agreed that the audio quality was good. Therefore, the paramedics confirmed that they could tell the tele-emergency doctor everything they wanted to tell. The tele-emergency doctor being an additional partner at the emergency site might make the communication at the emergency site more complex. Apart from that, in the current version of the *LiveCity camera* only one paramedic wears a headphone to communicate with the tele-emergency doctor. As explained in *Section“3.6.2 Communication via “ideal” camera (Phase B)”* this requires the paramedic wearing the *LiveCity camera* to echo everything that is said. This could further derange the communication of the paramedics at the emergency site. Paramedics who worked with the “ideal” camera in phase B mostly disagreed to a deranged communication. More paramedics working with the current version of the *LiveCity camera* in phase C than paramedics working with the “ideal” camera rated the communication between the paramedics as deranged. This is probably due to the single headphone. This is one of the practical findings that were reported back to the developers of the *LiveCity camera*.

5.1.7 Is the concept of a tele-emergency doctor efficient?

One aspect to highlight the value of the tele-emergency doctor is that the majority of paramedics stated that they would call a tele-emergency doctor in cases, they would not normally call an emergency doctor. Both emergency doctors and paramedics perceived that the tele-emergency doctor concept leads to a faster start of therapy, which is one important component in successful emergency medicine.

The quintessence question, whether a tele-emergency doctor system is useful, was asked twice to assess a possible shift of the opinion after working in a simulated tele-emergency doctor system. The already high opinion of the usefulness after the initial explanation of the tele-emergency doctor system, increased even further after working in the simulated system. This increase was detectable in propositi who worked with the “ideal” camera as well as propositi working with the *LiveCity camera*. Hence, one can conclude that the concept is appealing. And the aspects of the *LiveCity camera*, which differ from an “ideal” camera, seem not to influence the increase of the perceived usefulness.

Summarizing, emergency doctors and paramedics declared overwhelmingly that they could imagine working in a tele-emergency doctor system.

5.1.8. Does the tele-emergency doctor improve the quality of patient care?

Although the results are divers to some extent, the majority of teams performed with an increased adherence to guidelines, when they were supported by emergency doctors. There are a number of reasons for the varied outcomes ranging from decreased guideline adherence to increased guideline adherence.

The idea of this telemedicine approach is to offer the paramedics at the emergency site help by an emergency doctor. Therefore, the potential increase of quality will be achieved by the consultation of an expert. But since this expert is not an automatic computer reply programmed on the basis of the guideline, there is still the “human factor” to take into account. Furthermore, the teams were deliberately not matched according to knowledge and expertise in emergency medicine. Therefore, a team of well-experienced paramedics might have been working with a less experienced emergency doctor and vice versa. These factors could contribute to some of the decreased or unchanged aggregated points of quality when supported by an emergency doctor. Additionally, it has to be noted, that the level of guidelines adherence was already high in the cases without support by an emergency doctor.

For instance, some teams already had the maximum possible points of correct diagnosis without support by an emergency doctor, like team 2,5,7, and 11 and thus could not further improve.

Although in every scenario with an emergency doctor a video connection was generated, the individual teams of paramedics requested help to different extent. A restrained way of seeking help minimizes the opportunity for the emergency doctor to improve the quality. This might be one of the reasons for small or no differences between cases with or without telemedicine connection.

The multifaceted reasons for improved guideline adherence can be grouped into two clusters. The first cluster is characterized by adding a new partner to the existing team and thus increasing manpower. The second cluster describes benefits due to the specifics of emergency doctors.

The basis of the first cluster is, that an additional person is one more person to remember the guideline or to think of missing diagnostics or treatment options. Furthermore this third person is not at the emergency site but works from a remote place with the aid of telemedicine. Therefore, he is not occupied attaching the monitoring device or administering drugs and has time to think about the next step, what diagnostics might still be needed or what other therapeutic options might be possible. This is recognized as an important factor in emergency medicine. For instance the American Heart Association recommends team leaders in resuscitation not to work hands-on, but to step back to coordinate and distribute tasks [153].

The second cluster of reasons for improved guideline-adherence is based on the special training of medical doctors to become an emergency doctor. Emergency doctors have a longer education than paramedics and receive deeper knowledge e.g. on pathophysiology, pharmacology and differential diagnoses. Moreover, an integral part of the training and work of emergency doctors is inside a hospital. This helps them in detecting, which information crucial for the hospital can already or solely be obtained in the prehospital phase.

Figure 22 to *24* show that there are some teams that reached high scores in all three aspects, while others had lower scores or differed. Team 8 reached one of the highest points in diagnostics and the highest score in therapy, but had one wrong diagnosis when helped by an emergency doctor. This is one of the examples that show, that in the field of emergency medicine a high quality therapy is sometimes possible although the preliminary first diagnosis is later proven wrong.

5.2 Discussion of experiences in broader spectrum

The idea of a live video connection in high quality between paramedics at the emergency site and a remote emergency doctor is very welcome among providers, based upon the amount of agreement expressed by paramedics and emergency doctors in this study.

To increase the transferability of the data collected in this study, great emphasis was put on high verifiability, fidelity and validity, which are three of the most important concepts of evaluating the quality of simulation [154]. These three concepts are interconnected. To achieve high verifiability, phase A was developed to test and adapt all scenarios, before using them in phases B and C.

In *Section "3.3. Emergency patient: the Laerdal mannequin Resusci Anne"* the efforts to increase the equipment and environment fidelity and thereby psychological fidelity in this study are described. In the concept, that the behaviour in the simulated scenario mirrors the behaviour in a real case, high authenticity is essential [155]. In this study all participants took their work very seriously during the simulation, and the majority rated the simulated scenarios as realistic. Thus, the possibility of the participants behaving in the study environment similar to their normal behaviour is very high. This implies a good external validity. Furthermore, all emergency doctors and paramedics partly agreed or agreed that the chosen scenarios were relevant. This is also an indicator for a good external validity.

Since all paramedics and emergency doctors confirmed that the chosen scenarios were realistic and relevant, the simulation appears to be a suitable model and the findings might -at least partly- be transmitted from the simulation centre into the existing medical emergency system.

5.2.1 What are the advantages?

The majority of paramedics in this study stated, that they sometimes or often encounter situations in which they would like to get help by a more experienced colleague. So there seem to be situations, in which (remote) help would be appreciated. More than 2/3 of all paramedics would desire assistance in diagnostics and therapy. This is the main area, where the tele-emergency doctor can support

through the telemedicine connection. Because he works in an office at a computer, he is also able to check current guidelines and research regarding rare diseases and rare drugs or get into contact with the poison control centre. The tele-emergency doctor can also assist in manual and practical actions, because he sees the emergency site and the patient “through the eyes” of the paramedic due to the position of the *LiveCity camera* above the right ear of the paramedic. He can therefore guide the paramedic in manual tasks. In this context, it has to be considered that the emergency doctor should probably have to get a special training on how to guide from a distance.

One of the main purposes of the tele-emergency doctor concept is that the emergency doctor supports and helps the paramedics at the emergency site by providing expertise [156]. After completing all 10 scenarios, all paramedics rated the tele-emergency doctor as helpful. Hence, they confirmed that knowledge can be transferred via telemedicine to the emergency site. This concept of teleconsultation via video might be also expanded into other fields of emergency medicine. For example, emergency doctors with limited experience, who are at the emergency site, might want to get support by a remote emergency doctor, who has been working in emergency medicine for a longer time. Since some emergencies only occur rarely, the young emergency doctor might not have encountered a similar situation before [157]. And young emergency doctors often have a huge awareness of the responsibility they have and feel the difference between working in a hospital, where help by senior doctors is within reach and being the only doctor at the emergency site [158]. The emergency doctors in this study also stated, that they rarely or sometimes encounter situations, in which they would like to get help by a more experienced colleague. Thus, a young emergency doctor might also perceive support via the *LiveCity camera* by an experienced tele-emergency doctor as helpful.

Another advantage of the tele-emergency doctor is that support by an emergency doctor is easily accessible without the expensive mobilization of many resources. Additionally, this tele-emergency support starts without time delay the moment the telemedicine connection is built. If in the current medical emergency system, a paramedic wants to get help by an emergency doctor, the paramedic calls the emergency dispatcher, who then alerts the emergency doctor. The “normal”

emergency doctor would now start to travel to the emergency site. This whole procedure takes some time, which directly leads to a later start of transport to the hospital. As explained earlier, this time difference could be crucial. Thus, paramedics are more likely to call a tele-emergency doctor than a “normal” emergency doctor. This would presumably lead to a higher quality of emergency medicine.

Paramedics and emergency doctors were asked to rank the impact of a tele-emergency doctor on the quality of patient care. All participants agreed -or partly agreed- that the tele-emergency doctor improves the quality of patient care. BASHSHUR stated in 2002, that telemedicine has the potential to solve the existing problems in geographical differences in access to high standard medical care and might balance the uneven quality of care [159]. So the improvement of patient care by the tele-emergency doctor might be also used to enhance quality of diagnostics and therapies in geographical areas, where a high standard couldn’t be achieved before. It would be very interesting to test the concept of a tele-emergency doctor in countries outside of the European Union as well, which have not the medical emergency system of “advanced life support”, but “basic life support” or “no organized structure”. In these systems, the transfer of expertise is even more important and can increase the quality of patient care immensely. Roughly 90% of all trauma-related death worldwide occur in developing countries [160]. In these countries most trauma-related fatalities happen in the pre-hospital phase and some could be preventable through appropriate pre-hospital care [161, 162]. The World Health Organization has published a manual in 2005 about how pre-hospital trauma care management worldwide could be improved [163]. One concept for countries without an organized medical emergency system or with a low-grade medical emergency system was to teach volunteer citizens principles of basic life support. These volunteers could then work together to improve the pre-hospital care. One of the problems in teaching laypersons, who had not received a medical education before, is the low level of literacy [164]. Therefore, there is a need for special curricula, which uses the existing resources. A review by CALLESE and co-workers showed that trained volunteers can reduce the mortality after trauma [164]. If the volunteers could get help by a remote emergency doctor via telemedicine, this could lead to an even higher increase in quality of care. This telemedicine connection could, for instance, be achieved with the *LiveCity camera*.

As mentioned above, rapid start of treatment is crucial in an emergency. Time to start the treatment is also often used as an indicator for the quality of the medical emergency system [43]. One demand on telemedicine therefore is to not delay the therapy. In the development of the *LiveCity camera*, huge emphasis was put on reducing the time needed to build the connectivity. One approach was to enhance the capability of the hardware and software. And another one was to develop an easy-to-use and intuitive software, so that the video camera can be operated while working with the patient. A solid majority of the paramedics, who worked with the *LiveCity camera*, agreed or partly agreed, that operating the *LiveCity camera* was no additional burden. So, one of the main goals in the development of the *LiveCity camera* was achieved. After working with the *LiveCity camera* the majority of paramedics and emergency doctors partly agreed or agreed that they perceived that this tele-emergency doctor concept leads to an earlier start of therapy. It can be concluded for the *LiveCity camera* that the early availability of medical expertise regarding diagnostics and therapy leads to such an early start of therapy, that it can outbalance any delay due to technical reasons.

5.2.2 Where are the problems?

One might argue, that reducing the technical complexity to a minimum might lead to a faster data transmission and thus to an earlier start of therapy. Additionally, a complex system is often more failure-prone and requires a more stable and superior internet connection. To access the possibility to eliminate expandable features, the emergency doctors were consulted, what information was necessary to evaluate the specific emergency situation to advise the paramedics. 80% of emergency doctors stated, that the sole transmission of vital signs (blood pressure, heart rate, oxygen saturation) would not have been enough. And even the addition of an audio connection would have not been enough for 80% of the emergency doctors to sufficiently treat the emergency patient. This means, that the telemedicine devise also needs to transmit video to enable the tele-emergency doctor to successfully support the paramedics.

5.2.3 How is the future agenda?

Despite great promises of telemedicine, the implementation of telemedicine projects into the existing medical systems is a huge challenge [165, 166]. Some very

promising telemedicine projects were not as widely implemented as expected. The reason for that is studied worldwide and several “enablers”, e.g. well-working technology and training of the users, as well as “barriers”, e.g. technical problems and lack of technical support, were discussed [167]. One main factor for successful implementation of telemedicine is a good acceptance of the idea and device by the users, e.g. doctors [168]. WADE and co-workers stated that acceptance by clinicians is the most important key factor and that if clinicians supported the telemedicine project, various technical problems were tolerated [167].

The findings of this thesis indicate that most paramedics and emergency doctors perceived the current version of the *LiveCity camera* as failure-prone and not easy to operate. Nonetheless, due to the general good acceptance of the concept and high quality of video and audio features, most propositi rated the *LiveCity camera* as no additional burden and as useful.

In this study the propositi rated the idea of a tele-emergency doctor system as useful after hearing the background idea and concept. After the simulation work the opinion even improved for the ideal camera and the *LiveCity camera*. Thus, the acceptance of the tele-emergency doctor system is even higher after working within this system. It could be assumed, that the technical challenges and features of the *LiveCity camera*, which cannot meet the criteria for an “ideal” camera and inhibit the implementation of the *LiveCity camera* at this point of development, do not affect the general acceptance of the concept and camera system. The technology acceptance model (TAM) by DAVIS was applied to telemedicine and it could be shown that both the perceived usefulness and the perceived ease of use are significantly associated with the intention to use the system [168-171].

In the simulation work done in this study, an impressive majority of emergency doctors and paramedics agreed, that they could imagine working in a tele-emergency doctor system. Therefore, the impact of video communication on emergency medicine seems to be as convincing today as promising for the future.

6 Summary and Conclusions

The hypothesis of this study states that emergency medicine can benefit from telemedicine, whenever paramedics at a remote emergency site request consultation or mentoring by a distant emergency doctor.

The hypothesis was semi-qualitatively evaluated in accordance with the protocol of the EU project “LiveCity” in the setting of a medical simulation centre. Paramedics encountered simulated standardized emergency case scenarios, connected for teleconsultation and telementoring with emergency doctors by video and audio link through a newly developed real-time HD-video system called *LiveCity camera*.
Paramedics and emergency doctors regarded the simulated scenarios as realistic and relevant and took the simulation seriously. Thus, in concordance with the 5 items of the hypothesis, the following conclusions can be drawn:

1.) Emergency team members encounter situations at the emergency site, in which they would like to get help by a more experienced colleague, especially help with diagnostics and treatment.

2.) The telemedical contact to an emergency doctor makes paramedics feel confirmed in their work, more secure, even in legal aspects. Paramedics do not feel controlled by telemedicine or like a puppet on a string. Their relationship to the patient is not mainly deranged or interfered by the doctor and their course of action is not mainly disrupted. The tele-emergency doctors do not feel like puppet masters and continue feeling as doctors and do not perceive themselves as interferer within the emergency team.

3.) Emergency team members call for a telemedical system providing transmission of vital signs as well as audio- and video-connection.

4.) The *LiveCity camera* is an effective telemedical tool. The audio quality is good and the orientation on the screen is easy. Paramedics state, that filming the emergency site is easy, does not restrict the field of vision and paramedics can communicate the

emergency doctors everything they want to show and tell. Thus the emergency doctors get additional information.
While the *LiveCity camera* is mostly perceived as not too heavy, the *LiveCity camera* is not easy to operate, very failure-prone and can derange the communication among team members at the emergency site. Nevertheless, the *LiveCity camera* is not perceived as an additional burden.

5.) Telemedicine is predominantly and largely appreciated by the members of the emergency team. Connecting the tele-emergency doctor to the remote paramedics leads to a perceived faster start of the therapy and is considered as helpful, improving the situation and the quality of patient care. The adherence to medical guidelines and therefore the quality increased, when the paramedics were connected to an emergency doctor through the telemedicine connection. In general, the quality of diagnostics, the correctness of diagnosis and the quality of therapy were rated higher. The majority of paramedics would call a tele-emergency doctor in cases, they wouldn´t normally activate medical support. The emergency team members largely agree in perceiving the tele-emergency doctor system as useful, and they can imagine, working in a tele-emergency system.

As a conclusion, the general hypothesis of this study is mainly and in many items supported: Emergency medicine benefits from telemedical support via video- and audio link as studied here with a newly developed real-time HD-video system called *LiveCity camera*, whenever paramedics at a remote emergency site request consultation or mentoring by a distant emergency doctor.

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9 Index of Abbreviations

Abbreviation	Meaning
bpm	beats per minute
CIP	Competitiveness and Innovation Program
CT	Computed Tomography
DIN	Deutsches Institut für Normung e.V.
ECG	Electrocardiogram
EN	European Norm
EU	European Union
FP7	7thFramework Program
F2F, f2f	face to face
GA	Grant Agreement
HD	High Definition
ICT	Information and Communication Technology
LiveCity	Live Video-to-Video Supporting Interactive City Infrastructure
mmHg	millimetre of mercury
NSTEMI	Non-ST-elevation myocardial infarction
PC	Personal Computer
PSP	Policy-Support Program
STEMI	ST-elevation myocardial infarction
TAM	Technology Acceptance Model
WHO	World Health Organization
Wi-Fi, WiFi	Wireless Fidelity

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Figure 26: Members of the LiveCity Consortium at the Plenary F2F Meeting January22nd-23rd 2014

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12 Annex

Annex I encloses the following documents, all in German to display the original wording:

12.1 Questionnaires (Fragebögen)

The questionnaires are enclosed in German in full length to display all questions asked and to avoid unintentional changes in the timbre of the questions, when translated into another language.

12.2 Original description of the scenarios (Szenarien)

The main aspects of every scenario are described in *Section"3.4 Emergency Cases: ten scenarios".* In this Annex all scenarios are shown in the original wording with further medical details.

12.3 Original checklists of the scenarios (Checklisten)

The checklists to the corresponding emergency case scenarios, which are based on German and international guidelines, are displayed in German.

12.4 Propositi information ("Probandenaufklärung")

The propositi information in German is approved by the Ethics Commission of Greifswald University Medicine.

12.5 Informed consent ("Einverständniserklärung").

The informed consent in German is approved by the Ethics Commission of Greifswald University Medicine.

Annex II encloses:

- "Erklärung über Einzelanteile bei Gemeinschaftsanteile"
- „Eidesstattliche Erklärung" Bibiana Metelmann
- „Eidesstattliche Erklärung" Camillia Metelmann
- Lebenslauf Bibiana Metelmann

- Lebenslauf Camilla Metelmann
- Eigene Publikationen und Präsentationen

12.1 Questionnaires (Fragebögen)

12.1.1 Allgemeiner Fragebogen

Allgemeiner Fragebogen

Geschlecht

o männlich o weiblich o keine Angabe

Alter

… Jahre o keine Angabe

Tätig im Rettungsdienst als

o Rettungssanitäter o Rettungsassistent o Notarzt o Sonstiges

In dieser Funktion im Rettungsdienst tätig seit …

o < 1 Jahr o 1-5 Jahre o 5-10 Jahre o 10-15 Jahre o > 15 Jahre

Ich fühle mich in der Notfallmedizin

o unerfahren o eher unerfahren o eher erfahren o erfahren

Ich erlebe Situationen, in denen ich mir Unterstützung durch einen erfahrenen Kollegen wünsche.

o trifft nicht zu o trifft selten zu o trifft manchmal zu o trifft oft zu

Dabei wünsche ich mir vor allem Unterstützung bei

o praktischen/manuellen Tätigkeiten (z.B. Intubation, iv-Zugang, Thoraxdrainage)

o der Diagnosefindung und Therapieentscheidung.

Modernen Kommunikationsmitteln stehe ich aufgeschlossen gegenüber.

o trifft nicht zu o trifft eher nicht zu o trifft eher zu o trifft zu

Der Umgang mit modernen Kommunikationsmitteln fällt mir leicht.

o trifft nicht zu o trifft eher nicht zu o trifft eher zu o trifft zu

Das Konzept des Telenotarztes war mir bereits bekannt.

o ja o nein

12.1.2 Prätest-Fragebogen

Prätest-Fragebogen

Ich halte das Telenotarztsystem für sinnvoll.
o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Ich denke, dass dies zu einer relevanten Zeitersparnis führt.
o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Ich denke, dass dies die Qualität der Patientenversorgung verbessert.
o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Ich kann mir vorstellen, in einem Telenotarztsystem zu arbeiten.
o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

12.1.3 Kurzfragebogen für Telenotarzt

Telenotarzt kurzer Fragebogen

Als Telenotarzt habe ich geholfen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Als Telenotarzt habe ich gestört.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Versorgung des Patienten wäre ohne Telenotarzt wahrscheinlich schlechter gewesen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Gegebenenfalls Anmerkungen, Erläuterungen

Die Versorgung des Patienten wäre ohne Telenotarzt wahrscheinlich besser gewesen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Gegebenenfalls Anmerkungen, Erläuterungen

Ich bin gut mit der Technik zurechtgekommen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Gegebenenfalls Anmerkungen, Erläuterungen

12.1.4 Fragebogen für Rettungsfachpersonal ohne Telenotarzt

Rettungsfachpersonal ohne Telenotarzt

Der Telenotarzt hat gefehlt.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Versorgung des Patienten wäre mit Telenotarzt wahrscheinlich besser gewesen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Gegebenenfalls Anmerkungen, Erläuterungen

Hätte ich die Wahl gehabt, hätte ich den Telenotarzt gerufen.

o ja

o nein, denn *(Mehrfachnennung möglich)*

- o ich habe mich ausreichend sicher gefühlt.
- o es wäre mir zu umständlich, die Technik zu bedienen.
- o es wäre mir zu umständlich, dem Telenotarzt den Fall zu schildern.
- o der Telenotarzt hätte sowieso nicht helfen können.

12.1.5 Fragebogen für Rettungsfachpersonal mit Telenotarzt

Rettungsfachpersonal mit Telenotarzt

Der Telenotarzt hat geholfen.
o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Der Telenotarzt hat gestört.
o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Wenn der Telenotarzt nicht da gewesen wäre, hätte ich mich anders verhalten.
o ja o nein

Gegebenenfalls Anmerkungen, Erläuterungen

Die Versorgung des Patienten wäre ohne Telenotarzt wahrscheinlich schlechter gewesen.
o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Gegebenenfalls Anmerkungen, Erläuterungen

Ich bin gut mit der Technik zurechtgekommen.
o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Gegebenenfalls Anmerkungen, Erläuterungen

Die Kommunikation mit meinem Kollegen vor Ort wurde durch den Telenotarzt erschwert.
o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Hätte ich die Wahl gehabt, hätte ich den Telenotarzt gerufen.
o ja
o nein, denn *(Mehrfachnennung möglich)*
- o ich habe mich ausreichend sicher gefühlt.
- o es war mir zu umständlich, die Technik zu bedienen.
- o es war mir zu umständlich, dem Telenotarzt den Fall zu schildern.
- o der Telenotarzt hätte sowieso nicht helfen können.

12.1.6 Posttest für Telenotarzt

Posttest für Telenotarzt

Ich bin der Meinung, der Telenotarzt…

… verbessert die Patientenversorgung.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… führt zu einer relevanten Zeitersparnis.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… führt zu einer schnelleren Diagnosefindung.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… führt zu einem schnelleren Therapiebeginn.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… führt zu einer schnelleren Transportfähigkeit des Patienten.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… führt zu einer Verzögerung am Notfallort.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… stört die etablierte Struktur.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Als Telenotarzt habe ich…

… alles, was ich brauchte, sehen können.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… alle Fakten, die ich brauchte, mitgeteilt bekommen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… dem Rettungsfachpersonal sagen können, was ich sehen wollte.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Das Rettungsfachpersonal konnte mir alles zeigen, was ich sehen wollte.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Was fehlte Ihnen an Informationen?

Einschränkungen durch den fehlenden Tastsinn waren

o nicht vorhanden o eher nicht vorhanden o eher vorhandeno vorhanden

Einschränkungen durch den fehlenden Geruchssinn waren

o nicht vorhanden o eher nicht vorhanden o eher vorhandeno vorhanden

Einschränkungen durch die fehlende Dreidimensionalität waren

o nicht vorhanden o eher nicht vorhanden o eher vorhandeno vorhanden

Die Videos auf dem Bildschirm waren klar und gut erkennbar.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Bilder waren häufig verwackelt.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Bilder waren häufig unscharf.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Farben waren realitätsgetreu.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Kameraführung war angemessen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die einzelnen Bildsequenzen waren zu kurz und wechselten zu schnell.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Orientierung im Raum war gut möglich.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Ich konnte mich schnell in der Situation im Bild zurechtfinden.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Ich konnte alle Details sehen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Der Bildausschnitt war ausreichend groß.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Tonqualität war gut verständlich.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Technik war sehr störanfällig.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Das Standardmonitoring (EKG, SpO2, RR) hätte gereicht.

o ja o nein

Das Standardmonitoring (EKG, SpO2, RR) und ein Gespräch mit den Rettungskräften vor Ort hätten gereicht.

o ja o nein

Ich habe Zusatzfunktionen wie z.B. Rote Liste, Giftnotrufzentrale, Leitlinien, Lehrbücher, Taschenkarten genutzt.

o ja o nein

Ich nutze beim „normalen Einsatz“ Zusatzfunktionen wie z.B. Rote Liste, Giftnotrufzentrale, Leitlinien, Lehrbücher, Taschenkarten.

o ja o nein

Ich sehe Zusatzfunktionen im Internet wie z.B. Rote Liste, Giftnotrufzentrale, Leitlinien als hilfreich an.

o ja o nein

Bei einigen Fällen hätte ich gerne einen Facharzt einer anderen Fachdisziplin konsultiert.

o ja o nein

In einem „normalen Einsatz“ hätte ich einen Facharzt einer anderen Fachdisziplin konsultiert.

o ja o nein

Wäre ich live vor Ort gewesen, hätte ich wahrscheinlich

… genauso gehandelt.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

... noch andere Maßnahmen ergriffen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Gegebenenfalls Anmerkungen, Erläuterungen

… besser helfen können.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… die Anamnese effektiver führen können.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… die körperliche Untersuchung effektiver durchführen können.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

…. schneller die Diagnose gefunden.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… schneller mit der Therapie begonnen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… mich sicherer gefühlt.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… den Patienten mehr als Person wahrgenommen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… eine bessere Beziehung zum Patienten gehabt.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Wäre ich live vor Ort gewesen, wäre ich mir meiner Verantwortung als Arzt mehr bewusst gewesen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Ich konnte als Telenotarzt die Situation positiv beeinflussen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Als Telenotarzt habe ich mich als Hilfe empfunden.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Als Telenotarzt habe ich mich als Störender empfunden.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Als Telenotarzt konnte ich die Situation objektiver betrachten.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Als Telenotarzt erlebe ich die Konsequenzen meiner Entscheidungen nicht mehr so stark.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Ich habe mich als Arzt gefühlt.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Ich habe mich als Puppenspieler gefühlt.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Ich habe den direkten Kontakt zu dem Patienten vermisst.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Szenarien waren relevant.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Szenarien waren realitätsnah.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Ich habe die Situation ernst genommen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Für mich war es die ganze Zeit eine Simulation.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Zusammenfassend bin ich der Meinung, ein Telenotarzt-System…

… ist sinnvoll.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… verbessert die Qualität der Patientenversorgung.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… wird von Notärzten akzeptiert.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… wird von den Patienten akzeptiert.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… wird von Notärzten als Verbesserung angesehen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… wird von den Patienten als Verbesserung angesehen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Ich kann mir vorstellen, in einem Telenotarztsystem zu arbeiten.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Gegebenenfalls Anmerkungen, Erläuterungen

Ich empfinde eine Helmkamera als sinnvoll.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Gegebenenfalls Anmerkungen, Erläuterungen

Herzlichen Dank, dass Sie uns mit Ihrem Mitwirken unterstützt haben.

12.1.7 Posttest-Fragebogen für Rettungsfachpersonal

Posttest-Fragebogen Rettungsfachpersonal

Ich bin der Meinung, der Telenotarzt…

… verbessert die Patientenversorgung.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… führt zu einer relevanten Zeitersparnis.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… führt zu einer schnelleren Diagnosefindung.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… führt zu einem schnelleren Therapiebeginn.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… führt zu einer schnelleren Transportfähigkeit des Patienten.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… führt zu einer Verzögerung am Notfallort.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… stört die etablierte Struktur.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Technik war einfach zu bedienen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Bedienung der Technik war eine zusätzliche Belastung für mich.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Bedienung der Technik war ein großer zeitlicher Aufwand.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Technik war sehr störanfällig.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Kameraführung fiel mir leicht.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Kopfkamera hat mich gestört.

o ja o nein

Die Kopfkamera wog zu viel.

o ja o nein

Meine normale Kopfbeweglichkeit wurde gestört.

o ja o nein

Mein eigenes Blickfeld wurde gestört.

o ja o nein

Ich konnte dem Telenotarzt alles zeigen, was ich wollte.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Ich konnte dem Telenotarzt alles zeigen, was er wollte.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Ich konnte dem Telenotarzt alles Wichtige sagen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Tonqualität war gut verständlich.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Durch die Kamera hat der Telenotarzt noch zusätzliche Informationen erhalten.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Es war einfacher für mich, dem Telenotarzt etwas zu zeigen als es zu erklären.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Durch den Telenotarzt habe ich mich…

… sicherer gefühlt.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

…. rechtlich besser abgesichert gefühlt.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… beobachtet gefühlt.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… kontrolliert gefühlt.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… als Marionette gefühlt.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Der Telenotarzt hat

… mich in meinem normalen Handlungsablauf gestört.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… mich in meinem Handeln bestätigt?

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… meine Kommunikation mit dem Patienten gestört?

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… mein Verhältnis zu dem Patienten gestört?

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… meine Kommunikation mit meinem Partner vor Ort gestört?

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… mein Verhältnis zu meinem Partner vor Ort gestört?

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Ich würde einen Telenotarzt auch in Situationen anrufen, in denen ich einen Notarzt normalerweise nicht nachordere.

o ja o nein

Bei diesem Fall habe ich den Telenotarzt besonders stark gebraucht:

Bei diesem Fall hätte ich gerne einen Telenotarzt konsultiert:

Ich habe den Telenotarzt als Hilfe empfunden.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Ich habe den Telenotarzt als Störenden empfunden.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Szenarien waren relevant.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Die Szenarien waren realitätsnah.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Ich habe die Situation ernst genommen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Für mich war es die ganze Zeit eine Simulation.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Zusammenfassend bin ich der Meinung, ein Telenotarzt-System…

… ist sinnvoll.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… verbessert die Qualität der Patientenversorgung.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… wird von Rettungsfachkräften akzeptiert.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… wird von den Patienten akzeptiert.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… wird von Rettungsfachkräften als Verbesserung angesehen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

… wird von den Patienten als Verbesserung angesehen.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Ich kann mir vorstellen, in einem Telenotarztsystem zu arbeiten.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Gegebenenfalls Anmerkungen, Erläuterungen

Ich empfinde eine Helmkamera als sinnvoll.

o Trifft nicht zu o Trifft eher nicht zu o Trifft eher zu o Trifft zu

Gegebenenfalls Anmerkungen, Erläuterungen

Herzlichen Dank, dass Sie uns mit Ihrem Mitwirken unterstützt haben.

12.2 Original description of the scenarios (Szenarien)

12.2.1 „Akute Lähmung”

Beschreibung: Einsatzmeldung „akute Lähmung“ rechter Arm; 67 jähriger Pat kann am Morgen nach dem Aufwachen rechten Arm nicht mehr bewegen, keine Besserung in letzten 40 Minuten
Vorerkrankungen: keine bekannt, war seit Jahren nicht mehr beim Arzt
Vormedikation: keine
Gewicht: 82kg, Größe: 179cm

Vitalwerte:

A	Atemwege sind offen
B	14 bpm, SpO2: 95%
C	Radialispuls gut tastbar, RR 180/100, HF 72
D	WASB, rechter Arm Kraft 1/5, Sensibilität intakt
E	BZ: 6,5 mmol/l; Temperatur 37,8°C

Anamnese: Fremdanamnese

S	nach dem Aufwachen (8 Uhr) Lähmung des rechten Arms, keine Besserung in letzten 40 Minuten; bei Toilettengang um 6 Uhr morgens noch o.p.B.
A	Pflaster
M	keine
P	keine bekannt, war seit Jahren nicht mehr beim Arzt
L	Frühstück
E	ungestörter Nachtschlaf, Diagnose durch Pat. zunächst „Verlegen während der Nacht“

Untersuchung:

Kopf/Hals	opB
Thorax	Stabil, kein DS, Seitengleiches AG
Abdomen	Weich, opB
Becken	stabil
Extremitäten	Hemiparese rechter Arm

Maßnahmen und Verlauf:

Sicherheit Einsatzort	EO ist sicher
Ersteinschätzung	Zeitkritischer Patient →Lysefenster
A	O2-Gabe
B	keine Maßnahmen
C	i. v.-Zugang
D	CPSC, Lysekriterien
E	keine
Lagerung	OK-30°-Hoch
Monitoring	EKG, RR, SpO2
Volumen	Zugang freihalten
Medikamente	Antipyretikum
sonstiges	BZ messen, Temperatur messen

12.2.2 „Sensibilitätsstörung“

Beschreibung: Einsatzmeldung „Sensibilitätsstörung linker Arm “, 30jährige Patientin spürt beim Eincremen nach dem Baden ihren linken Arm nicht mehr
Vorerkrankungen: keine
Vormedikation: „Pille“
Gewicht: 88kg, Größe: 163cm

Vitalwerte:

A	Atemwege sind offen
B	17 bpm, SpO2:100%
C	Radialispuls ist kräftig tastbar, RR 150/90, HF 95
D	**W**ASB
E	Pat. sehr besorgt/verängstigt; BZ: 5,1 mmol/l; Temperatur: 36,8°C

Anamnese: Fremdanamnese

S	Beim Eincremen spürt Pat. linken Arm nicht mehr so stark, linkes Gesicht fühlt sich komisch an
A	Birkenpollen
M	Pille
P	Adipositas, Raucherin (1Pk/d), Z.n. Thrombose rechter Unterschenkel 2009
L	Frühstück
E	heißes Wannenbad, danach Sensibilitätsstörung bemerkt

Untersuchung:

Kopf/Hals	Sensibilitätsstörung li Gesicht, keine Fazialisparese, NAP indolent
Thorax	Stabil, kein DS, Seitengleiches AG
Abdomen	Weich, opB
Becken	stabil
Extremitäten	Sensibilitätsstörung li Arm; Kraft 5/5 allseits

Maßnahmen und Verlauf:

Sicherheit Einsatzort	EO ist sicher
Ersteinschätzung	Zeitkritischer Patient →Lysefenster
A	O2-Gabe
B	keine Maßnahmen
C	i. v.-Zugang
D	CPSC, Lysekriterien
E	Pat. beruhigen
Lagerung	OK-30°-Hoch
Monitoring	EKG, RR, SpO2
Volumen	Zugang freihalten
Medikamente	keine
sonstiges	BZ messen, Temperatur messen

12.2.3 „Akutes Koronarsyndrom“

Beschreibung: Einsatzmeldung „Akutes Koronarsyndrom“; 72 jährige Patientin klagt über Druck auf dem Thorax, Luftnot. Beschwerden traten nach Belastung beim Treppenputzen im Hausflur auf. Patientin ansprechbar, kurzatmig, bleich.
Vorerkrankungen: Adipositas per magna, art. Hypertonus, IDDM, Nikotinabusus, Hyperlipidämie
Vormedikation: Insulin, Metoprolol, Ramipril, Lojuxta
Gewicht: 65kg; Größe: 162cm

Vitalwerte:

A	Atemwege sind offen
B	24 flach, SpO2 95%
C	Radialispuls ist tastbar, sehr kräftig RR 190/85, HF 93 bpm
D	WASB
E	keine Besonderheiten, BZ 6,5 mmol/l

Anamnese:

S	Druck auf der Brust und Luftnot (7/10 NRS)
A	Penicillin
M	Insulin, Metoprolol, Ramipril, Lojuxta (neues, seltenes Medikament)
P	IDDM, art. Hypertonus, Nikotinabusus, Adipositas per magna, Hyperlipidämie
L	Mittag
E	nach kurzer Belastung beim Treppenputzen jetzt o. g. Beschwerden

Untersuchung:

Kopf/Hals	opB
Thorax	Seitengleiches AG, HF rhythmisch
Abdomen	adipöse Bauchdecken, sonst opB
Becken	stabil
Extremitäten	blass und kühl

Maßnahmen und Verlauf:

Sicherheit Einsatzort	EO ist sicher
Ersteinschätzung	akut vital bedroht
A	Sauerstoffgabe, wenn SpO2 < 95% oder Atemnot
B	keine Maßnahmen
C	i. V. Zugang, RR senken (Nitrospray)
D	keine Maßnahmen
E	Pat. beruhigen
Lagerung	OK-30°-Hochlagerung
Monitoring	EKG, 12-Kanal, RR, SpO2
Volumen	freihalten Zugang
Medikamente	ASS, Prasugrel/ Ticagrelor/ Clopidogrel, Heparin, Nitro, Morphin
sonstiges	

12.2.4 „Oberbauchbeschwerden“

Beschreibung: Einsatzmeldung „Oberbauchbeschwerden“, 54 jähriger Patient hat nach Spiel der deutschen Fußballnationalmannschaft im TV plötzlich starke Übelkeit, Schmerzen im Oberbauch und im Verlauf Schmerzen links thorakal. Er ist kurzatmig, blass und kaltschweißig
Vorerkrankungen: Hypertonus, Hyperlipidämie, Nikotinabusus
Gewicht: 90kg, Größe: 175m

Vitalwerte:	
A	Atemwege sind offen
B	18 angestrengt, SpO2 94%
C	Radialispuls ist tastbar, HF 80 bpm, RR 140/95
D	WASB
E	keine Besonderheiten, BZ 9 mmol/l

Anamnese:	
S	Übelkeit, Schmerzen im Oberbauch (8/10 NRS), im Verlauf Schmerzen linker Thorax, Luftnot
A	Nüsse, Hausstaub
M	Enalapril, Simvastatin
P	Hypertonus, Hyperlipidämie, Nikotinabusus
L	Abendessen
E	plötzlich starke Übelkeit und Schmerzen im Oberbauch

Untersuchung:	
Kopf/Hals	opB
Thorax	Seitengleiches AG, HT rein
Abdomen	Bauchdecke weich, kein Druckschmerz, Peristaltik in allen Quadranten
Becken	stabil
Extremitäten	Blass und kühl

Maßnahmen und Verlauf:	
Sicherheit Einsatzort	EO ist sicher
Ersteinschätzung	Vital bedrohter Patient
A	O2-Gabe wenn SpO2 <95%
B	keine Maßnahmen
C	i. V.-Zugang
D	keine Maßnahmen
E	Wärmeerhalt, zügiger Transport
Lagerung	OK-30°-Hochlagerung
Monitoring	EKG,12-Kanal, SpO2, RR
Volumen	freihalten i. V.
Medikamente	Nitrat, ASS, Prasugrel/ Ticagrelor/ Clopidogrel, Heparin, Morphin
sonstiges	

12.2.5 „Verkehrsunfall“

Beschreibung: Einsatzmeldung „VKU“, 21 jähriger Patient gegen Baum gefahren; Patient mit Thorax gegen Lenkrad geprallt; Patient bereits von Passanten aus Auto gerettet, jetzt schwere Luftnot

Vormedikation: keine *Vorerkrankungen: keine*
Gewicht: 81kg, Größe: 185 cm

Vitalwerte:

A	Atemwege sind offen
B	28 bpm, SpO_2 85%
C	Carotispuls ist schnell und flach tastbar, 152 bpm, RR 70/52, kein Radialispuls
D	W**A**SB
E	opB, BZ 5,2 mmol/l

Anamnese: Fremdanamnese

S	starke Schmerzen im Brustbereich, stärker werdende Luftnot, Sprechdyspnoe
A	keine bekannt
M	keine
P	keine
L	Abendbrot
E	Verkehrsunfall

Untersuchung:

Kopf/Hals	Halsveneneinflussstauung, Zyanose, Pupillen opB; Trachealverzeihung nach links
Thorax	fehlendes Atemgeräusch rechts; hypersonorer KS rechts, keine Atemexkursionen rechts, keine offenen Wunden, leichte Instabilitäten re Rippen 6-8, Hautemphysem
Abdomen	Weich, opB
Becken	stabil
Extremitäten	Schürfwunden, sonst opB

Maßnahmen und Verlauf:

Sicherheit Einsatzort	EO ist sicher
Ersteinschätzung	Patient ist vital gefährdet
A	O2-Gabe hochdosiert + assistierte Beatmung, ggf. Intubation
B	Entlastung mit/ohne Thoraxdrainage
C	i. V.-Zugang
D	KM
E	Wärmeerhalt
Lagerung	Oberkörperhochlagerung, Stifneck
Monitoring	EKG, RR, SpO2; ggf. CO2
Volumen	Vollelektrolytlösung
Medikamente	Fentanyl/ Morphin, ggf. Narkose
sonstiges	Alarmierung Schockraum

12.2.6 „Fahrradunfall“

Beschreibung: Einsatzmeldung „Fahrradunfall“ 22jähriger Patient hat bei Fahrradunfall mit ca. 20 km/h den Fahrradlenker in den Bauch bekommen, bei Eintreffen liegt der Patient auf dem Rücken und gibt starke Schmerzen im rechten Oberbauch an. Der Patient ist ansprechbar, blass und kaltschweißig
Vorerkrankungen: Hämophilie A *Vormedikation: keine*
Gewicht: 77kg; Größe: 185cm

Vitalwerte:

A	Atemwege sind offen
B	36 bpm, flach und schnell, SpO2 95%
C	Radialispuls ist tastbar, schnell und flach, Recap> 3 Sek., RR 79/48, HF 167 bpm
D	**W**ASB
E	keine Besonderheiten, BZ 4,5 mmol/l

Anamnese:

S	starke Schmerzen im Oberbauch (10/10 NRS)
A	keine bekannt
M	keine
P	Hämophilie A
L	Frühstück
E	Sturz mit dem Fahrrad

Untersuchung:

Kopf/Hals	Kleine Platzwunde re. Schläfe
Thorax	Stabil, kein DS, Seitengleiches AG
Abdomen	Gespannt, DS rechter OB, spärliche Darmgeräusche, keine offene Verletzung
Becken	stabil
Extremitäten	Abschürfungen

Maßnahmen und Verlauf:

Sicherheit Einsatzort	EO ist sicher, Polizei sperrt Straße
Ersteinschätzung	Vitale Bedrohung ist gegeben
A	O2-Gabe + assistierte Beatmung
B	KM
C	großlumiger i. V.-Zugang, Zieldruck 80-90 mm Hg
D	KM
E	Wärmeerhalt
Lagerung	Schocklagerung mit Knierolle
Monitoring	EKG, RR, SpO2
Volumen	Nach Zieldruck
Medikamente	Morphin, Fentanyl
sonstiges	

12.2.7 „Akutes Abdomen mit Bewusstseinsminderung“

Beschreibung: Einsatzmeldung „Akutes Abdomen mit Bewusstseinsminderung“, 21 jährige Pat. mit akuten Oberbauchschmerzen, Gelbsucht und zunehmender Eintrübung
Vorerkrankungen: Migräne
Vormedikation: Paracetamol b. Bed.
Größe: 160 cm, Gewicht: 50kg

Vitalwerte:

A	Atemwege sind offen
B	10 bpm, SpO2 97%
C	Radialispuls gut tastbar, RR 100/60, HF 63
D	W**A**SB, verlangsamt, voll orientiert
E	opB, BZ 4,0 mmol/l

Anamnese: Fremdanamnese

S	Oberbauchbeschwerden mit Übelkeit und Erbrechen seit dem Morgen
A	keine
M	Paracetamol b. Bed.
P	Migräne
L	Frühstück, danach heftiges Erbrechen
E	vor 3 Tagen stärkste Migräne mit nur leichtem Ansprechen auf Paracetamol (vlt. 10 Tabletten?)

Untersuchung:

Kopf/Hals	gelbe Skleren
Thorax	Stabil, kein DS, Seitengleiches AG
Abdomen	Abwehrspannung im rechten OB, Peristaltik normal, McBurney&Lanz neg.
Becken	stabil
Extremitäten	opB

Maßnahmen und Verlauf:

Sicherheit Einsatzort	EO ist sicher
Ersteinschätzung	Zeitkritischer Patient → Antidot-Gabe bei drohendem Leberversagen
A	keine Maßnahmen
B	keine Maßnahmen
C	i. v.-Zugang
D	keine Maßnahmen
E	keine
Lagerung	liegend
Monitoring	EKG, RR, SpO2
Volumen	Zugang freihalten
Medikamente	Acetylcystein 150mg/kg i.v.
sonstiges	Giftnotrufzentrale 0361 730 730

12.2.8 „Schlangenbiss“

Beschreibung: Einsatzmeldung „Schlangenbiss“, 53jährige Touristin beim Wandern von Kreuzotter in rechten Unterschenkel gebissen, jetzt Schmerzen und Rötung der Einstichstelle, Übelkeit, Schweißausbruch
Vorerkrankungen: art. HT
Vormedikation: Ramipril
Gewicht: 86kg, Gewicht: 167cm

Vitalwerte:

A	Atemwege sind offen
B	16 bpm, SpO2 98%
C	Radialispuls gut tastbar, RR 150/90, HF 110
D	**W**ASB, voll orientiert
E	kalt-schweißige Haut, BZ 5,2 mmol/l

Anamnese: **Fremdanamnese**

S	Vor 20 Minuten Biss durch Kreuzotter, Übelkeit, Schweißausbruch
A	Nickel
M	Ramipril
P	Hypertonus
L	Mittag
E	während Waldspaziergang Schlangenbiss rechter Unterschenkel

Untersuchung:

Kopf/Hals	o.p.B
Thorax	Stabil, kein DS, Seitengleiches AG
Abdomen	weich, o.p.B..
Becken	stabil
Extremitäten	re US: Bissstelle gerötet und geschwollen

Maßnahmen und Verlauf:

Sicherheit Einsatzort	EO ist sicher
Ersteinschätzung	stabiler Patient
A	keine Maßnahmen
B	keine Maßnahmen
C	ggf. i. v.-Zugang
D	keine Maßnahmen
E	keine
Lagerung	Ruhigstellung, Hochlagern rechter Unterschenkel
Monitoring	EKG, RR, SpO2
Volumen	Zugang freihalten
Medikamente	keine
sonstiges	Ruhigstellung, Desinfizieren, Kühlen, Hochlagern rechter Unterschenkel (wichtiger als schneller Transport!); keine Manipulation ggf. Rücksprache Giftnotrufzentrale 0361 730 730 (Antiserum)

12.2.9 „Bewusstlosigkeit in der Schwangerschaft“

Beschreibung: Einsatzmeldung „Bewusstlosigkeit in der Schwangerschaft“, 23 jährige Patientin, Erstgebärende in 35 + 6 SSW; Alarmierung durch Ehemann bei plötzlicher Bewusstlosigkeit, beim Eintreffen des Rettungsdienstes Pat. wieder wach, ansprechbar; Ehemann öffnet Wohnungstür
Vorerkrankungen: keine Vormedikation: keine
Gewicht: 70kg; Größe: 166cm

Vitalwerte:

A	Atemwege sind offen,
B	13bpm, SpO2: 98%
C	Pulse gut palpabel HF 62 bpm, RR 100/70
D	**W**ASB
E	keine Besonderheiten, BZ 7,5 mmol/l

Anamnese:

S	beim Hinlegen aufs Sofa nach dem Mittagessen: Schwindel, „Herzpochen“, Kaltschweißigkeit, Schwächegefühl, dann Bewusstlosigkeit
A	keine
M	keine
P	Schwangerschaft 35+6 SSW
L	Mittag
E	Ehemann hat Pat. in stabile Seitenlage gedreht → Pat. ist wieder wach

Untersuchung:

Kopf/Hals	opB
Thorax	opB
Abdomen	Schwanger
Becken	stabil
Extremitäten	opB

Maßnahmen und Verlauf:

Sicherheit Einsatzort	EO ist sicher
Ersteinschätzung	keine vitale Gefährdung
A	O2-Gabe
B	KM
C	i. V.-Zugang
D	KM
E	KM
Lagerung	Linksseitenlage
Monitoring	EKG, RR, SpO2
Volumen	freihalten
Medikamente	keine
sonstiges	Transport in die Klinik und Untersuchung des Feten

12.2.10 „Oberbauchbeschwerden in der Schwangerschaft“

Beschreibung: Einsatzmeldung „Oberbauchbeschwerden in der Schwangerschaft“, 35 jährige Patientin, Erstgebärende im 37 + 4 SSW; Alarmierung bei Oberbauchbeschwerden, Übelkeit, Erbrechen, Kopfschmerzen, Augenflimmern
Vorerkrankungen: Schwangerschaftsdiabetes; Vormedikation: keine
Gewicht: 87kg, Größe: 170cm

Vitalwerte:

A	Atemwege sind offen,
B	17bpm, SpO2: 98%
C	Pulse gut palpabel HF 90 bpm, RR 190/110
D	**W**ASB
E	keine Besonderheiten; BZ 8,1 mmol/l

Anamnese:

S	Oberbauchbeschwerden, Übelkeit, Erbrechen, Kopfschmerzen, Augenflimmern
A	Nüsse
M	keine
P	Schwangerschaft 37+4 SSW
L	Frühstück
E	Schwangerschaftsdiabetes

Untersuchung:

Kopf/Hals	Ödeme im Gesicht
Thorax	opB
Abdomen	Schwanger, Oberbauch druckschmerzhaft
Becken	stabil
Extremitäten	Knöchelödeme bds.

Maßnahmen und Verlauf:

Sicherheit Einsatzort	EO ist sicher
Ersteinschätzung	drohende Eklampsie → drohende vitale Gefährdung
A	O2-Gabe
B	KM
C	i. V.-Zugang
D	KM
E	Beruhigen, Abdunkeln, Reize abschirmen
Lagerung	OK-Hochlagerung oder Linksseitenlage
Monitoring	EKG, RR, SpO2
Volumen	freihalten
Medikamente	Magnesiumsulfat 1g langsam i.v., ggf. Sedierung
sonstiges	Intubationsbereitschaft

12.2.11 „Luftnot“

Beschreibung: Einsatzmeldung „Luftnot“, 24 jährige Patientin mit bekanntem Asthma bronchiale.
Patientin mit Orthopnoe, Sprechdyspnoe, Tachypnoe, starkes Giemen und Brummen zu hören,
hat eigenes Spray (Berotec) bereits mehrfach ohne Erfolg eingesetzt
Vormedikation: Pille, Berotec
Vorerkrankungen: Asthma bronchiale
Gewicht: 67kg, Größe: 170cm

Vitalwerte:

A	Atemwege sind frei
B	28 bpm, SpO_2 92%
C	Radialispuls ist kräftig tastbar, RR 147/85, HF 138 bpm
D	**W**ASB
E	opB, BZ 5,6 mmol/l

Anamnese: Fremdanamnese

S	plötzlich zunehmende Atemnot ist bekannt
A	ASS
M	Pille, Berotec
P	Asthma Bronchiale
L	Mittag
E	Zunehmende Luftnot

Untersuchung:

Kopf/Hals	opB
Thorax	Stabil, kein DS, Seitengleiches AG mit Giemen
Abdomen	Weich, opB
Becken	stabil
Extremitäten	unauffällig

Maßnahmen und Verlauf:

Sicherheit Einsatzort	Einsatzort ist sicher
Ersteinschätzung	vitale Bedrohung des Patienten
A	O2-Gabe mit Vernebelung
B	KM
C	i. V. Zugang , freihalten
D	KM
E	Wärmeerhalt
Lagerung	30°OK-Hoch
Monitoring	EKG, RR, SpO2
Volumen	freihalten
Medikamente	Salbutamol-Vernebelung, Prednisolon, Bronchospasmin
sonstiges	

12.2.12 „Schmerzen im Bein“

Beschreibung: Einsatzmeldung „Schmerzen im Bein“, 76 jähriger Patient mit plötzlich auftretenden stärksten Schmerzen im rechten Bein, das Bein ist blass bis marmoriert und kalt, der Patient gibt dort stärkste Schmerzen an.
Vorerkrankungen Diabetes, Nikotin, Hypertonus, KHK, Niereninsuffizienz, pAVK, Leberzirrhose bei C2
Vormedikation: ASS, Metoprolol, Ramipril, Insulin, Furosemid
Gewicht: 62kg, Größe: 170cm

Vitalwerte:

A	Atemwege sind offen
B	26 bpm , $SpO_2$98%
C	Radialispuls ist kräftig tastbar, 126 bpm, RR 158/95
D	**W**ASB
E	opB BZ 6,2 mmol/l

Anamnese: Fremdanamnese

S	plötzlich auftretender stärkster Schmerz im rechten Bein
A	keine bekannt
M	ASS, Metoprolol, Ramipril, Insulin, Furosemid
P	Diabetes, Nikotin, Hypertonus, KHK, Niereninsuffizienz, Leberzirrhose bei C2
L	Abendessen
E	plötzlich stärkste Schmerzen im rechten Bein

Untersuchung:

Kopf/Hals	opB
Thorax	Stabil, kein DS, Seitengleiches AG
Abdomen	Weich, opB
Becken	stabil
Extremitäten	Rechtes Bein kalt, marmoriert, keine Pulse, Schwellung, Schmerz

Maßnahmen und Verlauf:

Sicherheit Einsatzort	EO ist sicher
Ersteinschätzung	Patient nicht akut vital gefährdet, aber zügige Therapie
A	O2-Gabe
B	KM
C	i. V. Zugang
D	KM
E	Wärmeerhalt
Lagerung	OK-30°-Hochlagerung, Bein einwickeln
Monitoring	EKG, RR, SpO2
Volumen	freihalten
Medikamente	Morphin/Fentanyl, Heparin
sonstiges	zügiger Transport in Gefäßchirurgie

12.3 Original checklists of the scenarios (Checklisten)

12.3.1 „Schlaganfall“

Checkliste Schlaganfall

A1 (motorische Lähmung)	A2 (Sensibilitätsstörung)
Datum	
Gruppe	
Telenotarzt	

Diagnostik

	Ja	Ja, mit	Nein
SpO2, EKG, RR			
BZ			
Temperatur			
Medikamenten-Anamnese			
Dokumentation Beginn der Symptomatik			
Neurologische Untersuchung			
Face-Arm-speech-test			
Sehstörungen			
Sensibilitätsstörungen			
richtige Diagnose			

Therapie

	Ja	Ja, mit	Nein
iv-Zugang			
Antipyretika, ab Temperatur 37,5			
O2-Gabe			
Oberkörper 30 Grad-Hochlagerung			

Krankenhaus informiert

	Ja	Ja, mit	Nein
Zielkrankenhaus informiert?			
Transport in Stroke Unit			

Zeiten

Diagnosefindung	
Therapiebeginn (richtige Therapie)	
Transportbereitschaft	

Kontraindikationen

	Ja	Ja, mit	Nein
ASS, Heparin, im-Gabe, Steroide			
Blutdrucksenkung			
Traumatisierung der betroffenen Seite			

12.3.2 „Herzinfarkt“

Checkliste Herzinfarkt

B1 STEMI	B2 NSTEMI
Datum	
Gruppe	
Telenotarzt	

Diagnostik

	Ja	Ja, mit	Nein
SpO2, EKG, RR			
BZ			
12-Kanal-EKG			
Medikamenten-Anamnese			
richtige Diagnose			

Therapie

	Ja	Ja, mit	Nein
iv-Zugang			
Morphin			
ASS			
Prasugrel (Efient) / Ticagrelor (Brilique)			
Heparin			
Nitrate			
O2-Gabe			
Oberkörper 30 Grad-Hochlagerung			

Krankenhaus informiert

	Ja	Ja, mit	Nein
Zielkrankenhaus informiert?			
Transport in Herzkatheterlabor			

Zeiten

Diagnosefindung	
Therapiebeginn (richtige Therapie)	
Transportbereitschaft	

Sonstiges

	Ja	Ja, mit	Nein
Rote Liste… Orphan drug			

12.3.3 „Spannungspneumothorax“

Checkliste Spannungspneu

Datum	
Gruppe	
Telenotarzt	

Diagnostik

	Ja	Ja, mit	Nein
SpO2, EKG, RR			
BZ			
Unfallhergang			
Vorerkrankung			
Body Check			
Auskultation			
Perkussion			
richtige Diagnose			
B-Problem			

Therapie

	Ja	Ja, mit	Nein
iv-Zugang			
Volumengabe			
Schmerztherapie			
Entlastung			
Thoraxdrainage			
O2-Gabe			
Beatmung			
Schocklagerung			
Stifneck			
Wärmeerhalt			

Krankenhaus informiert

	Ja	Ja, mit	Nein
Zielkrankenhaus informiert?			
Schockraum informiert?			

Zeiten

Diagnosefindung	
Therapiebeginn (richtige Therapie)	
Transportbereitschaft	

12.3.4 „Abdominaltrauma“

Checkliste Abdominaltrauma

Datum	
Gruppe	
Telenotarzt	

Diagnostik

	Ja	Ja, mit	Nein
SpO2, EKG, RR			
BZ			
Unfallhergang			
Vorerkrankung			
Body Check			
Untersuchung des Abdomens			
richtige Diagnose			
C-Problem			

Therapie

	Ja	Ja, mit	Nein
iv-Zugang			
Volumengabe			
Schmerztherapie			
O2-Gabe			
Beatmung:			
Schocklagerung			
Knierolle			
Wärmeerhalt			

Krankenhaus informiert

	Ja	Ja, mit	Nein
Zielkrankenhaus informiert?			
Schockraum informiert?			

Zeiten

Diagnosefindung	
Therapiebeginn (richtige Therapie)	
Transportbereitschaft	

12.3.5 „Paracetamol-Intoikation“

Checkliste Paracetamol-Intoxikation

Datum	
Gruppe	
Telenotarzt	

Diagnostik

	Ja	Ja, mit	Nein
SpO2, EKG, RR			
BZ			
Medikamenten-Anamnese			
Untersuchung des Abdomens			
richtige Diagnose			

Therapie

	Ja	Ja, mit	Nein
iv-Zugang			
Acetylcystein			

Krankenhaus informiert

	Ja	Ja, mit	Nein
Zielkrankenhaus informiert?			

Zeiten

Diagnosefindung	
Therapiebeginn (richtige Therapie)	
Transportbereitschaft	

Sonstiges

	Ja	Ja, mit	Nein
Giftnotrufzentrale			

12.3.6 „Kreuzotter-Biss“

Checkliste Kreuzotter-Biss

Datum	
Gruppe	
Telenotarzt	

Diagnostik

	Ja	Ja, mit	Nein
SpO2, EKG, RR			
BZ			
Anamnese			
Untersuchung des rechten Unterschenkels			
richtige Diagnose			

Therapie

	Ja	Ja, mit	Nein
iv-Zugang			
Desinfizieren			
Kühlen			
Immobilisation			
Hochlagern			

Krankenhaus informiert

	Ja	Ja, mit	Nein
Zielkrankenhaus informiert?			

Zeiten

Diagnosefindung	
Therapiebeginn (richtige Therapie)	
Transportbereitschaft	

Sonstiges

	Ja	Ja, mit	Nein
Giftnotrufzentrale			

Kontraindikation

	Ja	Ja, mit	Nein
Manipulation			
Abbinden			

12.3.7 „Vena cava Kompressionssyndrom“

Checkliste Vena cava Kompressionssyndrom

Datum	
Gruppe	
Telenotarzt	

Diagnostik

	Ja	Ja, mit	Nein
SpO2, EKG, RR			
BZ			
Anamnese			
richtige Diagnose			

Therapie

	Ja	Ja, mit	Nein
Linksseitenlage			

Krankenhaus informiert

	Ja	Ja, mit	Nein
Zielkrankenhaus informiert?			
Kreißsaal informiert?			

Zeiten

Diagnosefindung	
Therapiebeginn (richtige Therapie)	
Transportbereitschaft	

Sonstiges

	Ja	Ja, mit	Nein
Mutterpass mitnehmen			

12.3.8 „Präeklampsie“

Checkliste Präeklampsie

Datum	
Gruppe	
Telenotarzt	

Diagnostik

	Ja	Ja, mit	Nein
SpO2, EKG, RR			
BZ			
Anamnese			
Untersuchung Bauch			
richtige Diagnose			

Therapie

	Ja	Ja, mit	Nein
Beruhigen, Reizabschirmung			
Magnesium 1g langsam i.v.			

Krankenhaus informiert

	Ja	Ja, mit	Nein
Zielkrankenhaus informiert?			
Kreißsaal informiert?			

Zeiten

Diagnosefindung	
Therapiebeginn (richtige Therapie)	
Transportbereitschaft	

Sonstiges

	Ja	Ja, mit	Nein
Intubationsbereitschaft			
Linksseitenlage			
Mutterpass mitnehmen			
keine Sondersignale			

12.4 Propositi information (Probandenaufklärung)

LiveCity

Universitätsmedizin GREIFSWALD

Probandenaufklärung

Vielen Dank, dass Sie an dem EU-Projekt LiveCity als Proband teilnehmen.

Dieses Projekt soll die praktische Durchführbarkeit einer videounterstützen Konsultation eines Telenotarztes im Rettungswesen untersuchen. Dabei sollen Vorteile und Nachteile aufgedeckt werden.

Hierzu bitten wir Sie, sowohl die einzelnen Szenarien im Simulations-Labor durchzuarbeiten als auch die Fragebögen zu beantworten. Dabei ist es von großer Wichtigkeit, dass Sie alle Fragen beantworten und sich jeweils für nur eine Antwort entscheiden. Bei einigen Fragen wird dies vielleicht schwer fallen, wir bitten Sie dennoch, die am meisten zutreffende Aussage auszuwählen.

Integraler Bestandteil der Simulation ist die Kommunikation via Video. Zur Auswertung der einzelnen Szenarien, werden diese Video-Sequenzen gespeichert.

Selbstverständlich behandeln wir Ihre Daten, Videos und Aussagen mit größter Sorgfalt und werden diese nur anonymisiert und im Rahmen dieses Projektes benutzen.

Da Ihre Teilnahme freiwillig ist, können Sie jederzeit ohne Angabe näherer Gründe von der Studie zurücktreten, ohne dass dies Ihnen zum Nachteil wird.

Herzlichen Dank, dass Sie uns mit Ihrem Mitwirken unterstützen.

Bibiana und Camilla Metelmann

Assistenzärztinnen in der Klinik für Anästhesiologie und Intensivmedizin Greifswald

12.5 Informed consent (Einverständniserklärung)

LiveCity

Universitätsmedizin GREIFSWALD

Einwilligungserklärung

Hiermit bestätige ich, dass ich einverstanden bin, als Proband an dem LiveCity-Projekt an der Universitätsmedizin Greifswald teilzunehmen.

Ich habe die Probandenaufklärung erhalten, gelesen und verstanden und habe im Moment keine weiteren Fragen.

Ich bin mir meiner Rechte als Proband bei dieser Studie bewusst.

Ich erkläre, dass ich mit der Aufzeichnung und Speicherung von Videosequenzen im Rahmen der Simulation und Erhebung von anonymisierten Daten mittels Fragebogen einverstanden bin.

_____

Name und Vorname des Probanden in Druckbuchstaben

_____ _____

Ort und Datum Unterschrift des Probanden

Erklärung über Einzelanteile bei Gemeinschaftsarbeiten

1 Hypothesis and Background	
1.1. Hypothesis	Camilla Metelmann
1.2. EU-Project LiveCity	Camilla Metelmann
1.3. Emergency Use Case of LiveCity Project	Bibiana Metelmann
1.4. Medical Emergency Sytems 1.4.1 Medical Emergency Systems worldwide 1.4.2 Medical Emergency System in Germany	Bibiana und Camilla Metelmann
1.5. Telemedicine 1.5.1 Concept of Tele-Emergency Doctor 1.5.2 Evaluation of different existing concepts of video-communication in emergency medicine	Camilla und Bibiana Metelmann
2 Aim	Bibiana und Camilla Metelmann
3 Material and Methods	
3.1 Telemedicine core device: the LiveCity camera	Bibiana Metelmann
3.2. Emergency site: the Medical Simulation Centre	Camilla Metelmann
3.3 Emergency patient: the Laerdal mannequin Resusci Anne	Camilla Metelmann

3.4	Emergency cases: ten scenarios 3.4.1 Stroke: with motoric paralysis 3.4.2 Stroke: with anaesthesia 3.4.3 Myocardial infarction: NSTEMI 3.4.4 Myocardial infarction: STEMI 3.4.5 Trauma: tension pneumothorax 3.4.6 Trauma: blunt abdominal trauma 3.4.7 Rare disease: Paracetamol intoxication 3.4.8 Rare disease: snake bite 3.4.9 Complications during pregnancy: aortocaval compression syndrome 3.4.10 Complications during pregnancy: preeclampsia 3.4.11 Training scenario: bronchial asthma 3.4.12 Training scenario: acute limb ischemia	Bibiana und Camilla Metelmann
3.5	Emergency team: emergency doctors and paramedics as propositi	Bibiana Metelmann
3.6	Emergency site procedure: phases and protocol 3.6.1 Communication via off-the-shelf camera (Phase A) 3.6.2 Communication via “ideal” camera (Phase B) 3.6.3 Communication via LiveCity camera (Phase C)	Bibiana und Camilla Metelmann
3.7	Emergency site experience: personal appraisal	Camilla Metelmann
3.8	Emergency site experience: professional performance	Bibiana Metelmann

4 Results 4.1 How valid is the emergency site simulated in this project? 4.1.1 Realistic 4.1.2 Relevant 4.1.3 Take simulation work serious 4.2 How much and what kind of support is needed at the emergency site? 4.2.1 Quantity of need 4.2.2 Quality of need 4.3 How is a tele-emergency doctor perceived in general? 4.3.1 Helpful 4.3.2 Improving the situation 4.3.3 Improving care 4.4 How do propositi feel during communication via LiveCity camera? 4.4.1 Confirming 4.4.2 Secure in general 4.4.3 Legally secure 4.4.4 Feeling controlled 4.4.5 Feeling of puppet-on-a-string 4.4.6 Professional identity 4.4.6 Relationship to patients 4.4.7 Interferer 4.4.8 Disrupting 4.5 What kind of data needs to be transmitted from the emergency site? 4.5.1 Transmission of vital signs 4.5.2 Transmission of vital signs and audio connection 4.6 How are the technical aspects of the LiveCity camera evaluated? 4.6.1 Adding information 4.6.2 Adding burden 4.6.3 Adding weight	Bibiana und Camilla Metelmann

4.6.4 Easy filming 4.6.5 Demonstrate everything 4.6.6 Easy on-screen orientation 4.6.7 No vision restriction 4.6.8 Audio quality 4.6.9 Tell everything 4.6.10 Easy operating 4.6.11 Failure-prone 4.6.12 Deranged communication 4.7 How is the concept of a tele-emergency doctor evaluated? 4.7.1 Additional calling 4.7.2 Faster start of therapy 4.7.3 Useful system 4.7.4 Commitment 4.8 Does the tele-emergency doctor improve the quality of patient care? 4.8.1 Adherence to guidelines for diagnostics 4.8.2 Correctness of diagnosis 4.8.3 Adherence to guidelines for therapy 4.9 Feedback by propositi	
5 Discussion	

5.1 Seriatim discussion of experiences 5.1.1 Is the simulated emergency site providing a valid test condition? 5.1.2 Is there a request for telemedicine at the emergency site? 5.1.3 How is the tele-emergency doctor perceived? 5.1.4 What do we learn about the psychological aspects of tele-mentoring? 5.1.5 What are the requirements for a telemedicine device? 5.1.6 How did the propositi evaluate the LiveCity camera as a device? 5.1.7 Is the concept of a tele-emergency doctor efficient? 5.1.8 Does the tele-emergency doctor improve the quality of patient care?	Bibiana Metelmann
5.2 Discussion of experiences in broader spectrum 5.2.1 What are the advantages? 5.2.2 Where are the problems? 5.2.3 How is the future agenda?	Camilla Metelmann
6 Summary and Conclusions	Bibiana und Camilla Metelmann

…….. ……

Bibiana Metelmann Camilla Metelmann

Die oben genannten Angaben wurden bestätigt:

……

Prof. Dr. K. Meissner

Eidesstattliche Erklärung: Bibiana Metelmann

Hiermit erkläre ich, dass ich die vorliegende Dissertation selbständig verfasst und keine anderen als die angegebenen Hilfsmittel benutzt habe.

Die Dissertation ist bisher keiner anderen Fakultät, keiner anderen wissenschaftlichen Einrichtung vorgelegt worden.

Ich erkläre, dass ich bisher kein Promotionsverfahren erfolglos beendet habe und dass eine Aberkennung eines bereits erworbenen Doktorgrades nicht vorliegt.

Greifswald, den 24. August 2015

……

Bibiana Metelmann

Eidesstattliche Erklärung: Camilla Metelmann

Hiermit erkläre ich, dass ich die vorliegende Dissertation selbständig verfasst und keine anderen als die angegebenen Hilfsmittel benutzt habe.

Die Dissertation ist bisher keiner anderen Fakultät, keiner anderen wissenschaftlichen Einrichtung vorgelegt worden.

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Greifswald, den 24. August 2015

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Camilla Metelmann

Eigene Präsentationen und Publikationen

Präsentationen

1. Metelmann B, Metelmann C. LiveCity - Current state of work in Greifswald subgroup. LiveCity Project Plenary F2F Meeting, January 22-23 2014, Greifswald University, Germany
2. Metelmann B, Metelmann C. Overview and Progress in the scope of Task 2.1. Presentation to the European Commission. LiveCity Project 2nd Review Meeting, May 13 –14 2014, Royal College of Surgeons in Ireland, Dublin, Ireland
3. Metelmann B, Metelmann C. Video demonstration of Task 2.1. Presentation to the European Commission. LiveCity Project 2nd Review Meeting, May 13 –14 2014, Royal College of Surgeons in Ireland, Dublin, Ireland
4. Metelmann B, Metelmann C. LiveCity – The Impact of Video Communication on Emergency Medicine. tGov, Transforming Government Workshop 2014; June 12-13 2014, Brunel University London, United Kingdom (Invited talk; ranked as one of the best five presentations)
5. Metelmann B. The Impact of Telemedicine. 3rd Workshop on Intelligent Innovative Ways for Video-to-Video Communications in Modern Smart Cities (IIVC-2014) within 10th Artificial Intelligence Applications and Innovations (AIAI) Conference, September 19-21 2014, Isle of Rhodes, Greece
6. Metelmann C. Evaluation of the LiveCity Camera. 3rd Workshop on Intelligent Innovative Ways for Video-to-Video Communications in Modern Smart Cities (IIVC-2014) within 10th Artificial Intelligence Applications and Innovations (AIAI) Conference, September 19-21 2014, Isle of Rhodes, Greece
7. Metelmann B. Videoübertragung in Echtzeit zur Verbesserung der Notfallmedizin (Live Video Transmission to Improve Emergency Medicine). Jahreskongress 2014 des Verbandes der Elektrotechnik, Elektronik und Informationstechnik (VDE): “Smart Cities – Intelligent Solutions for Life in the Future”, October 20-21 2014, Frankfurt am Main, Germany
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11. Metelmann C., Metelmann B. LiveCity – Telemedizin am Notfallort. Forum Gesundheit des Alfried Krupp Wissenschaftskolleg Greifswald. January 16-17 2015, Greifswald, Germany
12. Metelmann B. Welche Anforderungen muss eine Videokamera für den Einsatz im Rettungswesen erfüllen?. ConhIT 2015 – Connecting Healthcare IT, April 14-16 2015, Berlin, Germany
13. Metelmann C. Telemedizinische Unterstützung für Rettungskräfte am Notfallort – Erfahrungen aus dem LiveCity Projekt. Telemed 2015, June 23-24 2015, Berlin, Germany

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2. Metelmann B (1st author), Metelmann C (1st author), Meissner K, Wendt M, Goncalves J, Gilligan P, Amadi-Obi A, Morris D, Patouni E, von der Heyden M. The Potential of Telemedicine in Artificial Intelligence Applications and Innovations, Editors: Iliadis L, Maglogiannis I, Papadopoulos H, Sioutas S, Makris C; Springer Berlin Heidelberg; 2014; pp. 30-37
3. Metelmann C (1st author), Metelmann B (1st author), Meissner K, von der Heyden M, Wendt M. LiveCity - The Impact of Video Communication on Emergency Medicine, International Journal of E-Government Research (IJEGR), Volume 10, Issue 3, IGI Global, Hershey; 2014; pp. 47-65

4. Metelmann B, Metelmann C, Morris D, Cordeiro L, Chochliouros I, von der Heyden M, Meissner K, Wendt M. Videoübertragung in Echtzeit zur Verbesserung der Notfallmedizin (Live Video Transmission to Improve Emergency Medicine). Jahreskongress 2014 des Verbandes der Elektrotechnik, Elektronik und Informationstechnik (VDE): Smart Cities – Intelligent Solutions for Life in the Future, Proceedings;VDE Verlag; Frankfurt; 2014; pp. 497-501
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6. Metelmann B, Metelmann C. Telemedizinische Unterstützung für Rettungskräfte am Notfallort - Erfahrungen aus dem LiveCity Projekt (Telemedical Support for Paramedics at the Emergency Site – Experiences gained in the LiveCity Project). Telemed 2015 – Nationales Forum für Gesundheitstelematik und Telemedizin, Proceedings; in press