

Supporting lay bystanders during out-of-hospital cardiac arrest

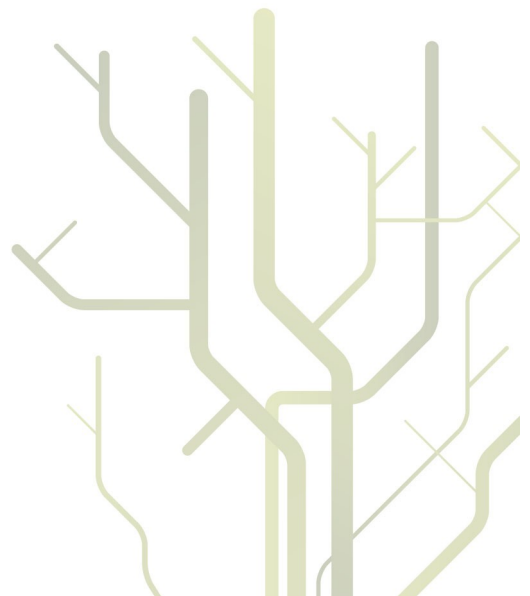
**Comparison of video calls and audio calls for
instructions and supervision**



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Philosophiae Doctor

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Foreword

This project started as an idea in 2005. We had spent some time to develop and study video conferencing between hospital teams for critically traumatized and sick patients. In that system, a rural hospital team interacts with a team of specialists at a university hospital for complex and time critical medical discussions and treatment. We had seen that video conferencing changed the way doctors and nurses interacted in treating the critically ill. Decisions were made with greater confidence, and people worked across hospitals as one team. There were rumors that, during the next few months, video conferencing would be introduced for mobile phone users in Norway. We started to discuss the possibilities. If a large part of the population carried camera mobile phones in their pockets, would not that be a resource that can be used in medical emergencies? What if we moved our focus from large and expensive videoconferencing systems to the small and cheap devices that everyone carried? What if we could move the eyes of doctors and nurses out to the emergency scenes? Could the competence kept behind the doors of health institutions be mobilized and used for prehospital care? Should we not prepare our health care system to find solutions for how to best support people with the tools they will have in the near future? Or is it a bad idea to use mobile phone video conferencing during emergencies? Are there answers to these questions when such services are requested by people using collaboration tools that are not supported by health care? This project was therefore born before we had seen the technology.

Contents

Acknowledgements	v
List of papers	vii
Abbreviations	ix
1 Introduction	1
1.1 The bystanders in prehospital emergencies	2
1.2 Emergency Medical Dispatchers	4
1.3 Caller and dispatcher interactions	6
1.4 Images in prehospital medical emergencies	7
1.5 The “need to know” on video-based dispatch	8
2 Objectives	11
3 Methods	13
3.1 Development of the study model	13
3.1.1 Resuscitation manikin and measurement of CPR quality	14
3.1.2 The intervention: video mobile phone versus audio mobile phone	14
3.1.3 Participants: rescuer groups	17
3.1.4 Participants: selection of rescuers	18
3.1.5 Scenario and scenario description	18
3.1.6 Questionnaires	19
3.1.7 Research assistants	19
3.1.8 The trial’s Emergency Medical Dispatch center	21
3.1.9 Participants: the dispatchers	23
3.1.10 Observations and interviews	23

3.1.11	Video recordings	25
3.1.12	The time and location of the simulations	26
3.1.13	Standard Operational Procedures (SOP) and pre-trial	26
3.1.14	Sample size calculations	26
3.1.15	Randomization	28
3.1.16	Statistical analysis	28
3.2	Risk assessment	29
3.3	Ethical considerations	29
4	Results	31
4.1	The effect of video calls according to dispatchers	31
4.2	The effect of video calls on rescuer confidence	32
4.3	The effect of video calls on resuscitation quality	32
4.4	Information security of video dispatch	34
5	Discussion	37
5.1	Methodological discussion	38
5.1.1	Choice of study design	38
5.1.2	Sample selection and validity	39
5.1.3	The questionnaire	40
5.1.4	Interviews	41
5.1.5	Data reliability of CPR quality measurements	41
5.1.6	Risk assessment	42
5.2	Discussion of the main results	44
5.2.1	Can video calls improve dispatcher assistance?	44
5.2.2	Can video calls improve bystander confidence?	46
5.2.3	Can video calls improve resuscitation quality?	47
5.2.4	The risk of implementing reception of video calls in dispatch centers	52
5.3	The future of video-based dispatch	53
6	Conclusion	55
	References	57
A	Questionnaires	73

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I would like to express my gratitude to everyone who contributed to make this project possible.

List of papers

Paper I

Johnsen E, Bolle SR.

TO SEE OR NOT TO SEE – Better dispatcher-assisted CPR with video-calls? A qualitative study based on simulated trials.

Resuscitation. 2008 Sep;78(3):320-6.

Paper II

Bolle SR, Johnsen E, Gilbert M.

Video calls for dispatcher-assisted cardiopulmonary resuscitation can improve the confidence of lay rescuers - surveys after simulated cardiac arrest.

J Telemed Telecare. 2010 Dec 7. [Epub ahead of print]

Paper III

Bolle SR, Scholl J, Gilbert M.

Can video mobile phones improve CPR quality when used for dispatcher assistance during simulated cardiac arrest?

Acta Anaesthesiol Scand. 2009 Jan;53(1):116-20.

Paper IV

Bolle SR, Hasvold P, Henriksen E.

Supporting lay bystanders during medical emergencies – risk assessment of video calls for emergency dispatch.

Submitted for publication.

Abbreviations

CPR Cardiopulmonary Resuscitation. An attempt to restore spontaneous circulation by performing chest compressions with or without ventilations.¹

DA-CPR Dispatcher Assisted Cardiopulmonary Resuscitation.

EMD Emergency Medical Dispatch.²

EMS personnel Personnel responding to a medical emergency in an official capacity.¹

EMS Emergency medical services. Services specifically designed, staffed, and equipped for the emergency care of patients.³

FMEA Failure Modes and Effects Analysis.

FTA Fault Tree Analysis.

HAZOP Hazard and Operability study.

s seconds

SOP Standard Operation Procedures. Written procedures used to prevent systematic errors in the collection and reporting of data.⁴

SWIFT Structured What-If Technique. A systematic team-oriented technique for hazard identification. Suitable for considering systems where human and organizational factors predominate.

Chapter 1

Introduction

The most sophisticated dispatch center in the world, teamed with the most advanced ambulance personnel, will achieve little if it is not combined with an alert, well-trained and involved citizenry.

Cambridge textbook of accident and emergency medicine⁵

Sudden cardiac arrest, accidents, and traumas are leading causes of suffering, disability, and death worldwide.^{6,7} In Europe, 700,000 individuals die from sudden cardiac arrest each year.⁸ In the USA, the figure is 300,000 annual deaths.⁹ A large portion of cardiac arrests occur out of hospital, of which less than 8% survive to hospital discharge.⁹ An estimated 6 million people worldwide die yearly from injuries, and a much larger number survive injuries with permanent disabling sequelae.⁷ Improved emergency care immediately after trauma, cardiac arrest, and other medical emergencies, are among the most important tasks of emergency medical services (EMS).

The “chain of survival” paradigm, used by the European Resuscitation Council and the American Heart Association, lists necessary community “links” to optimize survival from out-of-hospital cardiac arrest.^{10,11} The four links in this chain have been described as follows: (1) early access, (2) early cardiopulmonary resuscitation (CPR), (3) early defibrillation, and (4) early advanced life support (Figure 1.1).¹²⁻¹⁴ The “chain of survival”



Figure 1.1: The chain of survival for cardiopulmonary resuscitation.¹⁴ In the original version, the first link was named “early access”.¹²

metaphor has also been used for the handling of traumas and other emergencies.¹⁵⁻²² The first two links (Figure 1.1) include public education and involvement, notification of EMS by anyone witnessing the event, initiation of early lay people CPR, and rapid dispatch of trained and properly equipped emergency rescuers to the scene.¹⁰ Early intervention may prevent death, and the involvement of bystanders is crucial for notifying EMS and for the time-saving, initial action on the rescue scene.⁵

Emergency medical dispatch (EMD) centers are an important interface between the public and emergency medical resources. The dispatch center caller and call-taker (dispatcher) interact in a complex environment, in which the interplay of weather, distances, time, organizations, prehospital resources, patients, and bystanders is important for the final outcome.^{23,24} Human factors are important for interactions and communication in this environment, and may be important for strengthening the chain of survival. The emergency, the caller, the dispatcher, and the interactions between them are key areas for this thesis (Figure 1.2).

1.1 The bystanders in prehospital emergencies

Four categories of callers to EMD centers may be defined based on the callers’ involvement in the emergency²⁵:

First-party caller: the patient

Second-party caller: a person directly involved with or in close proximity

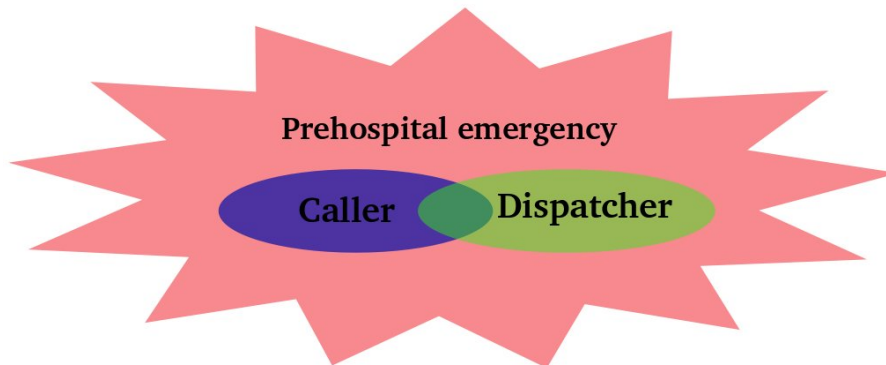


Figure 1.2: A simplified model for key areas in this thesis: the caller in an prehospital emergency, the dispatcher, and the interactions between them.

to the patient – often a friend or relative

Third-party caller: someone not directly involved with, or in close proximity to, the incident

Fourth-party caller: someone from a public service agency (who often communicates with the dispatcher via another agency operator)

In life-critical situations, the patient may not be able to use a telephone. For this thesis, I limit the study and discussions to second-party callers and bystanders, who have important roles as first responders close to the patient in prehospital emergencies.

For cardiac arrest, focus on good quality basic CPR has been suggested as the easiest means for improving survival.²⁶ Several programs have focused on increased citizen involvement and training, because initiation of CPR by emergency personnel may be too late.^{12,27} For both trained and untrained lay people, dispatcher instructions to callers have been effective in improving the quality of CPR and therefore important for increased survival.^{28–32} Although less studied, telephone instructions will likely help callers and patients in other medical emergencies also.

Most dispatch center callers behave calmly, and those who do not can often be instructed by dispatchers in a way that the callers can regain control, and follow commands or procedures given by the dispatcher.^{25,33–35} However, the emotional state of the caller was reported to be the most com-

mon reason for communication problems between the caller and dispatcher, in a study where more than a quarter of emergency ambulance calls had communication problems.³⁶ Lay bystanders are therefore resources who can be used in emergencies, but the quality of their communication with the dispatchers is likely to be important for the outcome.

Bystanders in medical emergencies are humans who unexpectedly find themselves in very distressing situations.³⁵ They are people who try to cope with dramatic situations while fearing that the person near them might die. Perhaps the patient, their friend or relative, is making awkward movements or strange noises.³⁷⁻⁴⁰ The desire to do something is mixed with the fear of doing something wrong.^{41,42} Yet many make heroic efforts to help. It may be dark, the weather might be bad, and the caller may feel hopelessly alone. Callers bring into this situation their previous knowledge and experience. Moreover, they gain from this situation an experience they will carry the rest of their lives. For these people, the telephone line can be a lifeline connected to a dispatcher offering support and help.

1.2 Emergency Medical Dispatchers

The public expects dispatchers to provide sound, safe, and fast instructions for dealing with life-threatening situations and other emergencies.⁴³ In addition to an involved populace, other important elements in the first link of the chain of survival include “an effective telephone system, personnel trained professionally as dispatchers, and an efficient dispatching system that alerts and dispatches response personnel rapidly and accurately.”⁴⁴ More specifically, “an emergency medical dispatcher must have the training, protocols, experience, and poise to interrogate callers quickly and accurately to determine whether a life-threatening emergency has occurred and if so, to send the appropriate public safety resources to the scene promptly.”¹⁰ Their tasks, when callers request medical aid, can be separated into several steps⁴⁵:

1. Initial telephone input
2. Triage
3. Radio dispatch

4. Logistics coordination
5. Resource networking
6. Life-saving by administration of telephone instructions

These tasks are often shared among several persons in the EMD center, or even in different organizations.^{46,47} Dispatchers handle a large variety of emergencies (Table 1.1), which must be differentiated from conditions not in need of emergency care. Written guidelines for the most common emergencies are available to ensure consistent and efficient caller interrogation, diagnostics, and telephone instructions.^{10,31,32,48,49} These guidelines are known in Norway as the “Norwegian index”,⁵⁰ or more generally as national dispatch protocols.

Organization of these services differs among countries. A survey of EMS systems in Europe and the USA revealed a variety of approaches, encompassing the following factors: (1) whether the medical emergency number is co-located with the police and fire departments, (2) the competencies of those who answer the call (paramedics, nurses, physicians, police officers or others), (3) dispatcher training, (4) simultaneous dispatch, and (5) whether dispatchers provide prearrival CPR instructions.⁴⁷ When researchers interpret studies dealing with dispatch, these differences must be kept in mind.

In Norway, there are three public free-of-charge emergency telephone numbers: 110 (fire emergencies), 112 (police emergencies), and 113 (medical emergencies). The Norwegian EMS have two levels of call centers: municipal casualty clinics (“Legevakt-sentraler”) and EMD centers (known as 113, “Medisinsk nødtelefon”, or “AMK-sentraler”).^{50,51} Because all 113 calls and most serious emergency situations are handled by the EMD centers,⁵⁰ the municipal casualty clinics will not be discussed further. The Norwegian EMD centers are staffed by trained and experienced nurses, who closely cooperate with the paramedics in charge of ambulance dispatch.

The EMD centers are technological advanced communication and cooperation centers, which use a number of technologies.⁵¹ Dispatchers collaborate with callers, other dispatchers, professionals in emergency services, and at health institutions.⁴⁶ Thus, the dispatcher may be part of several processes simultaneously for solving the required steps. This working environment may challenge the intellectual capacity of the dispatcher. Interventions to organization, workflow, and procedures should therefore be carefully

Table 1.1: Key words describing medical problems or areas where an emergency response from an emergency medical dispatch center may be needed (according to the Norwegian Index for Emergency Medical Assistance).⁵⁰

Unconscious (lifeless) adult	Skin complaints and rash
Unconscious (lifeless) child	Hypothermia/hyperthermia
Choking/foreign body in throat	Chemicals/gases
Major incidents and disasters	Seizures/convulsions/fitting
Transport reservations	Abdominal pain/back pain
Unclear problem	Possible death/cot death
Allergic reaction	Altered levels of consciousness/paralysis
Bleeding (non-trauma)	Psychiatry/suicide
Burns/electrical injuries	Breathing difficulties
Chest pain/heart disease	Intoxication, poisoning, drug overdose
Diabetes	Sick children
Drowning	Wounds, fractures, minor injuries
Scuba-diving accidents	Road traffic accidents
Animal bites/insect stings	Accidents
Fever	Urinary tract
Poisoning in children	Violence/abuse
Childbirth	Ear, nose, and throat
Gynaecology/pregnancy	Eyes
Headache	

assessed,^{52,53} in order to not impose unacceptable loads on dispatchers' cognitive abilities and negatively influence patient care.

1.3 Caller and dispatcher interactions

The person requesting help in a medical emergency uses some kind of communication technology. The type of technology decides not only the richness of the communication, but also the possibilities for shared understanding and creation of trust.⁵⁴ The early access link can be strengthened by installation of an efficient emergency communication system,¹² but triage and telephone instructions to callers are challenging when the patient and emergency scene cannot be seen by the dispatcher.^{35,55}

Mobile phones, mobile phone text messaging (SMS), social network services,⁵⁶ and SkypeTM (Skype Technologies S.A., Luxembourg) are among technologies that are changing the way people socialize and interact. Lay people in emergencies are able to communicate with friends, social networks,

newspapers, and other media through channels that make the current communication possibilities with emergency services seem limited and old fashioned. With help from the public, television channels and newspapers are able to report images from the scene as history evolves, while dispatchers link with callers only through audio communication.

The caller and dispatcher can be defined as a team, or part of a team.⁵⁷ In studies on hospital teams, improved information exchange and focus on human factors such as leadership and task distribution were associated with better performance.^{58,59} One may assume that the same is true for out-of-hospital emergencies, whether the role of leadership is kept by someone on scene or the dispatcher. Because new communication technologies have become available through mobile phones, important questions are whether these “smart phones” can improve the communication between caller and dispatcher, team effort, and patient outcome.

1.4 Images in prehospital medical emergencies

“Most of the work in the field of telemedicine in trauma and emergency care has been reported between emergency rooms located in the small hospitals or rural medical centers and tertiary or level I trauma centers.”⁶⁰ The use of mobile phone images has been tested for various applications such as for ultrasound,⁶¹ ECG,⁶² radiographs,^{63–67} wounds,^{68,69} injuries,^{64,70} and to decide the level of specialized care.^{64,70} These studies used still images, and communication was between health professionals, but indicated that mobile phone images would be useful for patient care in a clinical setting. The requirement of instant, interactive feedback between caller and dispatcher for communication, triage, and pre-arrival instructions limits the usefulness of still images. Further discussions will therefore be limited to the use of real-time video streams.

Videoconferencing systems have been developed to support group work. More than 20 years ago, several papers reviewed the failures of such systems, as stated in a review by Egido (1998): “In fact, videoconferencing has been commercially available for over two decades, and, despite consistently brilliant market forecasts, to date it has failed to succeed except in limited niche markets.”⁷¹ Two factors contributing to this failure were inadequacy of needs assessment and the questionable portrayal of videoconferencing as a

direct replacement for face-to-face meetings. The same paper reported that visual contact can be crucial for effective communication, and that people would include video communication if it was provided cheaply enough, and became more easily available. With video conferencing available to the public through mobile phones and services like SkypeTM, some of the factors in the disadvantage of video conferencing systems of the past are reduced.

Before the start of this project, one study had reported on simulated video-based dispatch. CPR-instructions for simulated cardiac arrest were given through a video-link, which significantly improved the number of correct ventilations and compressions.⁷² The performance of the group receiving CPR-instructions through the video-link was comparable to another group that received instructions from a direct observer. The video-link and direct-observer groups performed significantly better than those receiving telephone instructions only, and they also did better than a fourth group with previous CPR-training but no instructions during the trial. This small study was limited by its artificial study setup, which used a mock dispatcher not regularly providing dispatcher instructions, and its use of technology not directly comparable to the small handsets used for today's mobile phones.

1.5 The “need to know” on video-based dispatch

In this introductory chapter, we have seen that prehospital emergencies are major contributors to death, and the first links in the chain of survival are important for saving time and lives. Communication, caller-dispatcher interactions, and team effort are important in this setting. Images have been reported as an useful addition to clinical communication, and video conferencing may become a tool for strengthening prehospital communication and team effort. If so, the diagnostic accuracy of dispatchers may increase, and the quality of pre-arrival instructions may improve. Very little has been published on video-based emergency medical dispatch, as video conferencing only recently has become available for regular use by the public. A pilot study indicated that video communication may improve the quality of CPR.⁷² We wanted to test these findings in a larger setting with real dispatchers and real video mobile phones. In addition, the experiences of potential users of video-based dispatch, both callers and dispatchers, should be studied. In order to study video-based dispatch, cardiac arrest was chosen

as our main scenario because early intervention by first responders is important in this setting, and there are standardized, well described procedures to follow.

Chapter 2

Objectives

I will follow that system of regimen which, according to my ability and judgment, I consider for the benefit of my patients, and abstain from whatever is deleterious and mischievous.

Hippocrates

The objectives of this thesis were to test the following hypotheses:

1. Video conferencing with mobile phones rather than audio-only phone calls can improve communication from the viewpoint of dispatchers.
2. Video conferencing with mobile phones rather than audio-only phone calls can improve the support from the viewpoint of rescuers.
3. Video conferencing with mobile phones will improve the quality of dispatcher-assisted CPR compared to audio phones.
4. Video conferencing with mobile phones can be implemented in dispatch centers at acceptable risk levels.

Chapter 3

Methods

During the first few seconds of the call, the caller is, in effect, evaluating the dispatcher, asking the (mental) questions, “Have I reached a helper or a hinderer? A professional or an amateur? Someone who can help me or someone who is just as confused and helpless as I am?”

Jeff Clawson and
Robert Sinclair²⁵

Interventional studies during medical emergencies may risk the lives of patients in life-threatening situations. Simulated scenarios are often used to study different aspects of cardiopulmonary resuscitation. We therefore chose simulated cardiac arrest as a model for the study of video-based dispatch. People commonly experience simulations as artificial situations. To limit this drawback, we tried to improve realism for rescuers by creating an unexpected emergency.

3.1 Development of the study model

A randomized controlled study design was chosen to compare video-based and audio-only dispatcher assistance during a scenario of simulated cardiac arrest. Numerous studies have reported on different aspects of simulated cardiac arrest, many of which deal with different learning programs and

skill retention. We developed a study model where we used simulated cardiac arrest to study differences between two communication technologies used for dispatch. Although our study was similar to many CPR simulation trials, several decisions on study design were made to optimize the study of a realistic use case of video-based dispatch. In the following, the development of the study model is detailed.

3.1.1 Resuscitation manikin and measurement of CPR quality

For simulated cardiac arrest, we used one standard simulation manikin made for instruction in basic CPR skills (Laerdal Resusci[®] Anne manikin, Laerdal, Stavanger, Norway). The manikin was connected to a laptop with the Laerdal PC Skill Reporting System[®]. This software registered a number of parameters such as the volume of every ventilation, and the hand position and depth for every compression. Such data have been validated and recommended for evaluating of CPR performance.^{73,74} However, the manikin and software had no possibilities for calibration of measurements, and the manufacturer states that the accuracy of the measurements is 15%. The parameters automatically registered by this software are listed in Figure 3.1. The software also allowed the replay of every scenario, as exemplified in Figure 3.2. Parameters not automatically recorded, such as the time span between the start of the scenario and the first chest compression, could be found for each scenario with the scenario replay function.

3.1.2 The intervention: video mobile phone versus audio mobile phone

To compare video calls with non-video calls, we used two different mobile telephones in order to optimize the user experience of each modality. The Nokia N90 (Nokia Corporation, Helsinki, Finland) had received good reviews, and was considered one of the best video mobile phones available in the consumer market at the time of our studies. Some video mobile phones have two cameras, one directed towards the person holding the phone for face-to-face communication and a second camera on the back of the phone for filming the surroundings while still viewing the screen of the phone. To change which camera to use, users need to press buttons. The Nokia N90 has only one high-quality camera mounted on a swivel, which allows for easy

Ventilation data

Average minute volume [ml]
Average minute volume volume [ml]
Registered with adequate volume
Registered with insufficient volume
Registered with excessive volume
Registered with too short inspiration time
Average ventilation flow rate [ml/sec]
Average count per minute
Total counted
Registered with no errors
Registered with airway closed

Compression data

Average rate [n/min]
Average count per minute
Average duty cycle [%]
Total counted
Registered with no errors
Average depth [mm]
Registered with adequate depth
Registered with excessive depth
Registered with hand-position too low
Registered with hand-position too high up
Registered with hand-position too far to the right
Registered with hand-position too far to the left
Registered with incorrect hand-position
Registered with incomplete release
Average down-stroke/up-stroke ratio

“Hands Off” time data

Total Hands Off time
Average Hands Off time

Figure 3.1: Performance data recorded by the Laerdal PC Skill Reporting System, and automatically calculated for each scenario. In addition to the figures presented here, all events were recorded on a time axis, for later playback through the Laerdal PC Skill Reporting System[®].

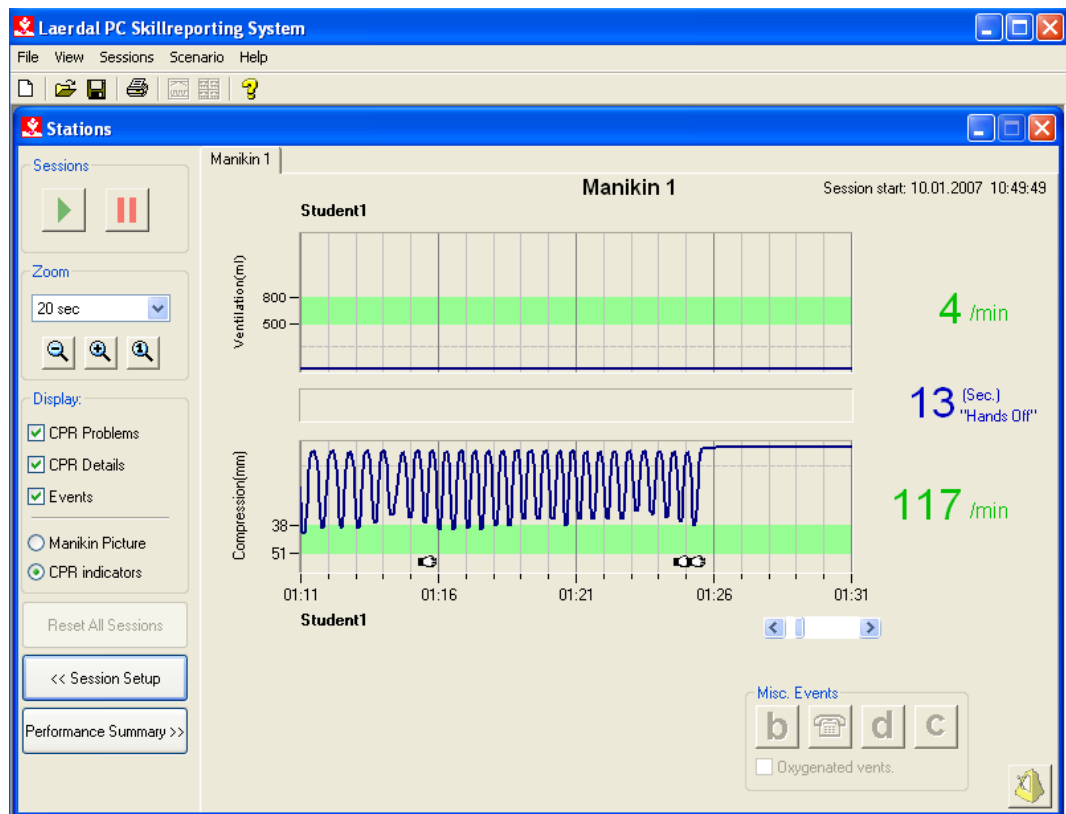


Figure 3.2: Example of the scenario replay-function (Laerdal PC Skill Reporting System). In this 20-seconds time clip, the rescuers performed zero ventilations and 27 chest compressions. The green areas indicate ventilations and chest compressions of sufficient depth. The hand symbol indicates wrong hand position.

positioning of the camera and ease of use by novices. The screen of the N90 was set up so that the caller saw two images: an outgoing image of what was transmitted to the EMD center and the incoming image transmitted from the EMD center. This setup allowed the caller on-screen viewing of both the dispatcher and the view of the phone's camera. The latter made it possible for the caller to adjust the camera position and thus the image seen by the dispatcher.

The drawback of the N90 is that it is rather big, and the camera can be annoying when it is not in use. To give callers during audio-only scenarios the best experience, we used a different phone, a Sony Ericsson K800i (Sony Ericsson Mobile Communications AB, Lund, Sweden), which is actually also a video mobile phone, but it was not set up for use with the video function.

3.1.3 Participants: rescuer groups

Most trials on simulated cardiac arrest include one or two rescuers in each scenario, either for one- or two-person CPR. Studies on dispatcher-assisted CPR (DA-CPR) usually include only one rescuer in each scenario, who is told to put the phone down when doing CPR. We wanted a scenario in which resuscitation attempts could be visually supervised by a dispatcher, so we decided to recruit three rescuers for each scenario for the following reasons:

- The video telephone could either be mounted in a fixed position or hand-held by a person. We chose to use hand-held telephones, which would better allow for dynamic interaction between rescuers and dispatchers regarding the placement and usage of the video phone, and a setup closer to real use.
- We did not want participants to discuss if putting the phone down for two-person CPR would be better than one-person CPR with dispatcher-assisted supervision through the video mobile phone.
- Rescuers supervised and guided through the video mobile phone would be compared to rescuers guided by audio-only telephone calls. If we were to include two rescuers in each type of scenario, rescuers in the audio group could choose to put the phone down for two-person CPR, while rescuers in the video group would possibly choose to do one-person CPR with the other person filming. The differences between

study groups could then be ascribed to differences between one- and two-person CPR.

Groups of three rescuers were therefore chosen, to allow for two-person CPR, while the third person could take care of the dispatcher communication both for video and audio-only communication, a situation typical for a cardiac arrest scenario in a public area.

3.1.4 Participants: selection of rescuers

The typical bystander in cardiac arrest is an elderly lady,^{75,76} but the typical user of the new functionality in mobile phones is a young person. Since we did not want to test the effectiveness of new training programs based on mobile phone technology, we chose to use high school students who would accept using new mobile phone technology without particular training.

To mimic an unexpected situation, and avoid students recapitulating any previous CPR knowledge before inclusion in the study, all scenarios in one school were completed during one day. No person included as a bystander took part in more than one scenario.

3.1.5 Scenario and scenario description

The simulated scenario took place in a classroom. Pre-scenario instructions were given to participants in an adjacent room and included a written description of the emergency (modified after Whitfield⁷⁷):

You are called to help a person who has collapsed. When you enter the room, you will see a training dummy supposed to be an adult about 50 years old. When this experiment starts, you should treat this “person” until we tell you to stop. We will give you a mobile phone that connects you to a nurse at the hospital dispatch center. [For the video group: The telephone has a camera, and the person carrying the phone should film what you do.] You can talk with the nurse if you need help to treat the person. In the room, a person will be filming but will not answer questions. If you have questions, you must use the phone. The scenario will last about 10 minutes. This may seem like a long time, but please continue to treat the person until we tell you to stop.

A scenario length of 10 minutes was chosen since this is the reported median time passing between the first call to the emergency number 113 and the arrival of an ambulance in urban areas in Norway (prehospital response time).^{78,79} During this time, it would also be likely that any problems arising during the initial phase of communication could be solved, and that rescuers would be able to complete several rounds of resuscitation.

3.1.6 Questionnaires

We developed a questionnaire to compare the experience of rescuers guided by video communication with those using audio-only. Questions dealt with age, sex, previous training, and experience, how well rescuers believed they understood the dispatchers' instructions, their confidence during resuscitation, and what type of telephone they believed was best suited for medical emergencies (Figure 3.3). The questionnaire had a few, and short questions to decrease the likelihood of hurried answers and improve the likelihood of complete questionnaires.⁸⁰ Personal identifiable information was deliberately avoided to assure respondents of their total anonymity and that they could feel confident to answer openly.⁸¹ The respondents received identical questions, except for an explanatory note given to the users of audio-only phones (Appendix A). The questionnaires were color coded to minimize the risk of giving questionnaires designed for the audio group to respondents in the video group, and vice versa. Responses were solicited as fixed alternatives and as open-ended answers.

3.1.7 Research assistants

One research assistant was in charge of recruiting rescuers. This person contacted the schools, made arrangements with school officials, and recruited groups of three students during class hours.

A second research assistant received groups of three recruited students in a room adjacent to the classroom in which the scenario was played. Here the students were informed about the scenario by the written scenario description. After the scenario description was read, one of the three students volunteered to use the telephone. For students using video calls, a test call was made to the research leader located at the trial's EMD center, so that students could see how a video call worked. For many students, this was

Student questionnaire

Please check what fits best. Feel free to comment.

1 Your age: 2 Your sex:

3 Have you been trained in resuscitation during the last three years? Yes No

4 Do you have former experience of real medical emergencies? Yes No

5 How easy was it to understand the instructions given during this trial?
Very difficult... A bit difficult... Pretty easy... Very easy...

Comment:

.....

.....

6 Did you feel uncertain about the correctness of your resuscitation?
Uncertain... Pretty certain... Certain... Don't know...

Why?

.....

.....

7 Do you believe telephones enabled with video communication are better or worse suited than standard telephones during medical emergencies?
Worse... Better... Don't know...

Why?

.....

.....

Thank you!

Figure 3.3: English translation of the questionnaire.

their first experience with video calls. The test call lasted about half a minute. The research assistant then dialled the phone number to the mock EMD center, gave the telephone to the student, and the group of rescuers was allowed to enter the scenario room.

In the scenario room, a third research assistant was in charge of data recordings and cleanup procedures between scenarios. Recordings of manikin data and a video camera were started when the students entered the room, and stopped after 10 minutes.

After the scenario was completed, a fourth research assistant handed out questionnaires to the students, collected the questionnaires, and marked them with the date and time.

3.1.8 The trial's Emergency Medical Dispatch center

To avoid disturbances between real emergencies and this trial, we built a mock EMD center in the Tromsø Research Park, Tromsø, Norway, for the use of two types of communication technology – video mobile phones for two-way video communication and regular phone calls.

For video communication, we set up a laptop with a UMTS (3G) card, video camera, video communication software (VT-phone, Dilithium Inc., Petaluma, California), and a standard headset. On the computer screen, the software was configured so that the dispatcher saw two real-time images, both approximately 10 cm x 10 cm in size (Figure 3.4). One image was the incoming image from the video mobile phone. This image displayed either the caller, or the manikin and any resuscitation attempts. The other video image was the image of the dispatcher captured by the video camera on the laptop. This image was sent to the screen of the callers' video mobile phone.

For audio-calls, dispatchers used a telephone with a standard headset.

A paper version of the Norwegian Index for Emergency Medical Assistance (Norsk indeks for medisinsk nødhjelp)⁸² was available for the dispatchers. The protocol was updated with the latest procedures and instruction to callers on cardiopulmonary resuscitation, which used a compression-ventilation ratio of 30:2 rather than the former 15:2 ratio.¹³



Figure 3.4: The computer workspace of the dispatcher. Incoming and outgoing images are visible on-screen.

3.1.9 Participants: the dispatchers

Experienced nurse dispatchers were recruited from the EMD center at the University Hospital of North Norway (Tromsø, Norway). They were recruited by their leaders in the EMD center on days when there was a sufficient number of dispatchers at work, to ensure that the safety of real patients was not compromised. The dispatchers had no previous experience in the use of video calls for dispatch. To avoid the risk that any training done in this trial could explain differences in outcome between study groups, we did not train dispatchers in the use of video conferencing for dispatch. The information the dispatchers received was kept to a bare minimum and only took a couple of minutes: they were shown how to answer and hang up the phone both when using video calls and no-video calls.

The dispatchers were told to expect any kind of emergency. Even if only one scenario was presented for the rescuers, we wanted the rescuers and dispatchers to go through normal procedures for diagnosing the “patient”.

All dispatchers had an equal number of video dispatch and audio dispatch calls. To reduce the likelihood of dispatcher exhaustion, which could have influenced their performance, two dispatchers were recruited for trials each day. The dispatchers took turns, and served every other “emergency” call. The dispatchers finished all scenarios with one communication mode before doing scenarios of the other communication mode in order to better separate their experience with either mode (Figure 3.5).

3.1.10 Observations and interviews

“High quality analysis of qualitative data depends on the skill, vision, and integrity of the researcher; it should not be left to the novice.”⁸³ For this reason, a social scientist with skills and experience in the use of qualitative research methods was recruited for observations in the mock EMD center and dispatcher interviews. To enable this researcher to listen in to all communication, headsets for both video communication and audio communication were duplicated. At the end of each trial day, the social scientist interviewed the dispatchers individually using a semi-structured interview guide (Figure 3.6) with open-ended questions.⁸⁴ The interview guide was effective; the dispatchers gave eager and relevant answers to the questions. Each interview lasted until the topic was saturated, approximately 30 min-

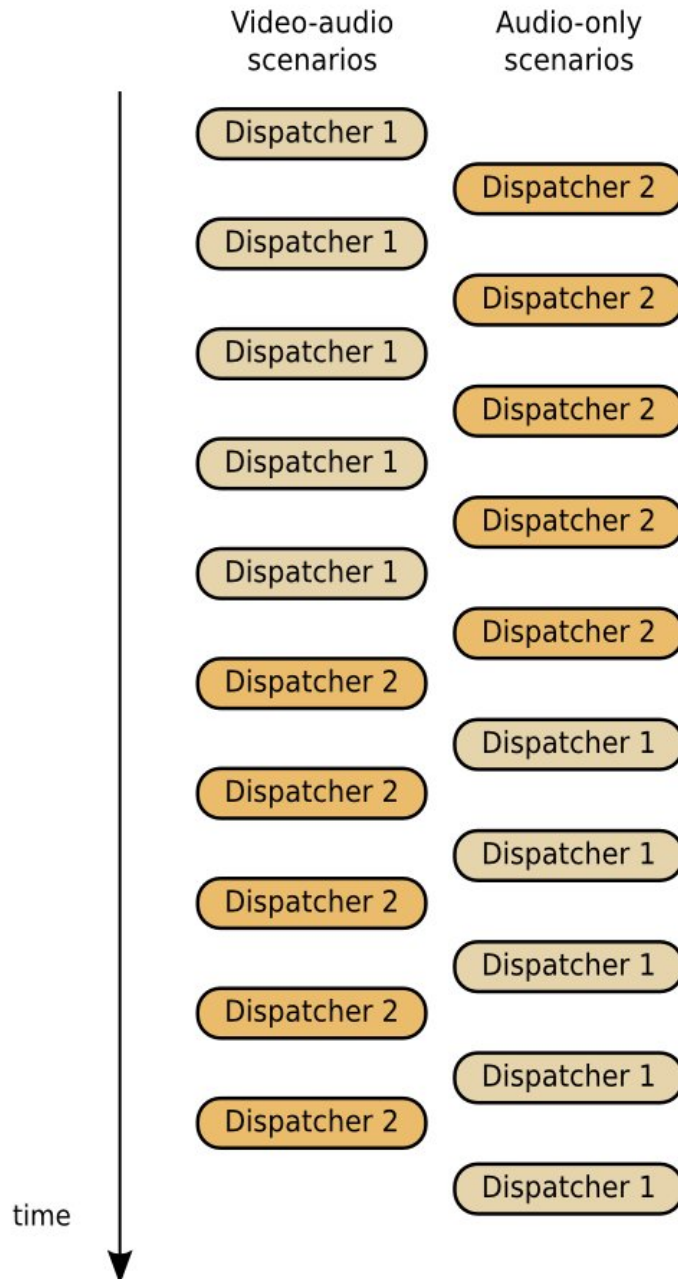


Figure 3.5: The order of 20 scenarios run by two dispatchers on a day when video conferencing was the communication mode in the first scenario. The communication mode of the first scenario and the dispatcher to run the first scenario were chosen by randomization.

Dispatcher experience from their work during the trial

- Was there a difference between the audio and the video sessions?
- Why?

How dispatchers experienced the use of video calls

- How was the picture quality?
 - How was the sound quality?
 - What was the experience of video calls compared with using traditional telephony?
 - Did video calls have any useful aspects that traditional telephony does not have?
 - Did video calls have any disadvantages compared with traditional telephony?
 - Did video calls involve differences that were important to the communication and the information you can obtain and give in CPR?
-

Figure 3.6: Principal questions for dispatcher interviews.

utes.

The interviews were taped and transcribed by administrative staff. The material was coded by the social scientist with regard to the themes in the interview guide. Sections concerning changes in the dispatcher's work related to the use of video communication were labelled. Variations and differences in the dispatchers' assessments were marked.

Analysis was done in a condensing process moving from lay descriptions to social scientific descriptions, concepts, and theories.^{83,85} The selected concepts were a conceptualization of communication, as consisting of information, utterance, and understanding. The focus of the analysis was on whether the dispatchers acted differently because of the video communication.

3.1.11 Video recordings

The scenarios were videotaped. We used two video cameras, one in the scenario room in the school and one in the mock EMD center. The video recordings were transferred to hard disks and viewed to better understand and interpret other data collected during the trials, and how the dispatchers used the input they received from the rescuers. For scenarios in which there were no chest compressions or ventilations, the video recordings were used to find explanations.

3.1.12 The time and location of the simulations

Students were recruited from three different high schools in Tromsø, Norway. Scenarios were played during regular school hours in a classroom of the students' school, in December 2006 and January 2007.

3.1.13 Standard Operational Procedures (SOP) and pre-trial

Before the study was started, operational procedures were written for each member of the research team with details on what to do during the trial. Such procedures are used to prevent systematic errors in collecting and reporting of data.⁴ SOP also serve as reminders of the correct way to perform a procedure. These procedures were used for training research assistants. Each member of the research team had a limited number of tasks. During several meetings, research assistants discussed their tasks, to better understand what to do, and what they could trust others to do. The operational procedures were updated when potential misunderstandings were discovered or to make the workflow more efficient. Each team member was trained for practical procedures. When it was believed that all members understood their instructions, a small pilot study was run to check that the team members was able to coordinate their work and work efficiently together.

3.1.14 Sample size calculations

For sample size calculations, the test statistic (the mean difference between two groups) was defined as the difference in delivered compressions per minute between the intervention group and the control group. We wanted our study to detect a 20% increase, a number we believed would have clinical significance. We used statistical significance of 5% and power of 80%.

Expected mean values and standard deviation for the study parameter were needed for sample size calculations. We used two data sets: numbers from the literature and numbers from our pilot study.

To estimate the expected values (mean and standard deviation) of the study parameter, numbers from studies similar to our own were wanted, which meant simulated trials in lay people cardiopulmonary resuscitation using adult manikins. Compression-only and defibrillator trials were excluded. Preferable were studies reporting findings from resuscitators in the same age group as the high school students, where the new protocol for

Table 3.1: Power calculations for different values for difference (delta), standard deviation (SD), and power. The numbers presented in the text appear in bold.

delta	SD	sign.level	power	n (in each group)
7.8	11	0.05	0.8	25.3
7.8	11	0.025	0.8	32.2
7.8	11	0.05	0.9	34.8
7.4	9.35	0.05	0.8	20.5
10	15	0.05	0.8	28.5
10	20	0.05	0.8	50.2
7	20	0.05	0.8	101.6
5	15	0.05	0.8	112.0

compression-ventilation ratio was used (30:2 preferred to the older 15:2) for two-person resuscitation, but no study fulfilling all criteria was found. One study reported our test statistic in a study on lay person, single-rescuer CPR, with most participants younger than 60 years, and using a compression-ventilation ratio of 15:2.⁸⁶ The reported value for actual compressions delivered per minute was 39, and the standard deviation 11. A 20% increase of 39 equals an increase of 7.8. Assuming the same standard deviation for both the intervention group and the control group, the sample size was calculated using the power-t-test of the R environment.⁸⁷ A sample size of 26 was suggested for each group.

Measurements during our small pilot to test the study setup and to train research assistants gave us the following values for delivered compressions per minute: mean = 37, SD = 9.35, 20% of 37.0 is 7.4. Repeating the power test with these values resulted in a sample size of 21 for each group.

Power calculations were repeated with different values for difference, standard deviation, and power (Table 3.1). With three rescuers in each group and $n = 112$, the total number of rescuers is 673:

$$112 \text{ scenarios/group} \times 2 \text{ groups} \times 3 \text{ rescuers/scenario} = 673 \text{ rescuers}$$

To allow for drop-outs, more participants are required.

One challenge when planning our trial was the scarcity of dispatchers and availability of high school students during the time frame of the study. Ideally, we wanted to have a larger study to improve power. However, it was

difficult to get hold of dispatchers because the EMD center at our hospital (Tromsø, Norway) was short of workers. It was also difficult to recruit a sufficient number of schools to participate. We could have used schools and EMD centers outside Tromsø, but with a considerable increase in cost and complexity. Thus, the wish for high power had to be balanced with expenses. Before conducting a large, expensive study, we had to determine whether or not we were on the right track, or if a different design would be better. Based on these considerations, we decided to keep this study small. We therefore used the calculations indicating $n = 21$ or $n = 26$ as the minimum number of scenarios in each group (bold in Table 3.1), and used $n = 30$ to allow for drop-outs.

Simulating 30 scenarios with both communication modalities meant a total of 60 scenarios, or 180 students. Each scenario would last 10 minutes, and we planned for 20 scenarios each day. As previously argued, we wanted to finish all trials in one school during one day, which meant we had to recruit three schools for the trials. With two dispatchers taking turns each day, a total of six dispatchers were needed.

3.1.15 Randomization

Block randomization was done each trial day by flipping a coin: (1) the communication mode of the first scenario that day and (2) which dispatcher would receive the first call (Figure 3.5).

3.1.16 Statistical analysis

The R language and environment for statistical computing was used for statistical analysis.^{87,88} Manikin data on cardiopulmonary quality were not normally distributed, and the Wilcoxon rank sum test was used for group comparison. For questionnaires, differences between the groups' categorical data were assessed with the Mann-Whitney U-test. The alpha level was set to 0.05.

Manikin data were automatically recorded and stored in a database. Study personnel were blinded to the treatment for outcome assessment and data analysis. The communication mode of each group was revealed only after the statistical analysis was completed by connecting the information on the communication mode to the dataset.

The original questionnaires revealed which communication mode was in use. The data was entered in a database by a person without knowledge of the study. The statistical tests were written using the R-environment and automated, which in effect blinded the study personnel to the outcome until the results were presented by the software.

3.2 Risk assessment

Risk assessment of information security was done for a potential future system allowing video calls into EMD centers for communication with lay bystanders in medical emergencies. We followed the information security standard ISO/IEC 27005.⁸⁹ A multi-professional team, led by a risk assessment expert, evaluated threats to confidentiality, quality, integrity, and availability of information and information exchange. The process of risk assessment consists of risk identification, risk estimation, and risk evaluation. Three iterations of the process were done to reach consensus on threats, their likelihood, and consequence. Risk level, the product of consequence and likelihood for each threat, was calculated. Each threat was evaluated, and possible actions to reduce the risk levels suggested.

3.3 Ethical considerations

The study was accepted by the Privacy Ombudsman at the University Hospital of North Norway. After discussions with the Privacy Ombudsman and conversations with the Regional Ethics Committee (REC), we did not find it necessary to submit a REC application.

The questionnaires and manikin recordings contained no person-identifiable information. The video recordings of the students and dispatchers were stored on hard disks. These hard disks were placed in locked storage, and have never been accessible through a network. The content of the hard disks will be safely destroyed after this research project is completed, in accordance with instructions given by the Privacy Ombudsman.

The dispatcher interviews were transcribed, and codes were used rather than names to distinguish the dispatchers. The sound files from the interviews were deleted after the publication of Paper I, and the interviews currently exist only in the transcribed and coded format.

Chapter 4

Results

Seeing is believing.

4.1 The effect of video calls according to dispatchers

Six dispatchers were interviewed individually after they participated in simulated cardiac arrest (Paper I). The dispatchers found video calls surprisingly easy to use, and quickly adapted reliance on the picture. They were able to observe matters that they would otherwise need to ask about such as how rescue breaths were given and the positions of the patient and rescuers. Some believed this would save time. With video, dispatchers found it easier to provide assistance and to correct actions. When dispatchers observed that rescuers did not seem to understand their instructions, the dispatchers could try new approaches. The loudspeaker function of the callers' video phone made it possible to communicate with all the rescuers at the same time, and this function was appreciated.

Some dispatchers thought too much information might interfere with their assistance of rescuers, and thus possibly cause delays. At times, the dispatch protocol was ignored in favor of watching the video. Minute details such as compression depth and hand position were difficult to see, and image quality deteriorated if there were much movement in the picture. Dispatchers assumed that more experience in the use of video dispatch would improve their use of images.

We concluded that visual observations during video calls may provide

a new basis for professional dispatcher assistance. Video communication can improve the dispatchers' understanding of the rescuers' situation, and the assistance they provide. The role and content of telephone-directed protocols used by dispatchers may need adjustments when video calls are used for medical emergencies.

4.2 The effect of video calls on rescuer confidence

After participating in scenarios of simulated cardiac arrest with dispatcher assistance via video calls or audio calls, 180 high school students answered a questionnaire to assess understanding, confidence, and usefulness of video calls for dispatch (Paper II). Most rescuers found it easy to understand the instructions given by dispatchers, with no difference between the video call and the audio call group ($p = 0.85$). Open-ended answers were similar in the two groups, with the exception that sound quality was mentioned only by rescuers using video phones. Responses varied from "heard it loud and clear" and "didn't catch everything" to "hardly heard what she said."

The video call group felt more confident in correctly applying first aid during the trials ($p = 0.01$). Some participants in the video group mentioned uncertainty only in the beginning of the scenario, while answers from participants in the control group did not suggest that their uncertainty improved with time.

The majority of rescuers in both groups believed that video calls were superior to audio calls during medical emergencies, and this proportion was significantly higher in the video group ($p = 0.0002$). Rescuers who had not used video phones had greater tendency to comment on immature video call technology, while some who had used video phones complained about poor sound quality during video calls.

We concluded that visual contact and supervision may improve rescuers' confidence in stressful emergencies.

4.3 The effect of video calls on resuscitation quality

Quality of DA-CPR and time factors were compared between video and audio scenarios (Paper III). We found no statistically significant differences between our study groups regarding age, sex, and previous resuscitation

4.3. THE EFFECT OF VIDEO CALLS ON RESUSCITATION QUALITY 33

training.

Video recordings carried out during the trial showed that dispatchers adapted their instructions based on the input the dispatchers had received from the rescuers. During video calls, dispatchers often responded to what they saw, clarified misunderstandings, or gave more detailed instructions when they saw that rescuers did not perform as they wanted. Verbal support was often provided on how to open the airway and how to perform ventilations when the dispatchers saw rescuers struggling with these procedures.

During the 60 cardiac arrest simulations, five cases had neither chest compressions nor ventilations registered by the recording manikin: one during video and four during audio sessions. Video recordings showed that students in these five scenarios believed that the manikin was breathing, and in cooperation with the dispatcher nurse, placed the manikin in the recovery position without attempts at resuscitation. Among the remaining scenarios, there were another four cases where no ventilations were registered: one during video and three during audio sessions. Our video recordings for these four scenarios show that students attempted ventilations, but failed to open the airway.

The test statistic for power analysis was defined as the difference in delivered compressions per minute between the intervention group and the control group, for which we found no difference (62 vs 61; $p = 0.34$).

Median CPR-time without chest compression (“hands-off time”) was shorter in the video call group vs the audio call group (303 vs 331 seconds (s); $p = 0.048$), but median time to first compression was not shorter (104 vs 102 s; $p = 0.29$). Median time to first successful ventilation was insignificantly shorter in the video call group (176 vs 205 s; $p = 0.16$). Thus, the major part of the time saving was due to less time spent during the first compression-ventilation cycle. The video group also had a slightly higher proportion of ventilations without error (0.11 vs 0.06; $p = 0.30$). This indicates that video dispatch may have the potential to improve ventilations during CPR.

Less hands-off time is considered a significant contributor to survival during prehospital CPR for cardiac arrest.^{90–92} This finding may not be clinically important because time savings were less than 10% and the first compression was not started earlier.

We concluded that low-quality video communication is unlikely to im-

prove DA-CPR significantly without proper training of dispatchers and when using dispatch protocols written for audio-only calls. In spite of these limitations, we found no parameter where video calls were inferior to audio calls for DA-CPR.

4.4 Information security of video dispatch

Information security was assessed for risk based on the information security standard ISO/IEC 27005:2008 (Paper IV). Twenty threats and unwanted situations were identified and described. The likelihood and consequence were estimated for each threat, and the risk level calculated. Solutions were proposed to reduce the risk level of each threat.

No threat had a severe risk level. Eight threats had a moderate risk level: worse sound quality, time delays when establishing videoconferencing, limited network capacity, weather exposure of mobile phones, lack of audio logs when a call is lost, misunderstandings due to several patients in the same emergency, the security of mobile networks, and the loss of dispatchers' identity protection. The following threats had a low risk level: inability to forward video calls and the lack of video logs for debrief or legal purposes.

We were not able to conclude the likelihood or consequence for the following threats, either because the threat would depend on the implementation of the technology or related to issues that can be answered only through clinical trials: increased battery drain on mobile phones during video conferences, delays due to unstable connections, unauthorized access to patient information, poor image quality, and the images receiving too much attention from dispatchers or bystanders. In the worst case, these threats could have an unacceptable severe risk.

Several threats can be removed by proper implementation. Some threats will be influenced by the intellectual capacity of dispatchers. For some dispatchers and in some situations, the image may be helpful, while at times images can be an extra burden. Training dispatchers may reduce the risk level of those threats. EMD centers commonly use criteria-based protocols for advice during emergencies.^{50,93,94} Such protocols should be adapted for video-based dispatch, which may contribute to reducing the risk level for these threats. The risk level of several threats will be largely influenced by factors external to EMD centers and likely decrease with time, as technology

and solutions mature. If users experience problems with sound quality or other technical problems during a video call, a switch to an audio call may solve the problem, but with a time cost.

Given proper implementation, we found no risks to information security that would advocate against the use of video calls between lay bystanders and EMD centers. The identified threats should be used as input to formal requirements when planning and implementing video calls from mobile phones for EMD centers.

Chapter 5

Discussion

With diagnosis clearly the most difficult of all medical skills, requiring the least medically trained individual in the system to diagnose as an initial step for response selection is foolish at best.

Jeff Clawson⁹⁵

Blindness is defined as the inability to see.⁹⁶ This has been the work conditions for dispatchers, whose ears have been eyes during emergency calls.⁵⁵ In this study, dispatchers not previously used to video calls for dispatch, got their eyes opened when they had their first experience with the use of video communication for guiding rescuers during simulated cardiac arrest. When testing mobile video calls before the start of the trials, we found the quality and reliability to be so poor that we seriously discussed stopping the project. To our surprise, the dispatchers and rescuers in our trials seemed to clearly prefer video conferencing despite the poor technical quality of image and sound.

5.1 Methodological discussion

5.1.1 Choice of study design

Survival is a “hard” endpoint to measure in interventional studies of cardiac arrest. As stated by the Helsinki declaration, studies involving human subjects should be preceded by adequate laboratory experimentation. The trial setup in this thesis was such a laboratory. The quality of cardiopulmonary resuscitation is directly linked to survival and therefore was chosen as our main study endpoint in the randomized controlled trial (RCT) for measuring the effect of the intervention.

In an RCT, the groups are on average identical apart from the intervention, and any differences in outcome are, in theory, attributable to the intervention.⁹⁷ RCTs have several drawbacks, including limited applicability as a result of inclusion/exclusion criteria, analysis of only pre-defined measurable endpoints, which may exclude important qualitative aspects of the intervention, and may be inappropriate to study “quality of care” issues in which the criteria for success have not yet been established.⁹⁸ These drawbacks also applied to our RCT, which will be detailed later.

Qualitative data may support quantitative results, can be used for the study of social processes, and have “been used to considerable effect in evaluating organisational reforms and changes to health service provision from the viewpoint of patients, health professionals and managers.”⁹⁹ The qualitative parts of our trials provided explanations for how video calls may be useful for real-time emergency medical dispatch. Qualitative studies rarely give hard facts, but they can provide information and insight, and guide further research.⁸⁵

Triangulation involves comparison of results from two or more different methods of data collection.^{85,100} In this thesis, three papers with different perspectives report results from the same trials. The fourth paper uses yet another approach to consider the same questions from the perspective of information security. The papers complement each other, and triangulation can be used to increase validity.⁸⁵

5.1.2 Sample selection and validity

The rescuers

As is often the case with randomized controlled trials, the selection of study groups to increase “internal validity” (comparability) may have resulted in reduced “external validity” (representativeness).¹⁰¹ The choice of groups of high school students as rescuers has been accounted for in chapter 3. People in this age group are more likely to be users of the new functionality in mobile phones, but we do not know who will be actual users of video mobile phones during emergencies.

More than 70% of our rescuers had previous resuscitation training. Video calls may possibly be of better help for untrained bystanders, and the lack of differences between the study groups might be explained by a high level of resuscitation knowledge in our subjects. Our findings may not be valid for populations with different competencies and training.

The demographic information we collected revealed no statistically significant differences between the study groups, which indicates acceptable internal validity, while external validity may be low for the reasons mentioned above.

The dispatchers

The dispatchers in this study were recruited by their leaders, and the research group had no influence on which dispatchers were selected each day. It is therefore possible that the recruited dispatchers were more willing to participate and more positive regarding the technology than dispatchers in the same dispatch center who were not recruited. To answer a question such as the portion of dispatchers in general who prefer video conferencing, a quantitative study and a different study design are needed. We found that the dispatchers during the trial became more positive about using video conferencing for dispatch and found it to be the preferred communication mode. “The Hawthorne effect,”^{102,103} where subjects change behavior in response to the fact that they are being studied, and not in response to the experimental manipulation, can be one explanation for the positiveness of the dispatchers.

For qualitative interviews, one should continue until the topic is “saturated”. We found that we had a sufficient number of participants and

sufficient time with each participant to answer the study questions.

As described in the introductory chapter of this thesis, some countries use dispatchers without backgrounds in the health care system, as opposed to Norway where dispatchers are experienced nurses. Our findings may not be transferrable to systems where dispatchers are differently educated.

5.1.3 The questionnaire

A valid questionnaire measures what it claims to measure.^{80,104} We simplified a questionnaire measurement tool¹⁰⁵ to measure rescuers' confidence, or certainty. One may speculate that rescuers would answer differently during the trials than afterwards (recall error), and that a questionnaire does not give true values for the lack of confidence. However, the difference in confidence reported between the intervention and control groups can likely be ascribed to the intervention.

We found no difference between the study groups regarding the ease of understanding the instructions given in this trial. We did not explicitly state what kind of instructions we were referring to, and as indicated by open-ended replies, some referred to the instructions given before the simulation scenario, while others referred to the dispatcher's instructions. The data collected for this question should therefore be treated with some care. The important finding is that very few found the instructions to be difficult, which serves as a background for interpreting the question on confidence. In spite of the easy-to-understand instructions, the audio group reported greater uncertainty.

Many of the respondents in the audio group probably had no experience or knowledge of mobile phone video calls. Some indicated in their open-ended answers that they thought of recording videos for later transfer to a dispatch center, while others stated that this technology is still immature and that such use today would not be possible. If respondents in the audio group were uncertain about which technology we wanted their opinion, then the responses from the two groups on the suitability of video calls for medical emergencies are not directly comparable.

We did not ask the rescuers about what role they played during the resuscitation scenario because they were allowed to change roles during a scenario, and we did not want to make the questionnaire too complicated. Some in the video group reported issues of sound quality and difficulties

with hearing the dispatcher. If these replies came from rescuers not holding the telephone, they should be compared with rescuers in the audio group not hearing the dispatcher at all, as the video phone was by default in loudspeaker mode, while the audio-only phone was not. It is possible that the person holding the telephone in the video groups had sufficient sound quality, while the others had difficulties hearing the dispatcher.

Unlike most questionnaire studies, we had a response rate of 100%. No misclassification was found, when controlling the color and time codes on the questionnaires with the date and time of video recordings. We therefore feel certain that no questionnaire replies were erroneously placed in the wrong exposure category.

5.1.4 Interviews

Half the dispatchers started their trial day with video conferencing; the other half started with audio-only calls. After five scenarios of one communication mode, the dispatchers switched to the other communication mode. Through this study design, dispatchers were able to compare their own experience with video and audio calls. Both groups of dispatchers explained they were surprised when they switched communication modes. The video-first group said they lost something important when they no longer had the picture. The audio-first group said they were surprised to find that the image really represented an improvement.

Relations between researcher and respondents may affect the reliability of qualitative data.¹⁰⁶ With their replies, the dispatchers may have tried to please the interviewer, although no previous relation existed between the interviewer and dispatchers in our study. Interviewer bias may also influence respondents' replies.^{85,107} Open questions were used to decrease this type of bias, and dispatchers were asked "why" and "how" to find explanations for their opinions.

5.1.5 Data reliability of CPR quality measurements

Only one simulation manikin was used in our trials in order to reduce sources of variability. The manikin was brand-new, and the manikin airway was replaced with a new one before each trial day, as recommended by the manufacturer. The potential for gradual impairment of the manikin or airway is

not likely to have caused differences between the groups, as the intervention and control group scenarios were equally distributed throughout the trial. However, measurements of time intervals, hand position, and compression depth by a training manikin may not represent cardiac output during resuscitation of humans. The lack of differences between our study groups could be explained by an inability of the manikin to detect important differences that would influence post resuscitation survival. The lack of calibration tools to adjust and validate important variables measures by the manikin, such as compression depths and minute- and tidal ventilation, might contribute to such inaccuracies.

Variability between dispatchers may have influenced rescuers' performance. Our data set was too small for meaningful assessment of the influence of inter-dispatcher variability on the quality of CPR. We could have used only one dispatcher for all scenarios, but then any differences between video groups and audio groups could have been ascribed to this particular dispatcher, with decreased external validity as a result. It is not likely that inter-dispatcher variability would explain any differences between the video and audio groups, as all dispatchers had the same number of scenarios of each mode.

5.1.6 Risk assessment

We used the information security standard ISO/IEC 27005:2008 to guide our risk assessment.⁸⁹ This standard does not strictly detail how each step of risk assessment should be done. We used structured brainstorming by a multi-professional team to find threats to the information security aspects confidentiality, quality, integrity, and availability. Determining the likelihood and consequences of threats in a future system is not an exact science. Several iterations were made to ensure the quality of the results and group consensus. Reaching group consensus in this manner has been referred to as GOBSAT (Good Old Boys Sat Together),¹⁰⁸ which suggests an unscientific approach and that a different group may have reached other conclusions. The strength of our group was its knowledge of the technology and the trials presented in Paper I – III, and that several different fields were covered through the competence of the team members. As with most qualitative methods, our approach resulted in a large amount of information, which would otherwise be difficult to obtain without implementation of a real sys-

tem. The results of our risk assessment should be tested during and after the implementation of such systems by using other methods.

Several methods exist for risk assessment of information security. Our approach, similar to SWIFT*, was prospective and addresses a future system at a high level.^{109,110} Other methods for risk identification such as HAZOP,[†] FMEA,[‡] and FTA[§] focus on process flow or hardware, and may be better suited for assessing equipment details in existing systems.¹¹⁰

A threat may have different outcomes, from common incidents with no practical implications to (very rarely) a chain of events with disastrous results. Poor sound quality, for instance, may be acceptable in many situations, but can cause misunderstandings that lead to worse patient treatment and possible patient death. Assessing the consequence and likelihood associated with threats of a new service is therefore difficult when no numbers exist to support the estimations. We found this led to a worst-case type of thinking that may have overestimated the risk level of some threats. Further studies are therefore needed to map the types of errors and problems that may arise.

*Structured What-If Technique (SWIFT). A systematic team-oriented technique for hazard identification. Suitable for considering systems where human and organizational factors predominate. “Brainstorming” supported by checklists.¹⁰⁹

[†]Hazard and Operability study (HAZOP).

[‡]Failure Modes and Effects Analysis (FMEA).

[§]Fault Tree Analysis (FTA).

5.2 Discussion of the main results

5.2.1 Can video calls improve dispatcher assistance?

One main objective was to find whether video conferencing with mobile phones rather than audio-only phone calls can improve communication from the viewpoint of dispatchers. Paper I concludes that video conferencing is such an improvement and provides the following explanations:

- the dispatcher's visual inspection creates the basis for better synchronization of the rescue activities during bystander CPR
- video communication can improve dispatchers' understanding of the rescuers' situation and the guidance they provide

Observations of our video recordings confirmed these findings. We suggest that the role and content of telephone-directed protocols used by dispatchers may need adjustments when video calls are used for medical emergencies. How dispatcher protocols need to change must be tested in future trials. One recent paper presented a dispatcher protocol for video conferencing in which 52 public officers without previous experience in the use of an automated external defibrillator, received video call instructions.¹¹¹ In this study, all participants placed the electrode pads correctly when guided by an emergency dispatcher through video mobile phones, and 51 of 52 participants were able to deliver a successful shock. The dispatcher protocol written for this procedure illustrates how dispatchers can use images actively during emergency calls, and may serve as a guideline for future development of video dispatch protocols.

If the image is used diagnostically, the ability to observe during phone calls may require greater medical competence. The introduction of video calls may therefore increase the need for physicians in dispatch centers because of new possibilities. In other situations, it seems likely that images from the caller side will decrease misunderstandings, regardless of the dispatcher competence, which is illustrated by a transcript from dispatcher communication, provided in Figure 5.1. Some problems may not be visible on images, but an image can provide clues to improve caller interrogation.

Time-critical emergencies do not seem to be a contraindication for video conferencing. In the foreword, a qualitative study of video conferencing

Dispatcher: Fire Department Emergency.
Caller: Yes, I see some smoke.
Dispatcher: Yes, ma'am, can I have your address?
Caller: 13 Bobolink Rd.
Dispatcher: OK, and you see smoke.
Caller: Yes.
Dispatcher: Can you tell me what direction it's coming from?
Caller: What?
Dispatcher: The smoke, what direction is it coming from?
Caller: I don't know.
Dispatcher: Can you see out your front window from the phone?
Caller: Yes.
Dispatcher: OK, looking out the window, which way does the sun rise? In front of you, in back, to the left or right? . . .
Caller: It rises in front of me.
Dispatcher: OK, that's east. OK, looking in that direction, which direction is the smoke coming from?
Caller: What?
Dispatcher: Looking out the window, which way is the smoke coming from, left, right, or what?
Caller: Well, it's coming from the right.
Dispatcher: OK, that's south. Can you give me a landmark?
Caller: What?
Dispatcher: Well, is the smoke near a PG&E tower or water tank or something?
(Pause)
Caller: Mister, the smoke is coming out of my closet!
Dispatcher: Oh! We'll be right there!

Figure 5.1: A transcript of a call to an American fire department in an area where they lately had several wildland arson fires. The fire department received “smoke scares” several times a day from nervous citizens seeing smoke from barbecues, fog, etc. The major problem was to locate the smoke without searching all over the district, so dispatchers had greater than usual focus on getting directions and landmarks.¹¹²

for critically traumatized and sick patients was mentioned, where a rural hospital team interacted with a team of specialists at our university hospital for complex and time-critical medical discussions and treatment.¹¹³ In that study, we concluded that video conferencing can improve communication between teams responsible for treating and triaging emergency patients, through images and increased interaction between team members at either side of the video link. Such team interaction requires thoughtful organization, training, and new rules for communication. These conclusions are similar to the findings presented in Paper I and in line with the findings of others who have used video conferencing for teams in charge of emergency care of patients.¹¹⁴

The dispatchers in our study found video communication with callers to be a learning experience. Seeing what took place at the other end made the dispatchers consider how they interact with bystanders. The use of video conferencing therefore has the potential for continuous education of dispatchers, which could result in improved quality of dispatch of both video and audio-only calls.

The obvious drawback of this study is that simulated scenarios were used rather than real patients. However, dispatchers could compare their experience with both modes of communication for the same type of scenario, and they found video communication to be easier. The methodological concerns require that new studies should focus on dispatcher experience during real emergencies, and our results should not be generalized to other than nurse dispatchers.

5.2.2 Can video calls improve bystander confidence?

Paper II concludes that audio-visual communication during DA-CPR improved rescuers' confidence. There may be several explanations for improved confidence. First, rescuers may trust that the image better communicates the patient condition, which eases the burden of rescuers in describing the situation. Second, knowledge of being observed during resuscitation may increase confidence in doing proper actions. Third, the video phones were used in loudspeaker mode, which made it possible for all rescuers to hear the dispatcher's voice, and this may have comforted those doing resuscitation. Fourth, video conferencing may be used for strengthening teamwork.⁵⁴ We did not explicitly ask for reasons for improved confidence during video

calls, but in their open-ended answers, some respondents provided explanations: easier to communicate the patient condition, dispatchers' ability to observe, that dispatchers can check if procedures are done correctly and correct mistakes, that it feels safe to see the person one is talking with, and that rescuers are not left alone. These explanations are in line with feedback from teams using video conferencing between hospitals for coordination of rescue work,¹¹³ and the dispatchers in our trial (Paper I).

Sound quality was mentioned by a few as a problem during video scenarios. Partial hearing may lead to misunderstandings and disagreement among bystanders, which in turn may result in worse bystander performance. However, when more people hear the bystander, misunderstandings can be discussed and clarified. When watching the video recordings, it seemed a positive benefit that the dispatcher could speak to the whole rescuer group, and that this could lead to better coordination of rescue activities. However, it cannot be ruled out that difficult to hear instructions could lead to dangerous misunderstandings. Studies are needed to find whether sound quality is a problem when the phone is used in loudspeaker mode, or if loudspeaker mode should be preferred also when video is not available.

The epigraph of this chapter states that the difficult skill of diagnosis should not be placed on the least medically trained individual in the system.⁹⁵ This statement was originally used about dispatchers to promote protocols to help them in their work. The statement could be applied equally to bystanders in medical emergencies, who may feel uncertainty as a burden, not only when suggesting a diagnosis but also when deciding what to do. The quality of information exchange and shared understanding among team members are important for effective teamwork,⁵⁹ which may explain the improved confidence among users of video calls. Paper II concludes that video conferencing may be a tool that relieves lay rescuers before the arrival of trained personnel. Whether this conclusion is true, and whether it has positive implications for patient treatment, should be studied during real emergencies.

5.2.3 Can video calls improve resuscitation quality?

Measurements of chest compressions and ventilations during CPR revealed no statistical significant differences between study groups (Paper III), but we found statistical significant time savings for video calls (decreased hands-

off time). We concluded that time savings were not likely to be clinically significant. The important finding in Paper III is that video communication did not cause delays when used by both dispatchers and callers untrained in using video calls for dispatch, when dispatchers followed a protocol written for audio-only communication.

In this study, a number of parameters were measured (Figure 3.1). It is not surprising that one parameter turned out positively. In fact, with an alpha level of 0.05, the chance of finding one or more significant differences in 20 tests is more than 60% (64.15%). The Bonferroni correction could have been used for adjustments, but as we concluded that our findings were not clinically significant, we did not find it necessary.

During the last few years, several studies have reported the use of video mobile phones in a variety of clinical settings. In a simulated trial, medical students were found to perform needle thoracocentesis better under the guidance of mobile phone video supervision than those without such supervision.¹¹⁵ For the treatment of patients with tuberculosis in Kenya, video mobile phones were used to remotely supervise patients swallowing their medications.¹¹⁶ In the British Medical Journal, two cases were reported in which mobile phone video clips of children were found useful for diagnosing and treating acute upper airway obstruction.¹¹⁷ Commercially-available video mobile phones have been successfully used for basic emergency consultations of cardiac ultrasound.¹¹⁸ Young patients aged 10 – 16 years dealt satisfactorily with minor orthodontic emergencies through mobile phone video calls, and the authors of this study concluded that such minor emergencies can be solved easily at home through video sharing.¹¹⁹ In a Korean study, the authors concluded that specialists could conduct remote consultations for acute stroke patients using a mobile phone network for video and audio transmission.¹²⁰ Video mobile phones have also been tested to replace visits to a hospital outpatient clinic for patients with diabetic foot ulcers.¹²¹ These studies demonstrate that mobile phone video can assist in supervision, diagnosis, and treatment in a variety of situations, in spite of limited bandwidth, low quality images, and the small screens of mobile phones.

Why, then, did we not find more significant quality improvements for the lay-person CPR in our trial? Possible explanations include (1) that video communication is no real improvement for CPR instructions, (2) that the study population was too small (type II error), (3) that the video or

sound quality was too poor in our trials, (4) that the organization of video dispatch should be different (guidelines and dispatcher training), (5) that we were looking for the wrong improvements, (6) that there are heterogeneous situations for which video can be useful but are not visible in a small trial, and (7) that the manikin was unable to detect important differences. Some of these issues require further comments.

The test statistic for which the power analysis was done was not significant. We wanted to detect a 20% increase in delivered compressions per minute. As our data for this parameter as well as other parameters on compression quality were almost identical in the two groups, we consider the risk of a type II error to be rather small. It is therefore reasonable to conclude that in our setup video calls did not cause improvement in measurements of chest compressions.

Using the same technology as in Papers I – III, another study done by our research group reported that cameras should be kept at low angles and 50 to 100 cm from the chest, at the level of the shoulders, in order to detect respiration.¹²² The dispatchers and rescuers in our trial had no knowledge of this. Therefore, camera positions were used inefficiently in detecting ventilation. Similarly, suboptimal camera positions to detect other aspects of CPR, such as compression quality, may have been used. One problem with mobile phone video images is that the compression - decompression algorithms used to save bandwidth transmit changes only to the previous image frame. If major parts of the picture change from frame to frame, which will be the case during close-up filming of chest compressions, the technology is insufficient to transmit and present the updated view. The result is a distorted image, which at times is useless. Alternatively, the camera can be placed farther away so that smaller portions of the image are changed from frame to frame, which makes it impossible to observe finer details. The issue of distorted images can be improved through other algorithms used in the phones, improved bandwidth, and different positions of the phone. The quality of the camera in the mobile phone also affects the image. With improved technology, some of these issues may no longer be important, but dispatchers should be taught the camera positions that render best results.

In our trial, we found that CPR was not started in four of 30 audio scenarios, while the number for the video group was one in 30 scenarios.

Our study was too small to test whether this lack of response represents a real difference between video and audio calls, but future studies should test if video calls increase the portion of scenarios in which CPR is started. If so, improved confidence and decreased uncertainty or feeling of support, as reported in Paper II, may be possible explanations for the increased rate of bystander resuscitation.

Some rescuers in the video group were able to complete more successful ventilations. In addition, the time to first successful ventilation was lower in the video group. Although not statistically significant, these findings can be explained through observations of our video recordings: during video calls, dispatchers gave more detailed verbal instructions on how to open the airway and how to perform ventilations when they saw rescuers struggling with these procedures. As mentioned above, camera position is important when the image is used for evaluating rescuer efforts.¹²² It is easier to observe successful ventilations than compressions, which gives a plausible explanation for why video calls may improve ventilations more than compressions. It is even easier to use the image for instruction and supervision of opening of airways, which may also explain why rescuers with video phones spent less time on ventilations. Our findings, although not statistically significant, therefore have plausible explanations. Some studies have suggested chest compression-only CPR for untrained bystanders,^{123,124} and telephone-guided chest compression-only CPR is encouraged for untrained rescuers in the 2010 guidelines from the European Resuscitation Council.¹⁴ One reason for the poor results with ventilations may be that rescuers struggle with this procedure: how to open and maintain a free airway and how to do rescue breaths. If video calls are supported by dispatch centers in the future, some of the arguments against rescue breaths may no longer be valid when video calls are used. This issue should be the focus of future studies.

A standardized simulated scenario may not be the best setting for testing video communication. Medical emergencies are not standardized situations, but happen in a great variety of environments with a number of factors that may cause communication problems and delays in rescue attempts (Table 1.1). Such situations include the ability of dispatchers to detect the number of patients involved, the number of people on scene, whether the patient is lying in a supine position, whether the patient is lying in a soft bed or on a couch during CPR, that rescuers have opened the airways, that

the patient is breathing, whether rescuers are doing ventilations and chest compressions during cardiac arrest, whether rescuers are struggling with a procedure, whether a bleeding is arterial or venous, whether bystanders or patients could be in a hazardous place and that actions should be taken to avoid further injury, to decide whether to dispatch an ambulance, etc. The ability of video conferencing to improve test characteristics (sensitivity and specificity) for each of these issues, or if time is saved, could be a focus for future studies. Simulated trials can demonstrate only certain aspects of emergencies, and therefore, trials during real emergencies are needed.

In parallel to the present work, a Taiwanese research group published two papers on the impact of adding video communication to dispatch instructions. The researchers mounted a video mobile phone and a resuscitation manikin in fixed positions, and gave through the phone either voice instructions alone or interactive voice and video instructions. The video group had better ventilation quality, but spent more time opening the airway and giving the first rescue breath, when the ventilations were studied in isolation.¹²⁵ Interactive voice and video instructions also improved the quality of chest compressions in a study on chest compression-only CPR, but with increased “hands-off” time (i.e., the time not spent on chest compressions).¹²⁶ These studies used single-rescuer scenarios, and realism was reduced by the artificial mounting of the mobile phone in a fixed position. Rescuers received demonstration of correct CPR procedures on the screen of the video phone, which explains why these rescuers spent more time when using video calls. Two Korean studies showed improved quality of chest compressions when participants received instructions through a video clip on a mobile phone rather than dispatcher instructions in scenarios of simulated cardiac arrest.^{127,128} More studies are needed on how to best use the small screen of video mobile phones during time-critical procedures.

In conclusion, there is increasing evidence that video communication through mobile phones is useful in a variety of clinical situations for supervision, instructions, and triage. Paper III shows that lay rescuers collaborating with dispatchers untrained in video dispatch do not perform worse when using video calls for simulated cardiac arrest, but more knowledge is needed on how to best use this technology to improve the quality of resuscitation.

5.2.4 The risk of implementing reception of video calls in dispatch centers

Several risks are associated with any health care project – for the patients, for health care workers, for the organization, and for the project itself. Our risk assessment (Paper IV) focused only on the purpose of a communication system, namely information exchange and storage. Assessing risks before a system is implemented can guide decision makers and provide valuable input for system requirements.

Twenty threats to information security were identified. For most threats, we were able to suggest ways to decrease or eliminate the risk associated with it with proper implementation, organization, and staff training. Potential delays and poor sound quality were the greatest risks of mobile video calls. No threat had an unacceptable high risk level, which indicates that it is possible to implement the reception of video calls from the public in dispatch centers.

Several benefits and drawbacks of information systems will be discovered only during and after their implementation.^{129,130} For conclusions on the usefulness and the potential of video-based dispatch, real-world implementation is needed.

Project complexity increases the risk of unsuccessful implementation and project failure.^{131,132} The complexity of dispatch centers and the handling of time-critical emergencies require a careful approach to reduce unnecessary project risks. The project size correlates to project complexity.¹³¹ One way to reduce project risk is the small-scale implementation before large-scale implementation of video calls in dispatch centers. During and after such an implementation, risk analysis should be repeated, and clinical research performed to guide the future development of video-based dispatch.

5.3 The future of video-based dispatch

It makes sense to use our eyes when we can, and this truism is no different for dispatchers. Therefore, studying the usefulness of dispatcher vision is similar to performing a randomized controlled trial to find out whether parachutes can prevent death: “Common sense might be applied when considering the potential risks and benefits of interventions.”¹³³ The importance of this thesis is not that vision is useful, but to guide future development and research on the use of video mobile phones in real emergencies for the benefit of dispatchers, bystanders, and patients.

The chairman of the Federal Communications Commission (FCC) in the USA announced November 23, 2010, that “the FCC will take steps to revolutionize America’s 911 system by harnessing the life-saving potential of text, photo, and video in emergencies.”¹³⁴ The announcement stated that 70% of 911 calls come from mobile phones, but that call centers lack the technical capability to receive text, photos, and videos, and that call center operators have not been trained how to effectively communicate using these new technologies. The technological limitations of dispatch centers can have tragic, real-world consequences, the chairman said, referring to the 2007 Virginia Tech campus shooting, when students desperately tried to send texts to 911 that local dispatchers never received. Bringing 911 into the twenty-first century is one of the FCC’s key public safety priorities, which includes text, particularly for those with disabilities, and mobile video and photos to assess and address emergencies in real-time.

As new communication means mature and become a natural part of many people’s lives, the emergency medical communication centers should adapt to this situation. How to organize implementation of new communication modalities in dispatch centers is outside the scope of this thesis. I will, however, provide a few notes to demonstrate some challenges.

Before a large-scale, nationwide implementation of video conferencing in dispatch centers, one should attempt smaller scale implementations and clinical trials during real emergencies. If one dispatch center allows the reception of images, the public must be informed about it. This information could cause the public to bypass municipal casualty clinics (Legevakt-sentraler in Norway), thereby overwhelming the dispatch center with minor medical problems. This problem would be solved by implementing the same

technological possibilities in all municipal casualty clinics in the same area, which would significantly increase the size and complexity of such a project.

User interfaces influence the ease of using technology and are likely to affect performance during time-critical events. Work is needed on improved user interfaces for video communication, both on mobile phones and for the dispatchers. If the initial contact is made with an audio call, the dispatcher could have the option to remotely turn on the camera of the caller's telephone, which would ease the barrier of using video in an emergency, but it comes with technological and ethical challenges.

Several communication protocols exist for video communication on mobile phones. The technology tested in this trial used the 3G-network (3rd Generation mobile network). The phone's built-in software used the 3G-324M protocol for video calls. A number of Internet communication methods based on instant messaging protocols such as SkypeTM or Session Initiation Protocol (SIP) also provide video on mobile phones. If all possible video call protocols are not supported by dispatch centers, it would be a challenge to communicate to the public which protocols are supported without creating uncertainty about the reliability of these communication means. The speed of development of new communication possibilities available through digital media may require continuous development of the communication systems in dispatch centers.

"Bringing dispatch centers into the twenty-first century" will therefore be a challenge. With an increasing number of users of mobile devices with multi-media capabilities, and the public's expectations of health care services, we believe it is a challenge that will be difficult to avoid, regardless of scientific proof of any lifesaving effects.

Chapter 6

Conclusion

Only fools can be certain; it
takes wisdom to be confused.

Unknown

The main conclusion of these studies of dispatchers and bystanders during simulated cardiac arrest is that bystanders can receive better support from video calls than from audio calls during out-of-hospital cardiac arrest.

Our main findings are the following:

1. Video calls may improve the quality of dispatch according to dispatchers.
2. Video calls may improve the confidence of callers.
3. Video calls did not improve the measured quality of cardiopulmonary resuscitation in our setup.
4. Video calls may require dispatcher training in how to use video during dispatch.
5. Video calls may require development of new dispatcher protocols.
6. Implementation of video calls in dispatch centers is not likely to introduce unmanageable risks to information security.

These findings are in line with a summary made more than ten years ago in a textbook of emergency medicine: “Dispatching - part of the early access link - merits much closer attention in almost every EMS system. This includes the performance of the telephone system, the training of the

dispatchers, the protocols they follow, the ability to perform simultaneous dispatching, the implementation of enhanced communication and the provision of dispatcher-assisted CPR.”¹³⁵

A standardized simulated scenario of cardiac arrest does not represent the variety of situations in which dispatchers operate. The results of the trials presented in this thesis should therefore be further studied in different settings of real emergencies.

We are probably at only the very beginning of the technological revolution of mobility. The range of technological solutions will continue to grow, and health care will not have the resources to try out all possibilities. Technology is not important in itself, but can be a useful tool for enhancing work, improving quality, reducing costs, and making work processes faster. There are, however, numerous examples of the contrary. All interventions mean change, and change is associated with risks. The risks of change must be balanced by the risks of not changing. The largest investments in mobile technology, wireless networks, and new possibilities for interactions and social networking are not made in the health care system, but outside it. How health care best can use, benefit from, and adapt to these new possibilities are questions for the future.

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Appendix A

Questionnaires

This appendix presents the Norwegian questionnaires used in Paper III. The questionnaires for the respondents in the video and audio groups were practically identical, except for color and an explanatory note given to the audio group.

SKJEMA STUDENTER - 3G-TELEFON (videokomm.) Klokka:...

Om utfyllingen: Vennligst kryss av det som passer og gjerne skriv forklaringer.

1 Din alder (fyll ut).... 2 Kjønn (fyll ut)

3 Har du gjennomgått opplæring i livredning i løpet av de tre siste år? Ja ... Nei ...

4 Har du tidligere erfaring fra virkelige akuttmedisinske situasjoner? Ja ... Nei ...

5 Hvor greit var det å forstå instruksjonen du mottok i forsøket?
 Svært vanskelig... Litt vanskelig... Ganske greit... Helt greit...
 Eventuell kommentar:

.....

.....

6 Var du usikker på om dere gjorde det dere skulle i redningsarbeidet?
 Usikker... Ganske sikker ... Sikker ... Vet ikke ...
 Eventuelt hvorfor?

.....

.....

7 Mener du telefon med videokommunikasjon er bedre eller dårligere egnet enn vanlig telefon i akuttmedisinske situasjoner, f. eks. ved livredning, ulykker og/eller annet?
 Spiller ingen rolle... Dårligere... Bedre ... Vet ikke ...
 Eventuelt hvorfor?

.....

.....

Takk for hjelpen!

Figure A.1: The questionnaire for respondents in the video group.

SKJEMA STUDENTER – VANLIG TELEFON Klokka:...

Om utfyllingen: Vennligst kryss av det som passer og gjerne skriv forklaringer.

1 Din alder (skriv)... .. **2 Kjønn (skriv)**

3 Har du gjennomgått opplæring i livredning i løpet av de tre siste år? Ja ... Nei ...

4 Har du tidligere erfaring fra virkelige akuttmedisinske situasjoner? Ja ... Nei ...

5 Hvor greit var det å forstå instruksjonen du mottok i forsøket?
 Svært vanskelig... Litt vanskelig... Ganske greit... Helt greit...

Ev. kommentar:

.....

.....

6 Var du usikker på om dere gjorde det dere skulle i redningsarbeidet?
 Usikker... Ganske sikker... Sikker... Vet ikke ...

Eventuelt, hvorfor?

.....

.....

7 Det finnes mobiltelefoner med videokamera. Mener du telefon med videokommunikasjon er bedre eller dårligere egnet enn vanlig telefon i andre akuttmedisinske situasjoner, f. eks. ved livredning, ulykke og/eller annet?
 Spiller ingen rolle... Dårligere... Bedre ... Vet ikke ...

Eventuelt hvorfor?

.....

.....

Takk for hjelpen!

Figure A.2: The questionnaire for respondents in the audio group.



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