# Medical Opportunities by Mobile IT Usage – A Case Study in the Stroke Chain of Survival

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**Abstract:** Mobile technologies are likely to reveal a high potential to improve the information exchange in medical treatment. Especially in emergency services, the use of these technologies can support the work of the regionally distributed actors. During the last years many projects dealing with innovative mobile systems were started as pilots but in most cases the concrete effects of their application were neither analysed in detail nor were the solutions able to reach the status of operative systems. This paper presents a concrete application scenario of mobile IT in medical treatment, presents the results from especially a process analysis and discusses chances and risks that can be deduced from the case study.

## 1 Introduction

Well-founded decision making at the point-of-care and efficient information transfer between the different players in a treatment process are crucial for Emergency Medical Services (EMS). Using mobile IT opens a wide range of possibilities to improve both aspects mentioned by telemedicine applications, communication and navigation systems, etc. [GrRS06].

To convince care providers to invest in these technologies and solutions, the benefits of the technology itself have to be clearly documented and organisational concepts of how to best apply the systems are of avail. Hence, analysing the potential is a precondition to elicit the real value of the technologies, which itself is a precondition to real world application.

This paper presents the analysis of 'Stroke Angel' – a mobile solution for intersectional processes of EMS between ambulances and hospitals' emergency units. The main goal is to provide clear evidence for improvements in intersectional processes of the stroke chain of survival. The following questions guide the argumentation:

1. How do an appropriate technical solution and infrastructure as well as the corresponding organisational approach should look like?
2. Do healthcare device providers that use the technology accept these solution and technical device?
3. How can the benefits of the approach be analysed and proved?

To answer these questions, the paper is structured as follows. First, the medical background of the stroke chain of survival is explained. Subsequently, the investigated case study Stroke Angel at Bad Neustadt/Saale is introduced including the technological concepts and the applied methodology for the evaluation. Finally, the obtained final results of the technology assessment and the acceptance analysis and the – preliminary – results of the process analysis are illustrated.

## 2 Medical Background – Stroke is an Emergency

With 575,000 cases a year, a mortality rate of 29%, another 25% of disablement within 12 months, and total costs of about 34 billion Euro in the EU per year, stroke is one of today's most threatening diseases in Europe and an upcoming epidemic. Even though the existing treatments of stroke are able to provide substantial benefits, stroke still takes a leading position on statistics of deathly causes.

Recent technical and medical developments give reason for hope for being able to improve stroke care. One important step in this direction was done in Germany by the approval of the thrombolysis for the treatment of the ischemic stroke in 2000. This acute therapy for strokes improves the chances for survival and healing[1]; but this treatment has to be started if possible within a time-frame of three hours after onset of symptoms [DMFP04].

### 2.1 Stroke – Time is brain

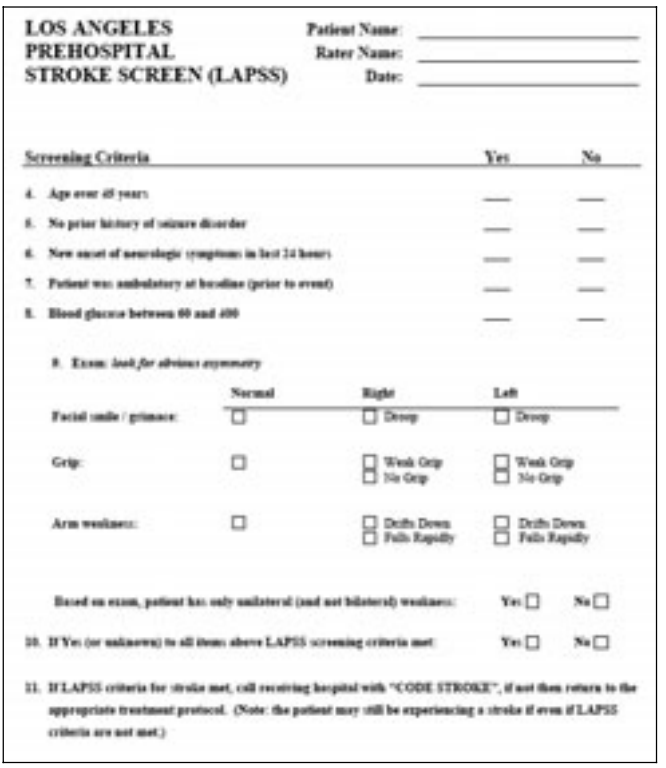
The stroke chain of survival commonly comprises the whole process from discovering the affected person to the patient's admission and treatment in hospital. In the best case, this happens during the so-called time-frame for lysis. If this time-frame is kept, the thrombolytic therapy (lysis) can be arranged.

[1] The thrombolytic therapy effectuates the blood clod that blocks the arteries with the help of dissolving medicaments, so that the degree of consequential damages can be reduced or rather completely avoid.

As the applicability of the thrombolytic therapy depends on the type of stroke and on the narrow time-frame, the guideline "Time is Brain" is essential. The first hours after the occurrence of a stroke are crucial for the options for and hence the success of the therapy, i.e. the prevention of subsequent reduction of the patient's quality of life and reduction of the economical consequences. Each hour without treatment leads to as much lose of neurons as caused within of 3.6 years normal aging [Save06].

### 2.2 Los Angeles Prehospital Stroke Screen (LAPSS)

Even if there are no reliable criteria for an explicit differentiation of the stroke type [Habe98, SHRB99], possibilities exist to support an optimised emergency management suspected diagnose.



**LOS ANGELES PREHOSPITAL STROKE SCREEN (LAPSS)**

Patient Name: _____
Rater Name: _____
Date: _____

| Screening Criteria | Yes | No |
|---|---|---|
| 4. Age over 45 years | ___ | ___ |
| 5. No prior history of seizure disorder | ___ | ___ |
| 6. New onset of neurologic symptoms in last 24 hours | ___ | ___ |
| 7. Patient was ambulatory at baseline (prior to event) | ___ | ___ |
| 8. Blood glucose between 60 and 400 | ___ | ___ |

9. Exam: *look for obvious asymmetry*

| | Normal | Right | Left |
|---|---|---|---|
| Facial smile / grimace: | ☐ | ☐ Droop | ☐ Droop |
| Grip: | ☐ | ☐ Weak Grip<br>☐ No Grip | ☐ Weak Grip<br>☐ No Grip |
| Arm weakness: | ☐ | ☐ Drifts Down<br>☐ Falls Rapidly | ☐ Drifts Down<br>☐ Falls Rapidly |

Based on exam, patient has only unilateral (and not bilateral) weakness: Yes ☐ No ☐

10. If Yes (or unknown) to all items above LAPSS screening criteria met: Yes ☐ No ☐

11. If LAPSS criteria for stroke met, call receiving hospital with "CODE STROKE", if not then return to the appropriate treatment protocol. (Note: the patient may still be experiencing a stroke if even if LAPSS criteria are not met.)

Figure 1: The Los Angeles Stroke Screen (LAPSS)

For realising the stroke specific protocol, the Stroke Angel system relies on widely adopted and clinically evaluated stroke scales. Stroke scales are standardised instruments to assess the symptoms, functional impairment and outcome of a potential stroke patient [Masu00]. A number of stroke scales have been developed for different purposes and stages during the stroke pathway. One of the most widely used scales in the US for the prehospital stage is the Los Angeles Prehospital Stroke Screen (LAPSS).

The LAPSS is a simple stroke checklist specifically designed for prehospital usage [KSEW00] to identify a stroke by considering six criteria related to symptoms (see Figure 1). If all considered criteria are approved, the LAPSS indicates a high probability for a stroke, whereas a negative LAPSS excludes this suspicion.

### 2.3 Process of the Stroke Chain of Survival

The vast majority of emergencies arrive at the hospital by EMS [SRG00] – to arrive at the hospital with the best medical treatment for strokes as soon as possible would itself be already a first success. This exemplifies the necessity of well coordinated goal-oriented work of a number of people during the rescue. Referring to Ahnefeld [AI71], the complete rescue system with EMS and its entire involved person is illustrated as the "chain of survival".

The chain of survival demonstrates the interplay of several parameters and aims for an optimal treatment of emergencies. It equates the sequence of rescue steps with the limbs of a chain. The smooth mesh chain limbs allow a maximum degree of success [JCNV01]. Figure 2 illustrates the stroke chain of survival: It starts with a layperson that indicates the emergency situation of a patient and ends with the professional treatment of the stroke patient at the intensive care unit - hopefully within a specialised hospital (e.g. stroke unit).

On a top level, the stroke chain of survival can be divided into the following three phases:

i. Identification and alarm: The first phase of the stroke chain of survival typically begins with the identification of an emergency by a layperson. Professional service providers are typically alarmed by calling an RCC, by first calling or visiting a family doctor and at arrival at a hospital.

ii. Preclinical treatment: With the emergency call at the RCC, the second phase of the chain of survival starts. After collecting all information needed from the emergency, the control-assistant gets this information in order to alarm the EMS. The EMS drives to the patient, starts the professionally first aid, gives a first diagnosis and transports the patient to the hospital where the third and last phase of the stroke chain of survival starts.

iii. Clinical treatment: After the report of the EMS to the doctors at the accident and the emergency department (A&E department), the diagnosis given by the EMS has to be confirmed. During the clinical phase, the medical history is taken, the patient is examined and the imaging is applied in order to identify the exact type and the localisation of the stroke. Depending on the exact diagnosis and the time spent since the initial event the therapy can be started.

Alternatives of possible therapies depend heavily on the time being spent since the initial stroke event. To save as much time as possible, an efficient and fast emergency management from the beginning of the stroke symptoms to the diagnosis using imaging is necessary. Efficient emergency management results from a good teamwork between the layperson, the Rescue Coordination Center (RCC), the EMS and the hospital involved.

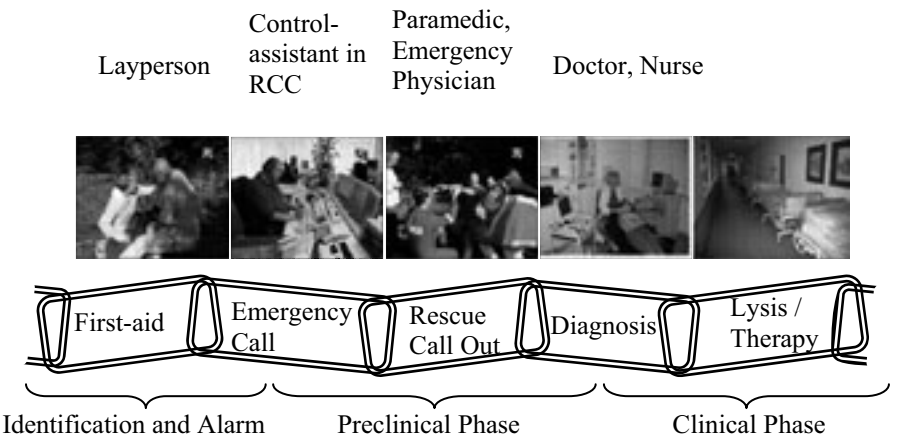



Figure 2: Stroke Chain of Survival

Challenges for the improvement of the stroke chain of survival result from the decision making and communication tasks within and between the different chain limbs: The problem is that the "[A]chain of survival is only as strong as its weakest link" [JCNV01]. The Stroke Angel System was started to overcome these problems it appears promising to support the decision making and the information exchange during the chain.

## 3 Stroke Angel: Mobile IT usage in the stroke chain of survival

The Stroke Angel[2] project started in 2006. The German partners are Neurological Clinic of the Rhön Klinikum Bad Neustadt/Saale, Bayerisches Rotes Kreuz Bad Neustadt/Saale, Heinrich-Heine-University in Düsseldorf, as well as Philips Research from Aachen and FZI Research Centre for Information Technology Karlsruhe. Together, they joint forces to apply the technical solution from Philips Research in the two test regions Düsseldorf and Bad Neustadt/Saale with the support of Boehringer Ingelheim Pharma and Stiftung Deutsche Schlaganfall-Hilfe. The intention of the project is to speed up the treatment of patients in the intersectional stroke chain of survival with help of mobile technologies (the Stroke Angel system).

[2] See www.strokeangel.de.

The Stroke Angel study aims at

- helping EMS to systematically support stroke diagnosis in the ambulance with a structured checklist for stroke diagnosis (e.g. Los Angeles Prehospital Stroke Screen – LAPSS) and other patient data on a portable computer (PDA),
- sending the corresponding information from EMS to the hospital through radio communication, and
- enabling the neurological clinic to be already prepared when patients arrive.

The system is evaluated in order to point out the chances and risks of such a mobile system by an interdisciplinary approach with economic, medical and social-technical partners involved. Before explaining the evaluation methodology, we present the system architecture, the decision support through the Stroke Angel system and the user interface in order to give an overview of the integrated technology.

### 3.1 System Architecture of the Stroke Angel System

The Stroke Angel system aims to be a coordination and support interface between the EMS and the Stroke Unit and hospital respectively. Figure 3 illustrates the architecture of the Stroke Angel system and the communication links between the EMS which collects patients data and sends them via Bluetooth connection of the mobile phone to the Stroke Angel Server of the hospital.

The Stroke Angel software runs on a personal digital assistant (PDA). The current prototype can read standardised patient cards containing demographic and insurance data of a patient.

The Stroke Angel system of the EMS transmits the patient data to the Stroke Angel Server, which resides on a computer in the A&E department of the hospital. The Stroke Angel system connects via Bluetooth to a mobile phone, which establishes a wireless data link using mobile communication technologies such as GSM/HSCSD, GPRS, or UMTS.

The actual data transmission between the Stroke Angel software and the Stroke Angel Server runs over a TCP/IP-based connection. More specifically, the Stroke Angel Server exposes a web service interface which is consumed by the Stroke Angel client. In order to prevent unauthorised access to the Stroke Angel Server and to the patient data during data transmission, the web service invocation is secured by strong SSL encryption (128 bit) with both client and server authentication. In addition, the GPRS dial-in node resides within the hospital, so that no data has to be transmitted via internet.

Whenever new patient data arrives at the Stroke Server, a GUI client is notified that runs on the A&E department computer. In response to this notification, the GUI client issues an alert. By clicking on the alert, the physician is displayed to a form with the Stroke Angel data.

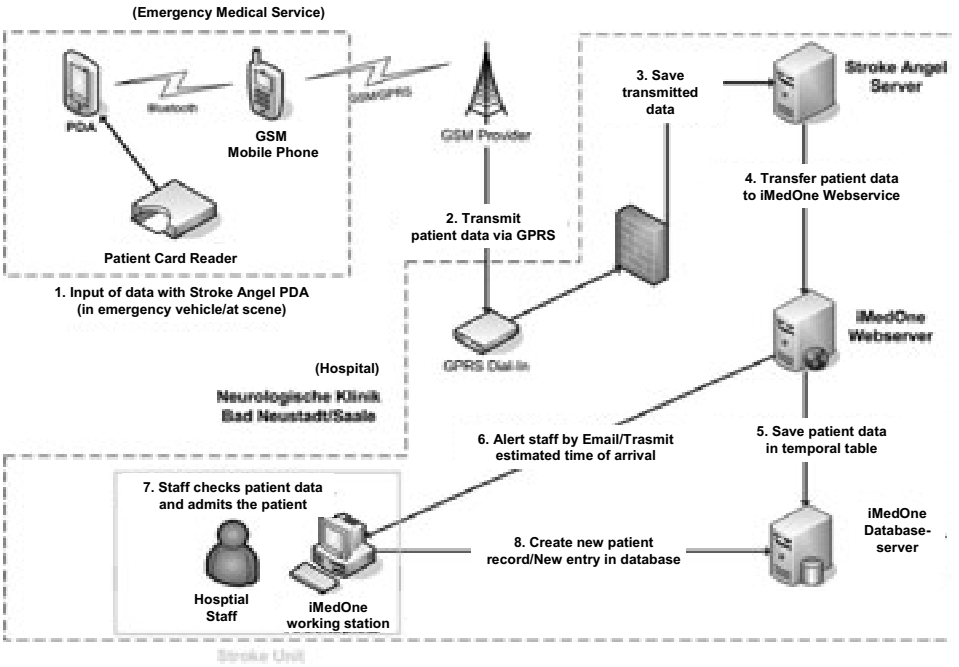



Figure 3: Stroke Angel Architecture with communication links

In the initial setup, the Stroke Angel Server was isolated from the rest of the hospital IT infrastructure. To create a new patient record, all patient data had to be manually transferred into the hospital's administrative IT system called iMedOne. In addition, the doctors at the A&E department would only realise an incoming patient if they were sitting in front of the Stroke Angel Server at the time of data transferral. To improve the information flow, currently a link from the Stroke Angel Server into the iMedOne system is implemented. After this implementation, whenever new patient data arrives at the Stroke Angel Server, these data will be forwarded via a web-service interface to the iMedOne system. Then, the iMedOne system will create a temporary new patient record and will be able to notify the doctors and nurses using communication means such as email or pagers.

The primary purpose of the Stroke Angel is to help the paramedic identify acute stroke patients and to assist them in capturing all relevant stroke information. The actual stroke protocol has been embedded into a more general emergency protocol for the following reasons:

- Only 2% of all emergency cases are stroke related [Hand03]. If the Stroke Angel system is only applied in these rare cases, the paramedics will not gain sufficient familiarity with the tool. Eventually, they might become reluctant to use the tool at all.

- The use of the Stroke Angel system by paramedics implies a concrete suspicion that the symptoms have been caused by a stroke. However, the objective is to support paramedics even in those cases where a stroke is not obvious.

- The paramedic is obliged to document patient data anyway. This is currently done using a special paper-based protocol [LuFl00]. A large share of this data, however, is relevant for stroke as well. This would result in a duplicate documentation effort for these data in a stroke case. Consequently, the Stroke Angel system implements a standard emergency documentation protocol into which the stroke-related part is embedded. Thus, the Stroke Angel system is in the first place an electronic replacement for the mandatory – and traditionally paper-based - documentation of an EMS run, which has to be done anyway. The stroke sub protocol can then either be invoked explicitly by the user or automatically triggered by a rule-based alert system based on the data entered in the general emergency protocol.

### 3.2 Decision Support in Stroke Angel

The Stroke Angel system provides decision support at levels of procedural guidance, completeness and plausibility checks, triggering the stroke protocol and at levels of hospital selection.

At procedural guidance, the Stroke Angel system suggests a predefined path through the necessary emergency procedures according to the structure of the mandatory protocol and the supplementary implemented LAPSS. Completeness and plausibility checks are run on finalization of the emergency protocol, so that the Stroke Angel system controls whether all mandatory items have been filled in. Triggering the stroke protocol, a rule-based system within the Stroke Angel system evaluates the data being entered into the standard emergency protocol. According to the specified rules, indicators for neurological problems (e.g., speech deficits or one-sided limitations of the mobility of extremities) are monitored. In case of a possible stroke suspicion, the Stroke Angel system suggests conducting the LAPSS. The paramedic can also manually invoke the LAPSS. Finally, at hospital selection, the Stroke Angel system issues a stroke alert and recommends the admission of the patient to a stroke unit, depending on the results of the LAPSS examination. Future versions of the Stroke Angel system will provide GPS-based navigation support to determine the nearest hospital with a stroke unit.

### 3.3 User Interface of the Stroke Angel System

The user interface of the Stroke Angel system consists of forms for each section of the emergency protocol and for the LAPSS. As the screen space of a PDA device is limited to 240 x 320 pixels, most sections of the emergency protocol had to be split over several tabs within a form. The upper area of the screen space is reserved for navigation controls.

As there is only a virtual keyboard available on the PDA, entry of textual data is a critical usability issue. In order to facilitate data entry as much as possible a patient card reader was added for support so that data such as name, address and insurance information can be directly read from the patients' health insurance card. Wherever possible, the Stroke Angel system can be pre-configured with default values for certain items (e.g. the names of the ambulance personnel which do not change with each run). There are also user-definable text element lists for diagnoses, findings, treatments and situations description that can be used within free-text areas.

### 3.4 Methodology: Evaluation with an interdisciplinary approach

In order to evaluate the Stroke Angel System different aspects are analysed:

- To figure out the specifications and functions required, a requirement and functional analysis is conducted.
- A process analysis delivers the different impacts of such an introduction.
- Expectations concerning the new technology are detected by carrying out a user acceptance analysis and stakeholder analysis, respectively.

For the purpose of testing the technical implementation, specification, requirements and functionality of the Stroke Angel system are examined. Investigations focus mainly on aspects of maintenance, applicability, robustness, integration, legal requirements and data security.

The process analysis comprises modelling of stroke chain processes just as measuring and comparing measuring points with and without Stroke Angel and is carried by the following four steps [HRGG06]:

Step 1: In order to collect the structure of the process and to point out the impact of the technical and economic approach, the parties involved have to be identified, the workflow has to be rudely structured and modelled as well as the process models have to be adjusted with the parties involved.

Step 2: After taking up the structure of the process, the time measuring points have to be identified, ensuring that they are measurable at all and measurement is as exact and easy as possible to ensure timeliness and cost efficiency. The objective of this step is to find out which sections of the process are affected by the introduction of the system, which time spans have to be collected.

Step 3: The data collection and interpretation for the actual analysis has been performed in the third step. Therefore, the clinical and emergency protocols of 2006/07 with Stroke Angel and of 2005 without Stroke Angel are used. All collected data is used in the process models in order to obtain time periods to interpret.

Step 4: In the fourth and last step, the processes will be simulated in order to indicate optimisation potential in and between process sectors.

Furthermore, user analysis are performed to examine the usability of Stroke Angel and to analyse the impact of the human factor within the chain of survival. It is the objective to survey the degree of satisfaction and to recognize expectations and needs of every individual stakeholder. Therefore, the relevant stakeholder groups of the stroke chain of survival are identified and surveyed.

## 4 First Results of the Analysis

The Stroke Angel system has been in use for 18 months and has been evaluated during all the time by the above described methodology. The functional analysis and a preliminary time analysis have been performed. Furthermore, user acceptance factors have been identified and an overview about the expectations and experiences of the Stroke Angel users has been obtained.

### 4.1 Requirement and Functional Analysis

The examination of the requirements, functionality and specification has shown that the proposed technical solution seems to be suitable for the usage in ambulances. Stroke Angel is a pragmatic approach, meeting all requirements and supporting the treatment of stroke patients using less technological effort. The mobility, which is also a relevant requirement allowing unproblematic operation, has also been observed.

Over a period of 18 months only one device got broken, so that the maintenance of the devices has been proved with satisfaction. Batteries' charge of the PDA lasted out the operation during an emergency without any difficulties and offers capacity for a long usage. For reasons of applicability, the data is sent automatically as early as the ambulance enters an area without dead spots of GPRS. This is an important observation, because the region around Bad Neustadt/Saale is a rural area with less deep coverage of radio transmission.

Until now, the robustness of the Stroke Angel system with its PDA, mobile phone and card reader could be demonstrate, even if not all EMS didn't need to use the system outdoors. Another aspect focused by the requirements and functional analysis was the integration of the Stroke Angel system within the involved parties of the stroke chain of survival. On the part of the EMS, the data collected through the Stroke Angel system is used for the mandatory documentation of the emergency case. Within the hospital, the examination of the integration has shown that for the moment the data from the Stroke Angel server can not be transferred digitally to the information system of the hospital. Non-existing interfaces between both components effort a manual transfer, because the producer of the information system has not been prepared to such an inter-organisational collaboration. This problem will be solved during the project.

Finally, the legal requirements and data security are fulfilled. All entered information has been transmitted fully and correctly to the hospital. The speed of radio transmission by mobile radio is sufficient, as the transmitted data only contains light-weight textual information.

### 4.2 Process Analysis

The first step of the process analysis mentioned above comprises the identification of the parties involved. In this context, the RCC of Schweinfurt, which assumes the coordination between the EMS (in that case the Bayerisches Rotes Kreuz), the emergency physicians and the Neurological clinic Bad Neustadt/Saale have been identified as the four important stakeholders. This selection is due to the direct involvement within the Stroke Angel system wherefore their intervention affects the workflow of decision making and information. Furthermore, the workflow has been rudely structured and modelled in order to gain process models. The measuring points in the second step have been identified concerning the process models of the previous step. Figure 4 illustrates the rude process workflows in relation with the collected measuring points (rectangles). The measuring points are chosen according to the EMS communication protocol[3] and to early medical studies [NINDS95].

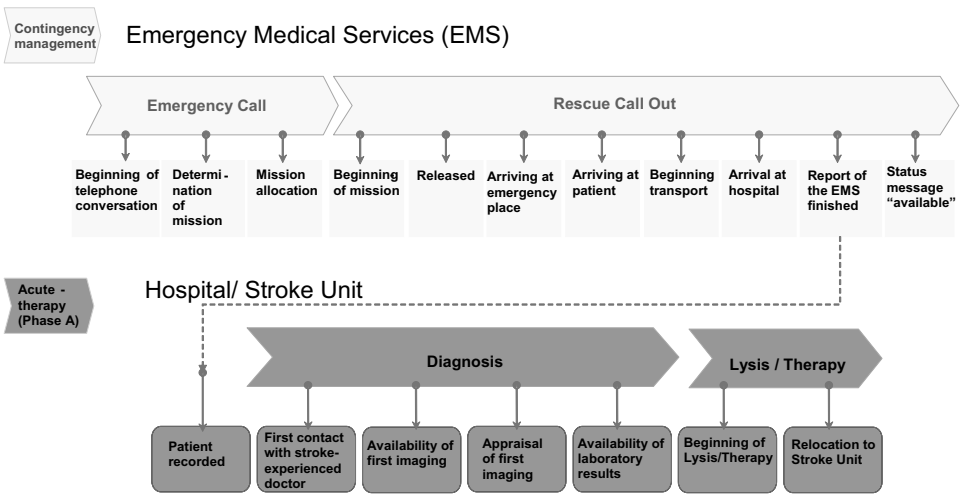



Figure 4: Overview of selected Measuring Points

[3] http://www.divi-org.de/

By the third step, data of the identified measuring points has been collected by utilising the existing emergency protocols, collecting data from the patient records and from additive collected data from the EMS processes. As a result of the fourth step, Table 1 contains the results of the recent data collection and compares the data of the year 2005 (without Stroke Angel) and the year 2006/07 (with Stroke Angel). The key performance indicators are "time in situ" and "time-to-imaging". Altogether, 197 cases have been admitted into hospital in 2005 and 180 cases since the start of the Stroke Angel (since January 2006/07) system. As a first improvement it can be highlighted, that the number of cases taken in hospital within 3 hours has been increased since start of the Stroke Angel system.

Table 1 lists the process time of both stroke patients, those whose stroke is less than three hours ago, and those of them who received a lysis treatment. The figures show differences of the process time regarding several process steps which were assigned to determine the performance of the preclinical and the clinical processes. The preclinical time discloses the "time in situ" recording how long paramedics need to start the professional first aid and to give a first diagnosis whereas the "transportation time" shows the time required to carry the patient to the hospital. "Time-to-imaging" represents the time needed during the clinical phase in order to diagnose the kind of stroke from the incoming patient with help of computer tomography.

| | **Incident < 3h** | | **Lysis** | |
|---|---|---|---|---|
| | 2005 | 2006/07 | 2005 | 2006/07 |
| Number of samples N | 78 | 104 | 18 | 13 |
| Time in situ | 00:18 | 00:23 | 00:19 | 00:23 |
| Transportation time | 00:23 | 00:22 | 00:28 | 00:23 |
| Time-to-imaging | 00:48 | 00:36 | 00:32 | 00:23 |

Table 1: Results with (2006/07) and without Stroke Angel system (2005)

In general, the results lead to the conclusion that Stroke Angel has improved the emergency management in total. Surprisingly, even though the "time in situ" retards in average around 5 minutes for all patients (4 minutes for all patients with lysis), it is compensated by the shorter transportation time, i.e. paramedics seem to need more time to enter the data, but they get alarmed earlier by the LAPSS. The introduction of the LAPSS makes them feel self-confident regarding the urgency of the incident. Consequently, the signal alarm was used more often in 2006/07 in order to speed up the transportation process. This conclusion can be empirically proofed according to subsequent questionnaires. Even though the "time in situ" using Stroke Angel has been increased, the "time-to-imaging" has been improved due to more fundamental decision making and due to earlier information and preparation of the neurological clinic saving 9 minutes (mainly on treatments of lysis-candidates).

Since the operation of the Stroke Angel system in 2006/2007, the total time entering the hospital to brain-imaging by computer tomography or magnetic resonance tomography has been reduced from 32 to 23 minutes for around 30% of the patients with lysis, due to parallel preparation and faster recording of the patient at the hospitals reception desk. In case of incoming patients whose stroke symptoms are less than three hours ago the "time-to-imaging" could be decreased by around 25% from 48 to 36 minutes.

### 4.3 User Acceptance and Stakeholder Analysis

Besides the first results of the process analysis, feedback from the user acceptance and stakeholder analysis also reveal positive signals. Generally, the interviewed participants desire the Stroke Angel system to be continued and to be employed in other regions, too. The users of the Stroke Angel expect a potential for saving time and they consider the LAPSS score as a helpful aide-mémoire and a good safeguard. They pointed out that the documentation of the emergencies was improved due to the fact that the Stroke Angel data can be printed out at the hospital and make the usual pen- and paper-based documentation unnecessary.

Nevertheless, during the interviews doubts were mentioned, too, e.g. the concern about losing time by the delay during the data entry in situ. Beyond that, it was observed, that not all users were satisfied with the user interface of the hardware ("Display is too small and Data-Entry by Pen is difficult at the scene and during transport") and, as expected, the PDAs are used more often by younger employees, while older colleagues first were more reluctant. Anyway, it turned out that the rescue workers got familiar with the handhelds quickly by playing mini-games on the handhelds during their breaks and between emergencies.

## 5 Discussion and Outlook[4]

After giving an introduction of the medical background, the case study Stroke Angel with its technological concept has been presented and the analysis methodologies have been explained.

Although some weaknesses (e.g. of the user interface) have been reported the results of the requirement and functional analysis approve that the current technical solution of the Stroke Angel system is appropriate for a practical application. The technical architecture of Stroke Angel is already running smoothly and quite sophisticated for a clinical trial. The mobile devices may be improved for better handling e.g. by using a bigger display. The use of different mobile devices (like e.g. Tablet PCs) and a combination with additional mobile services (like e.g. navigation systems) is deemed promising.

[4] Acknowledgement: The authors wish to thank all partners of the Stroke Angel as well as the PerCoMed (www.percomed.de) project team for their support, continuous discussions and critical feedback.

Future work could analyse if the user interaction can be better facilitated by speech recognition, gesture control, digital pen, or similar approaches. A stronger integration with possible ambulance infrastructure (like e.g. electrocardiogram ECG) could also be valuable.

Preliminary results of the process analysis offer promising insights. Although not all influence factors and dependencies are checked so far and statistical measures haven't been applied, there is a strong indication that the system allows for significant progress in decision making quality and hence resource allocation arbitrations. Exact results will have to be provided with the final data. Hopefully expectations can then be approved and experiences of the Stroke Angel study transferred to other emergencies scenarios.

Complementary research, which is performed by the medical partners at Rhön Klinikum as well as at the Heinrich-Heine-University in Düsseldorf, analyse the applicability of the LAPSS and alternative scores in detail. First results indicate that decision making should possibly be based on more complex scores and algorithms. Mobile IT would allow to do so easily. With systems like Stroke Angel one is no longer limited to the frameworks provided by the former pen&paper-based checklists and reasoning methods.

Finding reliable diagnosis as early as possible in the preclinical phase can clearly assure that treatment alternatives for the clinical phase remain possible. This is likely to provide an overall increase in quality of medical care.

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