PRoF Award abstract – Call 2015

TELESTROKE-AMBULANCE

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1. Research Outline

Acronym	TELESTROKE-AMBULANCE
Project name in English	Implementation of telemedicine in ambulances to improve acute stroke care
Pitch (1 sentence)	We aim to improve the outcome of stroke patients through mobile telemedicine bringing stroke experts virtually to patients during their ambulance transportation to the hospital.

Executive summary (max. 10 lines)

Stroke is a major global health problem. The personal and societal burden of stroke can be mitigated by rapid and competent emergency care. We have developed a scalable telemedicine solution to optimize acute stroke therapy by bringing expert physicians virtually to the ambulance. This allows immediate initiation of treatment and notification of the medical team in the hospital awaiting the patient. We were the first to develop a proof-of-concept for 24/7 in-ambulance telestroke support and to show that this approach is technically feasible and well-accepted by all stakeholders. Evaluation of the medical efficacy and health economical sustainability is ongoing. TELESTROKE-AMBULANCE will have a significant societal impact and makes an ideal case to leverage telemedicine for improvement of emergency care as a whole.

2. Cause and context of the research

Stroke is a rapidly developing loss of brain function due to a disturbed cerebral blood supply. This condition is the second cause of death world-wide and the second cause of disability-adjusted life years.[1] Stroke poses a growing global health problem with major individual and societal impact.[2]

Acute stroke is a time-critical medical emergency requiring immediate specialized treatment. In the acute phase of an ischemic stroke, approximately two million brain cells die per minute. Stroke-induced disability and mortality can be mitigated by emergent expert medical support. Much progress has been achieved for inhospital stroke management, but a scalable solution to optimize prehospital care (before patient arrival at the hospital) has not yet been established.[3] Telemedicine for optimizing inhospital stroke care (telestroke) is currently applied in many countries to solve the shortage of stroke experts and to bring stroke expertise to underserved geographical areas.[4] This is in sharp contrast to the scarce experience with prehospital telestroke, which is confined to merely three feasibility studies in healthy volunteers[5-7] and two pilot studies in small patient populations.[8, 9]

Telemedicine is the premium solution to bridge the gap to prehospital emergency care by providing medical expertise at the patient's location and during ambulance transportation to the hospital. This is especially the case for acute stroke, which typically involves complex patient-doctor interactions and complicated medical decision making under time pressure.

The recent publication of the Green paper on Mobile Health by the European Commission underscores that now is the time to pioneer research in this domain as key technological developments have come of age, but many hurdles still need to be cleared to allow breakthrough results: (1) Interference with routine paramedic care in ambulances must be avoided as this may negatively impact the patients' outcome. (2) Facilitation of coherent decision making by a Clinical Decision Support System is needed. (3) Evidence must be provided that telemedicine results in improved care and better outcome for patients. (4) Data security should be guaranteed to assure patient privacy. (5) Liability issues need to be clarified. (6) Reimbursement of telemedicine should be inquired. (7) The health economic effects of prehospital telemedicine are to be investigated.

3. Innovation results achieved

Led by disruptive innovation, our team has made important technological advancements and we have accumulated unique expertise regarding in-ambulance telemedicine. We were the first to develop 24/7 in-ambulance telestroke support provided by medical experts.

We have overcome the first hurdle identified above by developing and validating a novel scale for assessment of stroke severity without assistance of a third party at the patient's bedside.[10] We have provided a proof-of-concept for in-ambulance telemedicine in studies with (1) healthy volunteers,[6] (2) patients with general emergency conditions,[9] and (3) patients with suspected stroke.[11, 12] These results indicate that in-ambulance telemedicine is a safe, valid, accurate, reliable, and user-friendly tool to provide expert care in the prehospital arena.

We have resolved major issues regarding in-ambulance telemedicine, among which (1) visualization of patients in real-time from head-to-toe with adequate spatial resolution and frame rate during emergency ambulance transportation, (2) quantification of stroke severity making use of our novel stroke scale for safe and rapid assessment without the need for assistance of a third party at the patient's bedside (Unassisted TeleStroke Scale), (3) standardized data collection and reporting to the inhospital medical team, (4) reliable mobile data connection using 3G/4G technology, (5) legal issues, including data security, patient privacy, and informed consent based on 'opt-out sampling', (6) quality of life for teleconsultants who can access the telemedicine system from virtually any location using a small laptop and WiFi or 4G connectivity. Figure 1 and 2 illustrate the in-ambulance telemedicine solution from the patient's perspective and from the teleconsultant's perspective, respectively.

The questions on patient privacy, liability, reimbursement and health economics are further being tackled by a multidisciplinary consortium led by our research group. We are also conducting a single-center prospective randomized clinical trial at the Universitair Ziekenhuis Brussel comparing in-ambulance telestroke with standard emergency care for evaluation of efficacy to reduce disability and mortality of stroke patients and to assess the health economic effects of this approach.[12]

We have included all stakeholders (cf. §4. on the PRoF values for an exhaustive list) in the design of the telemedicine solution from the very first steps. It may therefore not be surprising that our systematical assessments of user-friendliness yield very encouraging results.[6, 9, 11, 12]

Recently, we also enquired the beliefs and opinions of the broad public regarding in-ambulance telemedicine in a large-scale survey (results to be published soon). It is especially noteworthy that only a very small minority (6% of more than 600 respondents) would prefer not to receive in-ambulance telemedicine support in case of a suspected stroke.

Figure 1. Bidirectional audiovisual communication between the patient and the teleconsultant is possible via the telemedicine device that is mounted to the ceiling of the ambulance.

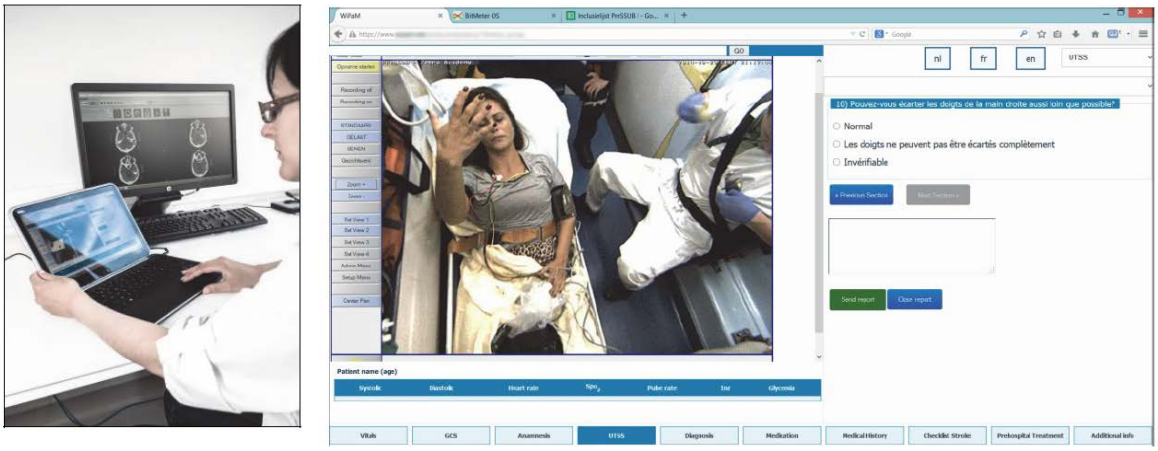

Figure 2. The teleconsultant uses a laptop computer to access the web-based telemedicine platform, showing video input from the ambulance (i.e. the patient spreading the fingers of her right hand) and the submenu of the Clinical Decision SupportSystem that is activated (i.e. item 10 of the Unassisted TeleStroke Scale in the language preferred by the patient). Navigation between the submenus is facilitated via touch screen activation of the buttons at the bottom.

A video fragment illustrating a real-life prehospital teleconsultation can freely be downloaded from: *http://journals.plos.org/plosone/article/asset?unique&id=info:doi/10.1371/journal.pone.0110043.s001*

4. Link to the PRoF values

The PRoF values can be found at the very heart of the TELESTROKE-AMBULANCE. Already from the very first steps and ever since throughout the entire project, we strongly have kept the emphasis on integrating the input from product designers into our research and development strategy. This helped us to include a 360° evaluation of all telemedicine related aspects, taking into account the opinions of patients, patients' relatives, paramedics, nurses, stroke experts, emergency physicians, radiologists, innovation specialists, business engineers, communication engineers, IT engineers, hospital management, lawyers, patenting offices, business developers, and representatives from social security and the political domain.

Minimal comfort

To ensure comfort for patients, paramedics and nurses, we gave special attention to the design and location of the telemedicine device in the ambulance. The device's dimensions were kept as small as possible. Most importantly, the device is fixated at the ambulance's ceiling where it is out of the way for paramedics and nurses while providing emergency care. The fixation system meets all regulatory requirements for emergency transportation and has officially been certified.

Much in contrast to other telemedicine systems, we have succeeded to create a mobile solution for the teleconsultants. Whereas other systems require physicians to use a specific telemedicine console, which typically is located inside a hospital or call center, our approach is based on lightweight laptops, mobile internet and a web-based telemedicine platform. This allows teleconsultants to access the system from virtually everywhere. This facilitates 24/7 availability of medical expertise and improves the quality of life of physicians who can attend to social activities rather than being confined to a hospital while being on guard.

Privacy

We have invested much of our energy in the protection of patient privacy. Technically, data privacy is, among others, secured by password-protected login, role-base access control, hypertext transfer protocol secure encryption, and transfer through a virtual private network. It further goes without saying that all healthcare professionals, teleconsultants included, are kept to their professional secrecy.

Security

The technical measures to guaranty data security and patient safety are described under the paragraphs *Privacy* and *Minimal comfort*, respectively.

Anti-loneliness

We consistently receive the input from paramedics and nurses the that virtual presence of a stroke physician via telemedicine not only provides medical assistance. It also offers a very welcomed moral support for the paramedic or nurse, who can feel very lonely when making challenging decisions in the prehospital setting.

Loneliness also is an underestimated problem for physicians who may experience imbalance between professional commitments and familial or social life. The mobile approach detailed in the paragraph *Minimal comfort* allows teleconsultants to better harmonize their various responsibilities as 24/7 presence at the hospital is not mandatory.

Non stigmatising solutions

In-ambulance telemedicine is at the disposal of each and any patient who is transported by an ambulance equipped with this device. Of course, no distinction is made based on age, gender, etnicity or any other characteristic.

Regarding the technical applicability, we have focused during the development of our telemedicine solution on a 'plug-and-play' design, allowing all types of ambulances to be equipped with our solution.

Inter generational

In-ambulance telemedicine is offered to patients of all ages. Most teleconsultations involve interaction between individuals representing various generations: a typical stroke patient is older than 60 years, whereas most emergency paramedics are in their forties or fifties and our team of teleconsultants consists of stroke physicians in their thirties. Despite the hectic during emergency transportations of critically ill patients, inter generational conflicts have not occurred sofar.

Respect

All teleconsultations are based on respectful and professional patient-physician interactions according to good clinical practice guidelines. The diagnostic and therapeutic independence of bedside paramedics and remote teleconsultants is mutually respected, within their standing operating procedures.

Flexibility

The high degree of mobility and flexibility, both in the ambulance setting and for teleconsultants is described in more detail in the paragraphs *Minimal comfort* and *Anti-loneliness.*

5. Applicable IPR rules

A Belgian patent has been granted for the in-ambulance telemedicine system (BE 2013/0287) and an international patent has been filed. The algorithm for the clinical decision support system has been registered and CE marking of the telemedicine system is ongoing. All information disclosed in this document is freely available (or will very soon be) in the public domain.

6. Information on the partners

The research and development of TELESTROKE-AMBULANCE is led by a multidisciplinary team from the Universitair Zieken Brussel and the Center for Neurosciences (C4N) of the Vrije Universiteit Brussel. This team consists of various medical experts, engineers, and an innovation specialist.

The project is strongly embedded in several research consortia within the Vrije Universiteit Brussel (e.g. Faculty of Medicine and Pharmacy, Department of Electronics and Informatics, Interdisciplinary Research Group on Law Science Technology & Society) and with other universities and university colleges (e.g. Interuniversity Center for Health Economics Research, Artesis Plantijn University College, University Catholique de Louvain, Université Libre de Bruxelles, Sahlgrenska University, Chalmers University of Technology, University of Oxford). We can also rely on independent input from a panel of renowned experts based at international institutions (e.g. University of Central Lancashire, University of Helsinki, Freie Universität Berlin, Georgetown University).

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We have built up long-standing partnerships with key companies in the field (e.g. Proximus, Materialise, IXSyS). In January 2015, we have started up a spinoff company of the Vrije Universiteit Brussel for providing specialist telemedicine care to stroke patients: Zebra Academy.

Addendum: References

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