CHALMERS

ASAP Stroke

Acute **S**upport **A**ssessment and **P**rioritizing

Can improved prehospital decision support reduce time delays to treatment?

Stefan Candefjord
Hoor Jalo

Digital Health in the BioMedical Signals & Systems Group

Care@Distance - Remote and Prehospital Digital Health

Supporting remote care & mobile teams in a new Health Care paradigm

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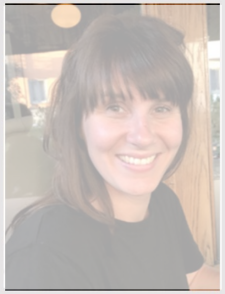

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Education in eHealth/Digital Health

- Masters Program Course since 2007
  (Initiated by B A Sjöqvist 2007; 2020 S Candefjord)
  ≈ 40 students/year
- Bachelor Program Course start 2020
  (S Candefjord)
  ≈ 60 students/year

On-going Collaborations

- Sahlgrenska University Hospital (SU)
  - Ambulance service
  - Neurology/Stroke
  - Trauma
  - Cardiology
- Region of Västra Götaland (VGR)
  - Sjukvårdens Larmcentral (SvLc; Dispatch)
  - Ambulance services
  - Primary Care (Närhälsan)
- City of Gothenburg (Göteborgs stad)
- Tre Stiftelser (Elderly Care)
- University of Borås/Prehospen
- VTI
- Norway
  - Oslo Met University
  - Östfold Univ.
- Industry
  - InterSystems
  - Nuance
  - Dedalus
  - Aweria
  - Telia
  - Cuviva
  - Raytelligence
  - Medfield Diagnostics
  - Dele Health
  - Autoliv Development
  - Volvo Cars
  - Consat
  - Detecht
  - SOS International
  - etc.

Our motto & vision

Increase Decision Precision
and
No errors in assessment, prioritization and handling!

Our Technology focus

Improving remote & prehospital care using:

- Data fusion
- Clinical decision support
- AI/ML
- Telemedicine
- Innovative user interaction

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ASAP

Acute **S**upport **A**ssessment and **P**rioritizing

- a generic concept for supporting data fusion, clinical decision support, AI, telemedicine and innovative user interaction in healthcare applications

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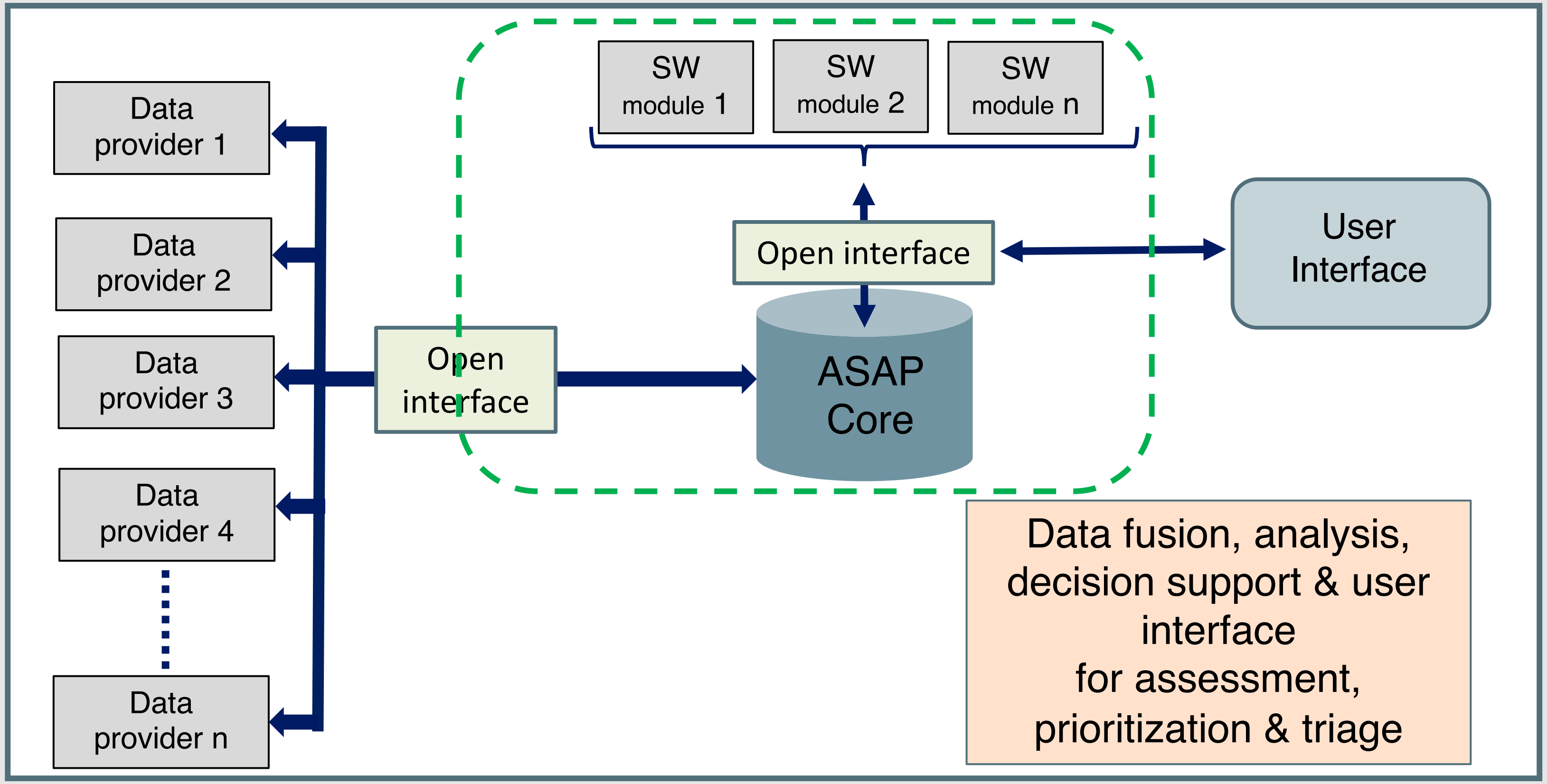
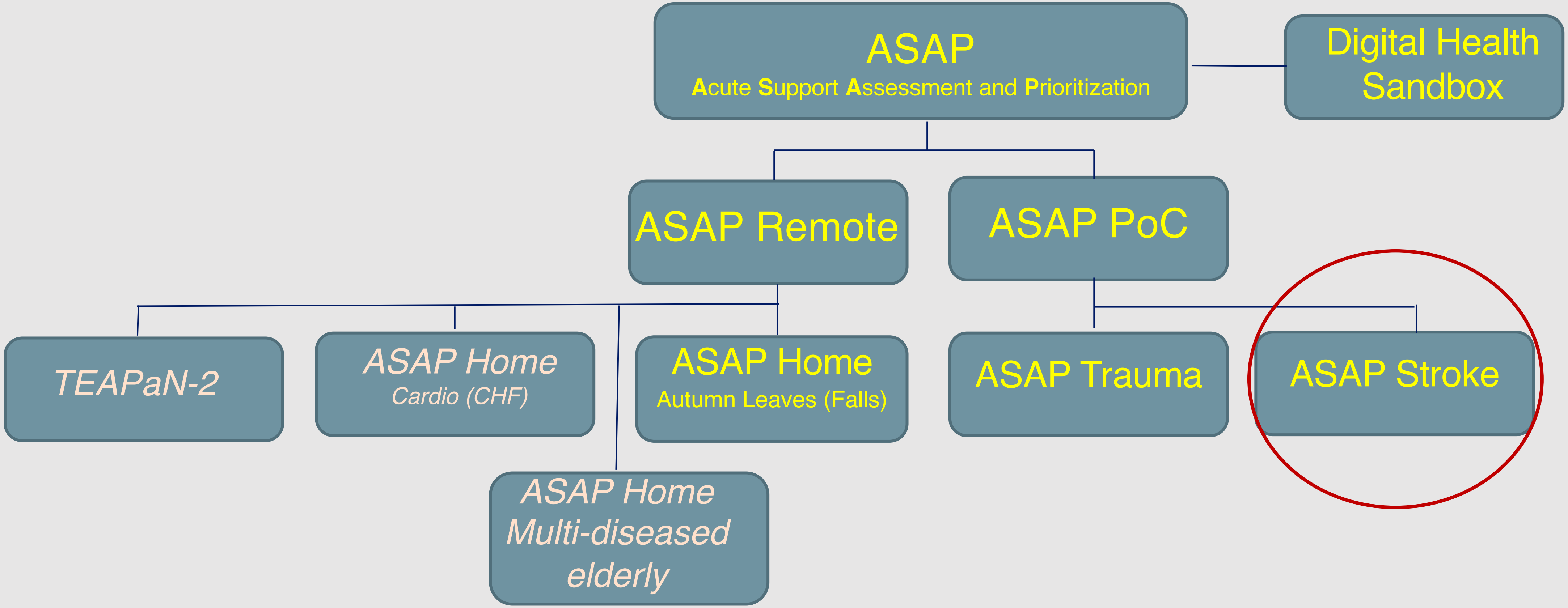
ASAP Concept

Supporting data-fusion, AI and clinical decision support

General structure ASAP



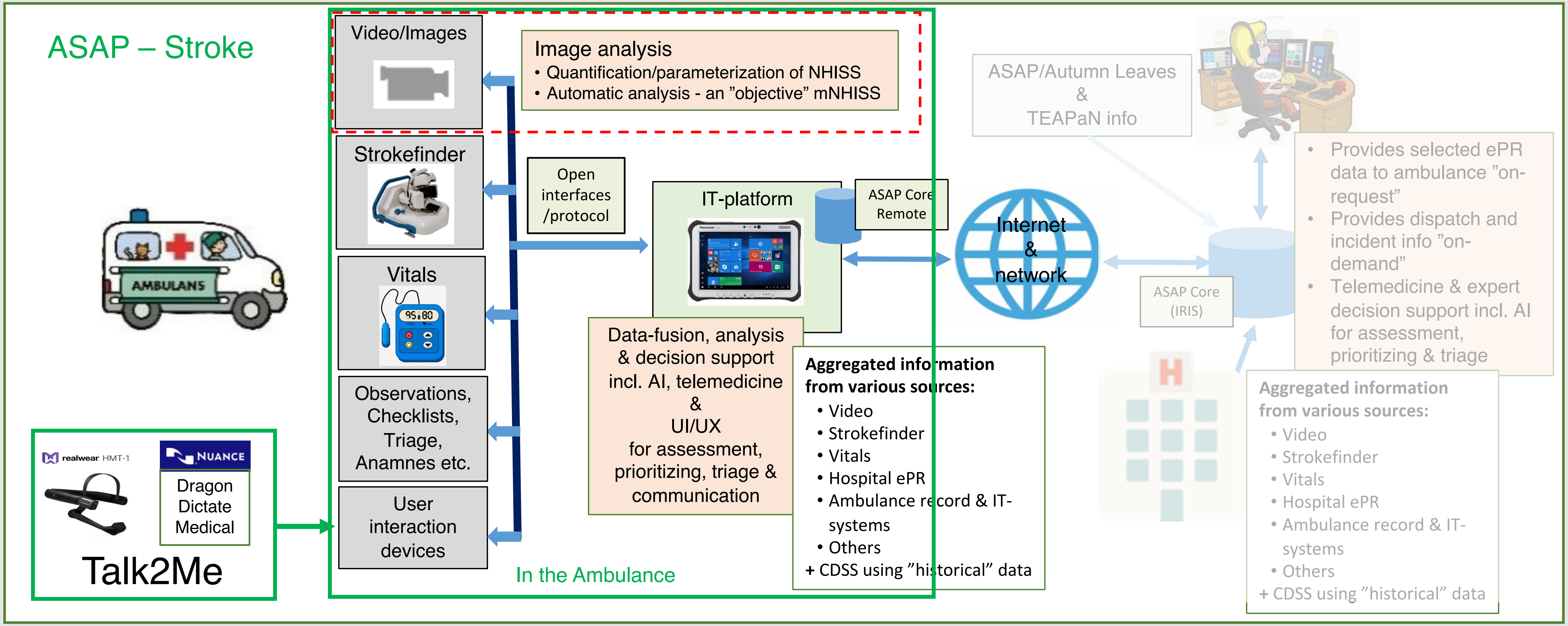
The ASAP Family Tree



ASAP PoC/Stroke

Telemedicine and innovative improving prehospital acute stroke care using data-fusion, image analysis AI supporting clinical decision user interaction

Overall technical concept



ASAP PoC/Stroke

Telemedicine and innovative improving prehospital acute stroke care using data-fusion, image analysis AI supporting clinical decision user interaction

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The main target of ASAP PoC/Stroke is to **increase decision precision.**

- Our goal is to develop a clinical decision support system that may include AI/ML utilizing data-fusion using data from various heterogenous sources and by promoting standards and interoperability between systems and devices.
- In next step we must make sure that the decision support solutions can be utilized in operational clinical environments and understandable and reliable enough for care personnel to use and trust.
- **A reduction in time delay, which is not just a result of logistics or driving faster, is always a combination of increased decision precision <u>and</u> care process**. Therefore, it is more important for us to focus on increasing decision precision and understand how this can influence the design of the care processes addressed.

ASAP PoC/Stroke

What are the different phases of this project?

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Phase I - Scoping review in the stroke decision making in prehospital assessment.

Phase II – Developing an AI decision support for prehospital stroke assessment based on the Swedish stroke registers.

Phase III – Machine learning and video analysis in early detection of stroke.

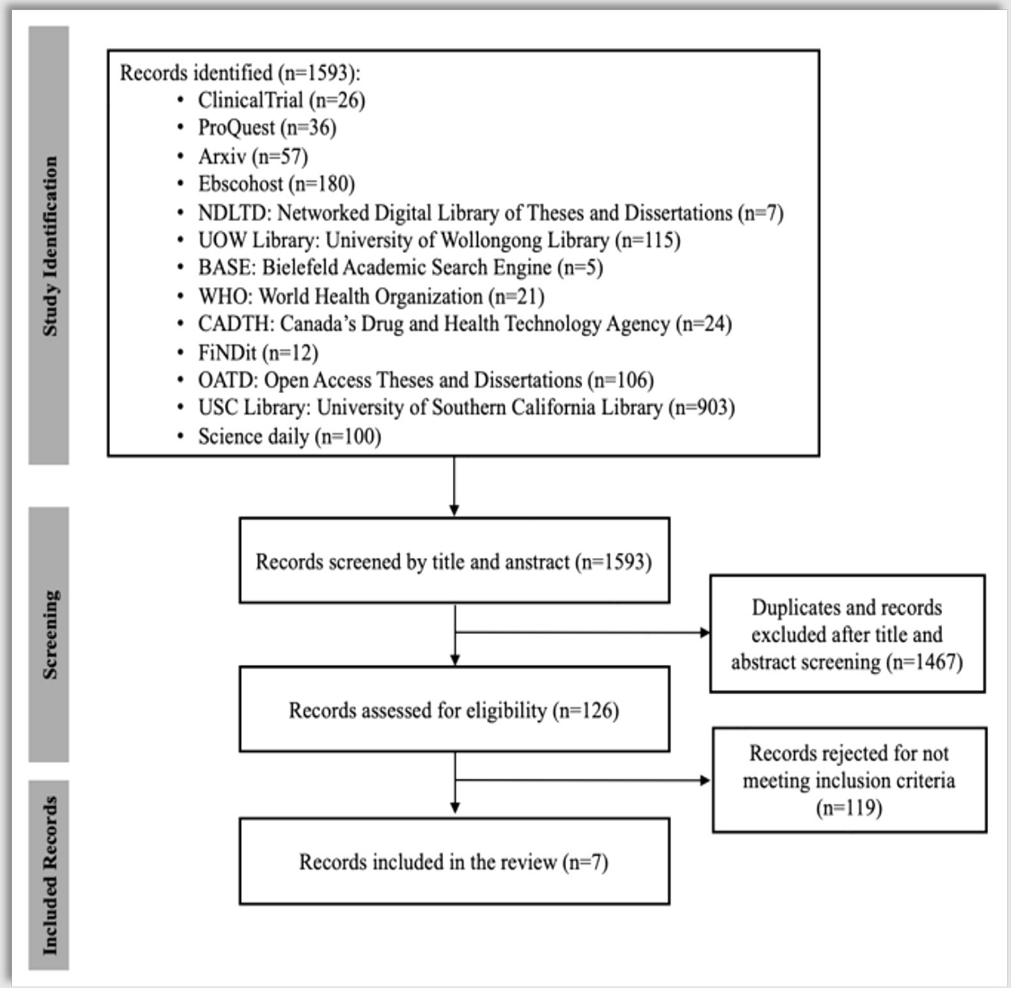
Phase IV – Simulation study to test the decision-support system in test ambulances (e.g., from ViPHS project).

Phase V - Clinical entry testing to evaluate clinical benefits of AI-based decision support systems.

ASAP PoC/Stroke

Phase I - Scoping review in the stroke decision making in prehospital assessment – Grey literature.

- *3 clinical trials*
- *2 mobile applications*
- *1 master's thesis*
- *1 PhD dissertation*

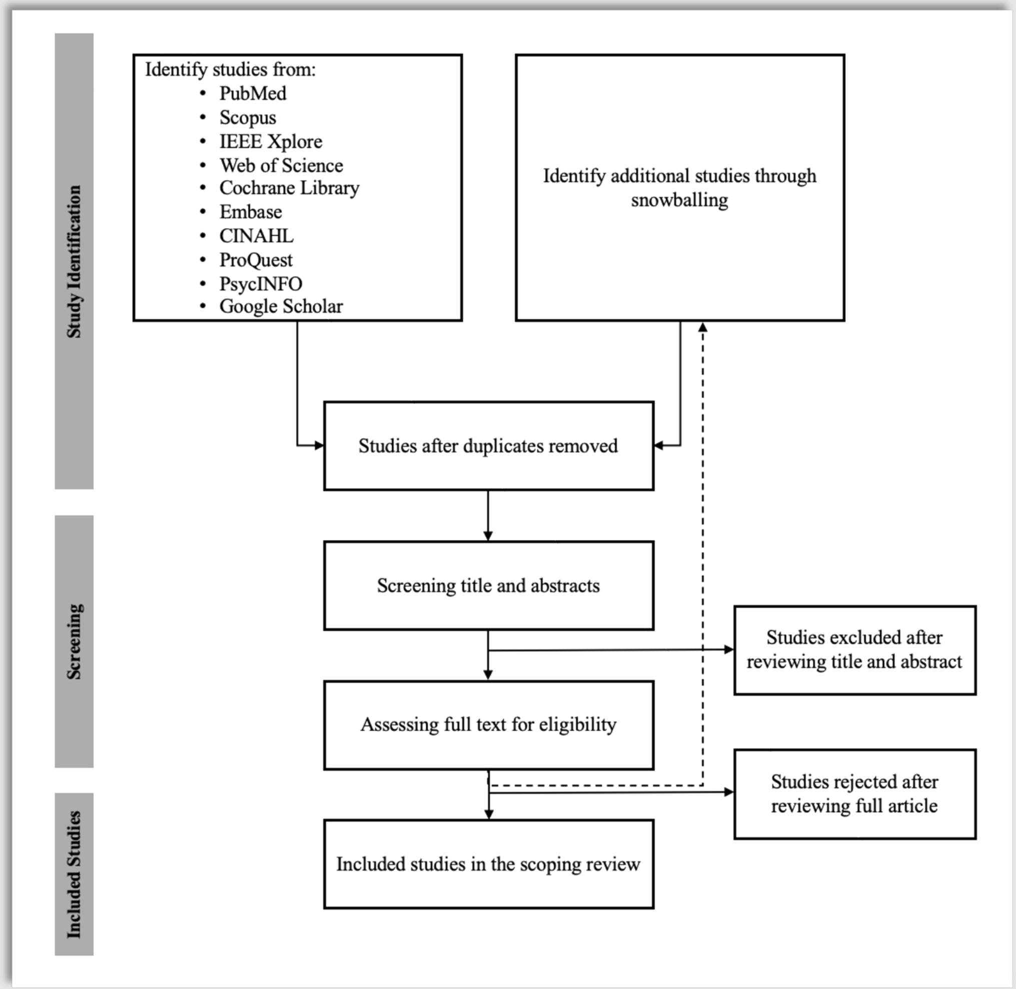


ASAP PoC/Stroke

Phase I - Scoping review in the stroke decision making in prehospital assessment – Peer-reviewed literature.

Aims of scoping review:

- To highlight the promising methods in early stroke characterization and investigate the possibility of using them as decision support systems for stroke, especially LVO.
- To compare the accuracy of AI-based decision support systems with the accuracy of clinical stroke scales based on evidence available in the literature.
- To identify new data sources and variables that could be used in the early characterization of stroke, e.g., vital data, observations by paramedics, biomarkers, sensors, video analysis, etc.



Emerging Detection Techniques for Large Vessel Occlusion Stroke: A Scoping Review

Jennifer K. Nicholls [1,2], Jonathan Ince [1], Jatinder S. Minhas [1,3] and Emma M. L. Chung [1,2,3,4]*

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Background: Large vessel occlusion (LVO) is the obstruction of large, proximal cerebral arteries and can account for up to 46% of acute ischaemic stroke (AIS) when both the A2 and P2 segments are included (from the anterior and posterior cerebral arteries). It is of paramount importance that LVO is promptly recognised to provide timely and effective acute stroke management. This review aims to scope recent literature to identify new emerging detection techniques for LVO. As a good comparator throughout this review, the commonly used National Institutes of Health Stroke Scale (NIHSS), at a cut-off of $\geq$11, has been reported to have a sensitivity of 86% and a specificity of 60% for LVO.

Methods: Four electronic databases (Medline *via* OVID, CINAHL, Scopus, and Web of Science), and grey literature using OpenGrey, were systematically searched for published literature investigating developments in detection methods for LVO, reported from 2015 to 2021. The protocol for the search was published with the Open Science Framework (10.17605/OSF.IO/A98KN). Two independent researchers screened the titles, abstracts, and full texts of the articles, assessing their eligibility for inclusion.

Results: The search identified 5,082 articles, in which 2,265 articles were screened to assess their eligibility. Sixty-two studies remained following full-text screening. LVO detection techniques were categorised into 5 groups: stroke scales ($n = 30$), imaging and physiological methods ($n = 15$), algorithmic and machine learning approaches ($n = 9$), physical symptoms ($n = 5$), and biomarkers ($n = 3$).

Conclusions: This scoping review has explored literature on novel and advancements in pre-existing detection methods for LVO. The results of this review highlight LVO detection techniques, such as stroke scales and biomarkers, with good sensitivity and specificity performance, whilst also showing advancements to support existing LVO confirmatory methods, such as neuroimaging.

Keywords: large vessel occlusion, LVO, stroke, stroke scale, biomarkers, algorithms, machine learning, imaging

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Machine Learning in Action: Stroke Diagnosis and Outcome Prediction

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The application of machine learning has rapidly evolved in medicine over the past decade. In stroke, commercially available machine learning algorithms have already been incorporated into clinical application for rapid diagnosis. The creation and advancement of deep learning techniques have greatly improved clinical utilization of machine learning tools and new algorithms continue to emerge with improved accuracy in stroke diagnosis and outcome prediction. Although imaging-based feature recognition and segmentation have significantly facilitated rapid stroke diagnosis and triaging, stroke prognostication is dependent on a multitude of patient specific as well as clinical factors and hence accurate outcome prediction remains challenging. Despite its vital role in stroke diagnosis and prognostication, it is important to recognize that machine learning output is only as good as the input data and the appropriateness of algorithm applied to any specific data set. Additionally, many studies on machine learning tend to be limited by small sample size and hence concerted efforts to collate data could improve evaluation of future machine learning tools in stroke. In the present state, machine learning technology serves as a helpful and efficient tool for rapid clinical decision making while oversight from clinical experts is still required to address specific aspects not accounted for in an automated algorithm. This article provides an overview of machine learning technology and a tabulated review of pertinent machine learning studies related to stroke diagnosis and outcome prediction.

Keywords: machine learning, artificial intelligence, deep learning, stroke diagnosis, stroke prognosis, stroke outcome prediction, machine learning in medical imaging, machine learning in medicine

INTRODUCTION

The term machine learning (ML) was coined by Arthur Samuel in 1959 (1). He investigated two machine learning procedures using the game of checkers and concluded that computers can be programmed quickly to play a better game of checkers than the person who wrote the program. Simply put, machine learning can be defined as a subfield of artificial intelligence (AI) that uses computerized algorithms to automatically improve performance through iterative learning process or experience (i.e., data acquisition) (2). Of late, the field of ML has vastly evolved with the development of various computerized algorithms for pattern recognition and data assimilation to improve predictions, decisions, perceptions, and actions across various fields and serves as an extension to the traditional statistical approaches. In our day-to-day life, a relatable example of

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What are the different phases of this project?

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Phase V - Clinical entry testing to evaluate clinical benefits of AI-based decision support systems.

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Phase II – Developing an AI decision support for prehospital stroke assessment based on the Swedish stroke registers.

VÄSTSTROKE

ett kvalitetsregister för hela strokevårdkedjan

EVAS

REGISTRET FÖR ENDOVASKULÄR BEHANDLING AV STROKE

RIKSSTROKE

The Swedish Stroke Register

- What are the type of data available in each register?

- What are the most important variables for the detection of LVO in prehospital environments?
  - Age
  - On-set time
  - Transportation time to comprehensive stroke centre
  - NIHSS score
    - Eye movement
    - Motor impairment
  - Comorbidity

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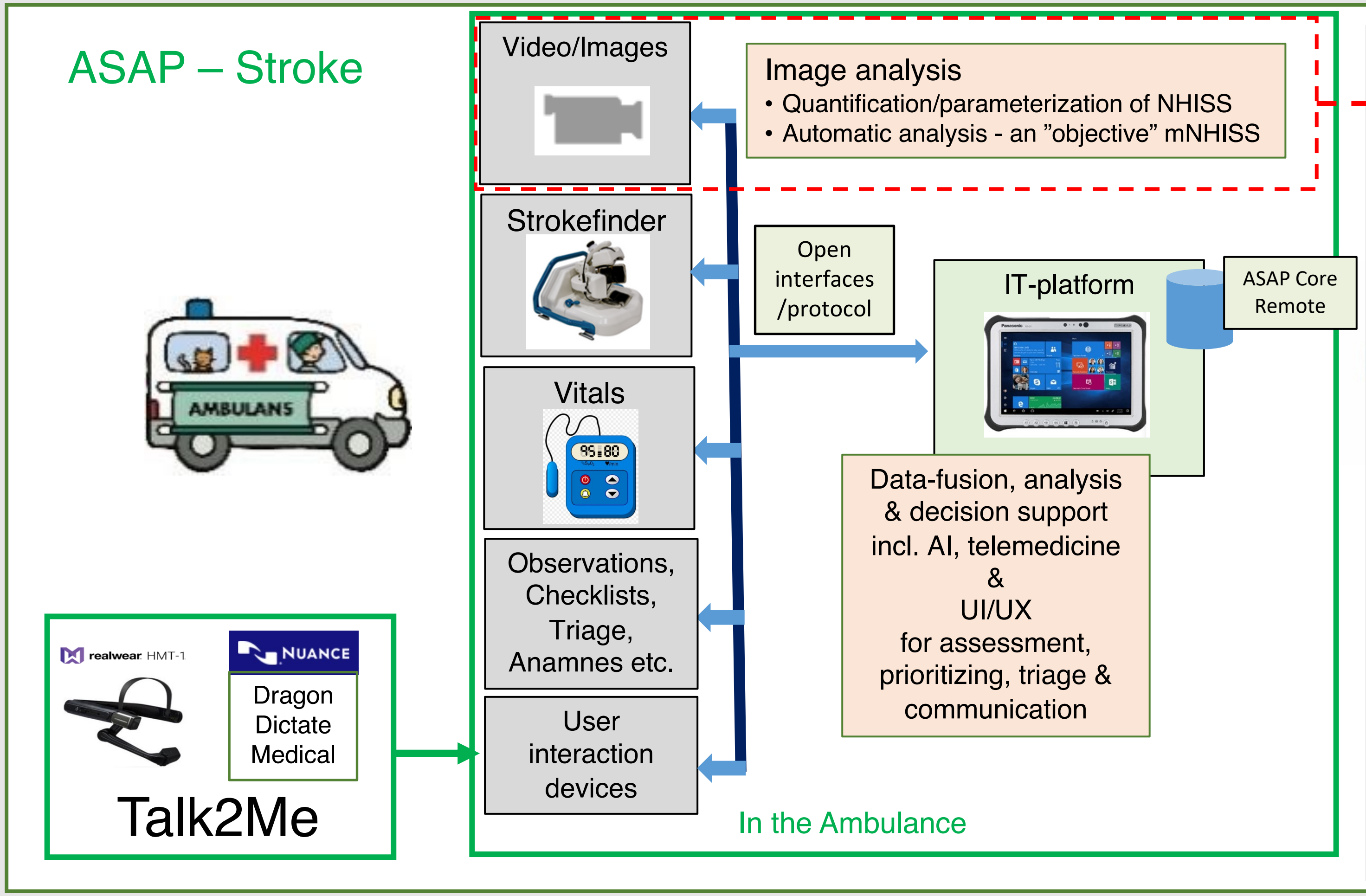
Phase III – Machine learning and video analysis in early detection of stroke.



Digitalization of NIHSS using machine learning and video analysis.

What can and cannot be digitalized?

- Facial expressions
- Eye movement
- Body movement
- Voice recognition (maybe)

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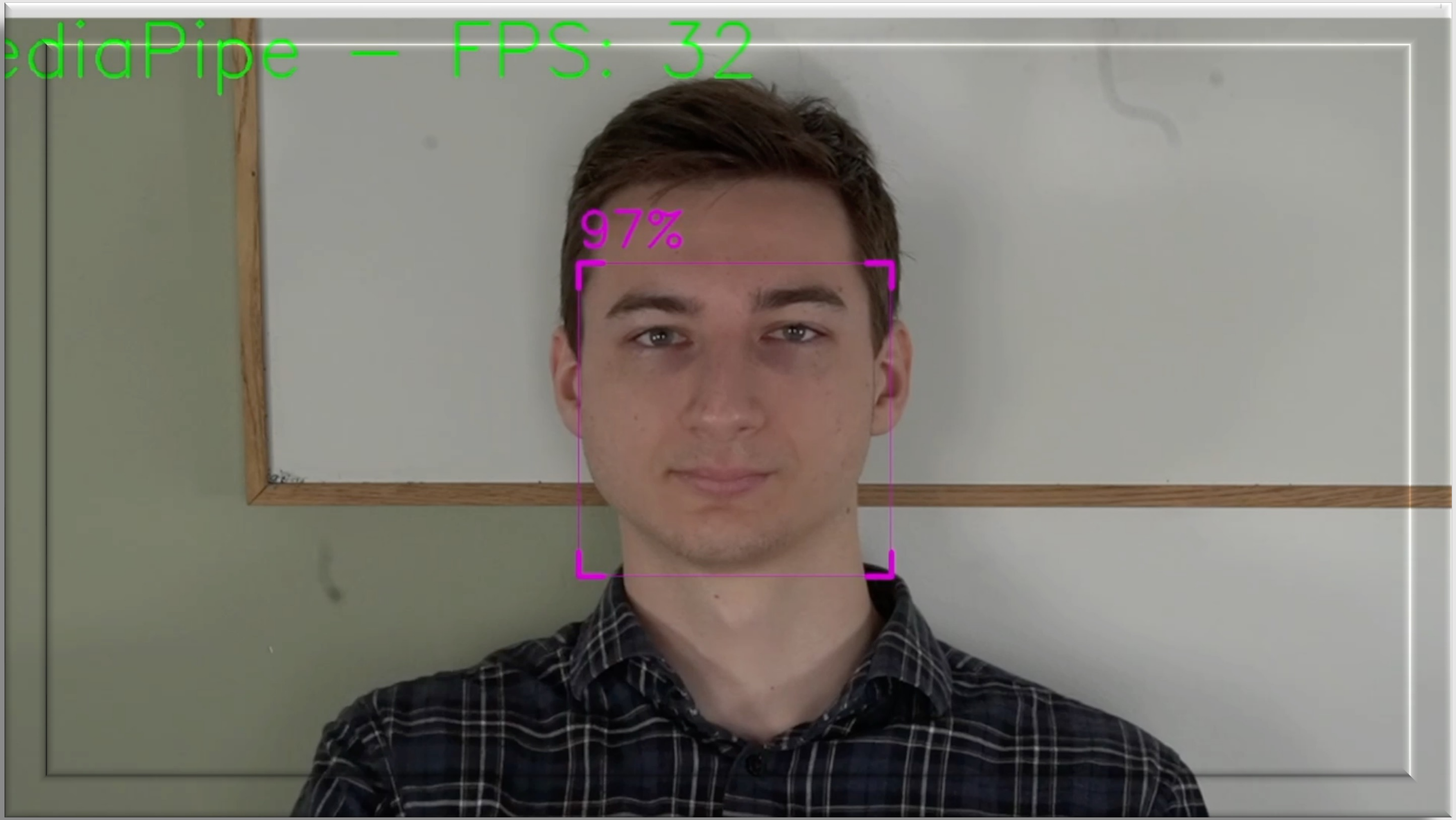
Phase III – Machine learning and video analysis in early detection of stroke.



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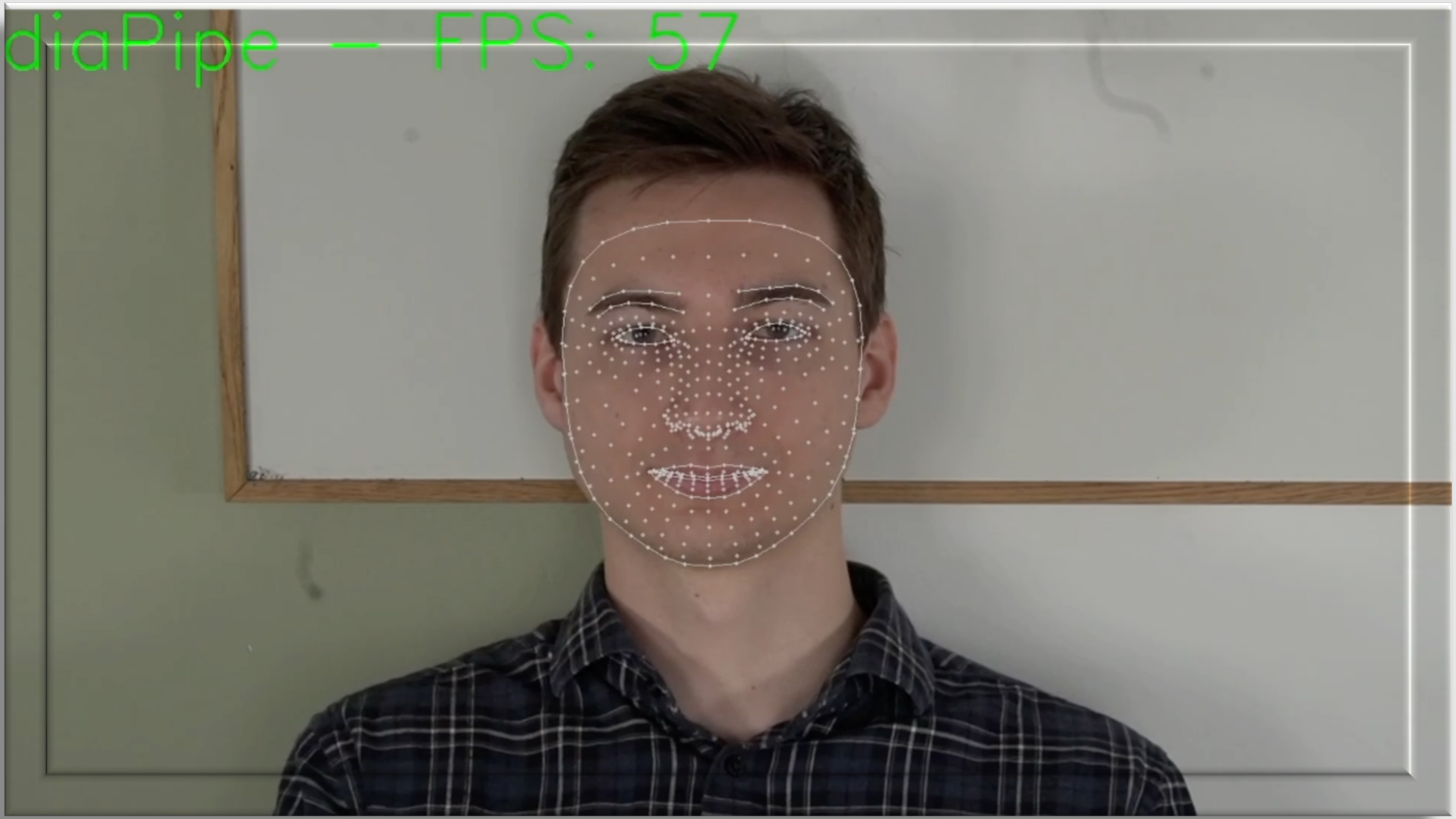
Phase III – Machine learning and video analysis in early detection of stroke.



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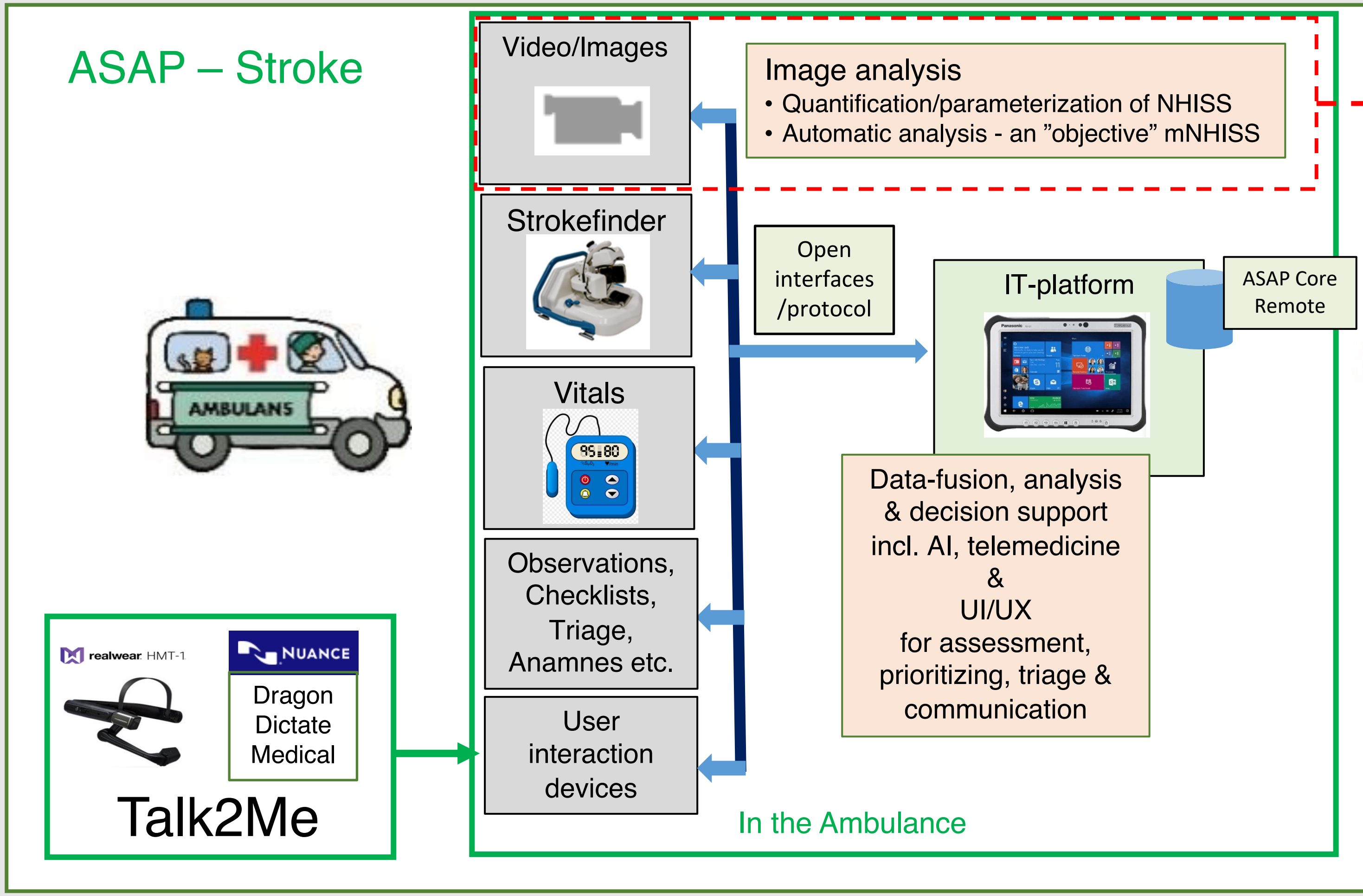
Phase III – Machine learning and video analysis in early detection of stroke.



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Thank you for listening!

Questions?

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