the future of drug delivery

angie

European Commission

MAgnetically steerable wireless Nanodevices for the tarGeted delivery of therapeutIc agents in any vascular rEgion of the body

FETPROACT-EIC-05-2019 – **Project Number:** 925152

Medical Microrobots: From the Lab to the Hospital

08.02.2022

ETH zürich

Chair for drug formulation & delivery
University of Würzburg

S·A·F·E
Stroke Alliance For Europe

Universitat de Barcelona

ΠΑΝΕΠΙΣΤΗΜΙΟ ΚΡΗΤΗΣ
UNIVERSITY OF CRETE

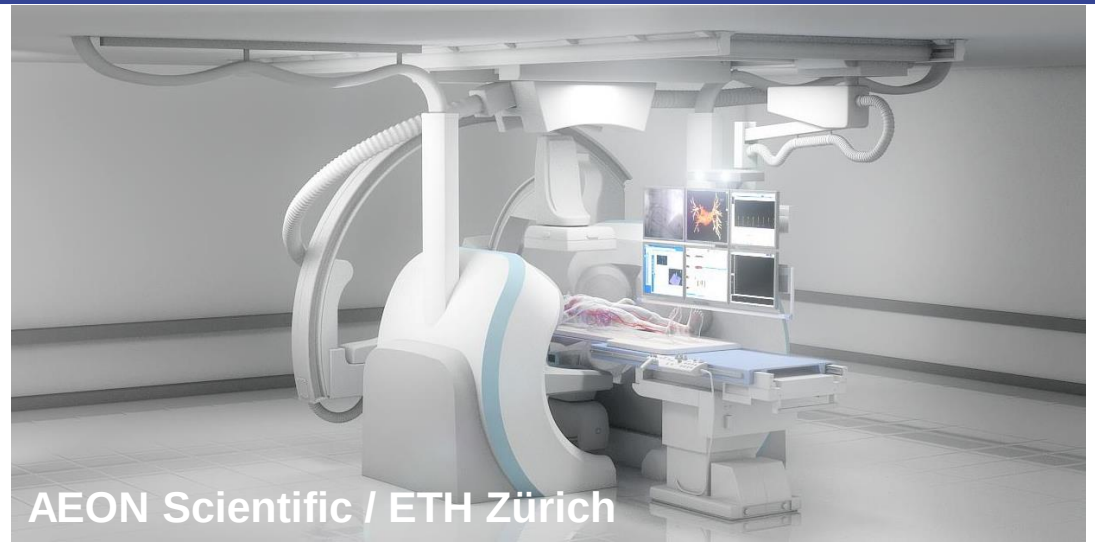
VERHAERT
MASTERS IN INNOVATION

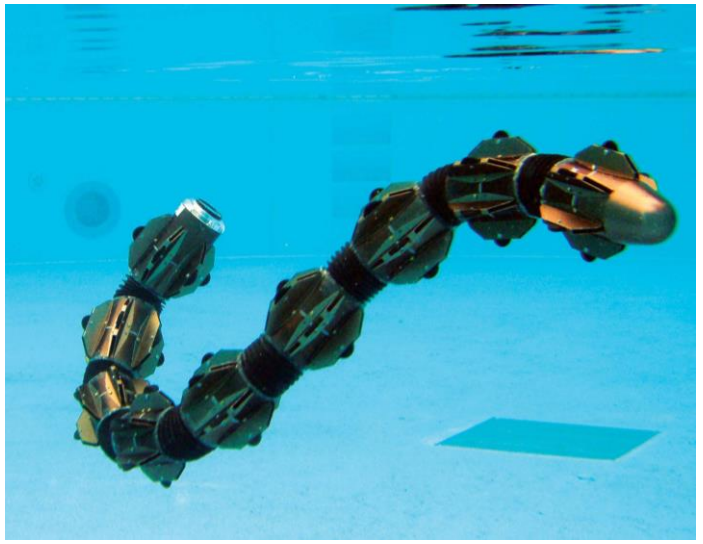
MagnebotiX

Discovery Foundation

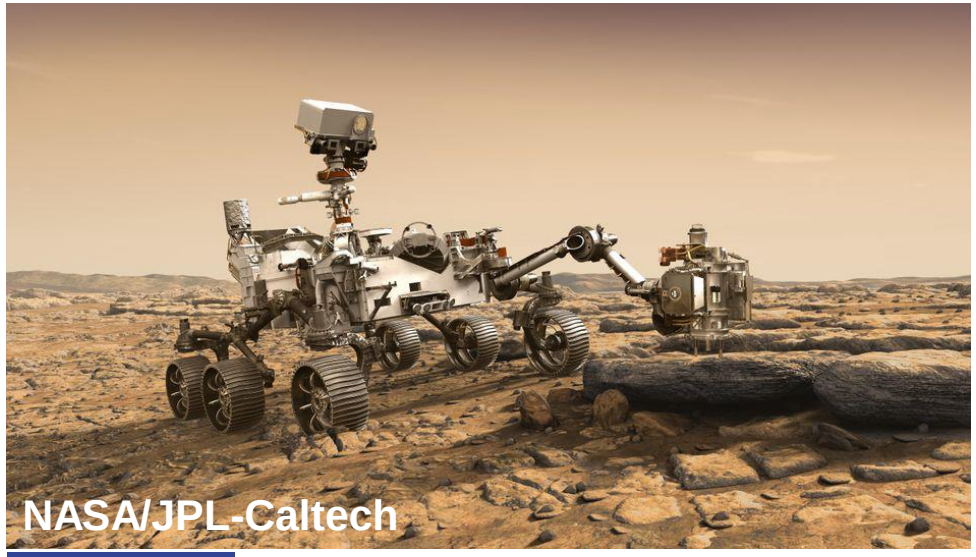
EXPERIAN RESEARCH & CONSULTING

Robotics…

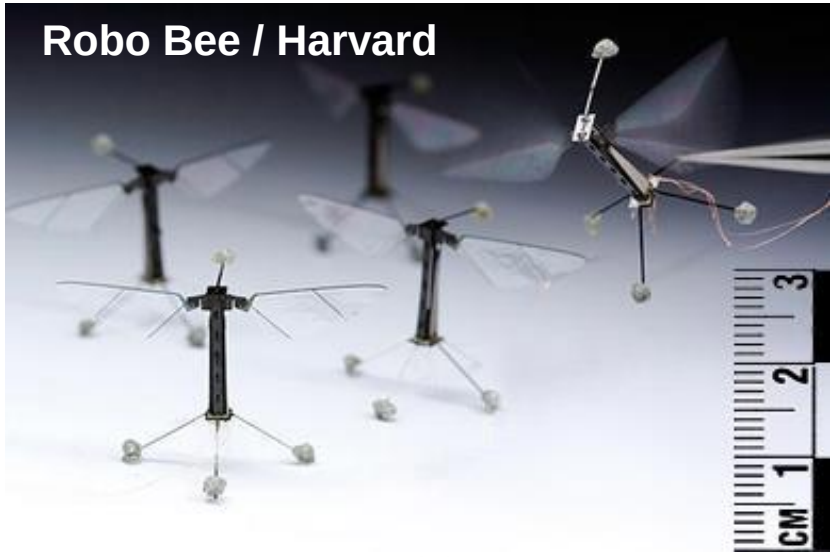

AEON Scientific / ETH Zürich



ANYMAL/ ETH Zürich


NASA/JPL-Caltech

KUKA AG


Robo Bee / Harvard

Current medical robots

Da Vinci, Intuitive

Pharmacokinetics – Route of Administration

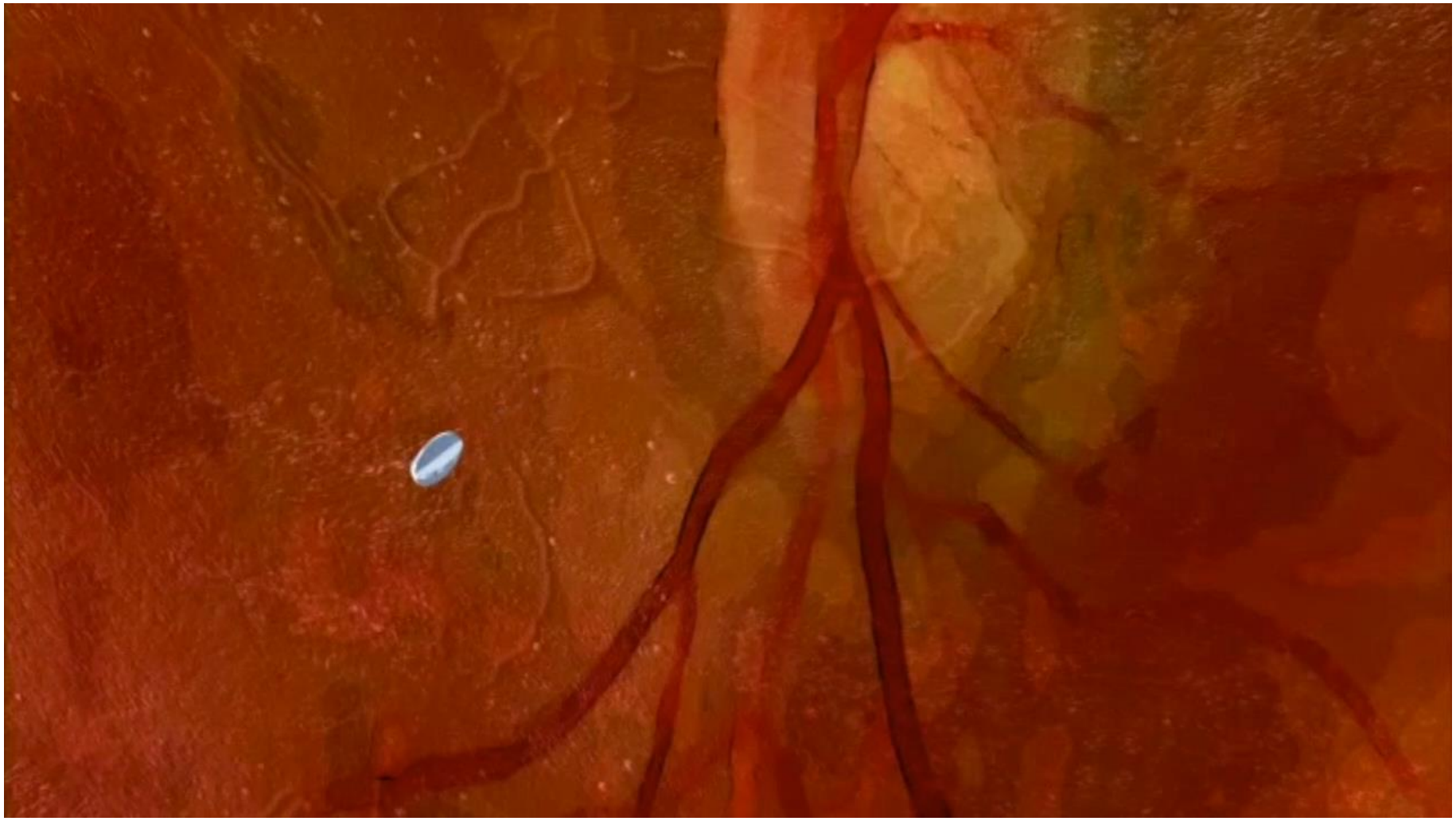
Route of Administration

Cardiovascular system

Treatment Site

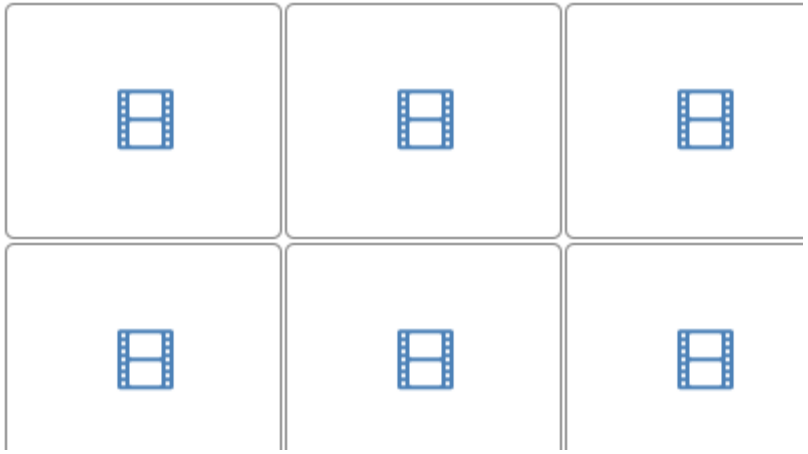
Off-target Effects

Project Overview – The Concept of ANGIE

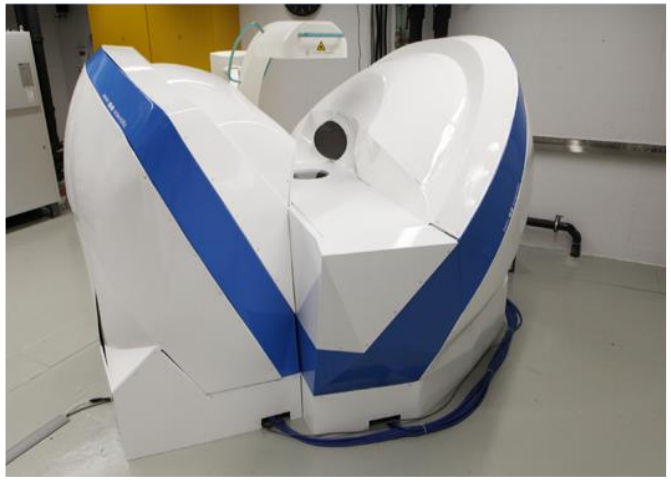


Microrobotics – the past 20 years

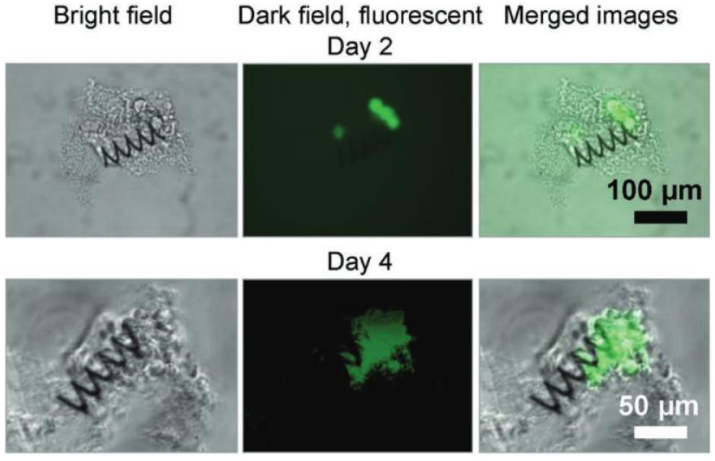
Small-scale locomotion



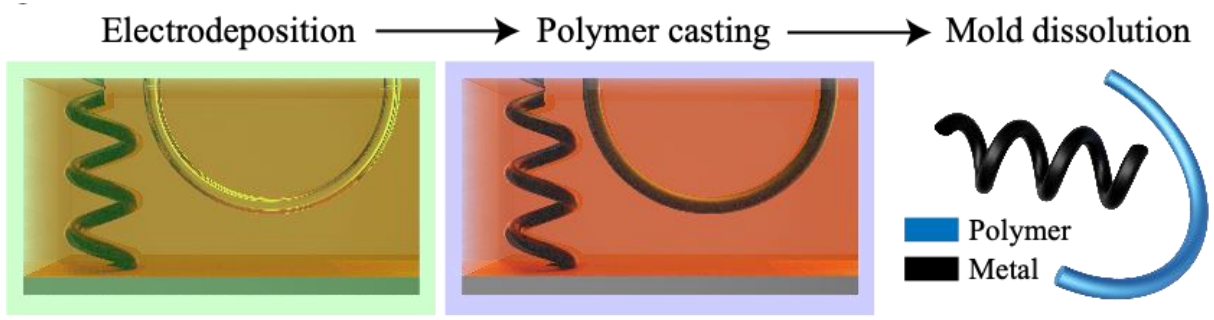
Magnetic navigation systems



Materials



Fabrication

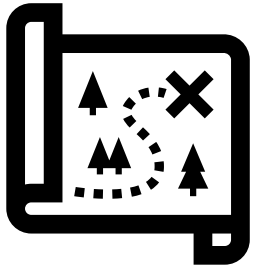


Challenges in translating the technology

Biocompatibility and Biodegradability

Drug compatibility

Sufficiently large workspace



Realistic flow and Navigation

The ANGIE project

The ANGIE consortium

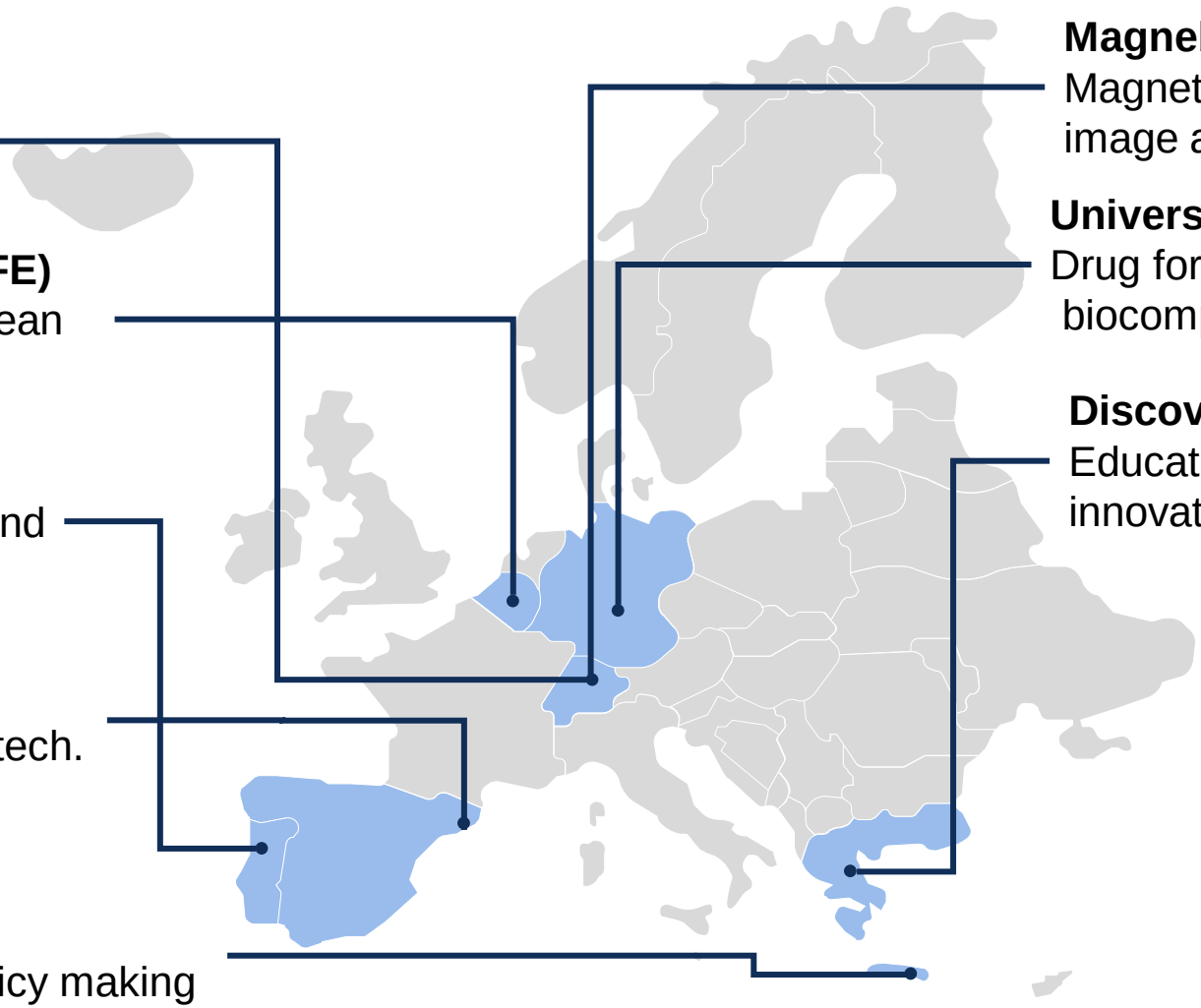
ETH Zürich
Micro/nanofabrication, robotics and electronics, materials

Stroke Alliance for Europe (SAFE)
Patient organisations in 30 European countries

Experian
Modelling, numerical simulation and optimization

University of Barcelona
Organic chemistry & microfluidic tech.

University of Crete
Pharmacology, toxicology and policy making



Magnebotix
Magnetic manipulation & image analysis

University of Würzburg
Drug formulation, biocompat. & biodeg.

Discovery Foundation
Education, dissemination, innovation

Stroke treatment

Significance of strokes

Second leading cause of death

WHO, Global health estimates, 2016

Third leading cause of disability

WHO, Global health estimates, 2016

Worldwide, every **two seconds** someone will have a stroke

UK Stroke Society, State of the Nation Report, 2018

One in six people will suffer a stroke in their lifetime

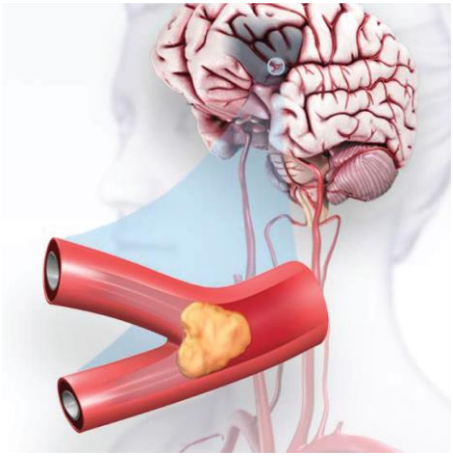
UK Stroke Society, State of the Nation Report, 2018

What is a stroke?

A stroke is **blockage** in the brain vasculature, resulting in **sudden cell death**

CDC, 2019

Image: Jyotsna A. Salunke



Stroke.org, 2019

Ischemic Strokes are caused by a **blood clot** in the brain's arteries

WHO, Cerebrovascular disease, 2006

Ischemic strokes account for **~87% of all strokes**

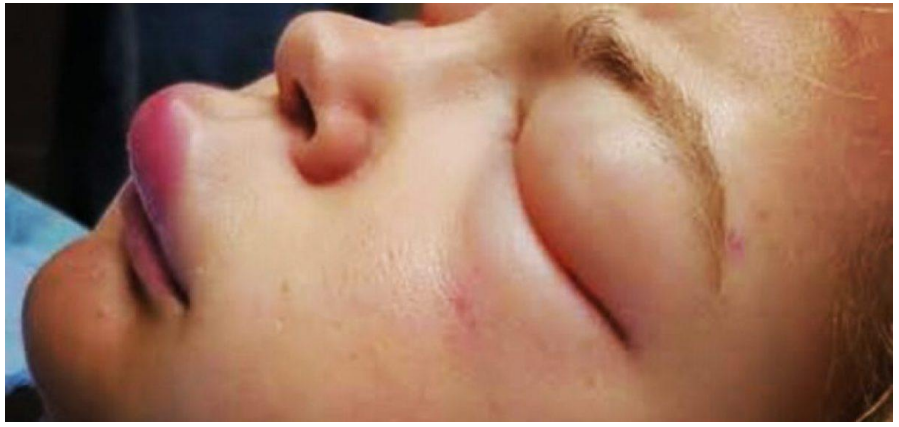
CDC, Cerebrovascular disease, 2019

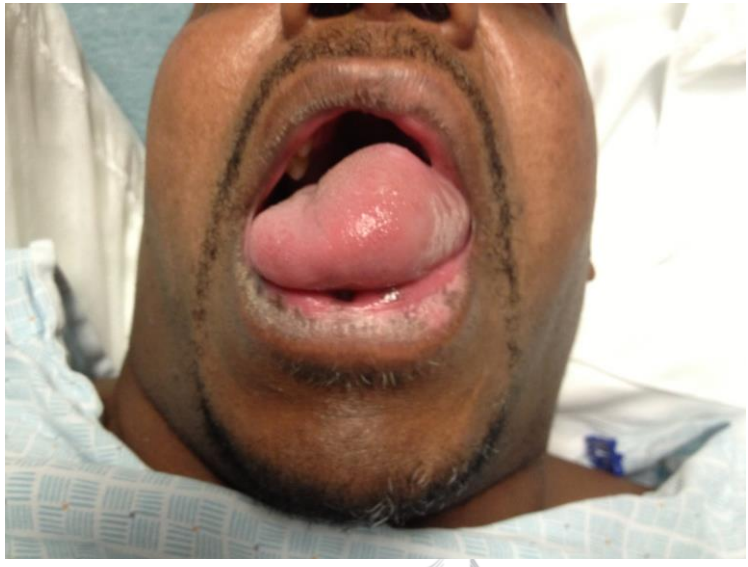
Stroke Treatment

What is t-PA ?

- Approved in 1995
- FDA approved treatment for ischemic strokes
- “Clot bursting” drug (protein)
- Verry narrow treatment window
- Total dose 0.9 mg/kg

Side effects of t-PA





Project Overview – The Concept of ANGIE

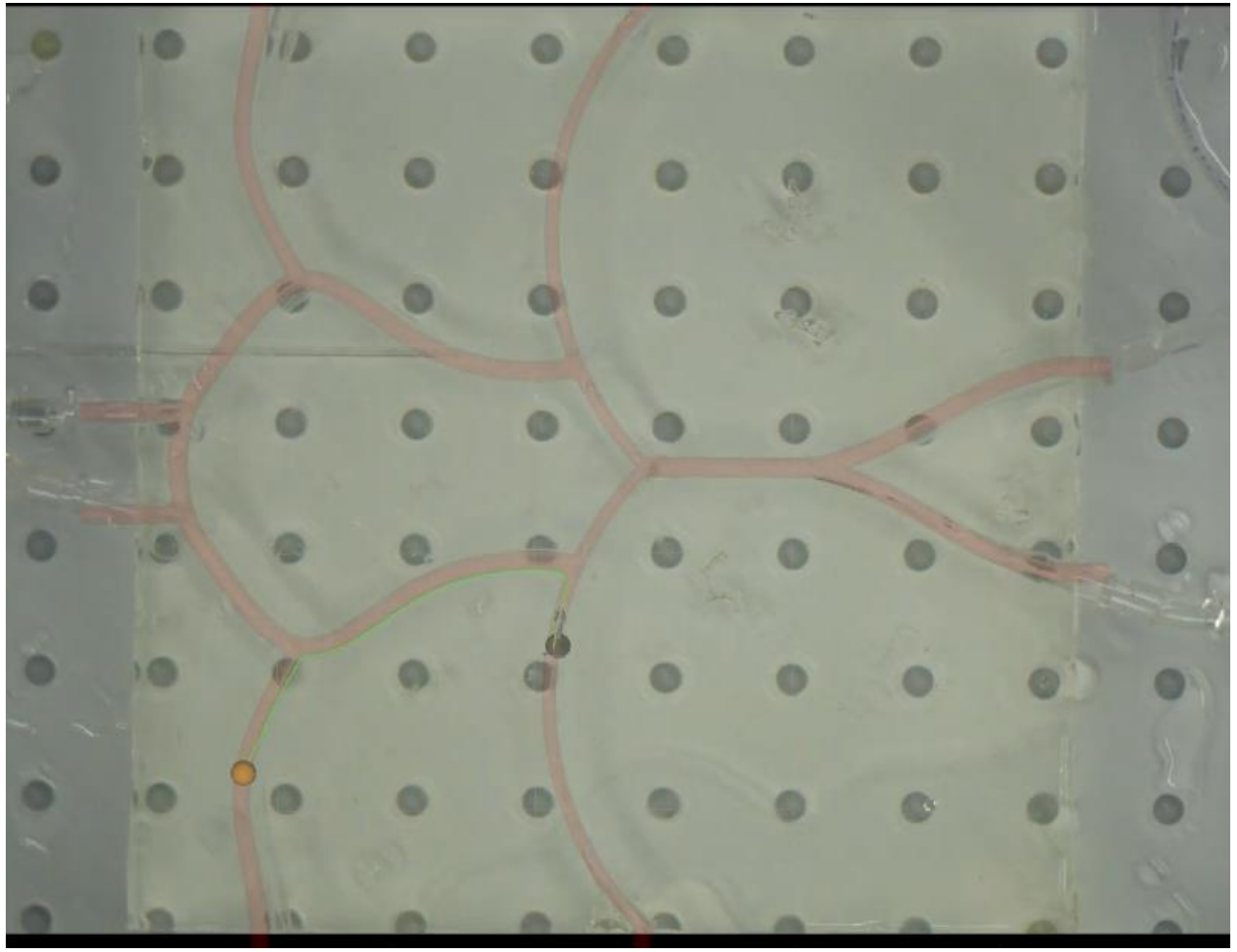
Requirements and constraints to develop a localised targeted drug delivery technology with magnetic small-scale robotics technology for application in clinical environment:

- Load, transport and deliver **relevant** therapeutic **amounts** for a given disease
- **Control rate of delivery** of therapeutic agents to the targeted location in the body
- Manipulate devices in **realistic volumes or workspaces** (i.e. human body regions)
- Systems are **compact enough** to allow easy integration in existing operating rooms
- Manipulation systems **comply with regulations** for use in medical settings
- Instruments **minimize the physical burden** on the health professionals

From the Lab to the Hospitals: Summary

State of the ANGIE technology

- ✓ Fabrication of ANGIE delivery robot
- ✓ Magnetic optimization
- ✓ Manipulation in large Workspaces
- ✓ Biocompatibility
- ✓ **Biodegradability**
- ✓ Drug loading (compatible with most drugs)
  - ✓ ~5000 times less rtPA then in systemic use



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Thanks for your attention!

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