NEWSLETTER

SUMMER ISSUE
2026

Welcome to the GEMINI Newsletter, in which we introduce the project, update you on recent meetings, workshops and upcoming events.
GEMINI - A Generation of Multi-scale Digital Twins of Ischaemic and Haemorrhagic Stroke Patients - is funded within the HORIZON-HLTH-2023-TOOL-05-03 call - Integrated, multi-scale computational models of patient patho-physiology ('virtual twins') for personalized disease management - and officially started December 1st 2023.
If you want to be part of the journey, follow us on our social media and subscribe to our newsletter.
A big thank you to all GEMINI partners and friends.

Enjoy the read!

https://www.linkedin.com/company/dth-gemini

https://dth-gemini.eu/

Some technical definitions

In the previous number…

In the previous newsletter, we mentioned a conference called VPH. But what does VPH actually mean?

https://www.annualreviews.org/content/journals/10.1146/annurev-bioeng-110915-114742

VPH DEFINITION

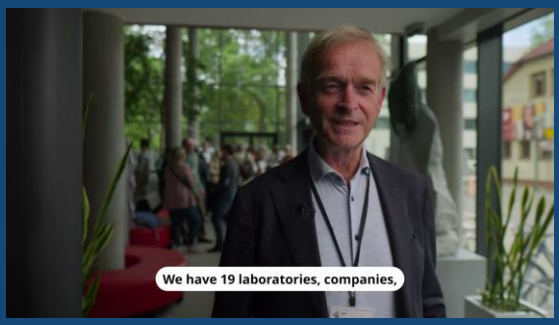
Virtual Physiological Human (VPH) refers to an integrated, ICT-enabled computational framework that models and simulates human anatomy and physiology across multiple scales—from molecules and cells to tissues, organs, and the whole body. It is often described as a grand challenge at the intersection of information and communication technologies and the biosciences because it demands multilevel modelling, high-performance computation, rich data integration, and stringent validation.

Rather than a single "digital twin," VPH is best seen as a family of interoperable models and tools that formalise health knowledge: how it is acquired, represented, analysed, communicated, and tested against evidence. By enabling in silico experiments alongside in vivo, in vitro, and clinical observations, VPH can speed up discovery while reducing trial-and-error.

Its near-term impact includes deeper understanding of physiology and disease, identification of reliable biomarkers for diagnosis and screening, and support for personalised medical decisions. VPH approaches can also improve drug development by simulating how innovative therapies and personalised regimens interact with individual patients. Finally, multi-physics, multi-resolution simulations can guide the design of targeted implants and artificial organs, and support reverse-engineering domains where understanding or emulating human function matters, including robotics and artificial intelligence. Ultimately, it links models with patient data for predictions.

GEMINI is funded by the European Union's Europe research and innovation program, grant number 101136438

Watch our YouTube Channel



Prof. Alfons Hoekstra
Computational Science and Engineering (UvA)

Prof. Charles Majoie,
Neuroradiology (AUMC)

Henk Marquering
Radiology (AUMC)

Prof. Oscar Camara
Engineering school (UPF)

Prof. Jonathan Coutinho
AUMC

Marek Kasztelnik
Full-stack developer (Cyfronet)

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News from the consortium

For our bi-annual meetings we are going around Europe! Last month (May 2026) we went to Rotterdam, where the meeting was organized by Erasmus Medical Center consortium partners. You can find photos and a brief description of the meeting at

https://www.linkedin.com/posts/dth-gemini_gemini-digitaltwins-strokeresearch-activity-7464445570976354304-ERCS?utm_source=share&utm_medium=member_desktop&rcm=ACoAAFNFoRoBg096tgdMxTpDD5_4RYLVbuQcCzE

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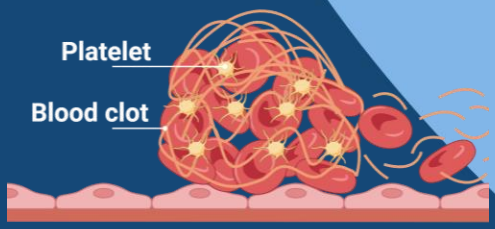
What are we doing now?

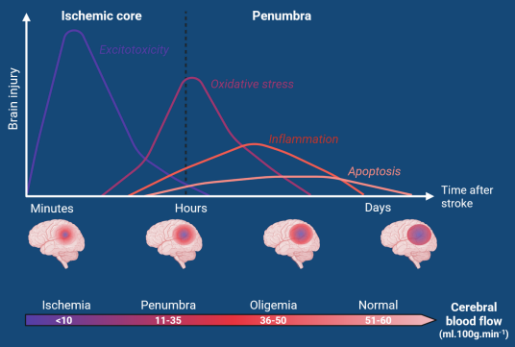
WP2

The team is developing ***patient-specific models*** to better understand ***aneurysms and blood clots***. By combining data on ***heart function, blood flow, and patient information***, the aim is to create more accurate tools for ***stroke research and care***. These models are validated using ***real patient data from medical devices***, ensuring clinical relevance. The results may support ***clinical decision-making*** and help improve technologies for ***stroke prevention and treatment***.



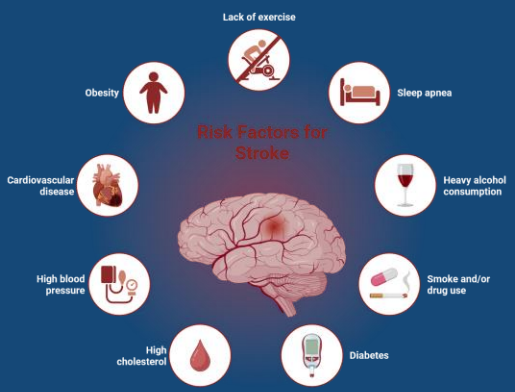
WP3

Researchers found that ***clot stiffness*** varies depending on ***location in the brain*** and ***platelet content***, which can help predict the success of ***clot removal treatments***. They are also studying how ***collateral blood flow*** (alternative pathways around a blockage) changes over time and how it influences ***brain damage progression***. This helps identify ***at-risk brain regions*** and supports better ***treatment decisions and outcomes***.



WP4

The project uses long-term ***patient data (20+ years)*** to study factors affecting ***stroke and aneurysm outcomes***. Lifestyle and treatment effects—such as how ***smoking cessation may slow aneurysm growth***—are analyzed over time. The team is also building ***personalised computational models*** to simulate treatments like ***coil procedures***, supporting more ***individualised clinical care***.



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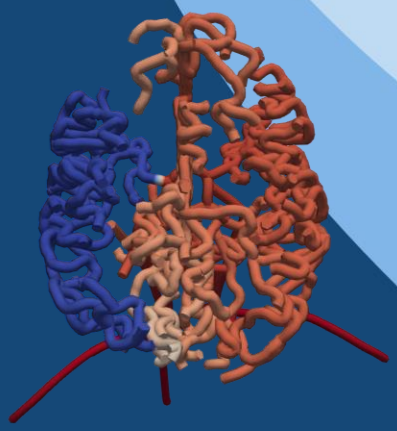
What are we doing now?

WP5

The team is developing ***validated, patient-specific tools*** to predict the success of ***clot removal and aneurysm treatments***.

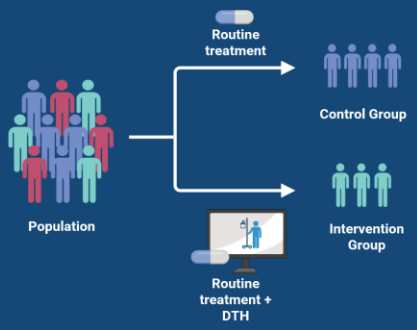


For ***clot removal***, they create ***personalized models*** to estimate ***treatment success*** and ***clot fragmentation*** during intervention. By analyzing ***clot structure and composition***, they improve ***individualised simulations*** for fast, ***clinical decision support***.

For ***aneurysm treatment***, they use **patient-specific validation** with ***coil devices*** and ***3D-printed phantoms***, based on data from Hôpitaux Universitaires de Genève. BME measures ***blood flow dynamics***, ensuring simulations reflect ***real clinical conditions***.

WP6

The team collaborates with clinicians to design ***clinical trials***, ensure ***reliable data collection***, and document procedures. They develop a ***data management prototype*** and explore ***secure cross-site data sharing*** while ensuring ***patient privacy and ethics***.



In collaboration with industry partner ***Nicolab***, they ensure tools are ***clinically practical and ready for real-world use***.

WP7

The team provides the ***computational backbone*** of the project, managing ***data pipelines***, ***high-performance computing***, and ***software optimisation***. They track ***model validation*** across all workflows, with many pipelines now in the ***publication and patient-adaptation stage***.

A key focus is integrating ***GEMINI (brain models)*** with ***VHD (whole-body virtual twin)*** to build a ***complete digital patient model***, enabling more ***comprehensive stroke simulation and treatment analysis***.

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Publications

WP1

Hoekstra A.G., Marquering H., on behalf of the GEMINI consortium. (2024). Towards a Generation of Digital Twins in Healthcare of Ischaemic and Haemorrhagic Stroke. In: Franco, L., de Mulatier, C., Paszynski, M., Krzhizhanovskaya, V.V., Dongarra, J.J., Sloot, P.M.A. (eds) Computational Science – ICCS 2024. ICCS 2024. *Lecture Notes in Computer Science*, vol 14834. Springer, Cham. https://doi.org/10.1007/978-3-031-63759-9_29

WP2

Segarra-Queralt M., Molla M., **Barrouhou M.**, **Olivares A.L.**, Albors C., Bernardino G., Regueiro A., Mill J., **Càmara O.,** Freixa X. (2025)The Role of Anticoagulants After Left Atrial Appendage Occlusion. *JACC: Case Reports.* https://www.jacc.org/doi/10.1016/j.jaccas.2025.105838

WP3

Olszewski W, Cavalcante F, van Poppel L, Beenen L, Emmer BJ, van den Wijngaard I, Lemmens R, Roos Y, **Marquering H, Konduri P, Majoie C**. Subacute edema progression after acute ischemic stroke: impact of intravenous alteplase administration and reperfusion degree. *Frontiers in Neurology*, 2025;16:1698480. https://doi.org/10.3389/fneur.2025.1698480

Fregona V., Bottini I., **Barati S.**, Cervo A., Macera A., Schwarz G., Pero G, Piano M, **Dubini G, Rodriguez Matas JF, Luraghi G, Migliavacca F.** (2025). Clinical image analysis to build patient-specific models of acute ischemic stroke patients. *Physical and Engineering Sciences in Medicine*, 1-11. https://doi.org/10.1007/s13246-025-01646-7

Nagargoje M.S., **Fregona V., Luraghi G., Migliavacca F.**, Pero G., **Rodriguez Matas J.F.**. The role of friction forces in arterial mechanical thrombectomy: a review. J Biomech. 2025 Sep 16;192:112966. https://doi.org/10.1016/j.jbiomech.2025.112966 . Epub ahead of print. PMID: 40972274.

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Publications

WP3

Nagargoje M.S., **Fregona V., Luraghi G., Migliavacca F.**, Poulos D.A., Good B.C., **Rodriguez Matas J.F**. Impact of friction force and retrieval speed on in silico mechanical thrombectomies: A sensitivity analysis. Comput Methods Programs Biomed. 2025 Nov;271:109018. https://doi.org/10.1016/j.cmpb.2025.109018 . Epub 2025 Aug 9. PMID: 40812230.

Fregona V, Luraghi G, Fereidoonnezhad B, Gijsen FJH, Majoie CBLM, Rodríguez Matas JF, Migliavacca F. Impact of thrombus composition on virtual thrombectomy procedures using human clot analogues mechanical data. J Mech Behav Biomed Mater. 2025 Mar;163:106886. https://doi.org/10.1016/j.jmbbm.2025.106886 Epub 2025 Jan 2. PMID: 39754893

WP4

Bernava G, **Sandralegar A**, Hofmeister J, Rosi A, Ylmaz H, **Morel S**, Reymond P, Brina O, Muster M, Lovblad KO, Schaller K, **Bijlenga P**, Machi P. Endovascular treatment of unruptured intracranial aneurysms at a single center: Outcomes, selection strategy, and transparent communication for patient decision-making. *Interventional Neuroradiology*. 2025;0(0). https://doi.org/10.1177/15910199251394476

Delucchi M, **Bijlenga P**, **Morel S**, Furrer R, Hostettler IC, Bakker MK, Bourcier R, Lindgren A, Maschke S, Bozinov O, Houlden H, Werring D, Ruigrok YM, Wostrack M, Meyer B, Neidert MC, **Hirsch S**, Spinner GR. Mixed-effects additive Bayesian networks for the assessment of ruptured intracranial aneurysms: Insights from multicenter data. *Computers in Biology and Medicine*, 2026;201:111380. https://doi.org/10.1016/j.compbiomed.2025.111380

Lea Bührer, Lisa L. Richard, Alexandre Genoud, **Abiram Sandralegar**, Julien Haemmerli, Insa K. Janssen, Jeremy Hofmeister, Andrea Rosi, Gianmarco Bernava, Paolo Machi, Karl Schaller, **Sandrine Morel**, **Philippe Bijlenga**, Vincent L'Allinec, **Sven Hirsch**, Reinhard Furrer, Georg R. Spinner, Disentangling determinants of one-year modified Rankin scale in patients with incidentally detected solitary intracranial aneurysms, *Computers in Biology and Medicine*, 2026, 111731, https://doi.org/10.1016/j.compbiomed.2026.111731.

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GEMINI on the move! Conferences 2026

The start of year 2026 has been active for the GEMINI team members, marked with a schedule of congresses, scientific presentations and deadlines for upcoming conferences. Our members have engaged with a wide range of experts of the field!

🤝 Joint events & multidisciplinary presence

European Stroke Organization Conference 2026 (May 2026)

- The **Amsterdam UMC, POLIMI**, and **Erasmus MC** teams presented collaborative research, including joint work on in-silico models for thrombectomy and prospective observational studies on thrombus stiffness.

GEMINI consortium members presenting their latest patient-specific stroke models and thrombectomy simulation results during the ESOC 2026 scientific sessions.

📍 Individual teams highlights events

- The **ZHAW team** presented their work in medical image analysis and digital twinning for stroke research in the Computational Life Sciences Day 2026 (January 2026) in Wädenswil, Switzerland.
- The **University of Galway team** presented their work focused on thermodynamic modelling for predicting intracranial aneurysms at the Bioengineering In Ireland 2026 (March 2026) in Athlone, Ireland.

For details about the presentations, photos and more, check out our LinkedIn page

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GEMINI on the move! Conferences 2026

Individual teams highlights events!

- **The ZHAW team** held a presentation showcasing model-based precision medicine at the Digital Health Zurich Webinar (March 2026).
- **The UPF team** traveled to Auckland, New Zealand, to participate in the 2026 Cardiac Physiome workshop, showcasing their work in cardiac thrombus modeling in the left atrium.
- **The POLIMI team** actively participated with an oral presentation on enhancing decision-making in endovascular thrombectomy at the ESB-ITA Meet the Lab (April 2026).
- **The UvA team** gave a lecture bridging the gap between experiments and multi-scale simulations of arterial thrombosis at the Vascular Immunology Symposium (April 2026).
- **The POLIMI team** participated in the open public workshop AI4Lungs Public Event connecting with other EU project consortia and clinicians (May 2026).
- **The ZHAW team** expanded its reach to both clinicians and pharma experts, presenting on model-based precision medicine and digital twins at the CABMM Symposium & ROCHE Digital Days (June 2026).

Cluster activity & joint webinars

TARGET-VITAL-GEMINI Cluster Activity: "Toward the Virtual Human: Multi-Organ Digital Twins for Cardiovascular Medicine"

- **A successful joint collaboration!** On May 28, 2026, the **TARGET**, **VITAL Horizon Europe**, and **DTH-GEMINI** teams gathered alongside leading experts for an insightful cross-project discussion.

For details about the presentations, photos and more, check out our LinkedIn page

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Upcoming conferences 2026

- The **21th International Symposium on Biomechanics in Vascular Biology and Cardiovascular Disease** will be held on the 18-19 June 2026 in Geneva, Switzerland and EMC and HUG will be among the organizers. Check here for information: https://shearstresssymposium.nl//
- The **9th International Conference on Computational and Mathematical Biomedical Engineering** will be held on 22-24 June in Kobe, Japan. Check here for more information: https://compbiomed.net/CMBE/cmbe2026/
- The **10th World Congress of Biomechanics** will be held in Vancouver, Canada on 11-15 July. Check here for more information: https://wcb2026.com//
- The **17th Wold Congress on Computational Mechanics and 10th European Congress on Computational Methods in Applied Sciences and Engineering (WCCM-ECCOMAS2026)** will be held in Munich, Germany on 19-24 July 2026. A mini-simposium on thrombus mechanics (MS332) will be organized by Behrooz Fereidoonnezhad (TUD), Giulia Luraghi (POLIMI) and Frank Gijsen (EMC, TUD). Check here for more information: https://wccm-eccomas2026.org//
- The **9th International Conference on the Virtual Physiological Human (VPH2026)** will be held in Milan, Italy on 1-4 September 2026. It will be organized by POLIMI. Check here for more information: https://vph-conference.org//

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GEMINI team members co-organize the TopAneu 2026 challenge

We are thrilled to announce that members of the GEMINI consortium are part of the team behind the upcoming **TopAneu 2026 Challenge**.

This challenge brings together top researchers and clinicians with expertise in medical image analysis and neurovascular diseases. Representing the GEMINI project in this global initiative, we are proud to highlight the involvement of the **ZHAW** and **HUG** teams!

Their leadership in organizing this challenge underscores GEMINI's active role and commitment to advancing the frontiers of neurovascular research and computational health.

📢 **Key Information:**

- **Where to find us:** TopAneu 2026 will be presented at the **MICCAI 2026** conference (Strasbourg, France).
- **Get involved:** For full details, guidelines, and updates on the data release, please visit the website: https://topaneu-26.grand-challenge.org/topaneu-26/

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Wishing everyone a wonderful summer!

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