The Virtual Human Twins' Potential in Scandinavia (Norway)

Jan F Nygård

Departement Direktor – Registry Informatics

Cancer Registry of Norway

NIPH

Scandinavia

- Rather small countries population-wise
  - Norway: 5,5 mill
  - Sweden: 10,5 mill
  - Denmark: 5,9 mill
  - Total: 21,9 mill
- Comparative advantage
  - High quality data
    - PIN
    - Health registries that follow citizens throughout their lives
  - Private public partnerships

Norwegian Initiatives
Digital Twin for Proton Therapy (Oslo)

dScience – Centre for Computational and Data Science

UNIVERSITY OF OSLO

- A project at the University of Oslo's dScience Centre for Computational Science is developing virtual copies of both the cancer patient and the proton beam therapy system combining the patient's medical imaging data with detailed physics models of the proton beam to run personalized simulations of treatment sessions.
- The twin tracks the tumor and adjacent healthy tissues in silico, allowing clinicians to adjust the proton beam in real time for maximum effect on the tumor while sparing normal tissue.
- Before each treatment fraction, the oncologist could test different beam configurations on the patient's digital avatar to see how the tumor responds and how much dose nearby organs would receive.
- Proton therapy, which is very sensitive to exact positioning and tissue density – small differences can mean the proton beam's peak dose (Bragg peak) lands slightly off target.
- The digital twin helps achieve the millimeter precision needed, by accounting for changes in the patient (like breathing or anatomical shifts post-surgery) and recalculating optimal beam settings.
- The expected outcome is more effective and adaptive proton therapy, with improved tumor control and fewer side effects, tailored to each patient's anatomy in real time.

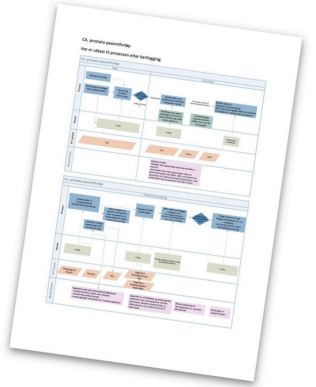
Norwegian Initiatives
Kongsberg Beam Technology & Oslo Cancer Cluster

- In a public–private effort, the Norwegian defense-tech company *Kongsberg* has applied its simulation expertise to healthcare.
- Kongsberg Beam Technology, together with Oslo University Hospital and the Oslo Cancer Cluster, is developing a platform called Multi-Array Multi-Axis Cancer Combat Machine
- This system creates a digital twin of the patient during radiotherapy, updating with each heartbeat, to guide radiation beams with extreme accuracy – a concept adapted from military targeting systems.
- Just as Kongsberg's defense systems aim for pinpoint strikes, here the goal is to "hit" the tumor with optimal radiation while avoiding friendly tissue.
- The digital twin provides a 3D, image-based map of the patient's internal anatomy and simulates different beam trajectories.
- This is particularly useful after surgery or between treatment sessions, when anatomy can shift or new cavities form; the twin can be updated with latest MRI scans and help neurospecialists and radiotherapists re-plan subsequent treatments.

Norwegian Initiatives:
Digital Twins for Patient Care and Treatment

- In 2024, a digital twin project for the entire care pathway for prostate cancer patients, integrating data from primary care, hospitals, logistics, and health economics in addition to clinical data.
- Using multi-source data into a patient's virtual model, clinicians and patients would get a holistic, real-time overview of the patient's health status and journey.
- This digital twin is envisioned to provide decision support at every step of the standardized prostate cancer care pathway, helping coordinate care between GPs and specialists and tailoring follow-up to the individual.
- The broader aim is to create a self-updating, AI-driven digital twin that can continuously adjust as new data come in – essentially a real-time updated virtual patient with decision support for clinicians.

1: Generell undersøkelse hos fastlege	2: Mistanke om kreft	3: Verifisering av mistanke	4: Registrering av henvisning til spesialisthelsetjeneste	5: Filter	6: Utredning	7: Klinisk beslutning	8: Behandling	9: Utskriving	10: Oppfølging og rehabilitering	11: Kontroll og evaluering	12: Livsforlengende behandling	13: Livets sluttfase
Pasient møter hos sin fastlege for generell undersøkelse.	Forhøyete PSA-verdier gir mistanke om kreft.	Det tas ytterligere prøve og/eller bilde (eks MR/UL) av pasient som sendes til analyse.	Pasient henvises til spesialisthelsetjeneste	Urolog gjennomfører kliniske undersøkelser for å vurdere om pasient skal henvises til pakkeforløp. Start pakkeforløp A16A	Utredning med undersøkelser sikrer diagnosen og kartlegger sykdomsutbredelsen. Utredning start A16S	På bakgrunn av utredningsfunnene, pasientens alder og komorbiditet tas det stilling til hvilken behandlings-mulighet pasient tilbys (pakkeforløp). Pasient gis informasjon om behandling, mulige bivirkninger, risiko for komplikasjoner og konsekvenser. A16CK/A16CM/A16CA/A16CI *Steg 5-7 kan være repetative for pasient avhengig av valgt forløp.*	Pasient settes opp til behandling innen de angitte forløpstidene. På første behandlingsdag registreres kode for behandling. Behandling bestemmes ut fra valgt pakkeforløp. A16FK/A16RM/A16FS/A16FL/A16FO/A16FI	Etter endt behandling skrives pasienten ut fra sykehuset. Under utskrivingssamtale forberedes pasient på hva han kan forvente seg etter utskrivelse.	Pasient følges opp av helsepersonell avhengig av bivirkninger. Oppfølging skjer i tett samarbeid med fastlege. Rehabilitering avhenger av hvilken behandling som er gitt, og det vurderes om pasient har behov for kontakt med fagpersoner. Behandlende lege vurderer behov for rehabilitering og vurderer sammen med pasient aktuelle tiltak.	Aktiv overvåking innebærer standardisert oppfølging i regi av urolog på anbefalte tidspunkter for kontroll. Fastlege informeres hva som skal følges opp hos pasienten.	Livsforlengende tiltak er sentrale for en del pasienter. Beslutning tas av behandlende avdeling i dialog med pasienten.	



Swedish Initiatives

SDTC Swedish Digital Twin Consortium

- **Swedish Digital Twin Consortium:**
  - In 2019, a group of leading Swedish universities and hospitals formed the *Swedish Digital Twin Consortium* as a coordinated initiative to apply digital twins in healthcare. Partners include Karolinska Institutet & University Hospital in Stockholm, Linköping University & Hospital, Chalmers University of Technology (Gothenburg), Lund University, and others.
  - The aim is to tackle a major healthcare problem, namely the large fraction of patients (in general, 38–75% by some estimates) that do not respond to standard drug therapy.
  - By using each patient's twin as a testbed for therapies, they aim to identify effective drugs (or drug combinations) *in silico* before prescribing them, thus personalizing treatment and avoiding ineffective options.

Denmark's Initiatives: Technological Innovation and Operational Twins

- Hospital Operations Twin – Teton's 3D Hospital Room Twin:
  - A recent development from Denmark is the creation of a real-time 3D "digital twin" of hospital rooms to assist healthcare staff.
  - In May 2025, Copenhagen-based startup *Teton* unveiled a system that uses Denmark's national supercomputer (Gefion) to render live digital replicas of patient rooms in 3D.
  - This hospital twin isn't about a specific disease but rather the environment and workflow: it continuously displays patient positions, movements, vital signs, and staff interactions in a virtual model of the ward.
  - The aim is to fundamentally change how nurses monitor patients and manage their workload: instead of physically checking each room, staff can supervise multiple patients through the digital twin dashboard, which alerts them to potential risks (like a patient getting up who is fall-risk) in real time.
  - Early pilot results have been promising: night shift workload for nurses was reduced by up to 25% using the system, as the twin provided continuous oversight and helped prioritize where human attention was needed most.

Finland's Initiatives: Precision Cancer Medicine and Public-Private Innovation

- Finland, also known for its health registries and biobank data, has also seized on digital twin concepts to advance cancer research and care.
- Finnish efforts often emphasize combining clinical data with lifestyle and molecular data, and involve significant public-private partnerships

- In 2024, Orion Corp. – a major Finnish pharma company – entered a collaboration with US-based AI company *Aitia* to use Aitia's "Gemini Digital Twins" platform in cancer drug discovery.
- Aitia's approach to digital twins is a bit different: instead of a twin of an individual patient for clinical use, they create disease-level digital twins by combining data from many patients (e.g., genomic, clinical, outcomes data) to simulate disease mechanisms.
- The goal is to identify hidden causal relationships and promising drug targets

Comparative Overview and Opportunities in Scandinavia

All Scandinavian countries share some common strengths that benefit digital twin research in healthcare:

- high-quality universal health systems
- extensive electronic health records and registries
- a culture of innovation and trust in technology
- collaborations across academia, healthcare, and industry

Scandinavia's digital twin endeavors span

- clinical care twins (patient-centric models)
- research twins (for drug discovery or mechanistic understanding)
- operational twins (health system or device simulations).

Comparative Overview and Opportunities in Scandinavia (cont.)

- **Diagnosis and Prognosis:**
  - By integrating genomics, imaging, biomarker data, and health registry data with long-term follow-up, digital twins can help stratify patients and predict long-term disease course.
- **Treatment Planning and Simulation:**
  - Proton therapy and radiotherapy twins– before treating a cancer patient, run simulations on the patient's twin to choose the best approach that maximizes tumor control and minimizes side effects.
- **Infrastructure & Data Modeling; infrastructure needs:**
  - Experience shows that to realize digital twins at scale, one must integrate diverse data types (clinical, omics, sensor, etc.) and ensure interoperability across hospitals and labs.
  - The Scandinavian countries, with long tradition of national identification numbers and centralized records, still face challenges in connecting data silos.
  - And don't forget, legal/ethical frameworks for data sharing

Comparative Overview and Opportunities in Scandinavia (cont.)

- **Improving Patient Engagement and Health Literacy:** Digital twins, especially when visualized (like the 3D models or user-facing apps), can also empower patients.
  - patient-centered care is a priority, with focus to help patients interacting with simplified versions of their digital twin – perhaps seeing a dashboard of their "virtual health" and the predicted impact of different choices.
  - This could enhance understanding of one's illness ("My twin shows that if I exercise more, my risk of cancer recurrence drops") and encourage shared decision-making with clinicians.
- **Commercial and Economic Opportunities:** Government agencies in the Nordics are likely supportive, seeing this as both a way to improve healthcare **and** a knowledge industry to invest in

Thank you

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