



veracell

Digital twins to model healthcare interventions' cost-effectiveness

MET research day, industrial pre-event, 29.10.2025



Cost-effectiveness analysis for data-driven decisions

Tampere advantage

A vibrant, connected health-tech ecosystem with an industrial and academic interplay.

The decision gap

We often lack clear, comparable evidence to choose strategies: which option delivers the most health for the money? When is an expensive complication-reducing treatment actually worth it?

Our proposition

A patient-journey **digital twin** with which intervention hypotheses can be projected to health outcomes and total costs under real-world assumptions.

Why it matters now

Reproducible cost-effectiveness analysis embedded within the ecosystems (e.g. P4, body-on-chip) improves translational relevance, and supports regulatory acceptance on the path to global markets.

Our aim

Simulation for policy & practice

Leverage national registry data into a living “what-if” engine that projects long-term **health (QALYs)** and **€ cost** impacts across age groups.

From data to decisions—fast and transparent

Provide side-by-side comparisons of preventive and treatment strategies with clear assumptions, uncertainty ranges, and reproducible outputs for payers, clinicians, and researchers.

Built to support Tampere health-tech ecosystem

Scalable to wide range of diseases, interoperable with testbeds and within reach by industrial and academic ecosystem members.

Our approach

State-of-the-art methods

State-of-the-art cost-effectiveness analysis using e.g. Markov chains and Hazard models with intuitive tuning parameters.

General-purpose data backbone

Secure ingestion layer for national/regional registries, EHR/testbed datasets, and more.

Accessibility, usability, and trust

Lightweight web UI with e.g. side-by-side comparisons of projected impacts of alternative hypotheses with explainability in mind.

Scalability

Modular engine that extends to new diseases, regions, and cost perspectives.

Proof-of-concept – start small and move quickly

We received funding from the MET faculty to pursue our vision, starting with a PoC.

Why Type-1 Diabetes (T1D)?

- **High national relevance:** Finland has among the world's highest T1D incidence; prevention choices today shape decades of outcomes and spend.
- **Decision support gap:** Policymakers lack a Finland-specific, transparent way to compare long-term effects on health, costs, and equity.
- **Strong local credibility:** Tampere hosts leading T1D research and clinical expertise within the MET ecosystem—ideal for high-quality data, partnerships, and rapid translation.

Data

FinDM registry

Yearly counts of people in each *state* (T1D / Complication / Death).

- Complication = hospital visit with ICD E10*, excluding E10.9.
- Contains population of **children** diagnosis before **age 5**, between years **2012 - 2022**.

A snapshot of one state-transition table extracted from the data:

year	age_band	mean_years_sin	n_T1D_start	events_first_con	n_comp_start	person_years_T	person_years_comp
2012	0-4	1.402956684	421	44	0	302.513347	22.53798768
2012	5-9	3.537149161	1635	87	0	1464.654346	46.2696783
2012	10-14	5.717607651	2712	144	0	2482.647502	75.89869952
2012	15-19	8.448849277	3339	169	0	3157.546886	111.4579055
2013	0-4	1.408009677	387	30	34	277.5468857	48.01368925
2013	5-9	3.524520919	1549	58	63	1387.290897	94.32717317
2013	10-14	5.752112999	2601	85	149	2440.706366	196.5420945
2013	15-19	8.535116189	3326	66	167	3214.138261	200.3175907
2014	0-4	1.361490437	383	23	46	268.6078029	57.53867214
2014	5-9	3.394387742	1524	45	107	1351.712526	126.7570157
2014	10-14	5.788496728	2651	73	215	2476.320329	254.4503765
2014	15-19	8.702315113	3271	47	225	3174.195756	247.8877481
2015	0-4	1.480502928	361	21	45	265.982204	54.88843258

Data

- **Cost table:** Shows the **average yearly healthcare cost per patient** by hospital area and disease stage. Costs are based on **Finland's 2017 unit-cost study** (€4,064 per inpatient stay, €279 per outpatient visit).

Hospital cost summary table:

Note: primary-care and medicine costs not yet included.

	A	B	C	D	E	F	G
1	calendar_yea	state	university_hospital	n_at_start	n_stays	total_los_days	costs
2	2012	Comp	Helsinki	13	121	242	98118.35
3	2012	Comp	Kuopio	6	50	100	40450.93
4	2012	Comp	Oulu	15	148	304	117009.6
5	2012	Comp	Tampere	6	64	131	51928.59
6	2012	Comp	Turku	4	107	136	48790.79
7	2012	T1D	Helsinki	104	569	1059	416198.6
8	2012	T1D	Kuopio	54	431	577	279270.3
9	2012	T1D	Oulu	61	317	492	224740.7
10	2012	T1D	Tampere	52	337	534	268173
11	2012	T1D	Turku	49	413	593	270461.2
12	2013	Comp	Helsinki	24	247	439	197632.3
13	2013	Comp	Kuopio	9	89	124	51336.61

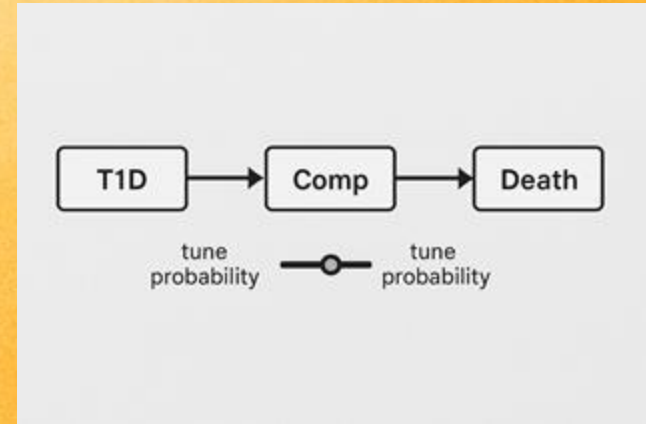
Modeling approach

- Model type: **Markov Chain (MC)** and **Decision Model (MDP)** built on aggregated statistics.
- Each “hypothesis” = a set of assumptions about risk reduction or cost change (e.g., new intervention).
- Tunable parameters:
 - Transition rates (disease progression probabilities)
 - Cost inputs (€/patient-year per state)
 - Intervention effects (from clinical evidence)
- Outputs:
 - **QALYs** (quality-adjusted life years)
 - **Estimated costs** for each scenario (A vs B, control vs treatment)
 - **Net Monetary Benefit** for policy comparison

State-transition modeling

Simplified state-transition view

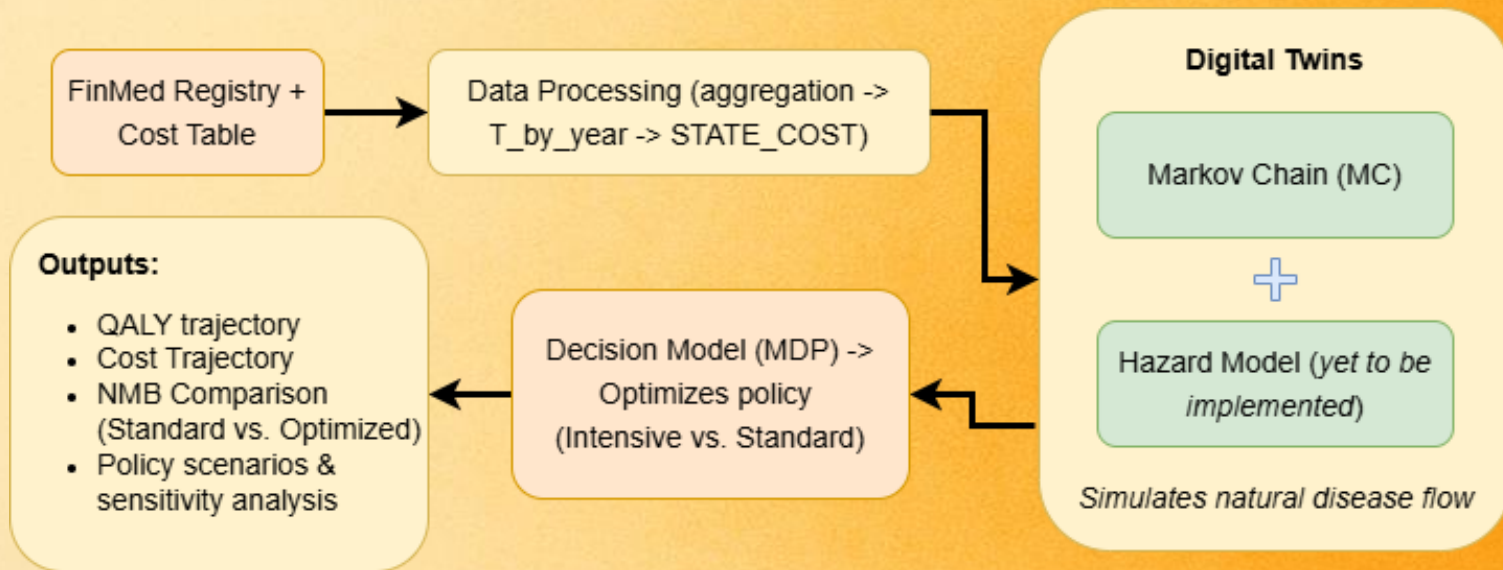
(probabilities can be tuned to test interventions)



- **Example:** This transition can be tuned to see what happens if a new intervention reduces the complication risk by 10 %.
- This flexibility allows us to test different hypotheses before real-world implementation.

Experimentation pipeline & where are we now

- Data integrated → transition and cost tables aggregated per year.
- Model implemented in Python (MC + MDP pipeline).
- Simulation run (12-year horizon, $n \approx 5\,000$ patients).



What's next

Integrating the hazard component

Adds age-dependent factor to better capture real-life disease dynamic, and enables more accurate prediction of long-term outcomes.

Improving cost model

We are missing costs from primary care and medication, which will be added.

Building an interactive tool

Web-based interface with tunable parameters (risk reduction, intervention cost, etc.) designed for both policy analysts and innovation developers to test scenarios safely. Each simulation runs in seconds, and we strive to keep it that way.

The team

Register data processing

Kamilla Ryöti

Model development

Sheikh Jubaer

Advisory board

- **Health economics:** Leena Forma
- **Type-1 Diabetes:** Heikki Hyöty, Nanna Kangasmäki, Jake Lin, Jutta Laiho
- **Project:** Timo Erkkilä, Olli Yli-harja, Frank Emmert-Streib

Thanks for your interest!