

The Economic Burden of Hip Fractures among Elderly Patients in Ireland: A Combined Perspective of System Dynamics and Machine Learning

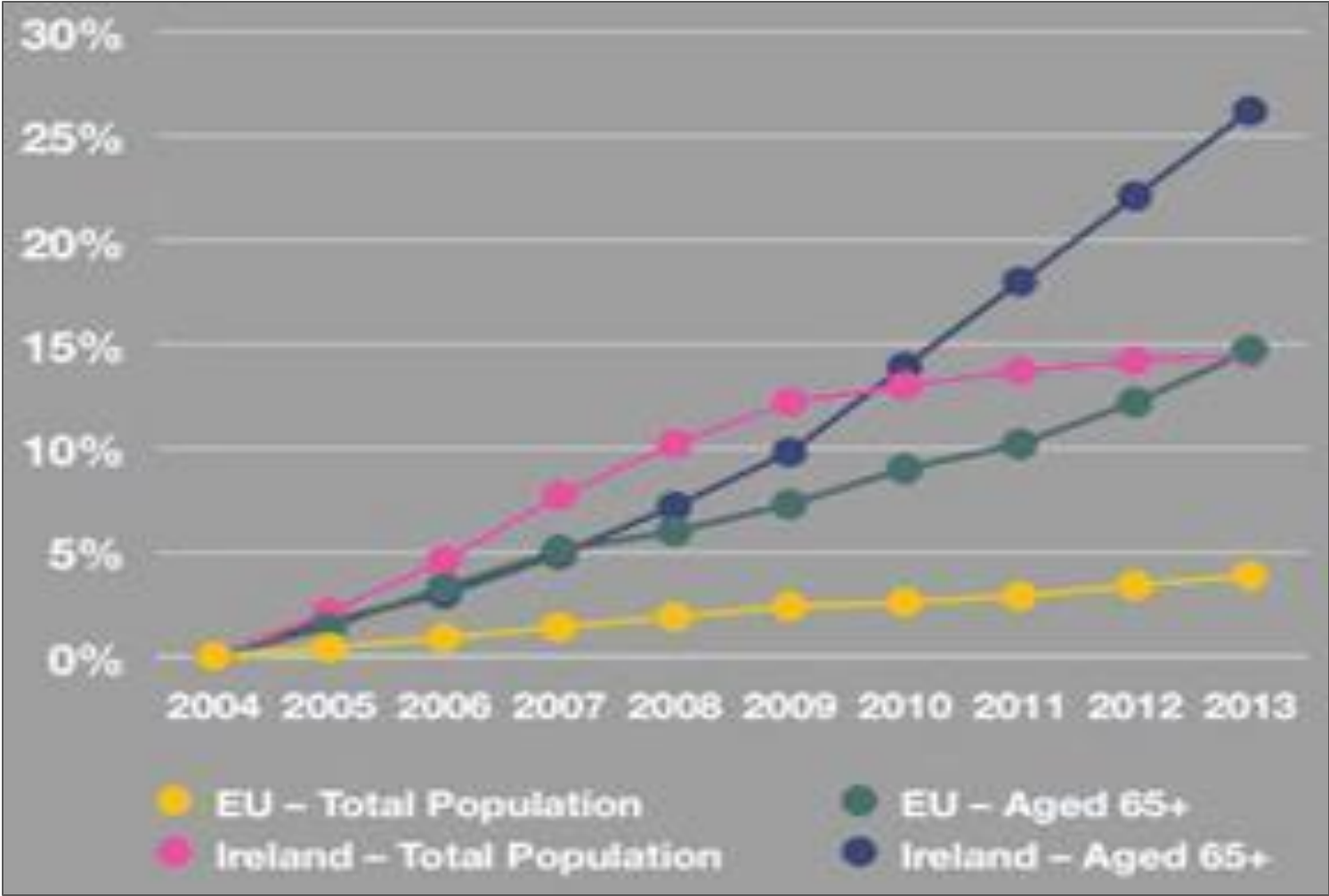
Mahmoud Elbattah, Owen Molloy

m.elbattah1@nuigalway.ie



National University of Ireland, Galway

Challenge to Healthcare: Population Ageing



Our Focus: Hip Fracture Care in Ireland

- A good exemplar of elderly healthcare.
- Exponentially increasing with age.¹
- Identified as one of the most serious injuries resulting in lengthy hospital admissions and high costs.²
- Availability of empirical data through the Irish Hip Fracture Database (IHFD).

Question of Interest

- With the growing trend of population ageing, how could be the potential economic burden of elderly hip-fracture patients on the healthcare system in Ireland over the next 10 years?

Given that:

Cost of Treatment =

(ED Cost) + (Hospital Inpatient Cost) +
(Outpatient Visits Cost) + (Long-Stay Care Cost)

Related Questions

Q1) How to predict the inpatient **length of stay** in acute facilities?

Q2) How to predict the **discharge destination** for a hip-fracture patient?

Our Approach: Integrating Simulation Modeling with Machine Learning



Patient-Focused Perspective

Machine Learning

Predict LOS and
Destination Discharge

Data-Driven Knowledge



Population-Driven Perspective

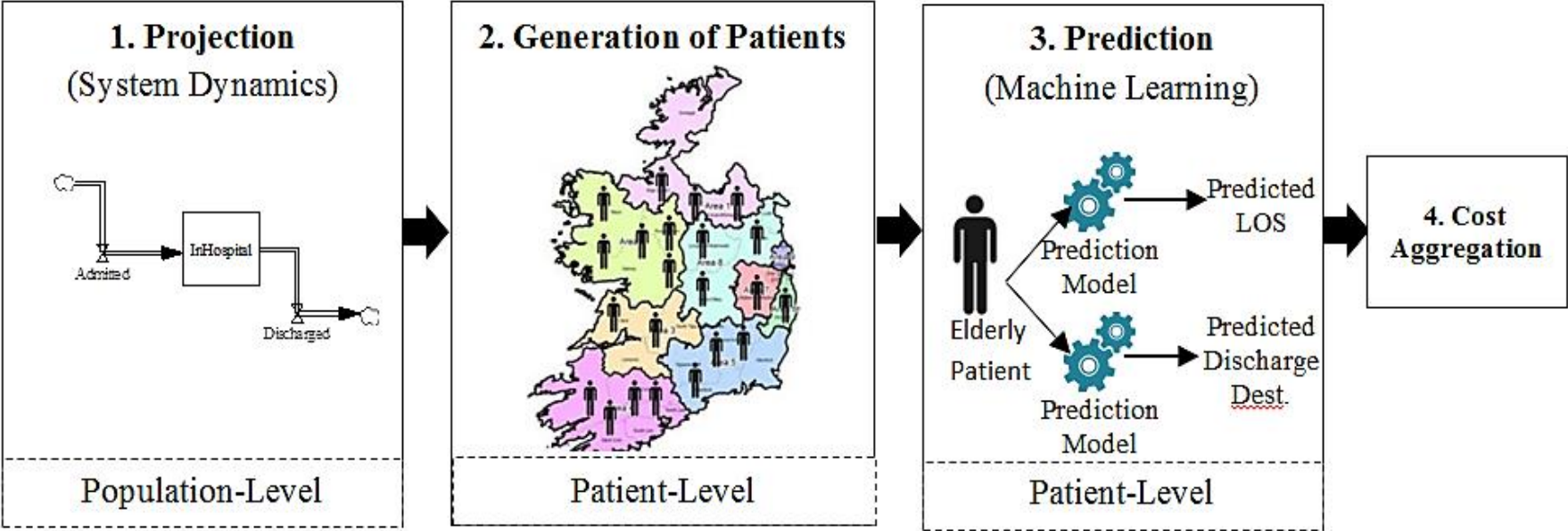
Simulation Modeling

Modeling Projected
Flow of Elderly Patients

Domain Knowledge



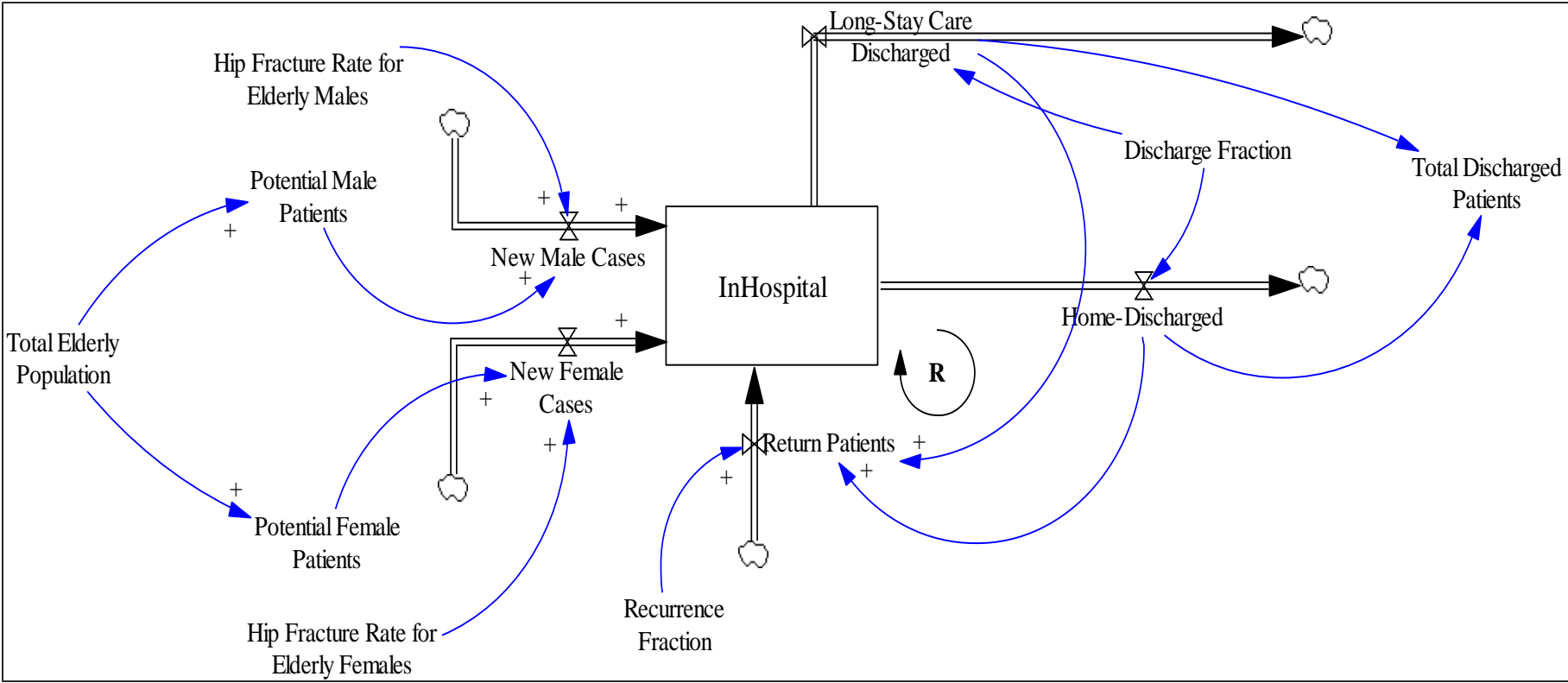
Methodology Overview



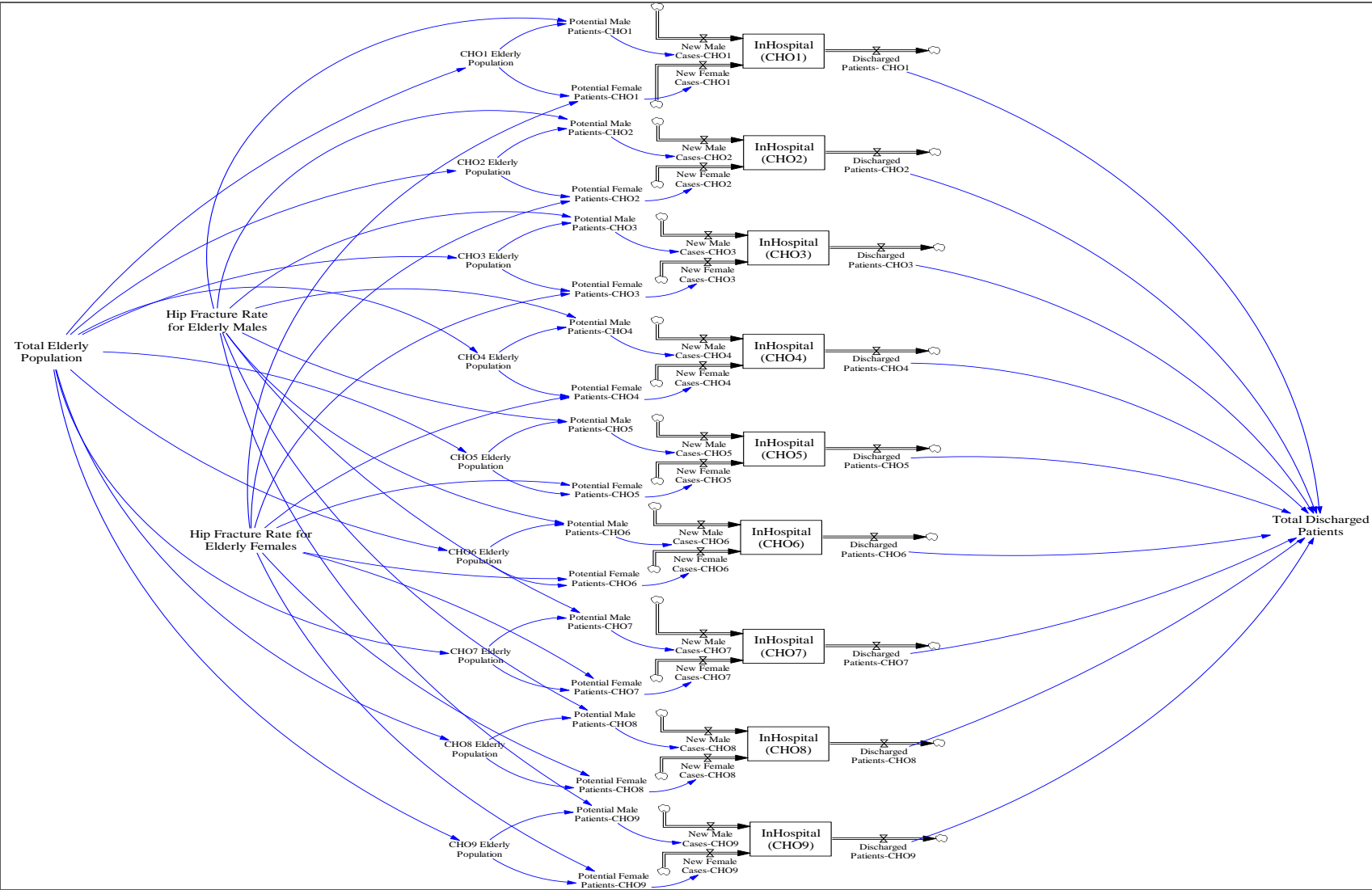
Sources of Data

- Irish Hip Fracture Database (IHFD). (Year 2013)
- Population projections from the Central Statistics Office (CSO).
- Additional population statistics with respect to CHOs from the Health Intelligence Department.

The Initial SD Model



Disaggregating the Model



Generation of Patients

Counts of patients generated per CHO over 50 simulation experiments.

Community Health Organisation (CHO)	No. of Simulation-Generated Patients
CHO1	151,850
CHO2	169,550
CHO3	142,450
CHO4	247,750
CHO5	187,050
CHO6	140,750
CHO7	191,900
CHO8	187,050
CHO9	180,650

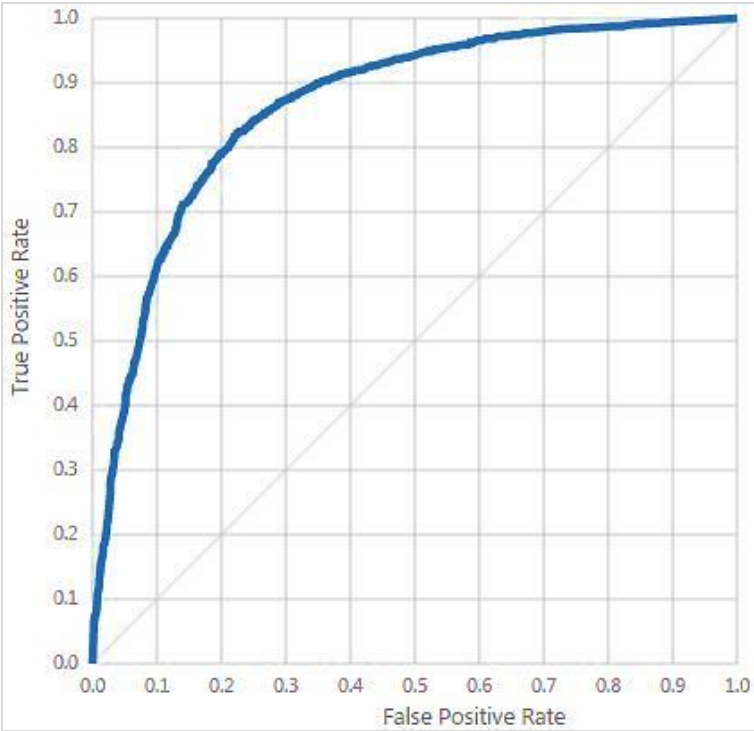
Machine Learning Models

- Regression Model -> Length of Stay.
- Classification Model -> Discharge destination.
- Machine learning algorithm: Random Forests.

Machine Learning Models (cont'd)

Average 10-fold cross-validation accuracy of the LOS predictor

Relative Absolute Error	Relative Squared Error	Coefficient of Determination
≈ 0.26	≈ 0.17	≈ 0.83



Average 10-fold cross-validation accuracies of discharge destination classifier.

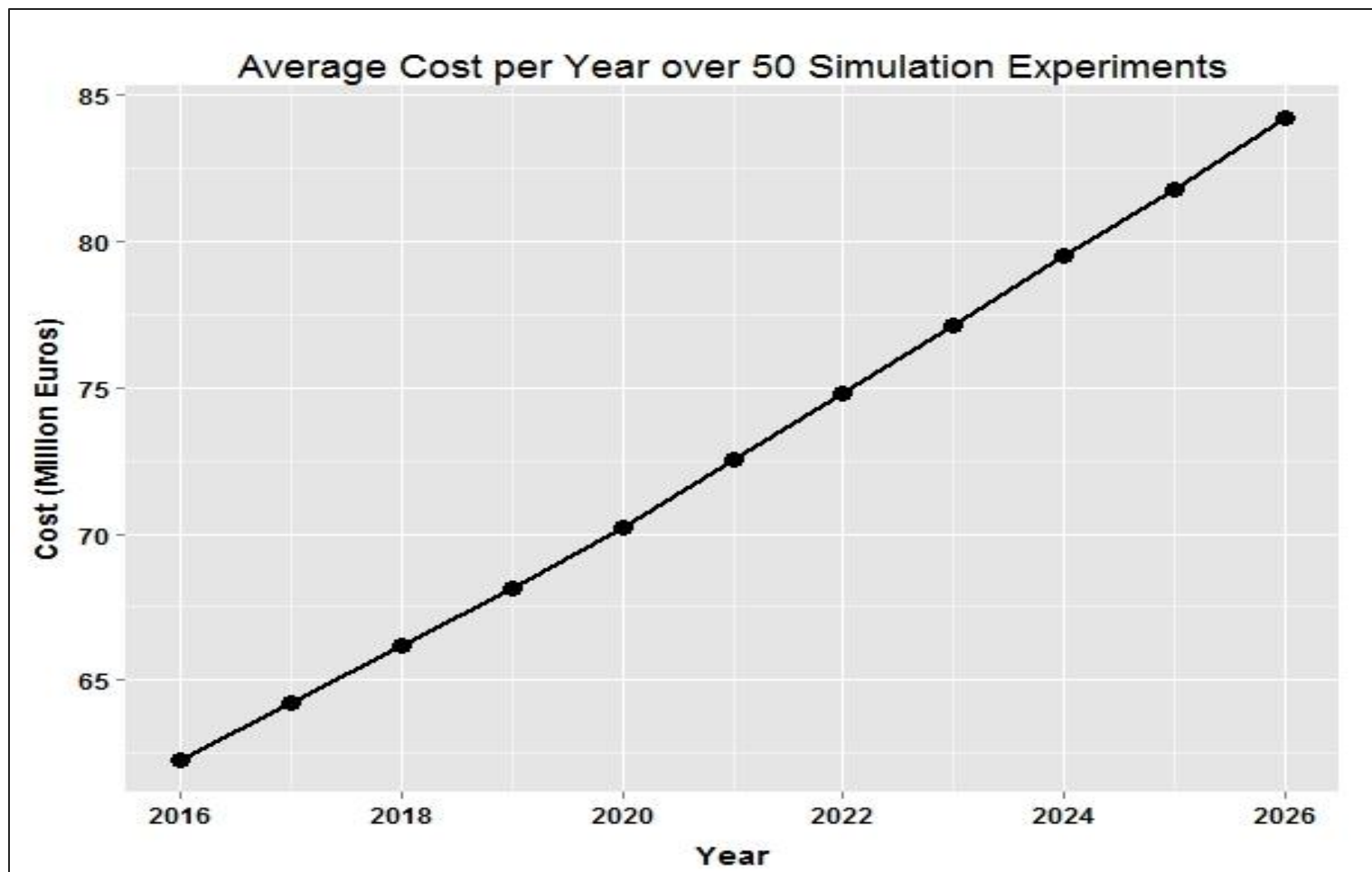
Calculation of Cost

Cost of Treatment = (ED Cost) + (Hospital Inpatient Cost) + (Outpatient Visits Cost) + (Long-Stay Care Cost)

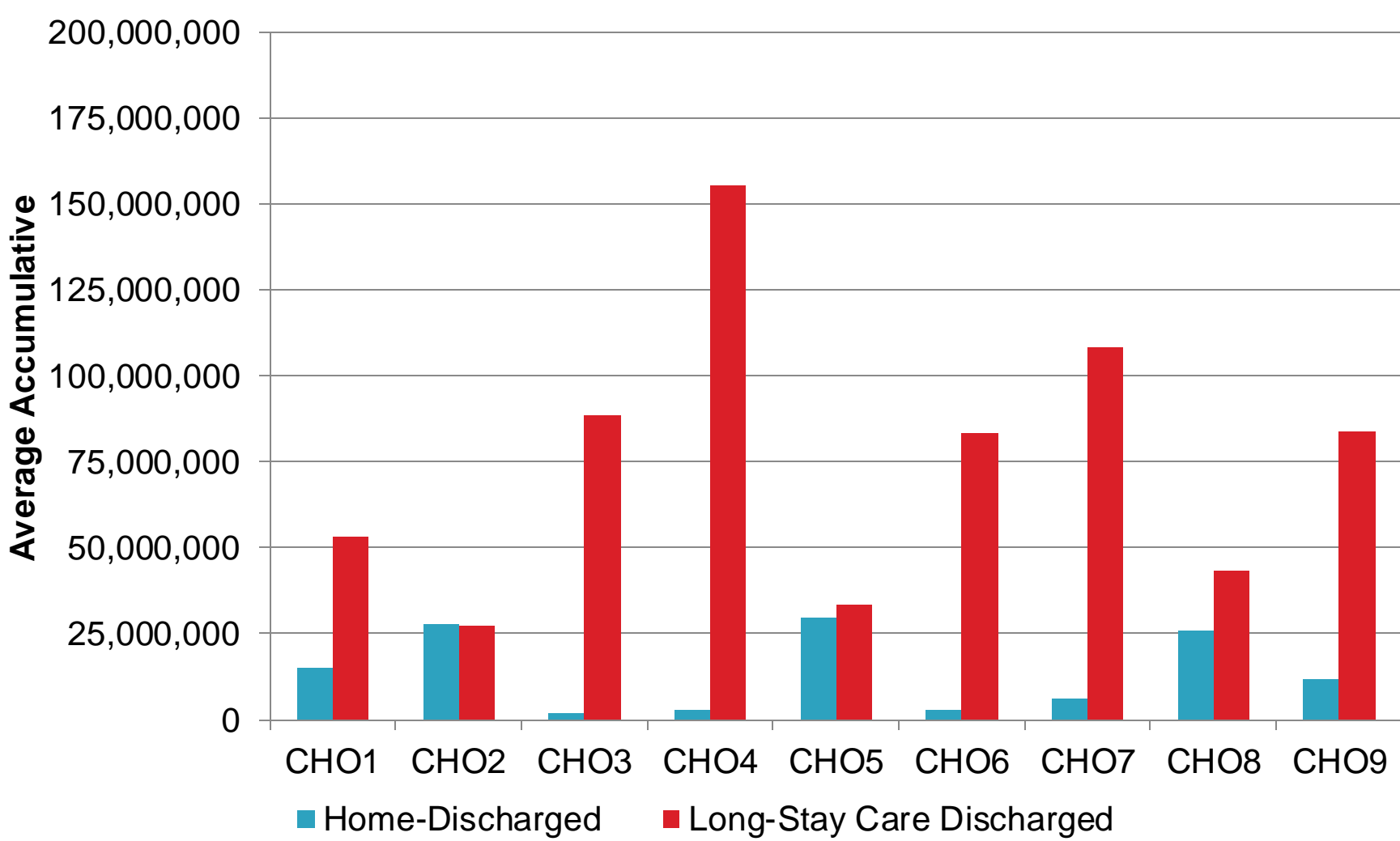
- Information on costs was acquired from the report “*The economic costs of falls and fractures in people aged 65 and over in Ireland*”.¹

¹ Gannon, B., O'Shea, E. and Hudson, E., 2007. The economic costs of falls and fractures in people aged 65 and over in Ireland. Irish Centre for Social Gerontology, Galway.

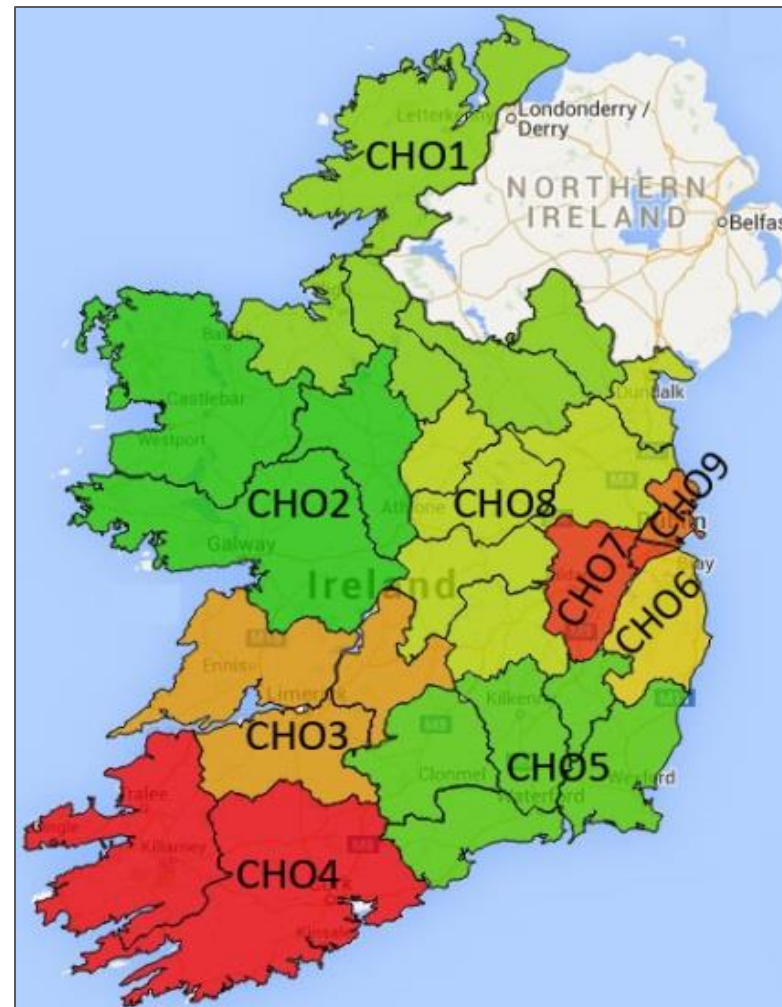
Results: Predicted Cost in 10 Years



Results: Predicted Costs in CHOs



Visualising Predicted Costs in CHOs



Heatmap: Overall predicted cost within every CHO.

Study Limitations

- Only public acute hospitals were considered.
- The IHFD dataset did not evenly represent the 9 CHOs.
- The dataset covered only a single year (2013).
- The rate of hip fractures was assumed as a constant over the simulated interval, however it might increase or decrease in reality.

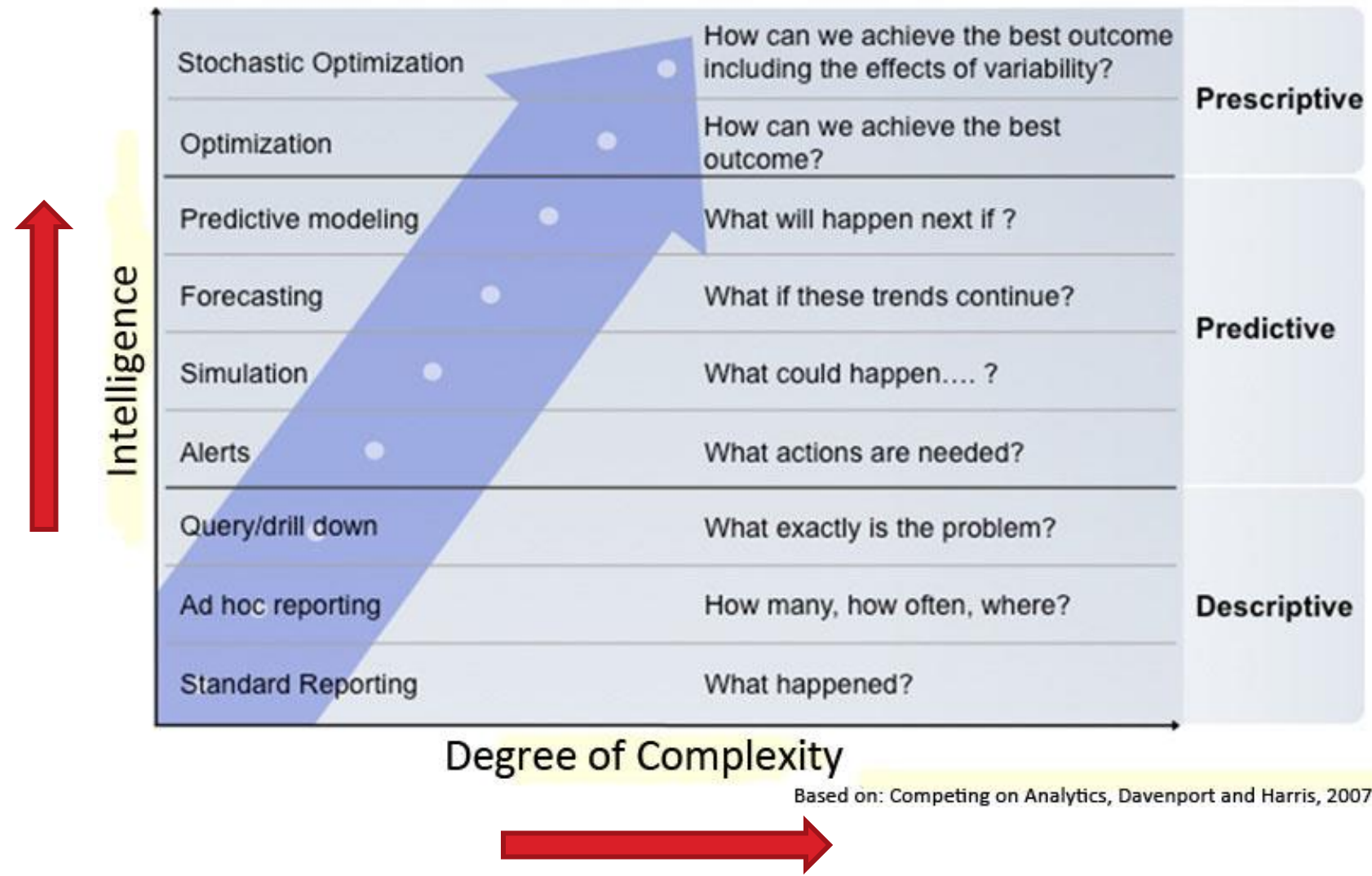
Study Limitations (cont'd)

- In-hospital cost of the patients aged 60-64 were considered the same as 65-69.
- The study did not consider other potential costs such as the ambulance costs.
- The study did not consider the indirect costs such as the quality of life.
- The study did not distinguish between the patients who are discharged to long-stay nursing homes and rehabilitation institutions.

Discussion

- Why not use Simulation Modeling alone?
- Why not use Machine Learning alone?

Discussion (cont'd)



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Authors: [Mahmoud Elbattah](#) [National University of Ireland Galway, Galway City, Ireland](#)
[Owen Molloy](#) [National University of Ireland Galway, Galway City, Ireland](#)

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THANK YOU!

Mahmoud Elbattah

m.elbattah1@nuigalway.ie