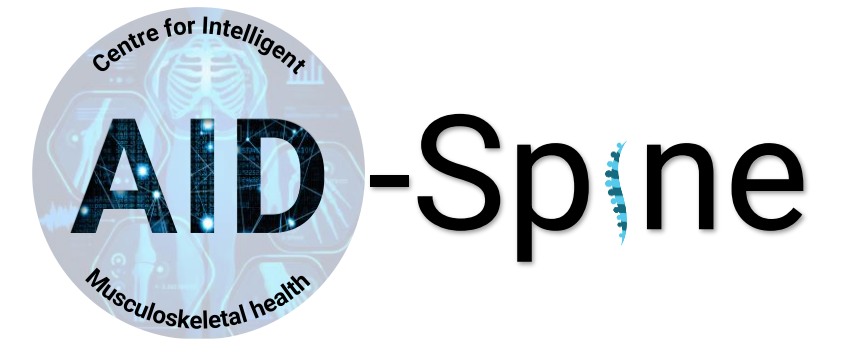
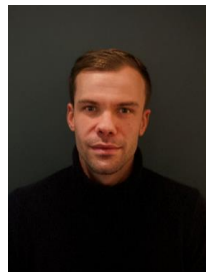


NORSpine: AI to be used in predicting results after spine surgery: Preliminary results from the AID-Spine project



“Applying AI in Spine disorders”

A collaboration between Centre for Intelligent Musculoskeletal Health (CIM), OsloMet and Tore Solberg et al from the Norwegian centre for clinical AI, SPKI, University Hospital of North-Norway/UiT.



Bjørnar Berg, postdoc AID-Spine, and Martin Gorosito (comp.sc) have conducted the analyses in this presentation.

Stockholm November 9-10, 2023

Professor Margreth Grotle

Centre for Intelligent Musculoskeletal Health, OsloMet



 The Research Council of Norway

No relevant disclosures

NorSpine studies; (non)-successful outcomes after surgery

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Acta Orthopaedica 2013; 84 (2): 196–201

Can we define success criteria for lumbar disc surgery?

Estimates for a substantial amount of improvement in core outcome measures

Tore Solberg^{1,2}, Lars Gunnar Johnsen^{3,4}, Øystein P Nygaard^{2,3,4}, and Margreth Grotle^{5,6}

¹Department of Neurosurgery, University Hospital of Northern Norway (UNN); ²The Norwegian Registry for Spine Surgery (NORspine), Centre of Clinical Documentation and Evaluation (SKDE), Northern Norway Regional Health Authority, Tromsø; ³National Centre for Spinal Disorders, University Hospital of St. Olav, Trondheim; ⁴Faculty of Medicine, Norwegian University of Technology and Science (NTNU), Trondheim; ⁵FORMI, Communication Unit for Musculoskeletal Disorders, Oslo University Hospital, Ullevaal; ⁶Department of Physiotherapy, Faculty of Health Sciences, Oslo and Akershus University College of Applied Sciences, Oslo, Norway.
Correspondence: tore.solberg@unn.no
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Eur Spine J
DOI 10.1007/s00586-017-5185-5



<http://crossmark.g/?doi=10.1007/s00586-017-5185-5&domain=pdf>

ORIGINAL ARTICLE

Criteria for failure and worsening after surgery for lumbar disc herniation: a multicenter observational study based on data from the Norwegian Registry for Spine Surgery

David A. T. Werner^{1,2} · Margreth Grotle^{3,4} · Sasha Gulati⁵ · Ivar M. Austevoll⁶ · Greger Lønne⁷ · Øystein P. Nygaard^{5,8} · Tore K. Solberg^{1,2,8}

Austevoll et al. *BMC Musculoskeletal Disorders* (2019) 20:31
<https://doi.org/10.1186/s12891-018-2386-y>

BMC Musculoskeletal Disorders

RESEARCH ARTICLE

Open Access



Follow-up score, change score or percentage change score for determining clinical important outcome following surgery? An observational study from the Norwegian registry for Spine surgery evaluating patient reported outcome measures in lumbar spinal stenosis and lumbar degenerative spondylolisthesis

Ivar Magne Austevoll^{1,2,3*}, Rolf Gjestad⁴, Margreth Grotle^{7,10}, Tore Solberg^{3,6}, Jens Ivar Brox^{3,5}, Erland Hermansen^{1,2,8}, Frode Rekeland¹, Kari Indrekvam^{1,2}, Kjersti Storheim⁷ and Christian Hellum^{3,9}

Original Article

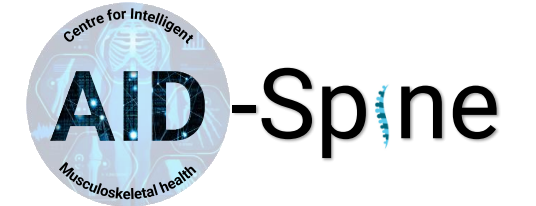


Can a Successful Outcome After Surgery for Lumbar Disc Herniation Be Defined by the Oswestry Disability Index Raw Score?

David A. T. Werner, MD^{1,2} , Margreth Grotle, MD, PhD^{3,4}, Sasha Gulati, MD, PhD^{5,6}, Ivar M. Austevoll, MD⁷, Mattis A. Madsbu, MD⁵, Greger Lønne, MD, PhD^{6,8,9}, and Tore K. Solberg, MD, PhD^{1,2,9}

Global Spine Journal
1-8
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Success/non-success in NorSpine 2007-2022 (n~60.000)

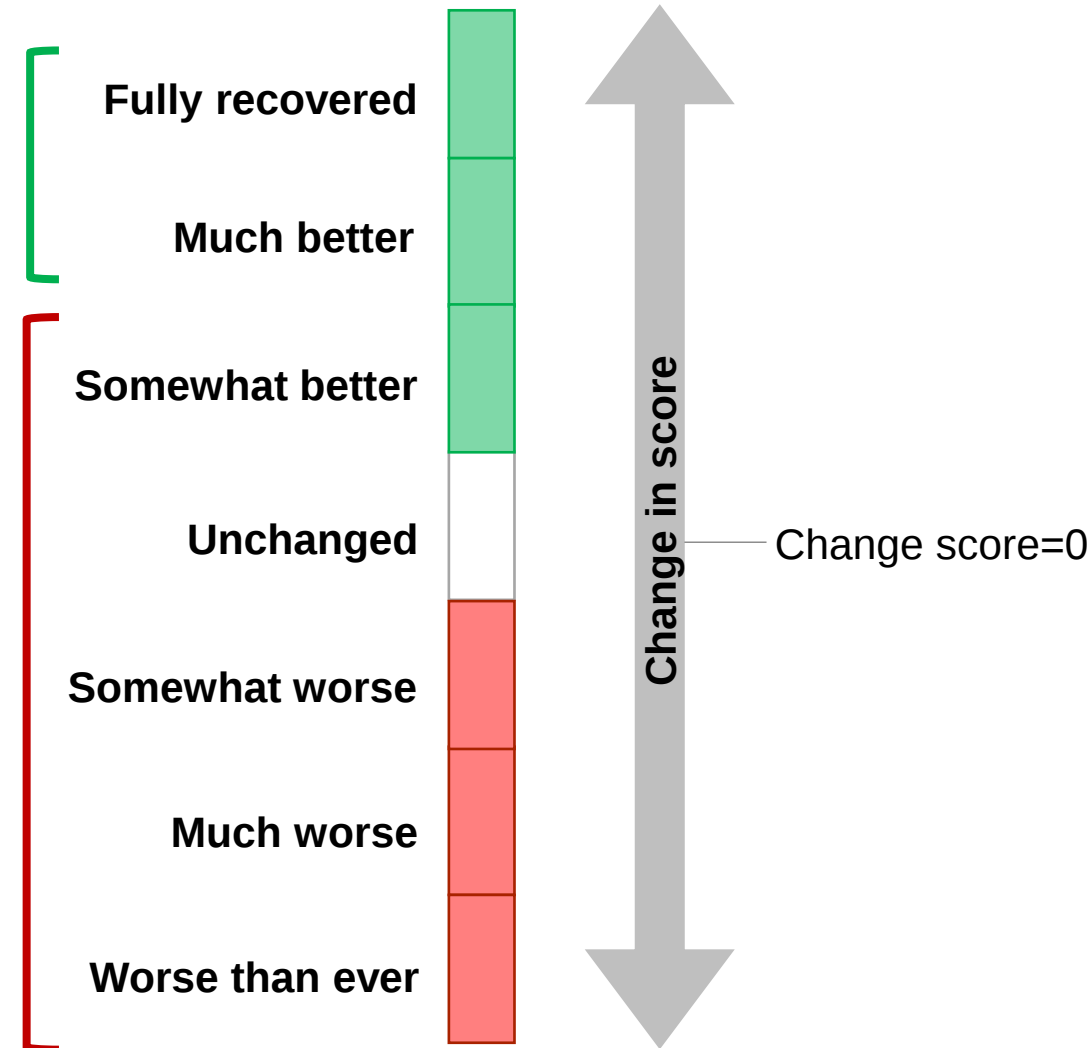


Success

disc herniation;

- ≥ 22 points (ODI)
- ≥ 2 points (NRS back)
- ≥ 4 points (NRS leg)

Anchor: GPE



Success

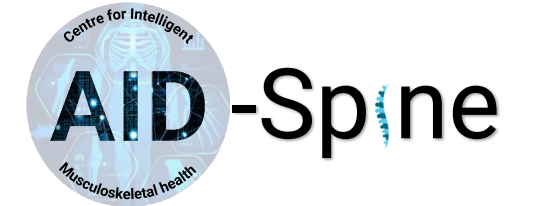
spinal stenosis;

- ≥ 14 points
- ≥ 2 points
- ≥ 3 points

Predictive modeling ($MIC_{\text{Predictive}}$)

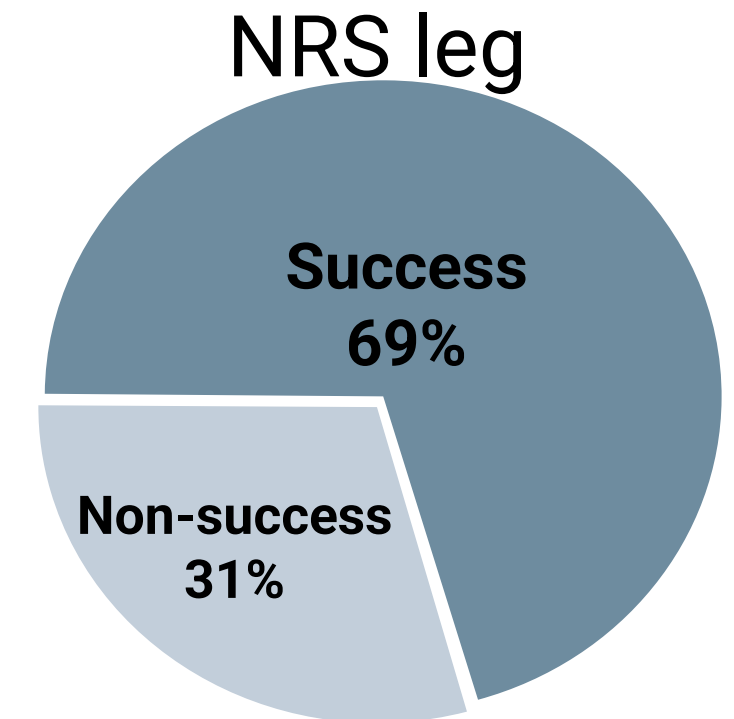
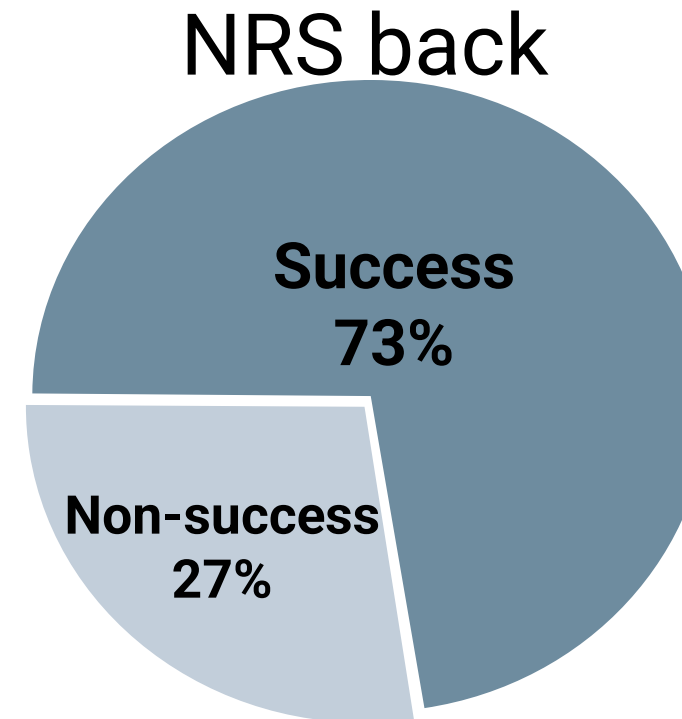
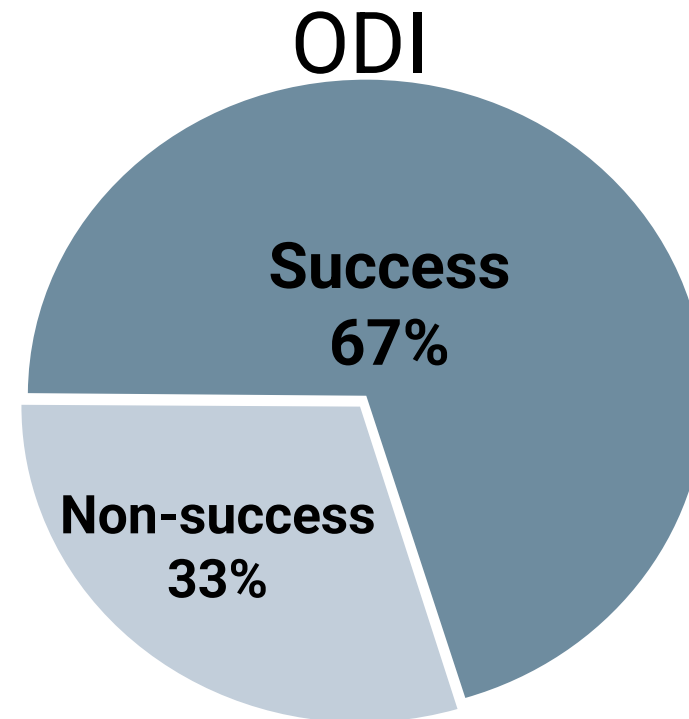
- Adjusted for the proportion of improved patients (MIC_{Adjusted})

AID-Spine – using data from NorSpine 2007-2022 (n~60.000)



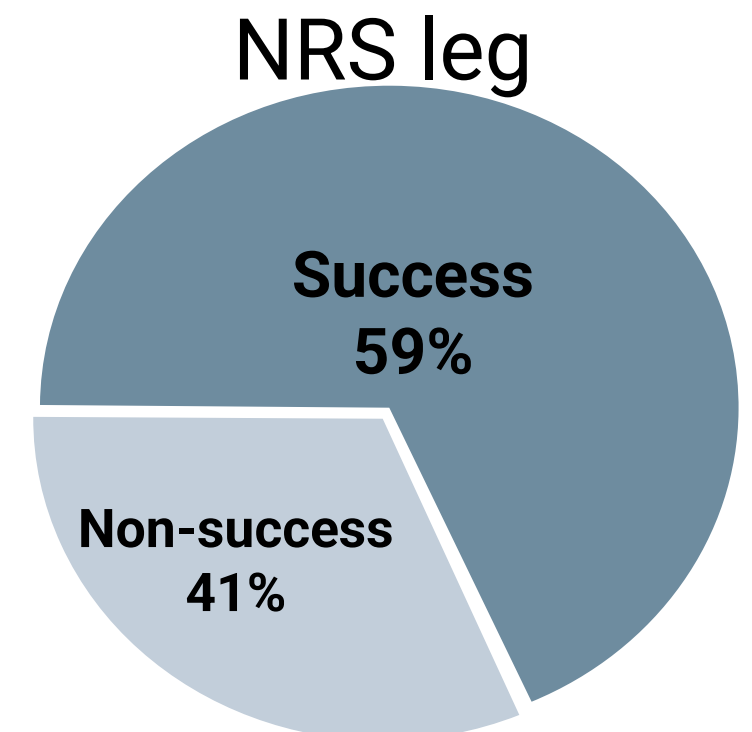
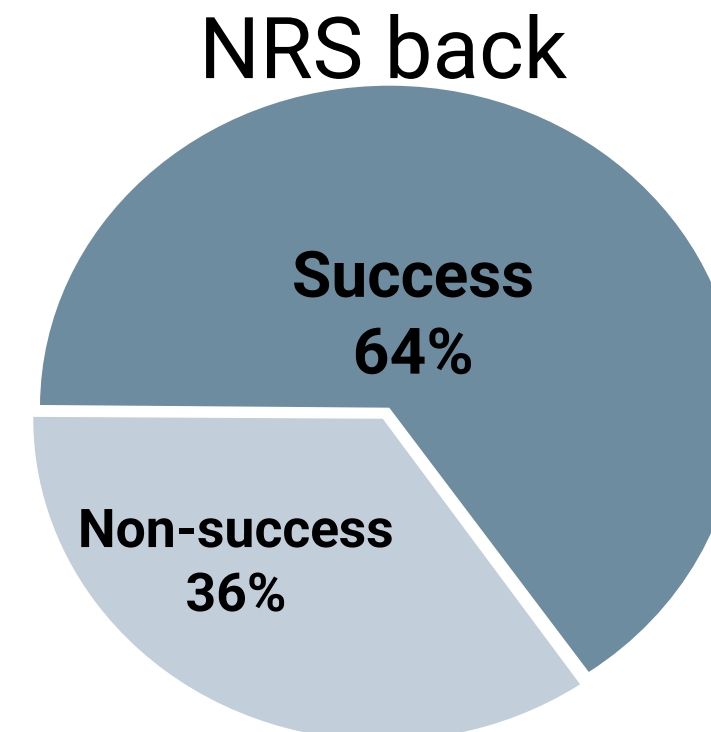
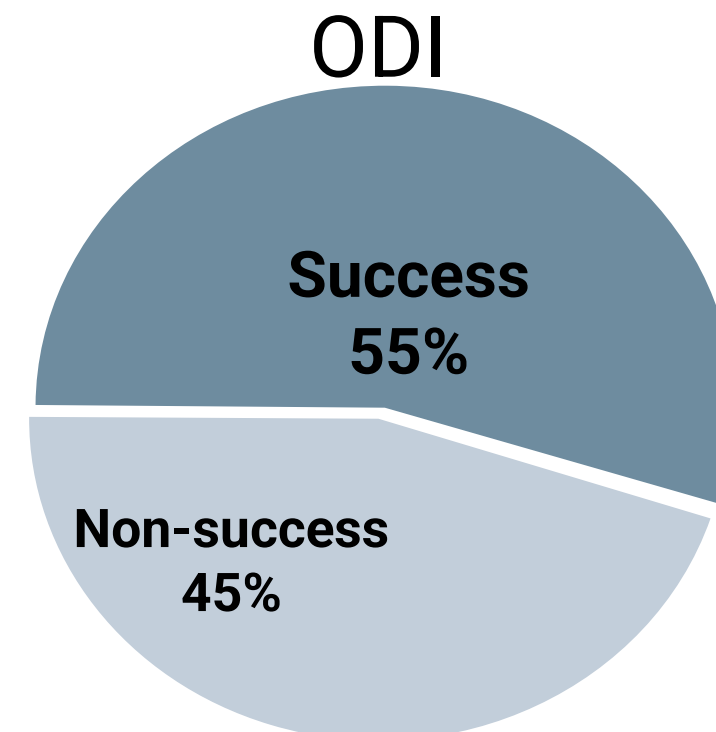
Success disc herniation 12 mo;

- ≥ 22 points (ODI)
- ≥ 2 points (NRS back)
- ≥ 4 points (NRS leg)

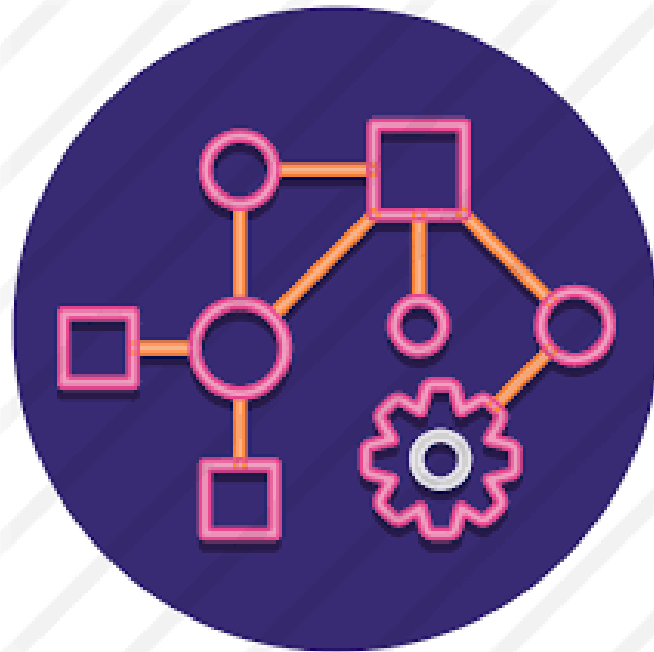


Success spinal stenosis 12 mo;

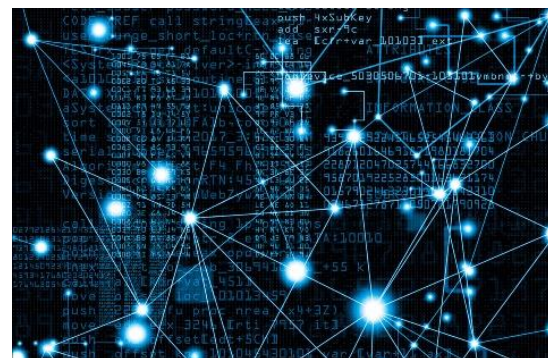
- ≥ 14 points (ODI)
- ≥ 2 points (NRS back)
- ≥ 3 points (NRS leg)



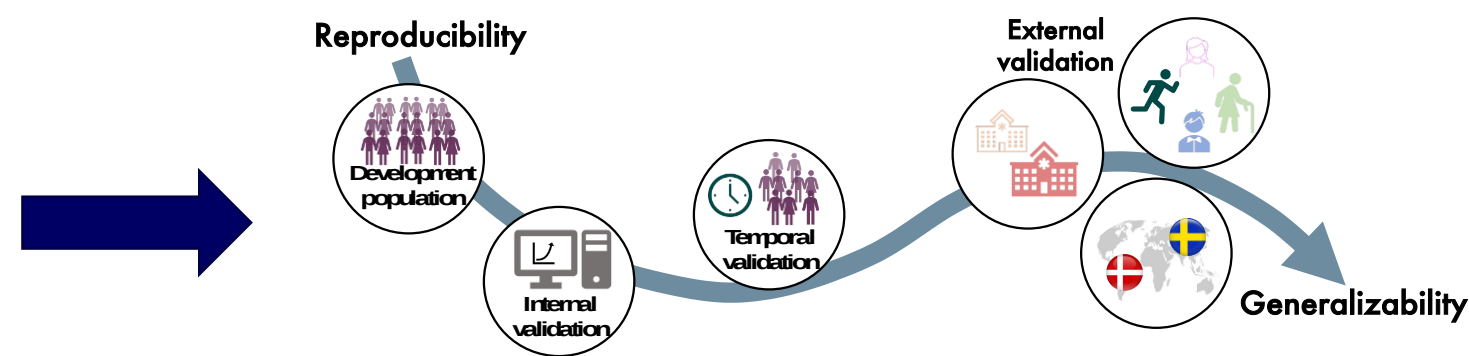
AID-Spine – Background and objectives



- So, are we satisfied with the 27-45% non-success rate?
- How to improve the success rates?
 - To become better in selection of patients referred to (elective) surgery?
- Can Machine Learning (ML) methods provide precise prediction models for successful/non-successful outcomes after surgery?

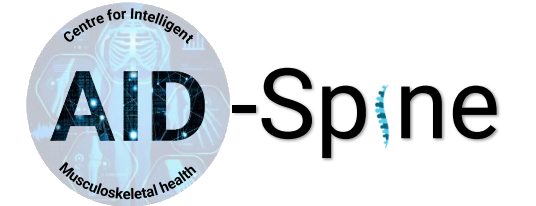


OSLO METROPOLITAN UNIVERSITY
STORBYUNIVERSITETET



AID-Spine treatment success

Objective

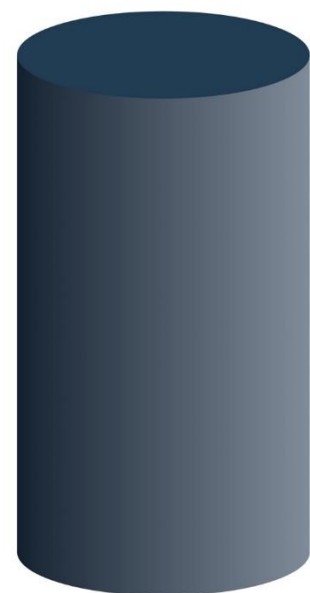


To develop and validate prediction models for disability and pain 12 months after lumbar disc herniation surgery (and spinal stenosis surgery):

Examples from prediction models for disability (ODI) after lumbar disc herniation surgery

The Norwegian Registry for Spine Surgery

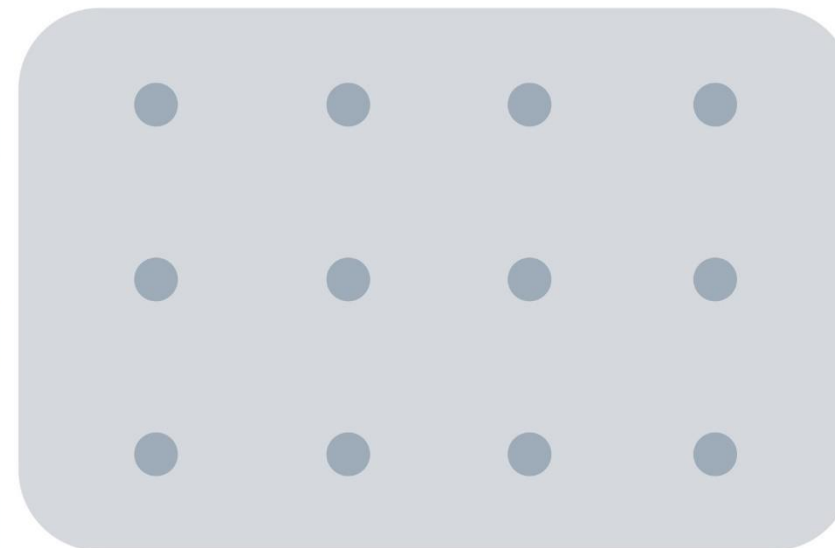
NORspine



Preoperative patient info

Preoperative patient info

Preoperative patient info

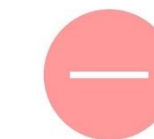


12 months

Treatment success



Success



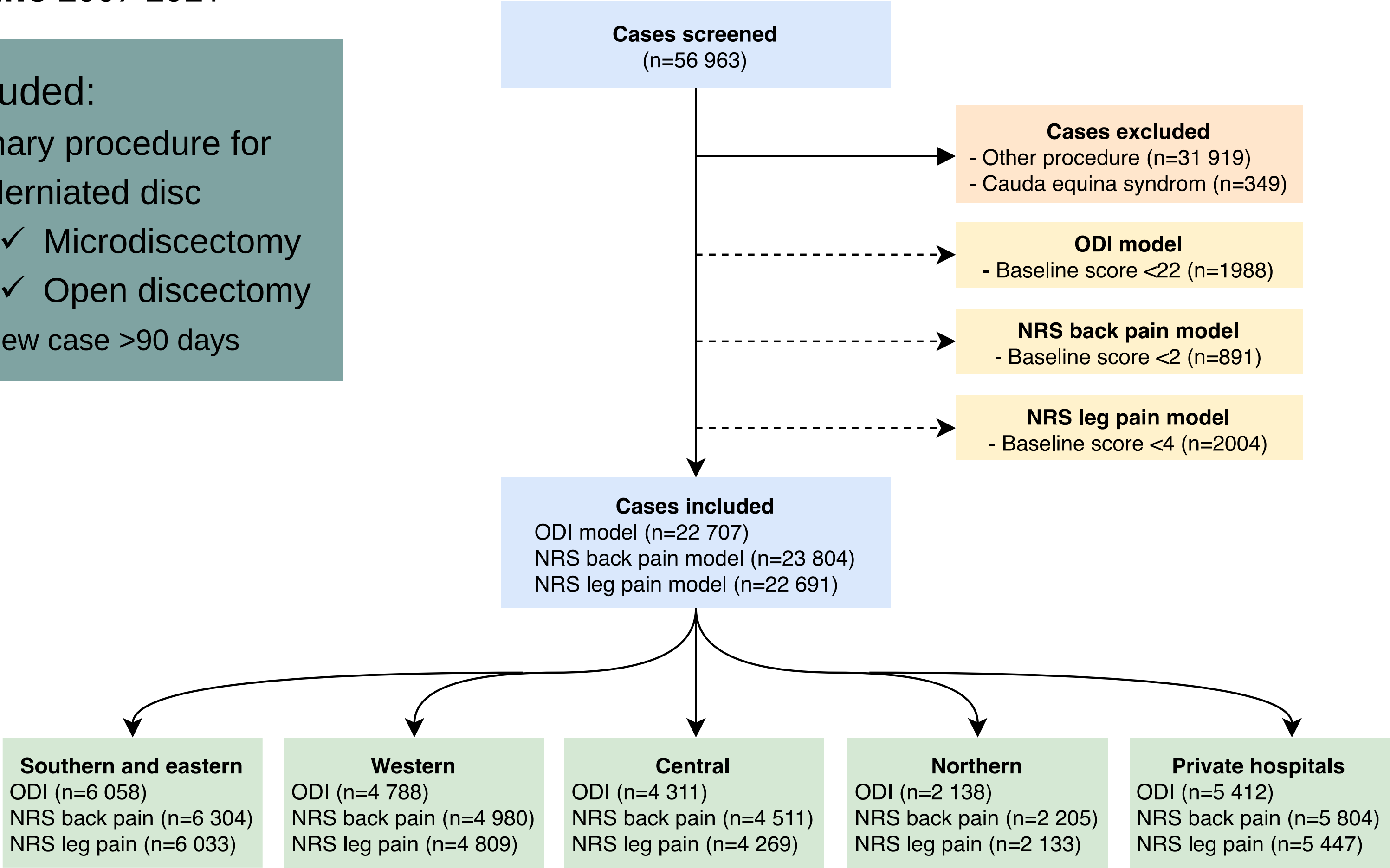
Non-success

NORspine 2007-2021

Included:

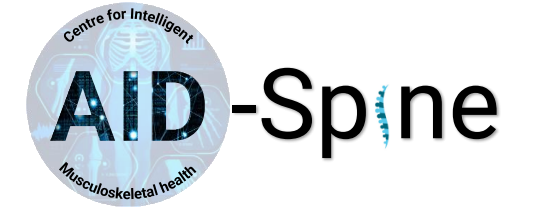
Primary procedure for

- ✓ Herniated disc
 - ✓ Microdiscectomy
 - ✓ Open discectomy
- + New case >90 days



AID-Spine treatment success

Machine learning approach



Data Manipulation

Cleaning

Feature
engineering

Preoperative predictors (n=25)

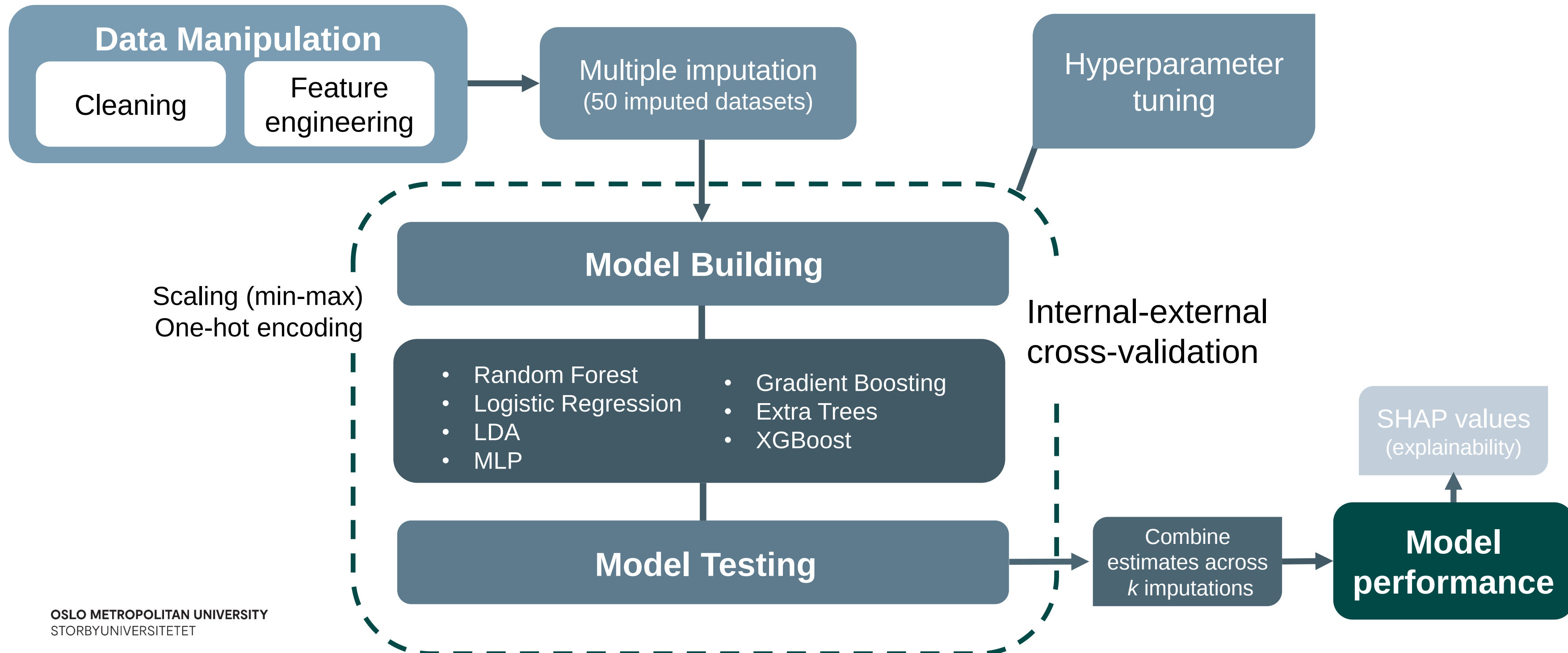
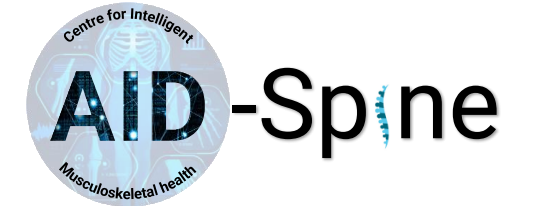
- Patient demographics
- Clinical characteristics
- Comorbidity
- Analgesics use
- Type of surgery

(No variable selection techniques)

Routinely available preoperative predictors

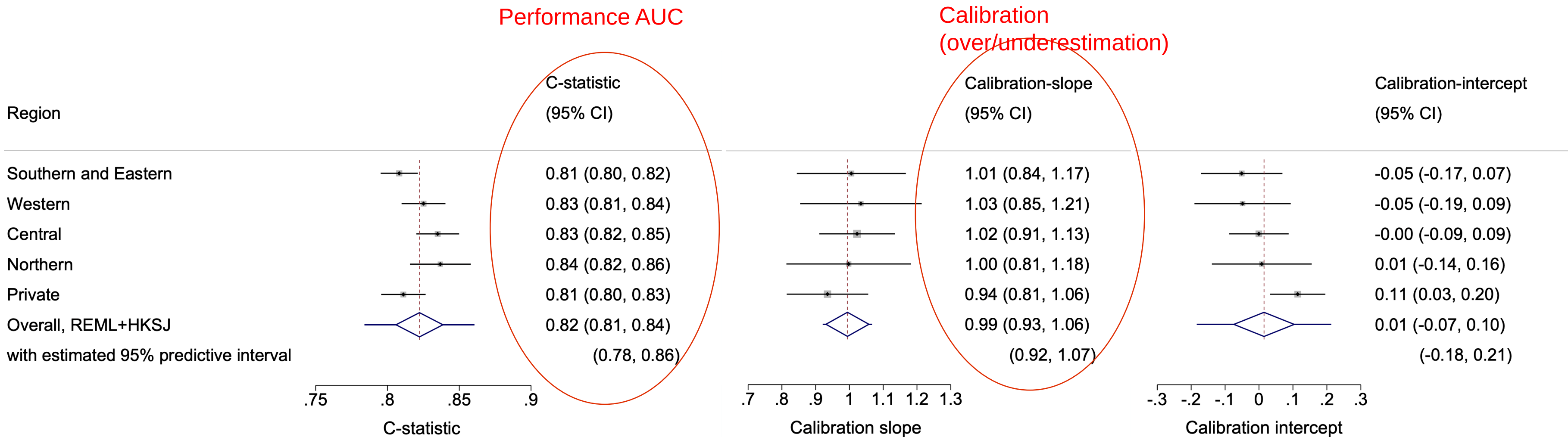
AID-Spine treatment success

Machine learning approach



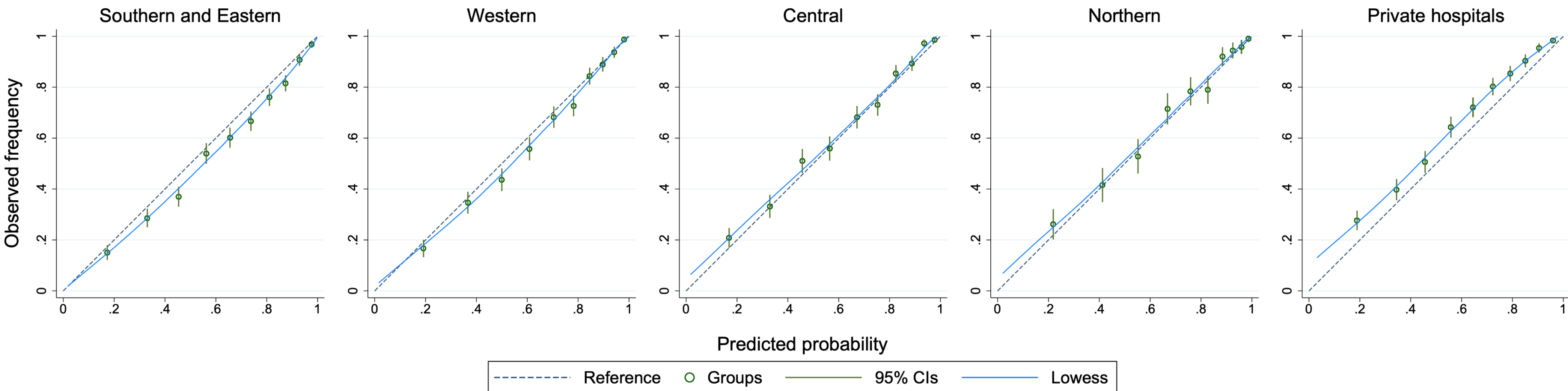
AID-Spine treatment success disc herniation

Results – performance ODI (AUC) for lumbar disc herniation



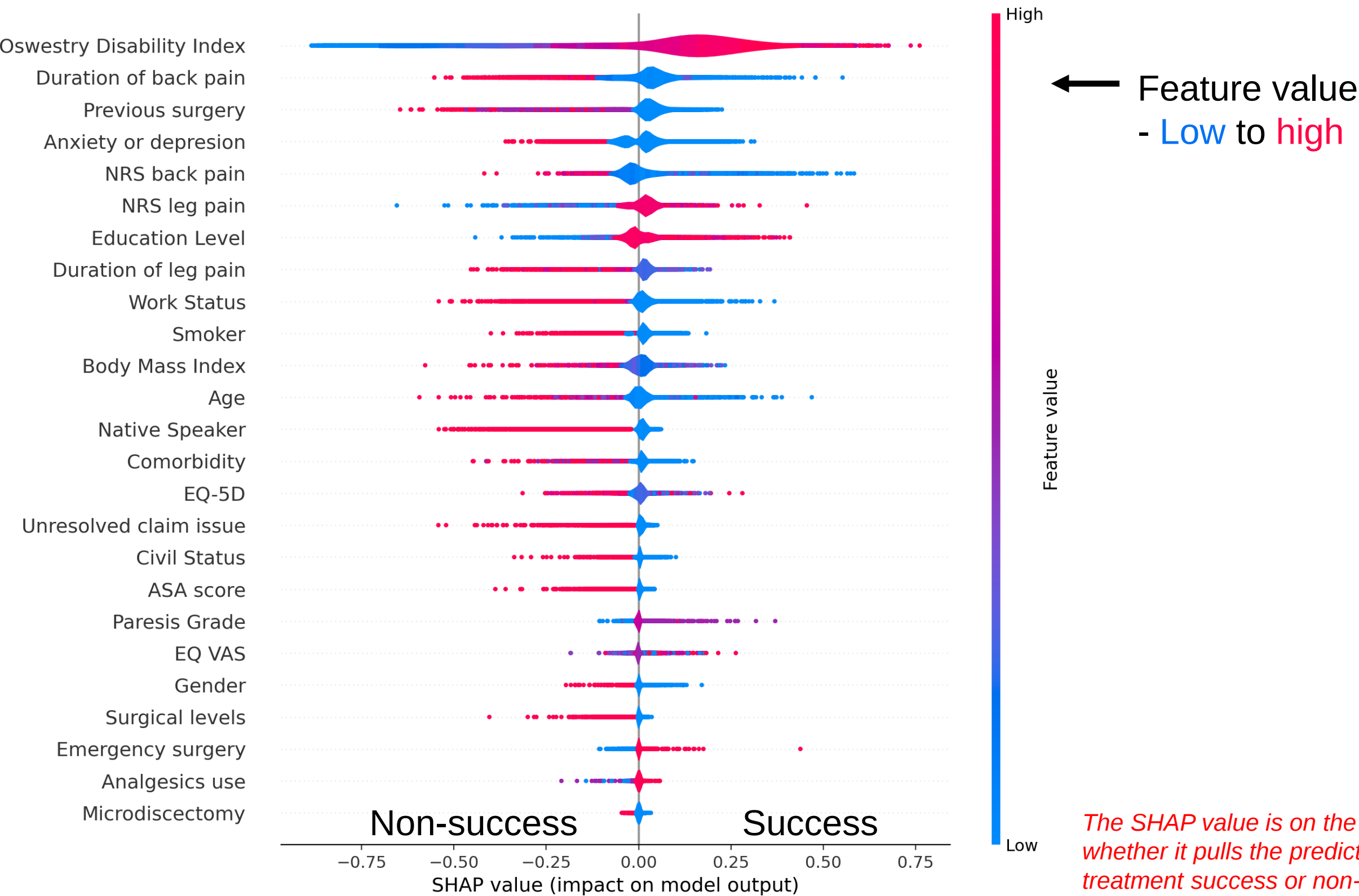
AID-Spine treatment success

Calibration plots for ODI (over/underestimations of the model)



AID-Spine treatment success

Predictive features ranked according to importance – ODI



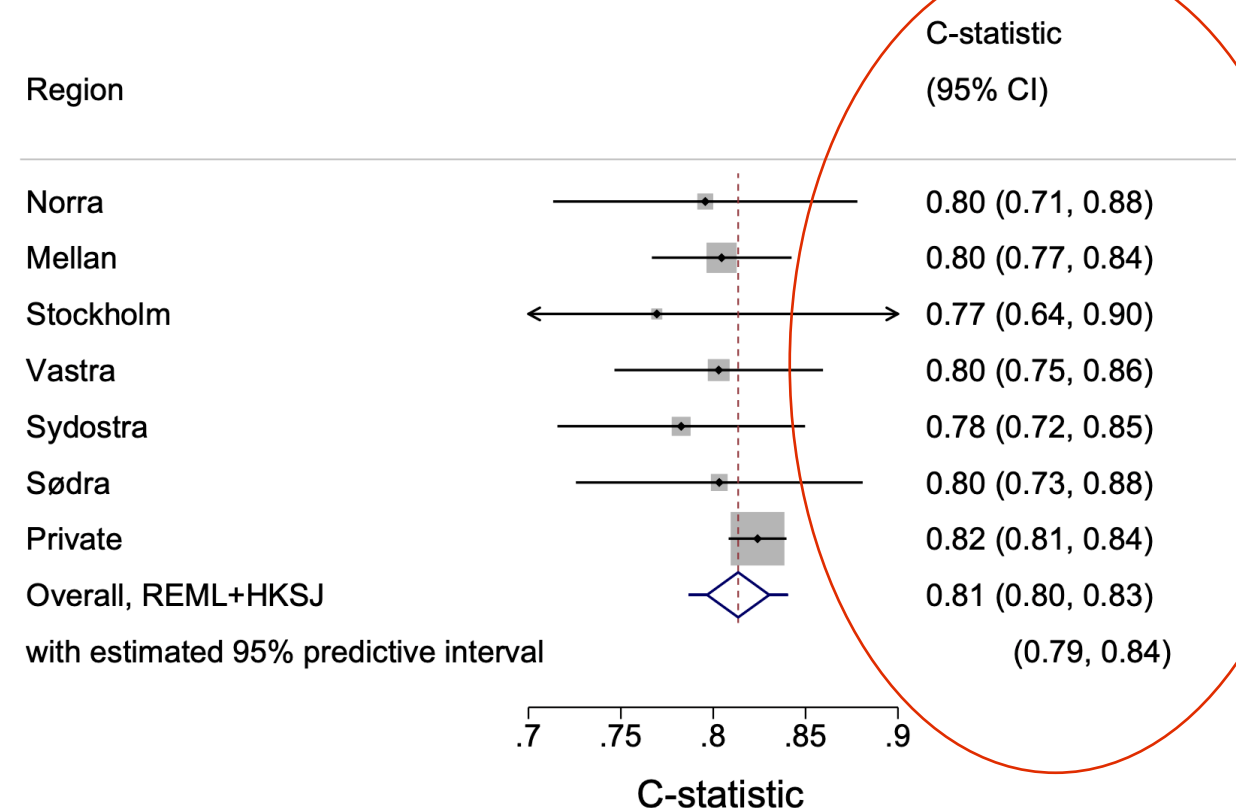
The SHAP value is on the x-axis, indicate whether it pulls the prediction towards treatment success or non-success.

AID-Spine external validation in SweSpine (2016-2023)

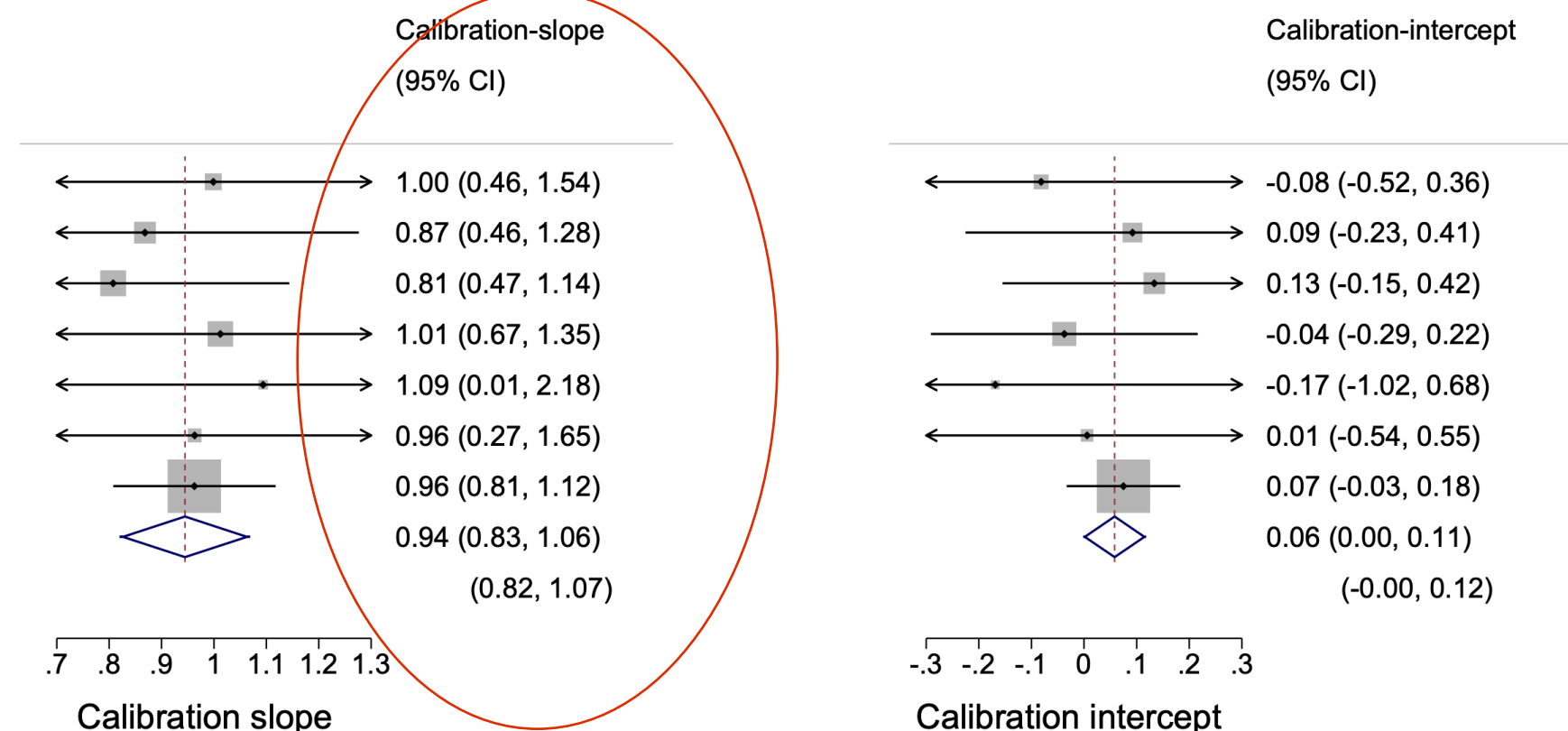
Performance of ODI with cross-validation of regional clusters in Sweden (Allan Abbott)

A ODI

Performance AUC

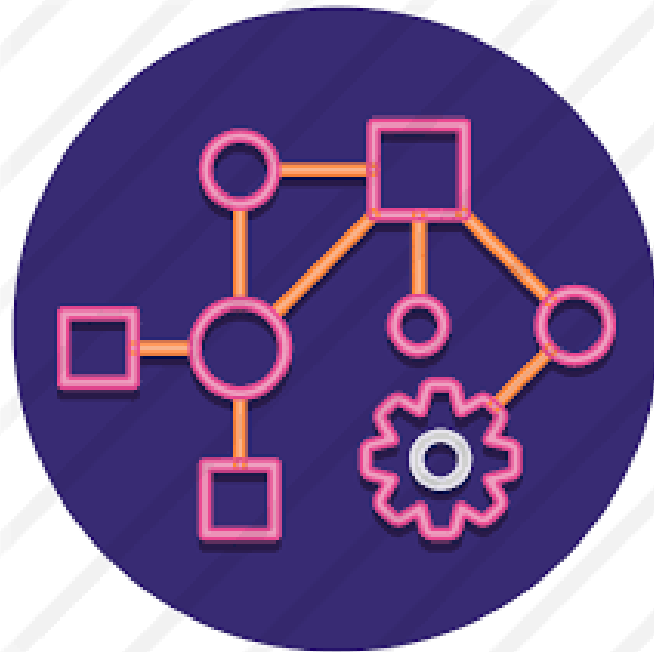


Calibration (over/underestimation)

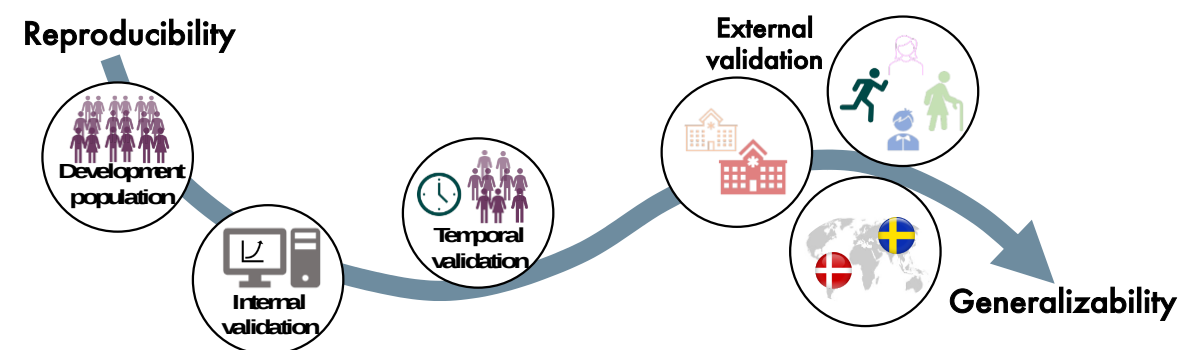
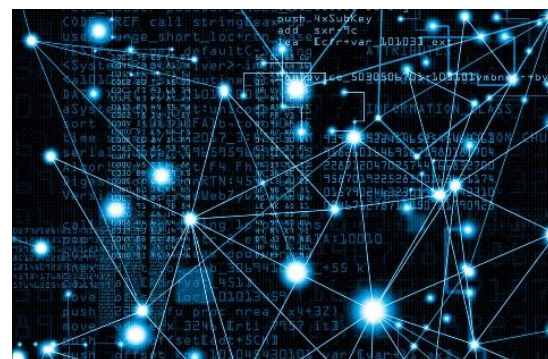


AUC of 0.81 but with larger differences between the health regions in Sweden,
also less stable calibration plot

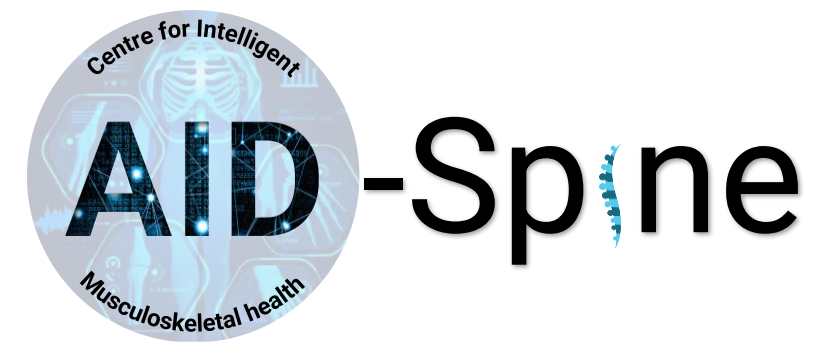
NorSpine analyses – preliminary conclusions



- Can Machine Learning (ML) methods provide precise prediction models for successful/non-successful outcomes after surgery?
 - *Promising for disc herniation surgery (both internal and external validations) using ODI as outcome*
 - *Lower accuracy for NRS back and leg pain*
 - *Lower accuracy for spinal stenosis surgery for all three outcomes*
 - *Further external validations in DanSpine*
- Further discussions and work in AID-Spine
 - *Access to other exposure variables/features*
 - *Other outcomes than PROMs (e.g. unfavourable outcomes, sickness absence, prescribed medication)*
 - *Complexity vs feasibility of ML models*



AID-Spine: Health and welfare outcomes (data source)



Treatment success or non-success (PROMs, NORspine and NNRR)



Unfavorable outcomes (health registers NPR, KUHR)



High use of prescribed medication (health registry NorPD)



Receiving sick leave and/or disability benefits (SSB/NAV)