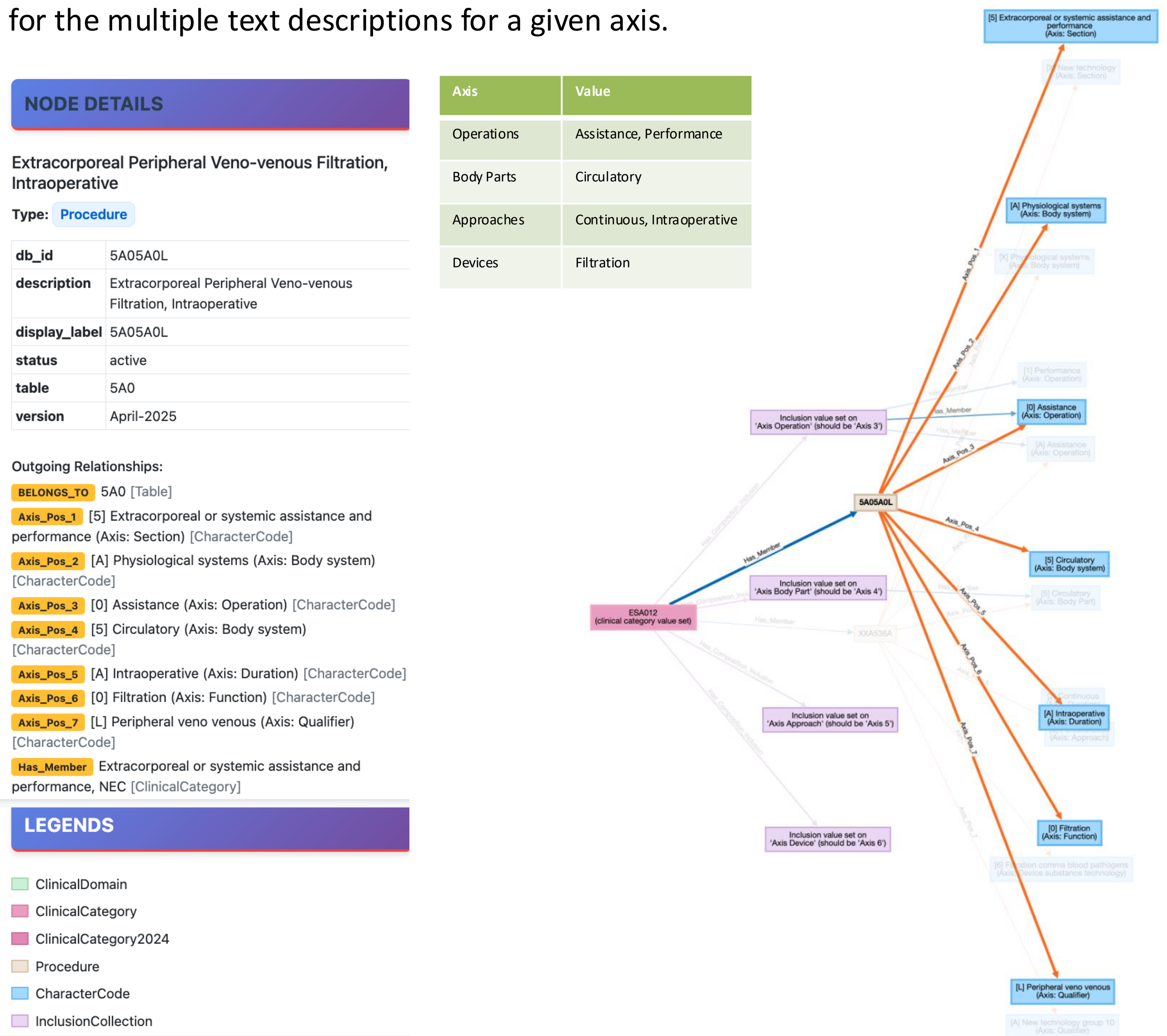
Knowledge Graph for Propositional Reasoning: A Multi-Case Study of Clinical Classifications Software Refined (CCSR) for ICD-10-PCS

Zheng Z. Milgrom MD, MPH,[1] Roberto A. Rocha MD, PhD[1]
[1] Semedy, Inc., Newton, MA

Introduction & Methods

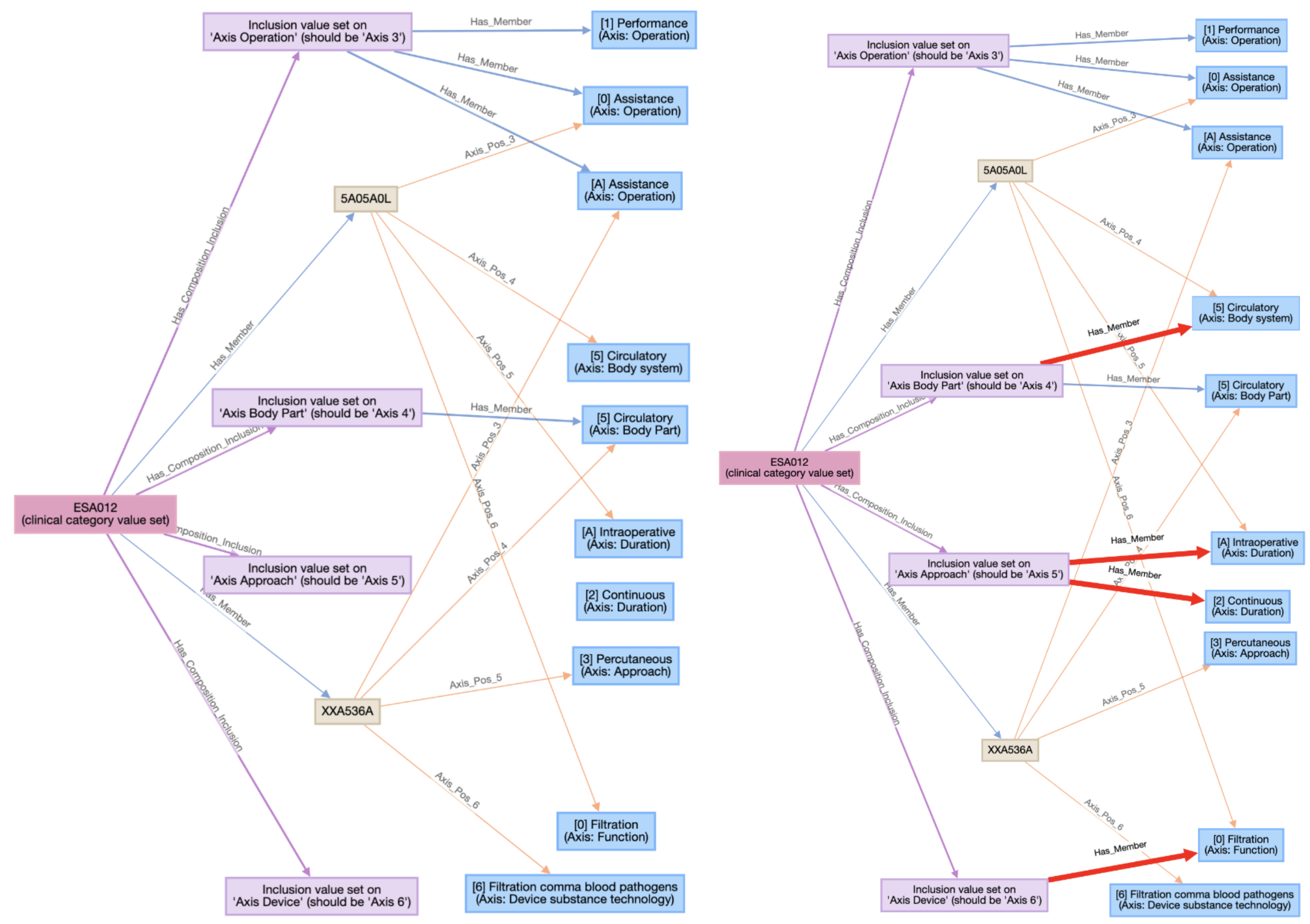
The CCSR value set's inclusion criteria were represented as **queries** on the knowledge graph reasoner – an 'AND' logic is used between the 4 axes, and an 'OR' logic is used for the multiple text descriptions for a given axis.



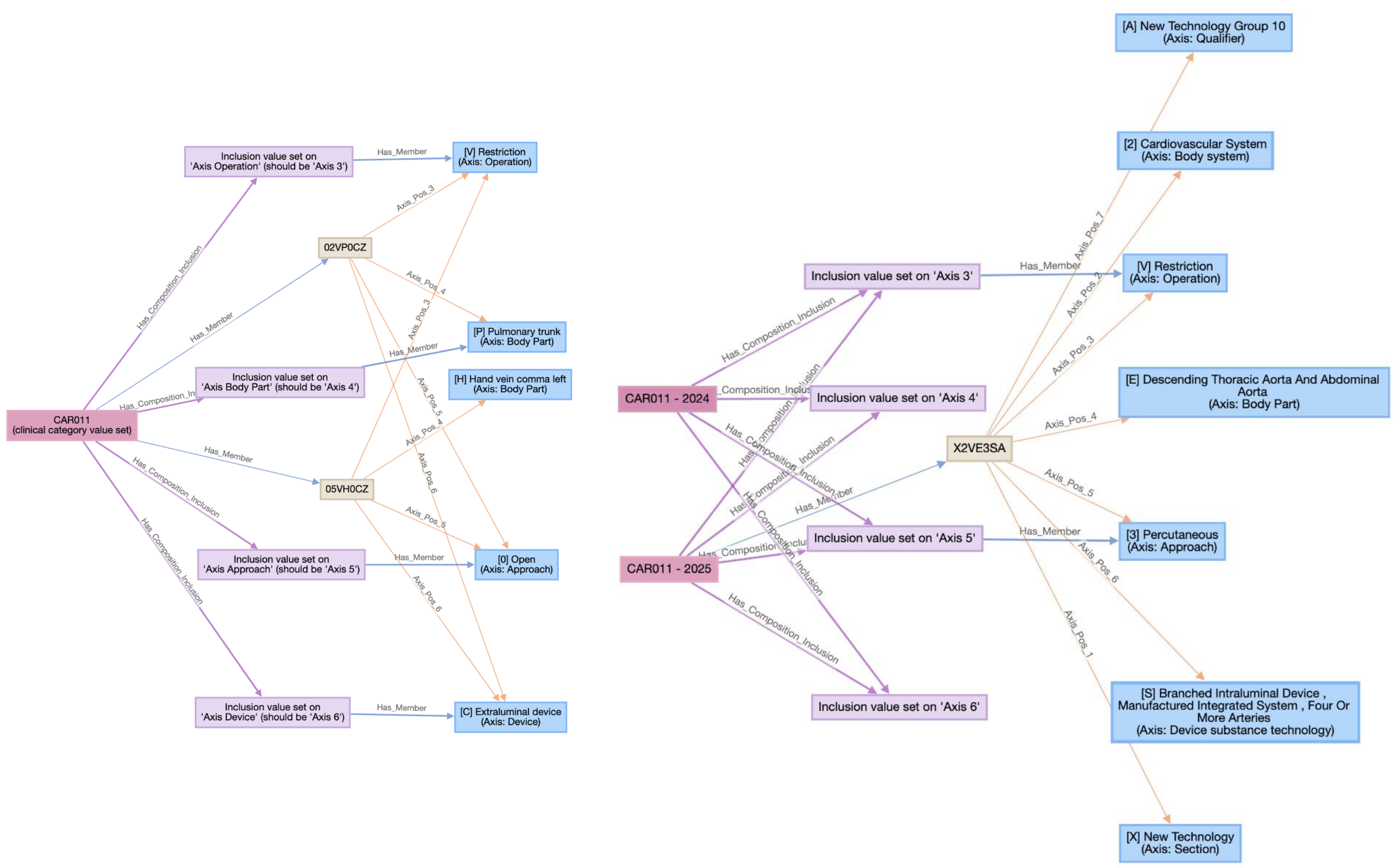
Axis	Value
Operations	Assistance, Performance
Body Parts	Circulatory
Approaches	Continuous, Intraoperative
Devices	Filtration

Results

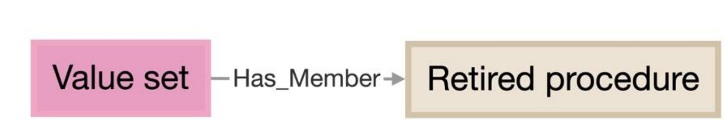
For value set 'ESA012', specifying the 4 axis names as inclusion criteria in the query yielded no results. We replaced them with axes on positions 3 to 6, and correctly yielded the only **non-X-section concept** '5A05A0L'.



Results (Cont.)



1. 80.1% concepts (N = 891) were identified in value set CAR011, with 93 'body part' in inclusion
   - Adding the 20 missing 'body part', 16.2% (N = 180) missing concepts (all **non-Section-X**) can be identified.
2. The **section-X concepts** (0.2%, N =2) not recoverable
   - Neither in ESA011
   - Section X is 'New Technology'.
   - New rule exploration on Axis 1 and 2
3. 3.5% (N =39) retired concepts have no linkage to construct the query and verify
   - **Similar to without KG**



Conclusions

- Several pitfalls when applying the 4-axis inclusion criteria for CCSR value sets using the knowledge graph granular representation:
  - (a) the positions are referred inaccurately as axe names,
  - (b) the values of text descriptions are missing, and
  - (c) the inclusion criteria are incomplete.
- While the intrinsic structure of ICD-10-PCS may not support the definition of complete inclusion criteria for CCSR value sets, the knowledge graph validates that no spurious concepts are identified outside of the two value sets. The identified pitfalls and the new rule exploration demonstrates **the critical role of KGs** in propositional reasoning.

References

[1] Centers for Medicare & Medicaid Services. ICD-10 | CMS. https://www.cms.gov/medicare/coding-billing/icd-10- codes. Published February 26, 2025. Accessed March 24, 2025.

[2] Agency for Healthcare Research and Quality. Healthcare Cost and Utilization Project (HCUP). Clinical Classifications Software Refined (CCSR) for ICD-10-PCS Procedures. https://hcup- us.ahrq.gov/toolssoftware/ccsr/prccsr.jsp. Published February 2025. Accessed March 25, 2025.