

INTERSECTION OF MACHINE LEARNING AND HEOR: A SYSTEMATIC REVIEW

Selin Merdan¹, Carol Kirshner¹, Melisa Erdogan², Melissa Lydston³, Turgay Ayer^{1,3}, Jagpreet Chhatwal^{1,4}

¹Value Analytics Labs, Boston, MA, USA, ²Istanbul Technical University, Istanbul, Turkey, ³Georgia Institute of Technology, Georgia & Emory Medical School, Atlanta, GA, USA, ⁴Massachusetts General Hospital, Harvard Medical School, Boston, MA, USA

OBJECTIVES

- The inclusion of machine learning based approaches in healthcare applications has increased at a rapid pace over the past years; however, there is limited understanding of how machine learning intersects with health economics and outcomes research (HEOR).
- The objective of this study was to conduct a systematic review of machine learning and HEOR to understand the intersection of the two fields, identify gaps, and suggest future directions.

METHODS

- A systematic electronic search for published literature between January 2004 and September 2021 was conducted by a medical librarian using Ovid MEDLINE (1946 to present), Embase.com (1947 to present), Web of Science (1900 to present), EconLit (1886 to present), Google Scholar using Publish or Perish software and Cochrane Central Register of Controlled Trials (CENTRAL) via Ovid (1991 to present). The searches were run in October 2021.
- The search strategy incorporated controlled vocabulary and free-text synonyms for the concepts of artificial intelligence, health economics or healthcare costs, and analysis. No restrictions on language or any other search filters were applied. A date limit was applied limiting to articles published after the year 2004.
- The title, abstract, and full-text screenings were performed by two independent reviewers per PRISMA guidelines. A third independent reviewer broke any ties. Inclusion and Exclusion criteria are detailed in Table 1.

Table 1: Inclusion and exclusion criteria.

Inclusion Criteria	Exclusion Criteria
English Language	Animal studies
Peer-Reviewed	Non-English publications
Full articles	The full-text methods section of the publication does not include a description a machine learning process.
Healthcare setting	The abstract or full text does not elaborate on the quantitative economic outcome of a machine learning process.
	Systematic Review
	Conference abstracts, posters, or preprints

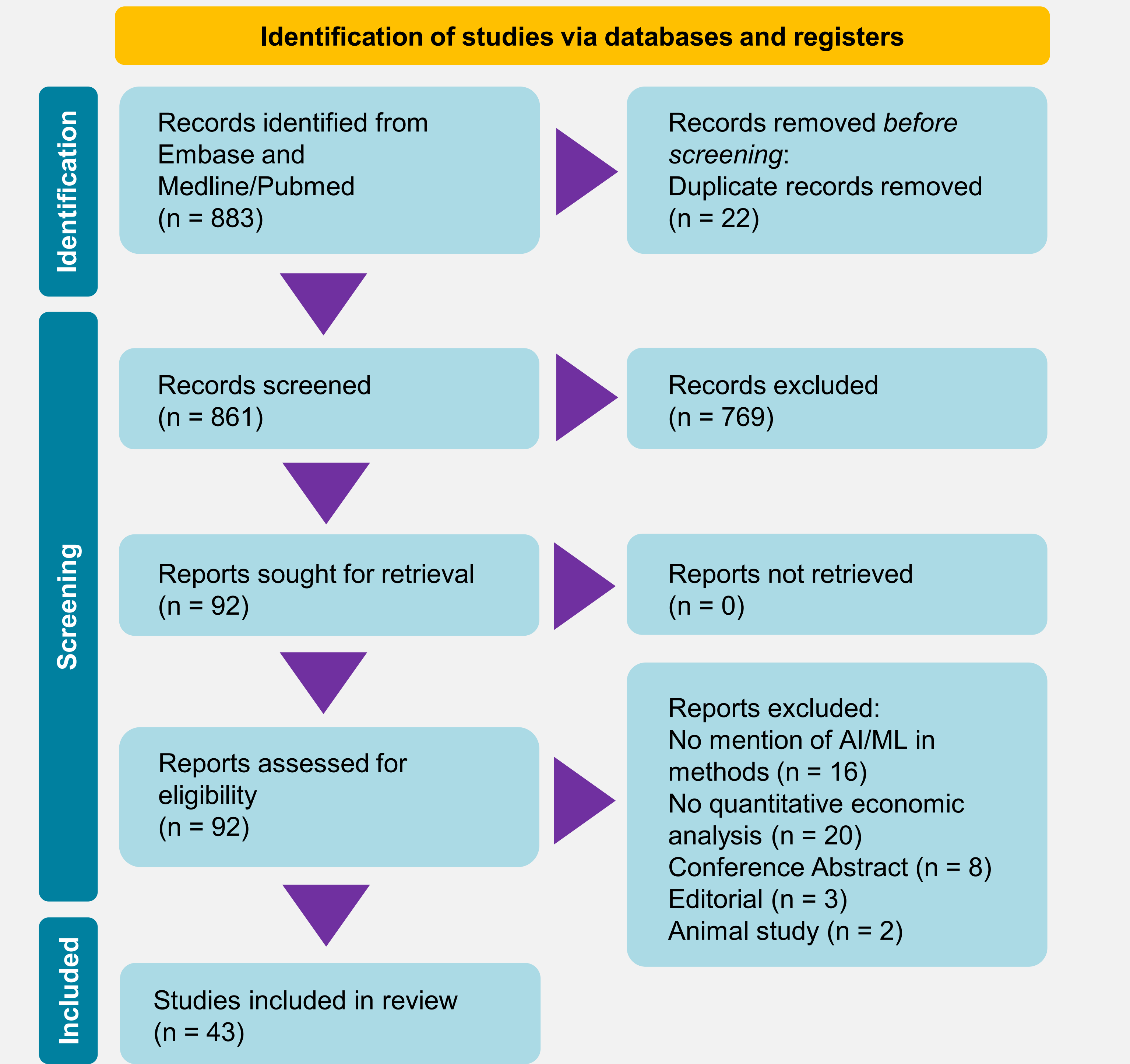
KEY FINDINGS

- Machine learning has a potential to influence HEOR, but the current applications remain limited in scope and depth.
- Future studies should explore the role of digital interventions, wearable technologies, and social media data in HEOR.
- Our review did not find any HEOR study on emerging machine learning technologies such as Generative AI that uses self-supervised learning to generate human-like text.

RESULTS

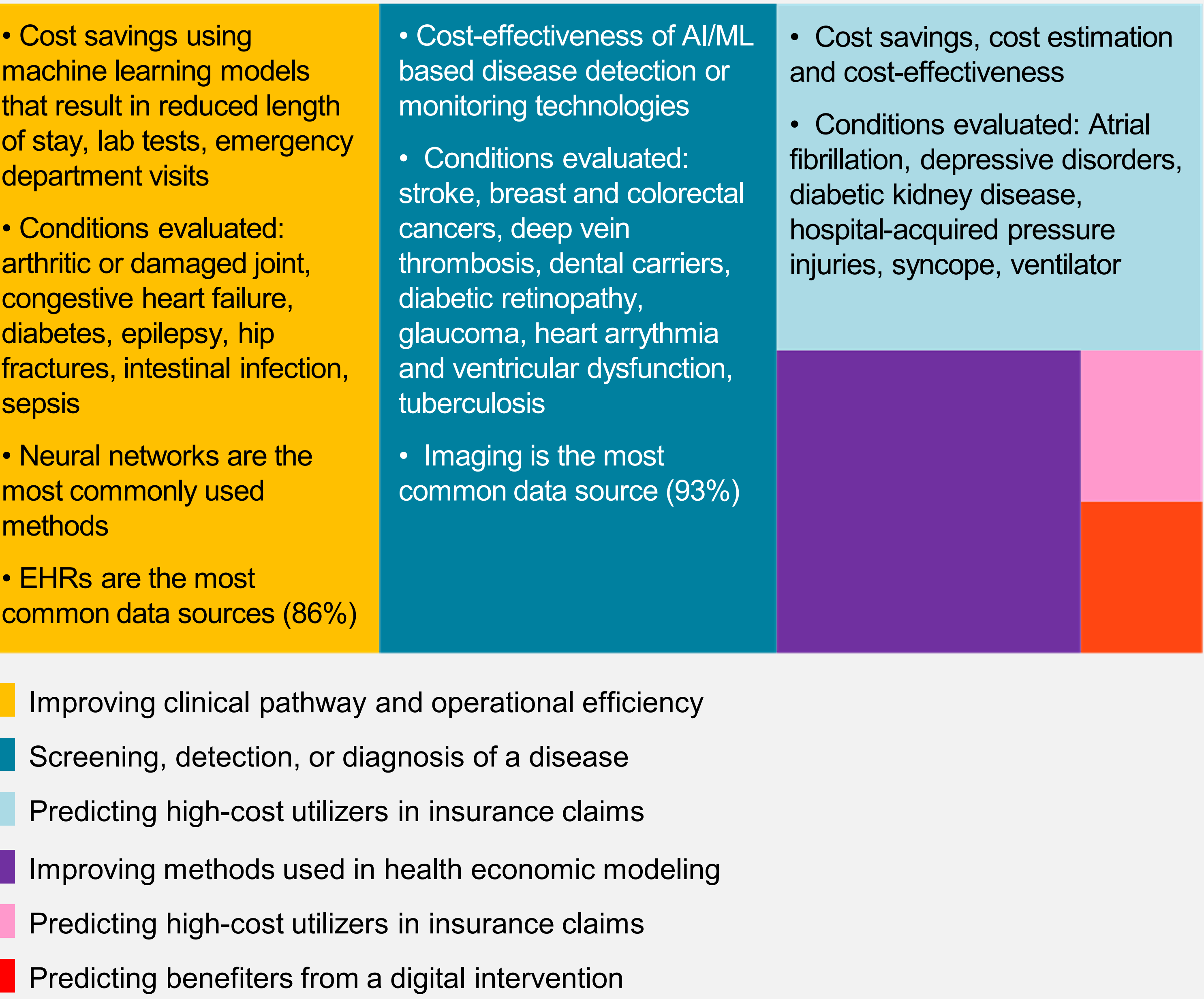
Of the 861 articles screened, 45 articles were included in the review. A flow diagram of records found, screened, selected, and excluded with the corresponding exclusion criteria is shown in Figure 1.

Figure 1: PRISMA flowchart describing study selection and reasons for exclusion during full-text screening.



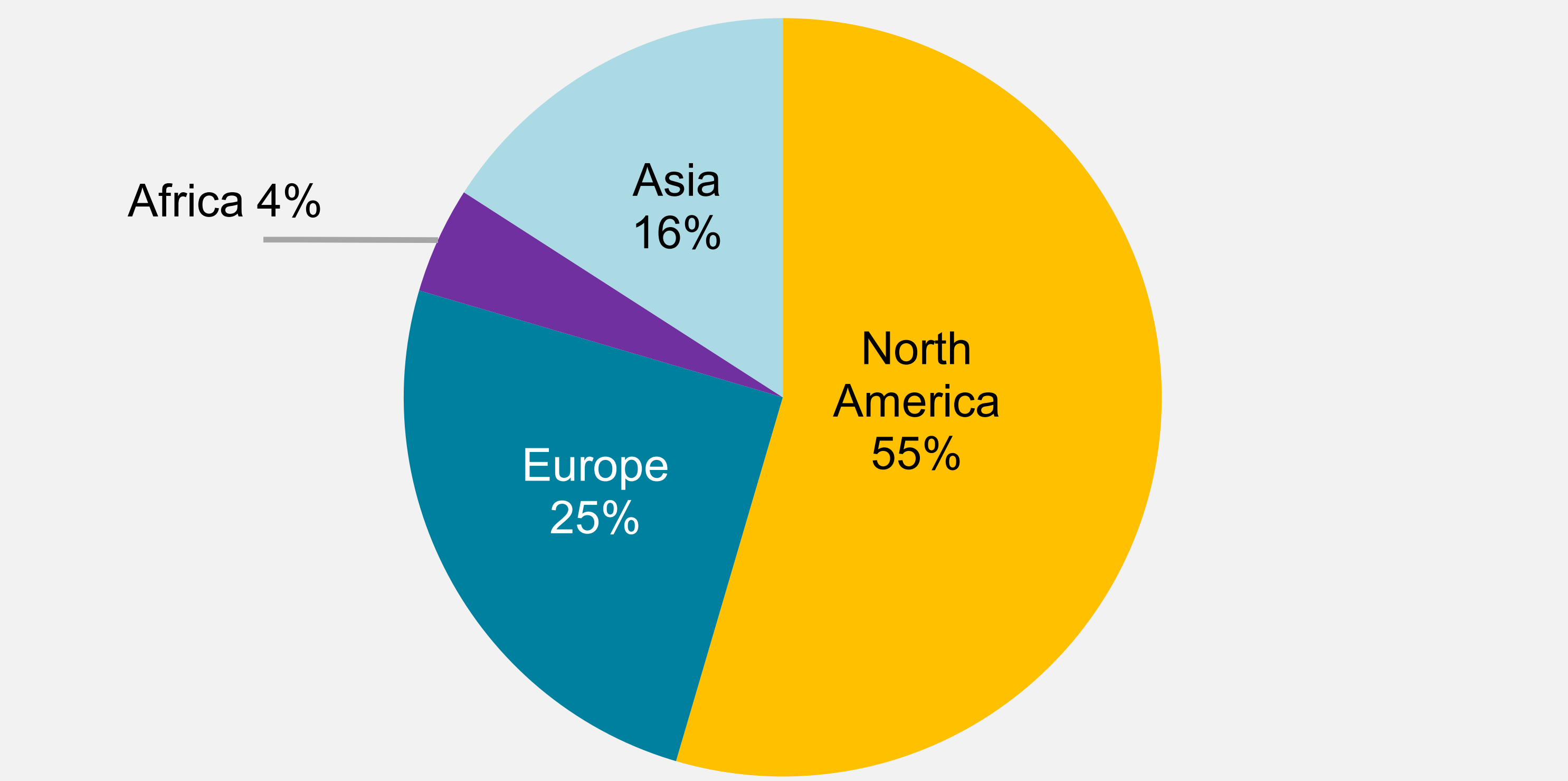
The included articles fell into six major categories: 1) improving clinical pathway and operational efficiency (33%), 2) predicting disease outcomes and treatment success (19%), 3) screening, detection, or diagnosis of a disease (33%), 4) predicting high-cost utilizers using insurance claims (2%), 5) improving methods used in health economic modeling (12%), and 6) predicting who will benefit from a digital intervention (2%). (Figure 2)

Figure 2: General overview of the types of AI/ML applications.



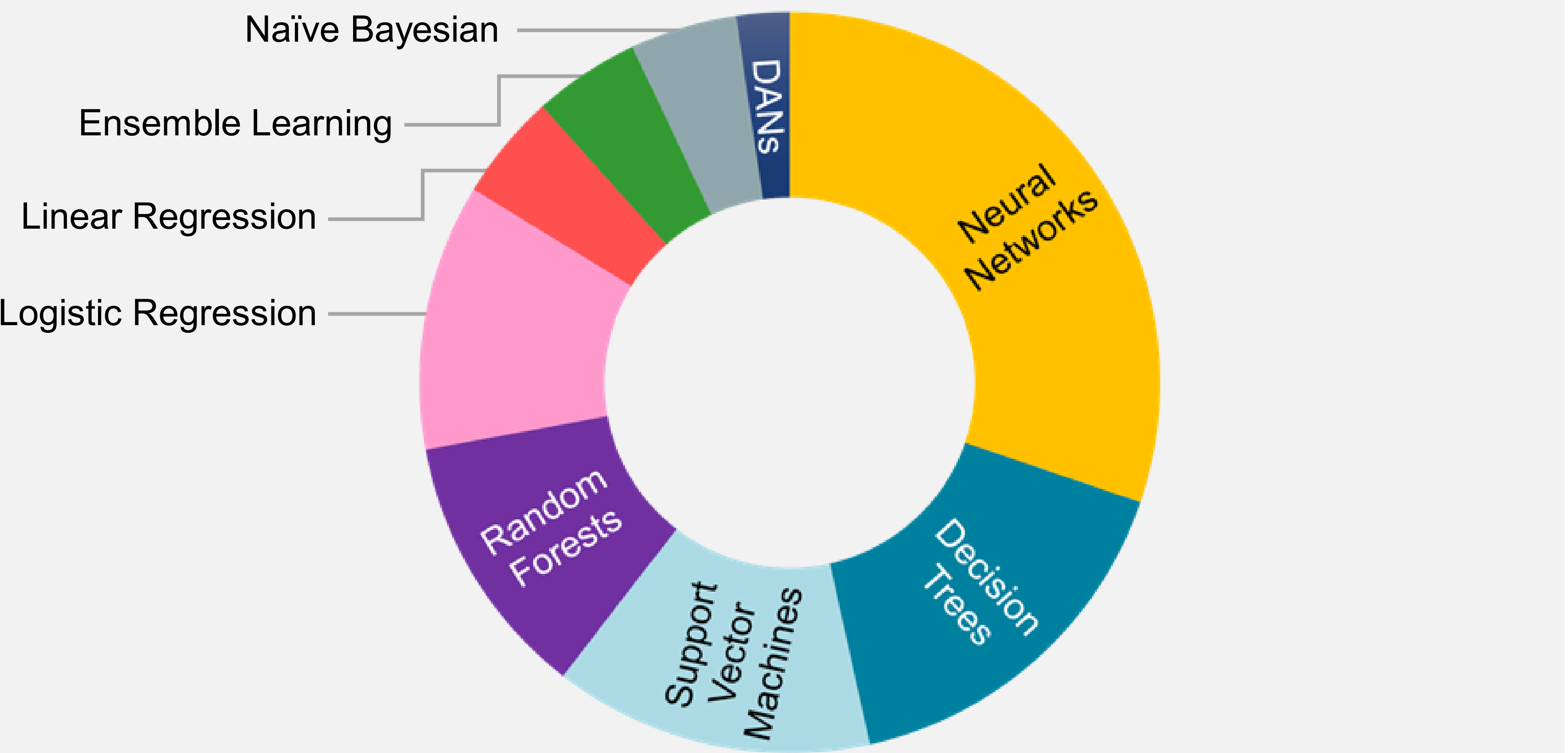
The majority of articles were from North America (55%) and Europe (25%) (Figure 3).

Figure 3: Overview of the locations of the included studies.



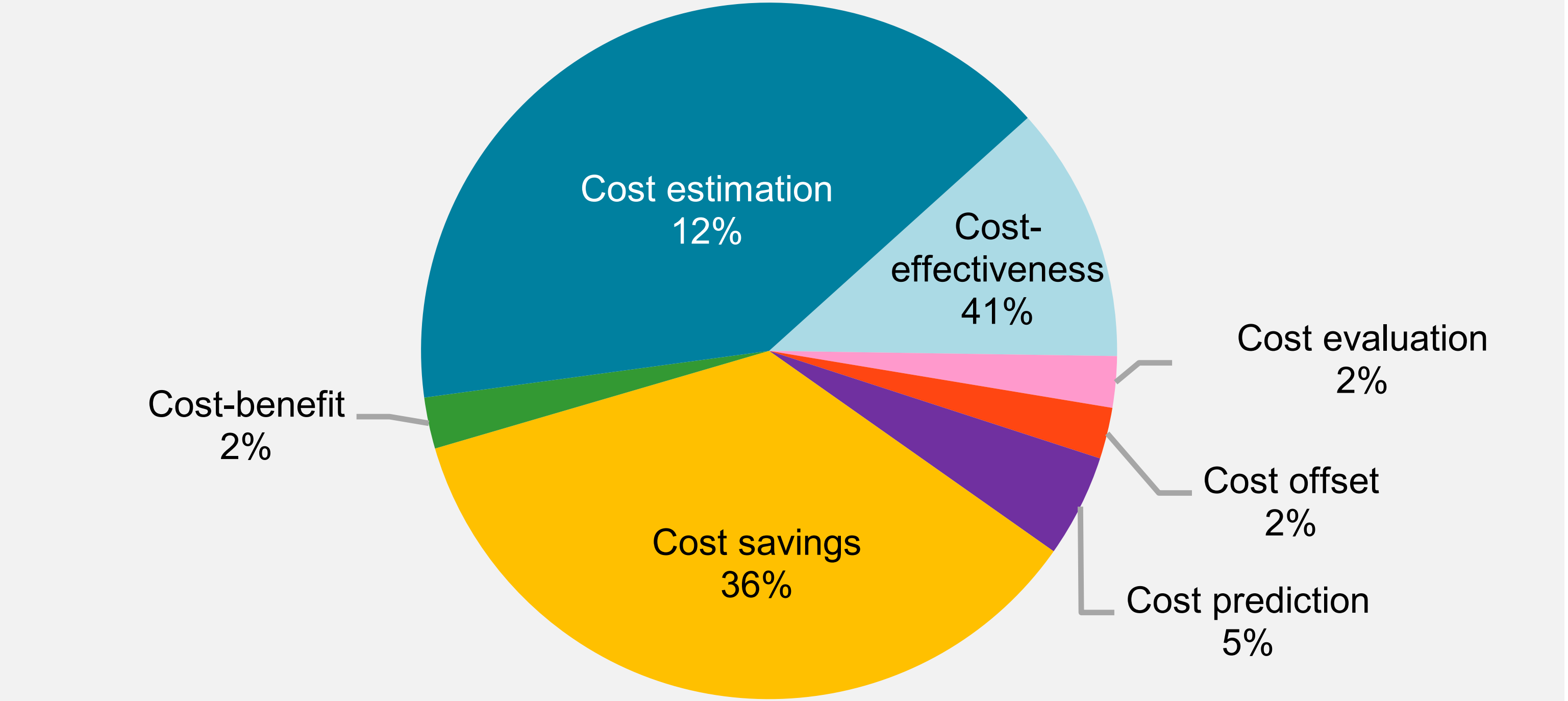
Neural Networks, Decision trees and Support Vector Machines were the most utilized machine learning algorithm (Figure 4).

Figure 4: Overview of the AI/ML algorithms used in the included studies. DANA: Decision analysis networks.



The primary health economic analyses were cost-effectiveness and cost savings (77% of all) (Figure 5).

Figure 5: Overview of the types of health economic evaluation methods used in the included studies.



The studies were conducted in a range of disease fields with cardiovascular, ophthalmic, and infectious diseases being the dominant fields (Figure 6).

Figure 6: Overview of the disease fields the included studies were conducted in.

