A Scoping Review of the Use of Machine Learning in Health Economics and Outcomes Research : Part 2 – Data from non-Wearables

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Table 1. Types of model outcomes by goal of application (n = 92)

	Goal of application			
Model outcomes	**Forecasting**	**Monitoring**	**All**	**Examples for model outcomes**
Clinical event or disease incidence	35 (38%)	4 (4%)	39 (42%)	The incidence of postpartum depression, the development of cardiac events, and death
Treatment outcomes	18 (20%)	2 (2%)	20 (22%)	RECIST criteria in patients treated with PD-1 blockade, complications after total hip arthroplasty, and outcomes for cognitive behavioral therapy
Healthcare resource utilization	15 (16%)	0 (0%)	15 (16%)	The use of prolonged mechanical ventilation, initiation of renal replacement therapy, and pre-surgery healthcare resource utilization
Disease progression and symptoms	3 (3%)	4 (4%)	7 (7%)	Functional level in subarachnoid hemorrhage, the level of persistent pain, and the progression of schizophrenia
Others	3 (2%)	2 (2%)	5 (4%)	Patient punctuality, awareness of precautionary procedures, and medication non-adherence risk
Costs	3 (3%)	0 (0%)	3 (3%)	Out-of-pocket health expenditures, healthcare cost under the oncology care model, and costs with digital health platform
General health status	2 (2%)	1 (1%)	3 (3%)	General health status, multimorbidity frailty, and dependence in the activities of daily living
Total	79 (86%)	13 (14%)	92 (100%)	

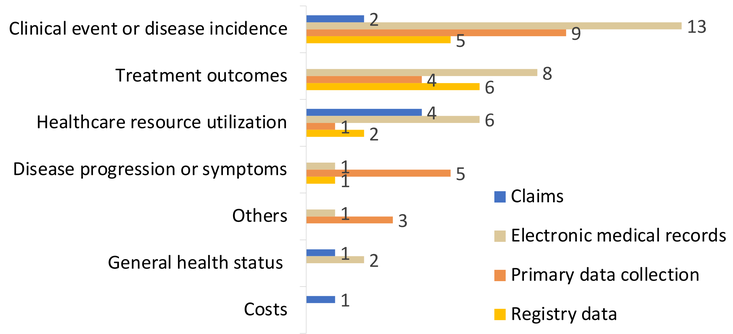

Figure. Types of training data by types of model outcomes.

Objectives

- Despite the increasing interest in applying machine learning (ML) methods in health economics and outcomes research (HEOR), stakeholders face uncertainties in when and how ML can be used.
- We reviewed the recent applications of ML in HEOR.

Methods

- We searched PubMed for studies published between January 2020 through March 2021, and randomly chose 20% of the identified studies for the sake of manageability.
- Studies that were in HEOR and applied an ML technique were included. Studies related to wearable devices were excluded.
- We abstracted information on the ML applications, data types, and ML methods and analyzed it using descriptive statistics.

Results

- We retrieved 805 articles, of which 161 (20%) were randomly chosen. Ninety-two of the random sample met the eligibility criteria.
- We found that ML was primarily used for predicting future events (86%) rather than current events (14%) (**Table 1**).
- The most common response variables were clinical events or disease incidence (42%) and treatment outcomes (22%). ML was less used to predict economic outcomes such as health resource utilization (16%) or costs (3%).
- While electronic medical records (35%) were frequently used for model development, claims data were used less frequently (9%) (**Table 2, Figure**).
- Tree-based methods (e.g., random forests, boosting) were the most commonly used ML methods (31%) (**Table 3**).

Conclusion

- The use of ML techniques in HEOR is growing, but there remain opportunities to apply them to predict economic outcomes, especially using claims databases, which could inform the development of cost-effectiveness models.

Table 2. Frequency distribution of training datasets and examples of model outcomes (n = 92)

Types of training datasets	**Examples of datasets**	**Examples of model outcomes**	**Number (Percent)**
Electronic medical records (EMR)	Retrospective chart review, outpatient clinical data, and radiological data	The risk of postpartum depression, postoperative death, and admission to the intensive care unit	33 (35%)
Primary data collection	A survey conducted in the outpatient clinic, daily outpatient blood collection, a survey conducted among wouded US service members	The demand for medical care, outcomes for cognitive behavioral therapy, and age-related macular degeneration	22 (23%)
Registry data	NSQIP dataset, OSHPD dataset, and US-department of defense trauma registry	The risk of prolonged medical ventilation, trauma patient mortality, and outcomes of limb revascularization	14 (15%)
Claims data	IBM MarketScan, administrative data from an Academic Medical Centre (AMC) in Singapore, and Medicare claims data	Presurgery healthcare resource utilization, persistent high utilizer, and postpartum psychiatric admission	8 (9%)
Miscellaneous	Free text pharmacy prescription databases, administrative data from clinics, ambulance calls, and twitter	Medication incidents, patient wait time, and demand for ambulances, etc,	16 (17%)
Not used[a]	N/A	N/A	1 (1%)

Table 3. Types of ML models by types of applications (N=210)[a]

Types of ML models	**Goal of application**		
	Forecasting	**Monitoring**	**All**
Tree-based models	59 (28%)	6 (3%)	65 (31%)
Logistic/linear regression	36 (17%)	2 (1%)	38 (18%)
Support vector machine	24 (11%)	6 (3%)	30 (14%)
Neural network	24 (11%)	5 (2%)	29 (14%)
Regularization	14 (7%)	1 (0%)	15 (7%)
K-nearest neighbors	5 (2%)	1 (0%)	6 (3%)
Bayesian network	5 (2%)	0 (0%)	5 (2%)
Bayesian classifier	1 (0%)	1 (0%)	2 (1%)
Others[b]	12 (6%)	1 (0%)	13 (6%)
Super learner	2 (1%)	0 (0%)	2 (1%)
All	187 (89%)	23 (11%)	210 (100%)