Hospital AI/ML Adoption by Neighborhood Deprivation

Jie Chen, PhD. Alice Shijia Yan, MAcc
Department of Health Policy and Management,
Hospital And Public health interdisciPlinarY (HAPPY) Lab,
Center on Aging, University of Maryland at College Park

Hospital And Public health interdisciPlinarY research lab

BACKGROUND

- AI/ML-assisted care coordination has the potential to reduce health disparities, but there is a lack of empirical evidence on AI's impact on health equity.

OBJECTIVE

- The objective of our study is to assess the adoption of AI/ML technologies among hospitals, with a focus on the use of ML and predictive models in electronic health records (EHR).
- We aim to understand the variation in AI/ML adoption based on different hospital characteristics and neighborhood social determinants of health.
- We hypothesize that hospitals serving areas with higher levels of underserved populations and more significant neighborhood deprivation and those in rural locations may lack the necessary information technology (IT) infrastructure and personnel, limiting their capacity to adopt these advanced technologies.
- We are interested in understanding whether hospitals enrolled in value-based performance models are more incentivized to adopt AI/ML.

DATA AND MEASURES

- Our primary dataset was linked datasets from the 2022 American Hospital Association (AHA) Annual Survey and the 2023 AHA Information Technology (IT) Supplement
- Using hospital service area codes, we matched each hospital with the average 2021 Area Deprivation Index (ADI) of its service area
- The ADI is derived from 17 indicators encompassing education, employment, housing quality, and poverty levels. It has been validated and widely used to assess various health outcomes and disease domains at the neighborhood level
- We mapped ZIP codes to hospital service areas using a crosswalk from the Dartmouth Atlas and averaged the ZIP code-level ADI national percentiles to obtain a measure of ADI at the hospital service area level.

RESULTS

Table 1: Hospital Application of Machine Learning (ML) and Other Predictive Modeling and Adoption of AI/ML in Workforce Development	Mean 100%	Std Dev
Indicator of whether hospital uses ML or other predictive models (n=2,285)	0.73	0.44
The number of ML and other predictive modules adopted ranged from 1 to 8 (n=1,670) (unit: count)	4.02	1.74
a. Predicting health trajectories or risks for inpatients	0.93	0.26
b. Identify high risk outpatients to inform follow-up care	0.82	0.38
c. Monitor health	0.35	0.48
d. Recommend treatments	0.46	0.50
e. Simplify or automate billing procedures	0.38	0.48
f. Facilitate scheduling	0.50	0.50
g. Other (operational process optimization)	0.26	0.44
h. Other (clinical use cases)	0.32	0.47
The number of domains in which EHR was used ranged from 1 to 6 (n=2,390) (unit: count)	4.93	1.57
a. Create an approach for clinicians to query the data	0.76	0.43
b. Assess adherence to clinical practice guidelines	0.73	0.44
c. Identify care gaps for specific patient populations	0.83	0.38
d. Support a continuous quality improvement process	0.90	0.30
e. Monitor patient safety (e.g. adverse drug events)	0.85	0.36
f. Identify high risk patients for follow-up care using algorithm or other tools	0.84	0.37
The number of areas in which AI/ML was used in workforce applications ranged from 1 to 5 (n=1,703) (unit: count)	1.39	1.81
a. Predicting staffing needs	0.25	0.44
b. Predicting patient demand	0.26	0.44
c. Staff scheduling	0.24	0.43
d. Automating routine tasks	0.31	0.46
e. Optimizing administrative and clinical workflows	0.33	0.47

Table 3: Decomposition results comparing hospital AI/ML adoption by ADI Q4 vs. ADI Q1 – Q3

	The number of ML and other predictive modules adopted		The number of domains in which EHR was used ranged		The number of areas in which AI/ML was used in workforce applications	
	Coef	P value	Coef	P value	Coef	P value
ADI Q1 – Q3	0.80	<0.001	5.18	<0.001	1.56	<0.001
ADI Q4 (the most vulnerable areas)	0.62	<0.001	4.59	<0.001	0.89	<0.001
Difference	0.18	<0.001	0.59	<0.001	0.67	<0.001
	%	p	%	p	%	p
Explained by the model	78.94	<0.001	95.73	<0.001	65.94	<0.001
Explained by the individual factor						
Government owned hospital	22.74	<0.001	14.28	<0.001	28.35	<0.001
Bed size large	23.68	<0.001	15.42	0.002	-	-
Teaching hospital	-	-	-	-	21.39	<0.001
ACO affiliated	16.59	<0.001	12.41	<0.001	24.78	<0.001
Rural	22.72	<0.001	22.64	0.003	-	-

Figure 1: Hospital AI/ML Adoption in 2022-2023 by Hospital Service Area Deprivation

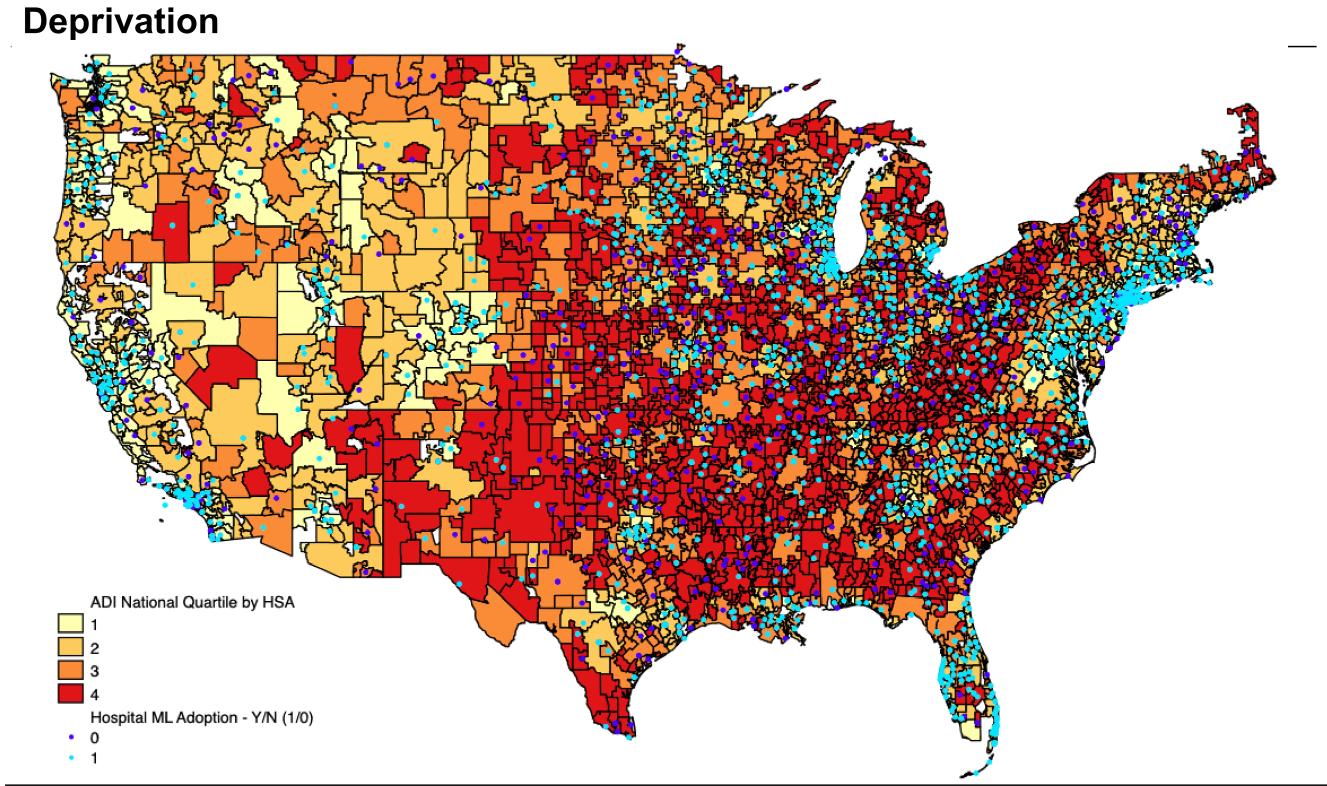

Table 2: : State-Fixed Multivariate Regressions of Hospital Application of Machine Learning (ML) and Other Predictive Modeling and Adoption of AI/ML in Workforce Development

Indicator of whether hospital uses machine learning or other predictive models (n=2,286)	Margins 100%	95% CI		P value
ADI quantile 1	reference			
ADI quantile 2	-0.04	-0.10	0.01	0.12
ADI quantile 3	-0.09	-0.15	-0.02	0.01
ADI quantile 4 (the most vulnerable)	-0.10	-0.18	-0.03	0.01
The number of ML and other predictive modules adopted ranged from 1 to 8 (n=1,671)	Margins 100%	95% CI		P value
ADI quantile 1	reference			
ADI quantile 2	-0.02	-0.29	0.24	0.86
ADI quantile 3	-0.19	-0.50	0.12	0.23
ADI quantile 4 (the most vulnerable)	0.02	-0.35	0.39	0.92
The number of domains in which EHR was used ranged from 1 to 6 (n=2,391)	Margins 100%	95% CI		P value
ADI quantile 1	reference			
ADI quantile 2	0.01	-0.19	0.22	0.90
ADI quantile 3	-0.40	-0.63	-0.17	0.001
ADI quantile 4 (the most vulnerable)	-0.26	-0.51	0.001	0.05
The number of areas in which AI/ML was used in workforce applications ranged from 1 to 5 (n=1704)	Margins 100%	95% CI		P value
% Population Black	0.51	-0.42	1.44	0.28
ADI quantile 1	reference			
ADI quantile 2	-0.21	-0.46	0.03	0.09
ADI quantile 3	-0.16	-0.44	0.12	0.25
ADI quantile 4 (the most vulnerable)	-0.40	-0.70	-0.09	0.01

RESULTS

- The sample included general medical and surgical hospitals, with sample sizes varying by outcome from 1,671 to 2,286 hospitals.
- Hospitals serving the most vulnerable areas (ADI Q4) were significantly less likely to apply ML or other predictive models (coef = -0.10, p=0.01) and provided fewer AI/ML-related workforce applications (coef=-0.40, p=0.01), compared to those in the least vulnerable areas.
- Decomposition results showed that our model specifications explained 79% of the variation in AI/ML adoption between hospitals in ADI Q4 versus ADI Q1 - Q3.
- Additionally, Accountable Care Organization affiliation accounted for 12% - 25% of differences in AI/ML utilization across various measures.

CONCLUSION

- The underuse of AI/ML in economically disadvantaged and rural areas, particularly in workforce management and EHR implementation, suggests that these communities may not fully benefit from advancements in AI-enabled healthcare.
- Our results further indicate that value-based payment models could be strategically used to support AI integration

CONTACT INFORMATION

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Jie Chen, PhD - jichen@umd.edu