

Information Processing Capacity in Healthcare: How Hospital Interoperability and EHR Maturity Enables Patient Engagement and Advanced Analytics

Problem and Research Question

Despite widespread EHR implementation, U.S. hospitals provided \$745 billion in uncompensated care (2000-2020), much attributable to data exchange deficiencies (Ayabakan et al., 2024). While 60% of providers invest in interoperability standards, organizational capacity constraints limit effective use (Craft, 2024). Zero studies examine concurrent interactions of interoperability standards, patient engagement, and advanced analytics. **Research Question:** To what extent does interoperability capability influence hospitals' EHR meaningful use maturity, and how does this maturity impact patient engagement and advanced analytics capabilities?

Justification

This research provides hospital executives evidence-based guidance for sequencing digital health investments, informs federal policymakers implementing the 2025 CMS Interoperability Framework, and supports federal health systems (VA, DoD, IHS) managing EHR modernization—demonstrating that organizational capacity development must precede advanced technology implementation to avoid "shelfware" investments.

Theoretical Framework

Organizational Information Processing Theory (OIPT) suggests interoperability infrastructure enables hospitals to develop information processing capacity—operationalized as meaningful use maturity—which enables advanced patient engagement and analytics mechanisms (Galbraith, 1974; Daft & Lengel, 1986). We reconceptualize "meaningful use" as *the extent to which*

hospitals have enabled and integrated advanced EHR functionalities demonstrating cooperative use of data for coordinated care, aligned with HIMSS EMRAM stages 5-7.

Research Design

Cross-sectional study employing structural equation modeling with mediation analysis testing five hypotheses: (H1) Higher interoperability capabilities predict greater meaningful use maturity; (H2) Greater meaningful use maturity predicts more advanced patient engagement; (H3) Greater meaningful use maturity predicts more sophisticated advanced analytics; (H4) Meaningful use maturity mediates interoperability → patient engagement; (H5) Meaningful use maturity mediates interoperability → advanced analytics. Four composite indices operationalize constructs with validation (Cronbach's alpha ≥ 0.70 , confirmatory factor analysis).

Data Sample

2023 AHA Healthcare IT Database: N=1,374 hospitals (43.9% of 3,128 responding hospitals) after listwise deletion. Sample characteristics: mean 208.5 beds, 65.5% nonprofit, 10.2% for-profit, 0.9% government. Retained hospitals significantly larger and more nonprofit than dropped hospitals. Temple University IRB exempt determination granted.

Findings

All five hypotheses supported at $p < 0.001$ using MLE with robust standard errors:

H1 (ICI → MUMI): $\beta = 0.120$, $SE = 0.024$, $z = 5.00$, $p < 0.001$. Interoperability capability positively predicts meaningful use maturity, explaining 1.4% of variance.

H2 (MUMI → PEI): $\beta = 0.415$, $SE = 0.026$, $z = 15.93$, $p < 0.001$. Meaningful use maturity strongly predicts patient engagement (strongest effect), explaining 17.3% of variance.

H3 (MUMI → AAI): $\beta = 0.291$, $SE = 0.025$, $z = 11.52$, $p < 0.001$. Meaningful use maturity positively predicts advanced analytics, explaining 8.5% of variance.

H4 (ICI → MUMI → PEI): Indirect effect $\beta = 0.050$, $SE = 0.009$, $z = 5.31$, $p < 0.001$.

Meaningful use maturity fully mediates interoperability → patient engagement relationship.

H5 (ICI → MUMI → AAI): Indirect effect $\beta = 0.035$, $SE = 0.007$, $z = 4.84$, $p < 0.001$.

Meaningful use maturity fully mediates interoperability → advanced analytics relationship.

Key Finding: Suppression effect confirmed—interoperability and patient engagement show a negative bivariate correlation ($r = -0.241$, $p < 0.001$), which reverses to positive through meaningful use maturity mediation, demonstrating that interoperability infrastructure alone is not enough without developing organizational capacity. Reliability: PEI $\alpha = 0.936$, MUMI $\alpha = 0.806$, ICI $\alpha = 0.773$, AAI $\alpha = 0.591$. Results remain robust when controlling for hospital size, ownership, and service type.

Practical Relevance

Findings show that organizational capacity is the key prerequisite for success in digital health. Hospital leaders can sequence investments by first building interoperability infrastructure (ICI), then developing organizational capacity through workflow redesign (MUMI), and finally implementing patient engagement and analytics (PEI/AAI). The suppression effect uncovers the "Infrastructure Paradox"—interoperability investments can negatively correlate with patient engagement outcomes when organizational capacity is lacking, explaining why hospitals often see "shelfware" despite technology spending. For policymakers, these results support the 2025 CMS Framework's focus on capacity building rather than just technical connectivity. The Infrastructure → Capacity → Mechanisms framework expands OIPT to healthcare digital transformation with empirical evidence relevant across information-intensive industries.

References

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