CHAPTER 5

INNOVATION DIFFUSION ACROSS 13 SPECIALTIES AND ASSOCIATED CLINICIAN CHARACTERISTICS

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ABSTRACT

Diffusion of innovations, defined as the adoption and implementation of new ideas, processes, products, or services in health care, is both particularly important and especially challenging. One known problem with adoption and implementation of new technologies is that, while organizations often make innovations immediately available, organizational actors are more wary about adopting new technologies because these may impact not only patients and practices but also reimbursement. As a result, innovations may remain underutilized, and organizations may miss opportunities to improve and advance. As innovation adoption is vital to achieving success and remaining competitive, it is important to measure and understand factors that impact innovation diffusion. Building on a survey of a national sample of 654 clinicians, our study measures the extent of diffusion of value-enhancing care delivery innovations (i.e., technologies that not only improve quality of care but has potential to reduce care cost by diminishing waste, Faems et al., 2010) for 13 clinical specialties and identifies healthcare-specific individual characteristics such as: professional purview, supervisory responsibility, financial incentive, and clinical tenure associated with innovation diffusion. We also examine the association of innovation diffusion with perceived value of one

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type of care delivery innovation – artificial intelligence (AI) – for assisting clinicians in their clinical work. Responses indicate that less than two-thirds of clinicians were knowledgeable about and aware of relevant value-enhancing care delivery innovations. Clinicians with broader professional purview, more supervisory responsibility, and stronger financial incentives had higher innovation diffusion scores, indicating greater knowledge and awareness of value-enhancing, care delivery innovations. Higher levels of knowledge of the innovations and awareness of their implementation were associated with higher perceptions of the value of AI-based technology. Our study contributes to our knowledge of diffusion of innovation in healthcare delivery and highlights potential mechanisms for speeding innovation diffusion.

Keywords: Diffusion of innovation; value-based care innovations; AI-based technology; healthcare organizations management; survey

INTRODUCTION

Over 50 years ago, Everett Rogers published his theory of the diffusion of innovation, which he defined as the "adoption and implementation of new ideas, processes, products or services" (Rogers, 1962) to explain how and when new ideas spread in organizations. Today, innovation diffusion is still a critical challenge, as now more than ever organizations must find ways to incorporate new ideas, processes, and technologies to effectively compete. In health care, for example, a variety of innovations, including those that rely on changes in personnel, process, culture, and technology, offer promise of substantial improvement in the value of healthcare delivery. Yet, innovation adopters still face barriers (Stornelli et al., 2021). One known problem with adoption and implementation of value-enhancing, care delivery innovations is that while organizations often make innovations immediately available, organizational actors are more wary about adopting new approaches. As a result, innovations remain underutilized, and organizations miss opportunities to improve and advance (Adams et al., 2006). As innovation adoption is vital for organizations to achieve success and remain competitive, it is important to measure and understand the factors that impact innovation diffusion (O'Reilly & Tushman, 2004).

Diffusion of value-enhancing, care delivery innovations in health care is both particularly important and especially challenging. On one hand, stakeholders encourage healthcare organizations to adopt and implement novel practices, procedures, and treatments in order to promote advanced care at the lowest possible cost (Bloem et al., 2017). On the other, healthcare professionals may be wary about adopting new technologies and methods of treatment because they may impact not only patients and practice but also reimbursement. Employees are naturally resistant to changes as changes might lead to loss of status, pay, or comfort (Dent & Goldberg, 1999). Clinicians, therefore, may not rush to diffuse innovations because when adopted and implemented inappropriately, change in care delivery could cause clinical harm and financial and reputational damage (Balas & Chapman, 2018). Ultimately, although value-enhancing care delivery

innovations may be embraced at healthcare system and organizational levels, innovations diffuse in practice when healthcare professionals and teams adopt and implement them. Therefore, healthcare professionals play a key role in innovation diffusion by transmitting information regarding availability and performance of care delivery innovations to colleagues (Balas & Chapman, 2018). This inter-colleague diffusion of information occurs through knowledge sharing mechanisms such as professional and social interactions, formal and informal communication, and meetings of professional associations (Fitzgerald et al., 2002). Having knowledge of the existence of innovative ideas and being cognizant of their successful implementation is critical for facilitating their diffusion within organizations (Dearing & Cox, 2018).

Research has shown that individual differences can play a significant role in shaping the success of innovation diffusion efforts, and that these factors interact with organizational context. Factors such as gender, age, and educational background can impact the adoption and implementation of innovative practices (Zhang et al., 2015). Furthermore, different types of innovations, such as technological versus process innovations, may require different skill sets and knowledge to be successfully implemented (Damanpour & Schneider, 2006). Given that individuals vary in their diffusion of care delivery innovations, identifying characteristics of individuals that support value-enhancing care delivery innovations diffusion in health care could increase the ability of those seeking to encourage it to improve the quality of care.

Building on a national sample of 654 clinicians, our study measures the extent of diffusion of value-enhancing care delivery innovations for 13 clinical specialties and identifies individual healthcare-related characteristics associated with diffusion of innovation: professional purview, financial incentive, supervisory responsibility, and clinical tenure. We also evaluate the relationship between knowledge and awareness of current and future care delivery innovations and clinicians' perceived value of one type of care delivery innovation – artificial intelligence (AI) – for assisting them in their clinical work. In doing so, our study contributes to our knowledge of diffusion of innovation in healthcare delivery and highlights potential mechanisms for speeding innovation diffusion.

BACKGROUND

Diffusion of Innovation

Diffusion of innovation in health care is considered a social process that occurs among people in response to learning about an innovation, such as a new evidence-based approach for extending or improving health care (Dearing & Cox, 2018). Focusing on how individuals spread innovations within and across organizations, diffusion of innovation theory suggests the innovation itself, communication channels through which information about novel sources of innovation transmits, social systems consisting of interrelated units engaged in achieving a common goal, and time, i.e., the timeline between becoming aware of an innovation and its implementation, are key elements of innovation diffusion

(Rogers, 1962, 1995). According to innovation diffusion theory, two important factors impact the timeline to innovation implementation – individual knowledge of the innovations and awareness of their implementation – and these factors are often impacted by adopter characteristics (Zhang et al., 2015).

Knowledge of the Innovation and Awareness of Its Implementation

Knowledge is the first requirement for deciding to adopt and diffuse an innovation. Becoming knowledgeable of an innovation means becoming aware of the existence of the innovation and learning about its potential for assisting with clinical care (Rogers, 1962). In becoming knowledgeable, individuals explore and investigate pros and cons of the innovation to determine whether they and their organization should adopt and implement it. When individuals acquire knowledge of an innovation, they may transmit their impressions of the innovation to other organizational actors (Balas & Chapman, 2018). Awareness of an innovation's implementation is also important. When clinicians become aware of organizations that are currently implementing innovations or are planning to implement them, their trust in possible positive outcomes increases relative to their hesitation to change, and their desire to adopt innovations goes up. Taken together, knowledge of the innovation and awareness of its implementation determines how and when innovations will be diffused within and across healthcare organizations (Fitzgerald et al., 2002).

Characteristics of New Adopters

Rogers (1995) characterized innovation adopters according to their willingness to adopt, as innovators (representing about 2.5% of the market), early adopters (13.5%), early majority (34%), late majority (34%), and laggards (16%). In research exploring diffusion of innovation in various settings, studies suggest that individual characteristics and behaviors are positively associated with adopter segments (Zhang et al., 2015). For example, studies found that the two earliest groups of adopters (innovators and early adopters) were characterized by high income, innovativeness (i.e., individual's willingness to change his or her familiar practices), inward focus (i.e., self-efficacy and market "mavenism," being knowledgeable about the market), and previous technology usage and digital skills associated with innovation adoption and diffusion (Dedehayir et al., 2017; Van Braak, 2001). The early majority, those willing to adopt innovations just before the average person, were usually educated individuals, also with high levels of income. The late majority were characterized by skepticism, often adopting innovations only as a result of peer pressure (Haider & Kreps, 2004). Laggards have been characterized by lower incomes and education and show brand loyalty (Uhl et al., 1970).

Understanding which healthcare-related characteristics associate with adopter segments would enable healthcare leaders to speed up dissemination of innovations at the early stages and ensure adoption and implementation across the full spectrum of innovation diffusion. However, most research exploring adopter characteristics

has focused on organizational settings outside of health care. Research has yet to explore individual characteristics associated with their innovation adoption, despite evidence suggesting that innovators' characteristics vary by type of innovation (Dedehayir et al., 2017). In this study, we aim to measure care delivery innovations for 13 clinical specialties and to identify adopter characteristics that are relevant to diffusion of innovation in healthcare settings. Specifically, we examine the role of professional purview, supervisory responsibility, financial incentives, and clinical tenure in clinicians' knowledge and awareness of current and future implementation of value-enhanced care delivery innovations, and the relationship between knowledge and awareness of current and future innovation implementation and clinicians' perceived value of AI.

METHODS

Survey Development

The Clinical Excellence Research Center at Stanford University School of Medicine developed the "High-Value Care Method Adoption Survey" to gain knowledge and awareness of the implementation of 62 value-enhancing, innovative approaches recently documented in the clinical literature. For example, primary care providers received questions pertaining to selected aspects of primary care, clinically fragile patients with chronic disease, technology-enabled ambulatory care, high-need high-cost care, dementia care, prescription medication care, spine pain care, ambulatory surgical care, stroke prevention, and acute care (see appendix Table A1 for detail on care delivery domains relevant for each medical specialty).

Following Rogers's (1962, 1995) conceptualization of innovation diffusion, the survey was designed so that individual respondents would answer three questions for each care delivery innovation that applied to their specialty: one focused on *knowledge of the innovations*: "Have you heard of a care method similar to this?"; a second focused on *awareness of current implementation*: "Are you aware of a care organization in your region or state currently using a similar care method?"; and a third focused on *awareness of future implementation*: "Are you aware of a care organization in your region or state planning to use a similar care method?" Yes/no response options were offered for each question. To remove order bias, the survey randomized the order of care delivery innovations and concepts within care delivery innovations displayed to respondents, unless the order was inherent to the care delivery innovation.

The survey also asked participants three questions about their perceptions of the value of AI for assisting them in their clinical work in (1) *clinical decision support*: "assistance for clinicians in identifying clinically important health risk factors, diagnoses, and treatment plan elements," (2) *physical action support*: "assistance for clinicians in detecting and correcting deviations from the physical actions required by the treatment plan, e.g., hand hygiene before patient

contact," (3) *automating documentation*: "automating documentation in the electronic health record of verbal interactions and physical examination activity occurring during in-person or virtual patient–clinician interaction." Each of these items measuring *perceived value of AI assistance* used a 10-point rating scale, with 10 indicating the highest value.

In addition to professional specialty, the survey asked four questions about participants. One item measured *professional purview*: "Generally, how broad is your understanding of the nature of care delivery in your clinical specialty." A second item measured *financial incentive*: "What percentage (%) of your total annual professional services income is determined by your performance on measures of cost of care and/or quality." A third item measured *supervisory responsibility*: "What is your level of supervisory responsibility?" Lastly, one item measured *clinical tenure*: "How long have you been practicing clinically, excluding years spent in training programs?"

Survey length differed for different specialties, depending on the number of care delivery innovations relevant for that specialty. Survey length ranged from 5 minutes to 15 minutes.

Sample

The final sample for this survey included a total of 654 frontline clinicians, consisting of random samples of 50 healthcare professionals from 13 medical specialties drawn from Medscape's proprietary market research panel of practicing health professionals who joined Medscape to access its clinical content. Healthcare professionals who do not opt out of market research participation can be sampled for a research study.

To achieve the desired sample, 1,255 respondents accessed Medscape's survey link. Of these, 290 did not qualify because they did not select a valid role (220) or valid speciality (39) or because they were hospital-based pharmacists (31). An additional 311 qualified for specialities that already had 50 respondents by the time they accessed the survey link.

Survey Administration

Medscape administered the survey from November to December 2020. Sample members received invitation and reminder emails if they did not respond.

Measures

Independent Variables. We treated the four demographic items as independent variables: professional purview, financial incentive, supervisory responsibility, and clinical tenure. For each, we created categorical variables, with categories representing four levels of purview (from *limited to the clinical unit where I work* to *extends across multiple states*), four levels of financial incentive (based on quartiles of percentage income at risk for quality), three levels of supervisory responsibility (from *none* to *supervisory responsibility across multiple care delivery*

units), and four levels of clinical tenure (from *less than 5 years* to *more than 25 years*), respectively.

Dependent Variables. We created variables measuring the three dimensions of innovation diffusion for the specialty-specific, care delivery innovations for each of the 20 domains of care delivery captured in the survey: *knowledge of the innovations*, *awareness of current implementation*, and *awareness of future implementation*. For each diffusion innovation dimension within each clinical specialty, we counted the number of 'yes' responses for each value-enhancing innovation, indicating that respondents knew about or were aware of its current or future implementation, respectively. We also created variables measuring the three dimensions of perceived value of AI assistance, focused on *identifying health risk factors, diagnoses, and treatment elements*; *detecting/correcting deviations from treatment plan*; and *automating documentation*.

Analysis

We used descriptive statistics to report overall diffusion of innovation in terms of clinicians' knowledge of care delivery innovations, awareness of current and future implementation of care delivery innovations, and perceived value of AI technology. We first calculated the average percentage of respondents in each professional discipline reporting knowledge of the care delivery innovations and awareness of current and future implementation (Fig. 5.1). Next, we calculated innovation diffusion scores for knowledge of the innovations, awareness of current implementation, and awareness of future implementation for each respondent in the sample, as well as a summative score measuring total innovation knowledge and awareness. For this purpose, we first calculated the sum of the number of innovations a respondent reported as known, currently implemented, or planned to be implemented. We converted these to proportions by dividing this sum of known, currently implemented, and planned to be implemented innovations by the total number of innovations offered to a respondent. We created a total innovation knowledge and awareness score by summing scores for knowledge, current, and future implementation. We performed bivariate analyses to assess differences in knowledge of the innovations, awareness of current and future implementation, and total innovation knowledge and awareness. Because subgroups for health-related individual characteristics had unequal sample sizes and were not normally distributed, we performed a Kruskal–Wallis H test, a nonparametric alternative to ANOVA that requires neither of these assumptions (Hettmansperger & McKean, 1998), followed by a Mann-Whitney *U*-test (Corder & Foreman, 2014) to determine the effect size for professional purview, financial performance incentives, supervisory responsibility, and clinical tenure on innovation awareness scores. We converted clinical tenure into two categories: less than 16 years and 16 years and more to increase robustness of our results. We adjusted for pairwise comparisons within each row (measuring the differences in knowledge of the innovations, awareness of current and future implementation, and total innovation knowledge and awareness scores among each characteristic) using Bonferroni correction. We performed linear regression analysis to test the

relationship between knowledge of the innovations, awareness of current implementation, awareness of future implementation, and total innovation knowledge and awareness scores as independent variables and the value of AI technology as dependent variables.

RESULTS

Respondent Characteristics

Table 5.1 summarizes characteristics of our survey sample. Most respondents (75.3%) claimed that their professional purview extended at least to the city, region, or state where they provided care, if not across multiple states. Most also reported supervisory responsibility across or within a care delivery unit (55.4%); limited, i.e., 0%–25%, income at risk (68.5%); and clinical tenure between 6 and 25 years (63.6%).

Table 5.1. Sample Characteristics.

Characteristics	Percentage of Respondents
Professional purview	
Limited to the clinical unit where I work	5.5
Limited to the healthcare organization where I work	19.1
Limited to the city, region, or state where I provide care	36.5
Extends across multiple states	38.8
Supervisory responsibility	
No supervisory responsibility	29.7
Supervisory responsibility across or within a care delivery unit	55.4
Supervisory responsibility across multiple care delivery units	15.0
Financial incentive (% income at risk)	
0%–25%	68.5
26%–50%	16.4
51%–75%	10.6
76%–100%	4.6
Clinical tenure	
Less than 5 years	15.1
Between 6 and 15 years	38.1
Between 16 and 25 years	25.5
More than 25 years	21.3
Less than 5 years	15.1

Note: $N = 654$.

Knowledge and Awareness of Current and Future Implementations Overall and by Clinical Specialty

Overall among respondents, 61.5% reported knowledge of value-enhancing, care delivery innovations relevant for their clinical specialty, 63.2% were aware of current implementation of the innovations by a care organization in their region or state, and 50.4% were aware of planned future implementation of the innovations by a care organization in the region or state (Table 5.2). Across medical specialties, more respondents reported knowledge of care delivery innovations than awareness of current implementation of care delivery innovations, and of planned future implementation, respectively. However, most respondents who reported knowledge of care delivery innovations also reported awareness of organizations currently implementing or planning to implement these innovations. About 75% of the clinicians were aware of at least one of the care delivery innovations relevant for their specialty.

Fig. 5.1 reports descriptive results by specialty. Knowledge of care delivery innovations ranged from 73.3% among obstetricians to 24.2% among emergency department doctors. Awareness of current implementation of care delivery innovations ranged from 70.7% among hospital nurses to 18% among emergency department doctors. Awareness of future implementation of care delivery innovations ranged from 61.4% among pharmacists to 12.6% among emergency department doctors. In general, emergency department doctors, neurologists, and paramedics consistently demonstrated lower levels of innovation diffusion across all three measures, while specialties with higher levels of innovation diffusion were more mixed. Innovation diffusion reported by pharmacists put their specialty among the top three for each of the three measures and oncologists in the top three twice.

Relationship of Clinician Characteristics with Innovation Diffusion

Tables 5.2a and 5.2b report results of bivariate analysis comparing innovation diffusion scores based on other clinician characteristics: their professional purview, supervisory responsibility, performance incentive, and clinical tenure. Respondents whose professional purview extended across multiple states had higher innovation diffusion scores (mean = 0.55, $p < 0.05$ for knowledge of the innovations, mean = 0.39, $p < 0.01$ for awareness of current implementation, mean = 0.33, $p < 0.05$ for awareness of future implementation, mean = 1.28, and $p < 0.01$ for total innovation knowledge and awareness) compared to respondents whose professional purview was more limited (mean ranging from 0.48 to 0.49 for knowledge of the innovations, mean 0.33 for awareness of current implementation, mean ranging from 0.23 to 0.28 for awareness of future implementation, and mean ranging from 1.06 to 1.09 for total innovation knowledge and awareness).

Respondents with higher responsibility, i.e., across multiple care delivery units had higher innovation diffusion scores (mean = 0.53, $p < 0.05$ for knowledge of the innovations, mean = 0.40, $p < 0.05$ for awareness of current implementation, mean = 0.34, $p < 0.01$ for awareness of future implementation, and mean = 1.27,

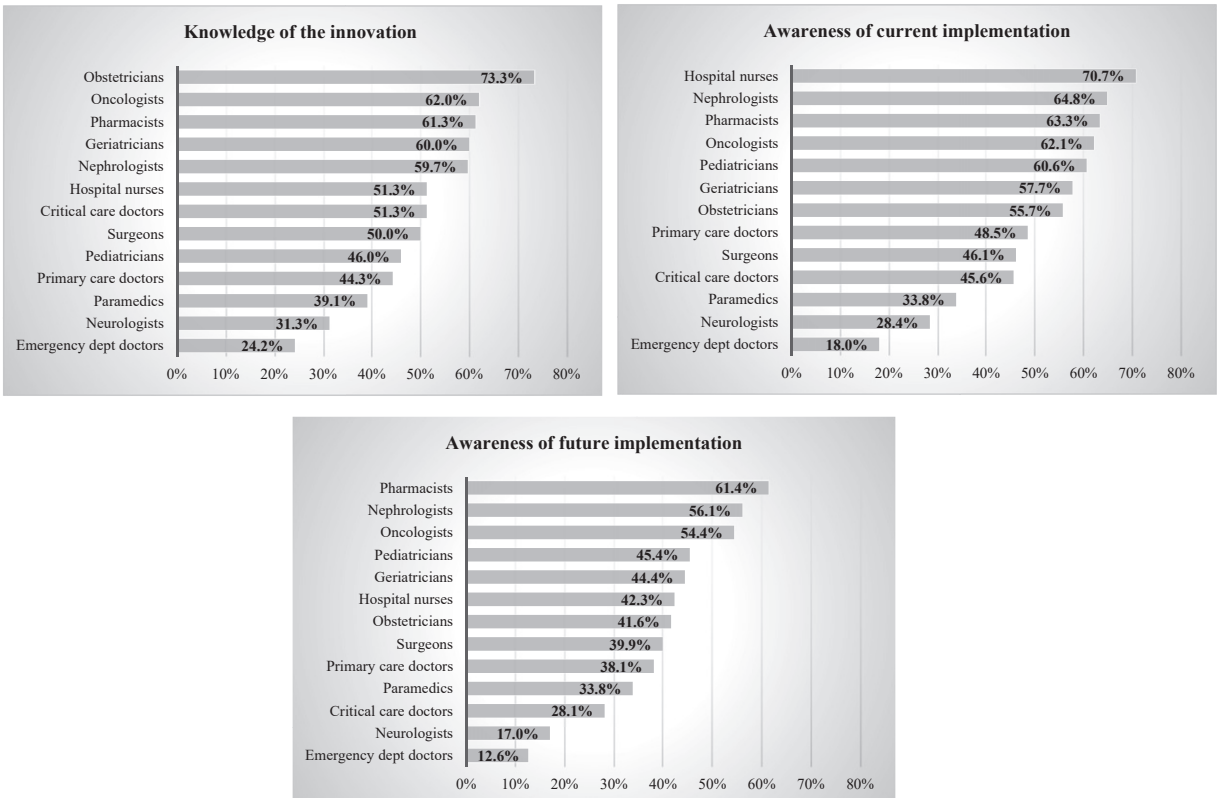

Fig. 5.1. Percent of Respondents Reporting Knowledge of the Innovations and Awareness of Its Current and Future Implementation by Professional Discipline.

Table 5.2a. Knowledge of the Innovations, Awareness of Current Implementation, and Awareness of Future Implementation, and Total Innovation Knowledge and Awareness by Individual Characteristics.

	All Respondents	Professional Purview					Supervisory Responsibility			
		Limited to My Unit (A)	Limited to My organization (B)	Limited to My Region (C)	Extends Across Multiple States (D)	Kruskal–Wallis Test Results	No Responsibility (A)	Across or Within a Care Delivery Unit (B)	Across Multiple Care Delivery Units (C)	Kruskal–Wallis Test Results
Percent of respondents reported knowledge about, and awareness of current and future implementation of care delivery innovations										
Knowledge of the innovations	61.5%	53.1%	56.7%	59.3%	65.9%		55.1%	63.3%	67.1%	
Awareness of current implementation	63.2%	48.3%	52.7%	58.6%	70.4%		53.9%	63.9%	71.9%	
Awareness of future implementation	50.4%	19.7%	34.6%	50.0%	59.5%		30.5%	53.7%	64.6%	
Innovation diffusion score[a]										
Knowledge of the innovations	0.51 (0.26)	0.49 (0.28)	0.49 (.27)	0.48 (0.25)	0.55 (.27) C B	H (3) = 8.58; $p < 0.05$	0.49 (0.25)	0.52 (0.27)	0.53 (0.27)	H (2) = 1.31; $p > 0.05$
Awareness of current implementation	0.35 (0.25)	0.33 (0.26)	0.33 (0.25)	0.33 (0.22)	0.39 (0.26) C B	H (3) = 12.88; $p < 0.01$	0.32 (0.24)	0.36 (.24)	0.40 (0.26) A	H (2) = 10.47; $p < 0.05$
Awareness of future implementation	0.29 (0.27)	0.23 (0.26)	0.24 (0.28)	0.28 (0.26)	0.33 (0.26) B C	H (3) = 17.39; $p < 0.05$	0.22 (0.24)	0.31 (0.26) A	.34 (.29) A	H (2) =19.27; $p < 0.01$
Total innovation knowledge and awareness	1.16 (0.67)	1.06 (0.61)	1.06 (0.69)	1.09 (0.64)	1.28(0.67) BC	H (3) = 17.08; $p < 0.01$	1.03 (0.62)	1.19 (0.67) A	1.27 (0.75) A	H (2) =10.21; $p < 0.05$

[a]The results of innovation diffusion scores are based on Kruskal–Wallis no-parametric test analysis. Two-sided U tests applied for conducting post hoc tests with Bonferroni correction for multiple comparisons. Where letters accompany results, these represent significant differences in innovation scores between segments. For each significant ($p < 0.05$) pair, the letter of the compared smaller category appears in the category with the larger mean. For example, knowledge about care delivery innovations among clinicians whose professional purview extends across multiple states (mean = 0.55, SD = 0.27) is significantly higher (as indicated by the letter B) than that of clinicians whose professional purview is limited to their region (mean = 0.48, SD = 0.25).

Table 5.2b. Knowledge of the Innovations, Awareness of Current Implementation, and Awareness of Future Implementation, and Total Innovation Knowledge and Awareness by Individual Characteristics.

		Financial Incentive					Clinical Tenure		
	All Respondents	0%–25% (A)	26%–50% (B)	51%–75% (C)	76%–100% (D)	Kruskal–Wallis Test Results	Less than sixteen years (A)	Sixteen years and more (B)	Kruskal–Wallis Test Results
Knowledge of the innovations	61.5%	59.5%	62.8%	65.6%	58.8%		68.0%	50.9%	
Awareness of current implementation	63.2%	59.4%	64.7%	69.2%	61.2%		65.3%	46.9%	
Awareness of future implementation	50.4%	43.3%	55.3%	64.7%	58.9%		38.5%	28.6%	
Knowledge of the innovations	0.51 (0.26)	0.49 (0.26)	0.52 (0.24)	0.58 (0.28) A	0.62 (0.30) A	H (3) = 14.28; $p < 0.01$	0.50 (0.23)	0.52 (0.30)	H (3) = 14.28; $p > 0.05$
Awareness of current implementation	0.35 (0.25)	0.33 (0.23)	0.36 (0.22)	0.45 (0.28) A	0.51 (0.32) A	H (3) = 22.18; $p < 0.01$	0.36 (0.21) B	0.33 (0.27)	H (3) = 22.18; $p < 0.05$
Awareness of future implementation	0.29 (0.27)	0.26 (0.25)	0.32 (0.26)	0.39 (0.30) A	0.48 (0.34) A	H (3) = 25.22; $p < 0.01$	0.27 (0.22) B	0.24 (0.26)	H (3) = 25.22; $p < 0.01$
Total innovation knowledge and awareness	1.16 (0.67)	1.07 (0.63)	1.19 (0.64)	1.42 (0.77) A	1.61 (0.88) A	H (3) = 25.74; $p < 0.01$	1.14 (0.55) B	1.08 (0.70)	H (3) = 25.74; $p < 0.05$

$p < 0.05$ for total innovation knowledge and awareness) compared to respondents with less supervisory responsibility (mean ranging from 0.49 to 0.52 for knowledge of the innovations, mean ranging from 0.32 to 0.36 for awareness of current implementation, mean ranging from 0.22 to 0.31 for awareness of future implementation, and mean ranging from 1.03 to 1.19 for total innovation knowledge and awareness).

Respondents with stronger financial incentives (76–100% of total annual income determined by their performance on measures of the cost of care or quality) had higher innovation diffusion scores (mean = 0.62, $p < 0.01$ for knowledge of the innovation, mean =0.51, $p < 0.01$ for awareness of current implementation, mean = 0.48, $p < 0.01$ for awareness of future implementation, and mean = 1.61, $p < 0.01$ for total innovation knowledge and awareness) compared to respondents with weaker financial incentives (mean ranging from 0.49 to 0.58 for knowledge of the innovation, mean ranging from 0.33 to 0.45 for awareness of current implementation, mean ranging from 0.26 to 0.39 for awareness of future implementation, and mean ranging from 1.07 to 1.42 for total innovation knowledge and awareness).

Respondents with less clinical tenure (less than 16 years) compared to those with more clinical tenure (16 years or more) had higher awareness of current implementation (mean = 0.36 vs. 0.33), awareness of future implementation (mean = 0.27 vs. 0.24), and total innovation knowledge and awareness (mean = 1.14 vs. 1.08).

Relationship Between Innovation Diffusion Scores and Perceived Value of AI Assistance

Table 5.3 reports results of regression analysis relating respondents' innovation diffusion scores to their perceived value of AI assistance for clinical decision support, physical action support, and automating clinical documentation. Awareness of

Table 5.3. Regression Analysis: Relationship Between Knowledge of the Innovations, Awareness of Its Current and Future Implementation, and Perceived Value of AI Assistance.

Innovation Diffusion Score	Form of AI Assistance		
	Clinical Decision Support Est. (SE)	Physical Action Support Est. (SE)	Automating Clinical Documentation Est. (SE)
Knowledge of the innovations	0.45 (0.25)	1.15** (0.31)	0.28 (0.29)
Awareness of current implementation	0.71* (0.30)	1.43** (0.33)	0.12 (0.31)
Awareness of future implementation	0.45 (0.28)	1.12** (0.31)	0.17 (0.29)
Total innovation knowledge and awareness	0.23* (0.11)	0.54** (0.12)	0.08 (0.11)

$*p < 0.05$; $**p < 0.01$

current implementation and total innovation knowledge and awareness related positively to clinical decision support ($b = 0.71$, SE $= 0.30$, $p < 0.05$ and $b = 0.23$, SE $= 0.11$, $p < 0.05$, respectively). All innovation diffusion scores related positively to physical action support (knowledge of the innovations $b = 1.15$, SE $= 0.31$, $p < 0.01$; awareness of current implementation $b = 1.43$, SE $= 0.33$, $p < 0.01$; awareness of future implementation $b = 1.12$, SE $= 0.31$, $p < 0.01$; and total innovation knowledge and awareness $b = 0.54$, SE $= 0.12$, $p < 0.01$). Innovation diffusion scores did not relate to automating clinical documentation.

DISCUSSION

Innovation diffusion is critical for improving the value of care delivery, and through their knowledge of the innovations and awareness of their implementation, clinicians contribute to innovation diffusion. Our study found that not all clinicians were equally knowledgeable of value-enhancing, care delivery innovations relevant to their clinical specialties and aware of their current and future implementations. Overall, less than two-thirds of clinicians had knowledge and awareness of relevant value-enhancing care delivery innovations, though three-quarters of clinicians were aware of at least one care delivery innovation in their domain. The percentage of knowledge of the innovation and awareness of current and future implementation varied by clinicians' specialty, and individual characteristics of clinicians related to innovation diffusion scores. Clinicians with broader professional purview, higher supervisory responsibility, and stronger financial incentives had higher innovation diffusion scores, indicating greater knowledge and awareness of value-enhancing, care delivery innovations.

Study findings suggest moderate diffusion of value-enhancing, care delivery innovations. If the two-thirds or so of clinicians who reported knowledge about or awareness of implementation of care delivery innovations in their region had adopted the innovations themselves, the market share for value-enhancing innovation would penetrate well into the late majority adopters segment. However, we cannot assume awareness is equivalent to adoption. Achieving significant advances in value-based care sufficient for bending the proverbial cost curve will likely require moving further along Roger's adopter curve. Nevertheless, given clinicians key role in innovation diffusion (Balas & Chapman, 2018), their knowledge and awareness of innovations is a key first step.

Wide variation in knowledge and awareness among clinicians of different specialties suggest extra effort may be required among selected specialties. Pharmacists and oncologists reported the most knowledge of the innovations and awareness of their current and future implementation, while emergency department doctors, neurologists, and paramedics consistently demonstrated least innovation diffusion. Whether this is attributable to characteristics of these specialties or to qualities of the innovations available to these specialties is difficult to discern. One possibility is that emergency department doctors, neurologists, and paramedics face less pressure or have fewer incentives to improve value or remove waste relative to pharmacists, oncologists, and other clinicians. This would explain why they may be less familiar

with innovations that improve value as opposed to quality only. Further research should examine this hypothesis and, if confirmed, policy actions may be required to motivate a quest for value in some specialties. Another possibility is that, given the nature of their work, emergency department doctors, neurologists, and paramedics may enjoy fewer opportunities for observing innovation implementations or sharing information with colleagues about them. Emergency doctors and paramedic clinicians typically do shift work, often at night, which may reduce their availability for participating in their organization's innovation efforts. Neurologists tend to work alone, in labs, consulting on cases or in clinic, which may limit their exposure to value-enhancing innovations.

Study findings also suggest that in the case of value-enhancing, care delivery innovations, supervisory responsibility, broad purview, strong financial incentives for quality performance, and less tenure are associated with earlier adoption of innovations. These findings add to the set of individual characteristics associated with adoption identified in previous literature (Dedehayir et al., 2017; Haider & Kreps, 2004; Uhl et al., 1970; Van Braak, 2001). Clinicians with less clinical tenure, often younger, may be less set in their ways and more open and curious about value-enhancing innovation (Woods et al., 2018). Clinicians who occupy higher levels in the organizational hierarchy (e.g., supervisors and clinicians with longer clinical tenure) and those with broader professional purview have greater opportunities for exposure to innovations. This highlights the important role that individuals with more power in organizations must play in leading innovation diffusion in their organizations. It also suggests that it could be helpful to intentionally expose clinicians with less supervisory responsibility and narrower professional purview to care delivery innovations in order to facilitate their adoption and implementation. Such efforts are important because lower level clinicians represent the majority of frontline personnel in health care, and they are vital to reach if innovations are to diffuse sufficiently in organizations. Engaging frontline clinicians in the innovation diffusion process is also critical as they can provide insights and feedback regarding care delivery innovation effectiveness (Tucker et al., 2008). Their engagement in decision-making about innovation also protects against resistance to change. Our findings related to financial incentives indicate that the greater the financial risk for quality performance the more clinicians may be motivated to learn about care delivery innovations. This finding implies a specific mechanism through which financial risk could enhance value-based care.

We also found that innovation diffusion scores indicating greater knowledge and awareness of value-enhancing, care delivery innovations related positively with perceptions of the perceived value of AI-based technology. This relationship was present specifically for perceptions of value of AI in assisting clinicians with clinical decision support and physical action support (deviations from physical actions required by the treatment plan), albeit not for automating clinical documentation, for which recognition of value was consistently high. This suggests that earlier adopters may have greater appreciation for the benefits or fewer concerns about the risks of innovation, at least in the case of AI-based technologies.

This study is not without limitations. First, the survey did not ask respondents directly whether they or their own organization has adopted the care delivery innovations in question, so we are unable to assess this measure of innovation diffusion. Nor did it ask about reasons why clinicians may have regarded a specific innovation as value-enhancing or not given their local needs and culture. Additional research should explore these questions. Second, the survey was administered once, so represents a snapshot in time of innovation diffusion. A subsequent survey is planned and will enable tracking of innovation diffusion over time. Third, we acknowledge that care delivery innovations in larger organizations are predominantly governed by priorities of senior-level managers; if, e.g., they prioritize maximizing fee-for-service (FFS) revenue, care delivery innovations that depress FFS revenue are less likely to be known to or adopted by clinicians. Fourth, our survey was conducted during the COVID-19 pandemic, which could have reduced innovation diffusion if attention and resources were diverted to urgent needs.

CONCLUSION

Our study, nevertheless, offers important insights for healthcare leaders and clinicians. To more rapidly and thoroughly diffuse innovations, layers of organizational actors beyond those with high supervisory responsibility and broad purview should be engaged. Financial incentives that put clinician income at higher risk for value may be a lever for motivating curiosity about value-enhancing innovations. Healthcare organization leaders should monitor the diffusion of innovation and encourage it by raising awareness of innovations and their potential to add value. Selected specialties may be more prone to inertia, requiring regulatory or institutional change.

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APPENDIX

Table A1. Care Delivery Domains and Value-Enhancing Innovations Relevant for Each Medical Specialty.

Medical Specialty	Relevant Care Delivery Domains	Examples of Value-Enhancing Care Delivery Innovations
Critical care doctors	Critical care	Economical physiological monitoring technology embedded in Emergency Department and non-ICU hospital beds triggers alerts to a mobile ICU team.
Emergency department doctors	Stroke prevention and acute care	Nurse-led teams use a physician-approved prescribing protocol to approach national benchmarks for hypertension control of >85%.
Geriatrics	Dementia care, late life care	Younger seniors are trained to provide socialization, screening, and referral for unmet medical and social needs of late-life and/or frail seniors.
Hospital nursing	Technology-enabled inpatient care	Predictive analytics software is used to match inpatient nurse staffing for each shift and unit with predictive clinical needs.
Nephrology	Chronic kidney disease (CKD) care, nephrology care	A nurse based in a nephrology practice coordinates care for CKD patients with multiple chronic illnesses during nephrology office visits via tele-connecting with a contracted network of CKD-relevant specialists such as cardiologists, endocrinologists, clinical pharmacologists, dietitians, and occupational therapists in order to reduce travel burden imposed on CKD patients.
Neurology	Stroke prevention and acute care	Following a TIA or mild stroke and a <24 hour evaluation in a hospital emergency department, willing patients who live nearby with a capable adult caregiver are discharged and scheduled for further evaluation via an office visit the next day.
Obstetrics	Maternity care	Hospital-affiliated and immediately adjacent outpatient birth centers with regularly rehearsed rapid hospital transfer protocols are routinely offered to low-risk women desiring less medicalized births by nurse midwives in conjunction with a neonatal specialist.
Oncology	Late-stage cancer care, oncology care regardless of prognosis, oncology care	Oncology teams use nonclinician health coaches to help patients with late-stage cancer in collaboration with their close

Table A1. *(Continued)*

Medical Specialty	Relevant Care Delivery Domains	Examples of Value-Enhancing Care Delivery Innovations
		family periodically select personalized care goals ranging from curative care to comfort care only.
Paramedic	High-need high-cost care, technology-enabled ambulatory inpatient care	Supervised housing is provided for the 10% of the chronic homeless population consuming the greatest share of health, social services, and criminal justice spending.
Pediatrician	Transition of pediatric chronic illness to adult care, early childhood pediatric care	The transitions team establishes tele-mediated connections between patients' prior pediatric specialty providers and new adult care providers to enhance interphysician coordination and supports adult system care-providers until patients are securely integrated.
Hospital pharmacy	Technology-enabled inpatient care	First responders use apps with telehealth consultation connections to nurse practitioners and social workers to reduce preventable ED visits and hospitalizations.
Primary care	Stroke prevention and acute care, ambulatory surgical care, spine pain care, prescription medication care, dementia care, high-need high-cost care, technology-enabled ambulatory care, primary care, clinically fragile patients with chronic disease	Patients at risk for catastrophizing are referred to a behavioral health therapist with rapid access to consultation from a physical medicine specialist.
Surgery	Ambulatory surgical care	Consistent with surgical level of care standards widely employed in the United Kingdom and EU countries, most nonurgent outpatient surgeries for patients without major surgical risk factors are provided in free-standing ambulatory surgical center.