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Factors associated with emergency department adoption of telemedicine: 2014 to 2018

Kori S. Zachrison MD, MSc[1,2] | Krislyn M. Boggs MPH[1] | Emily M. Hayden MD, MHPE[1,2] | Rebecca E. Cash PhD, MPH[1] | Janice A. Espinola MPH[1] | Margaret E. Samuels-Kalow MD, MPhil[1,2] | Ashley F. Sullivan MPH[1] | Ateev Mehrotra MD, MPH[3] | Carlos A. Camargo Jr MD, DrPH[1,2]

[1] Department of Emergency Medicine, Massachusetts General Hospital, Boston, Massachusetts, USA

[2] Department of Emergency Medicine, Harvard Medical School, Boston, Massachusetts, USA

[3] Department of Healthcare Policy, Harvard Medical School, Boston, Massachusetts, USA

Correspondence
Kori S. Zachrison, MD, MSc, Massachusetts General Hospital, Department of Emergency Medicine, 55 Fruit Street, Boston, MA 02114, USA.
Email: kzachrison@mgh.harvard.edu

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Abstract

Objective: Telemedicine is used by emergency departments (EDs) to connect patients with specialty consultation and resources not available locally. Despite its utility, uptake of telemedicine in EDs has varied. We studied characteristics associated with telemedicine adoption during a 4-year period.

Methods: We analyzed data from the 2014 National Emergency Department Inventory (NEDI)–New England survey and follow-up data from 2016 and 2017 NEDI-USA and 2018 NEDI-New England surveys, with data from the Center for Connected Health Policy. Among EDs not using telemedicine in 2014, we examined characteristics associated with adoption by 2018.

Results: Of the 159 New England EDs with available data, 80 (50%) and 125 (79%) reported telemedicine receipt in 2014 and 2018, respectively. Among the 79 EDs without telemedicine in 2014, academic EDs were less likely to adopt by 2018 (odds ratio, 0.12; 95% confidence interval, 0.03–0.46). State policy environment was not associated with likelihood of adoption. In 2018, all 7 freestanding EDs received telemedicine, whereas only 1 of 9 academic EDs (11%) did.

Conclusions: Telemedicine use by EDs continues to grow rapidly and by 2018, >3 quarters of EDs in our sample were receiving telemedicine. From 2014 to 2018, the initiation of telemedicine receipt was less common among higher volume and academic EDs.

KEYWORDS
emergency department, healthcare policy, telemedicine

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1 | INTRODUCTION

1.1 | Background

Resource availability in US emergency departments (EDs) varies substantially, with major disparities in access.[1,2] Growing regionalization with concentration of specialty care at higher volume centers has contributed to decreased consultant availability in many smaller or rural EDs.[3,4] Telemedicine in the ED, using virtual connections between patients and remote clinicians or specialists, may mitigate these access disparities. This has been shown to be feasible and effective for improving clinical care in EDs, particularly for stroke care.[5–14] Yet for other patient groups with high levels of evidence for telemedicine efficacy,[8,15–17] such as pediatric emergency care, telemedicine remains underused.[5,7,18] The value of telemedicine has been recognized by rural EDs, patients, and caregivers.[19,20] Telemedicine capacity has become particularly important in the midst of the coronavirus disease 2019 response and having telemedicine capacity at baseline can facilitate greater use in a public health emergency and allow flexibility in a variety of situations in which demand exceeds resources.

1.2 | Importance

In 2016, 48% of US EDs reported receiving telemedicine services for patient care in their ED (ie, telemedicine receipt).[21] Among rural EDs without telemedicine, cost was the most commonly cited barrier.[22] In non-ED settings, payment policy environment has been associated with telemedicine use. However, there has been little exploration of ED adoption over time, the role of policy in ED adoption, characteristics of EDs that are using it, how it is used, and how it impacts patient care and outcomes.[23,24]

It is important to acknowledge that the optimal rate of telemedicine receipt among US EDs is unknown. Many EDs have comprehensive resources and no need for telemedicine receipt; these EDs may even provide telemedicine services to others. Some EDs have most resources but still need telemedicine for particular clinical indications. Yet other EDs have fewer resources and need telemedicine more broadly. Although it is difficult to determine which EDs fall into these categories, it is likely that there remain EDs that would benefit from telemedicine but do not yet have it.

1.3 | Goals of this investigation

Using combined data from a series of surveys of New England EDs from 2014 to 2018, we describe telemedicine uptake over time and what factors are associated with ED telemedicine adoption (defined as initiation of a program for telemedicine receipt). We also examine whether state policy environment is associated with ED adoption.

The Bottom Line

In an analysis of 159 emergency departments in New England, telemedicine use increased from 50% to 79% during a 4-year period. Adoption of telemedicine was more common in lower volume and non-academic emergency departments.

2 | METHODS

2.1 | Study design, setting, and selection of participants

As part of the 2014 National Emergency Department Inventory (NEDI)–New England survey (appendix), we surveyed all 195 EDs in New England states (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont) that were open in 2014. We included all EDs responding to the NEDI-New England survey with complete response to the question about telemedicine use. We also used data from the 2016 and 2017 NEDI-USA national surveys and the 2018 NEDI-New England survey to determine ED telemedicine receipt in the subsequent years. All surveys are included in the appendix (Figures A1–A4). We do not have data from 2015 because the telemedicine question was not included during that iteration of the NEDI-USA survey. These surveys were approved by the Partners Healthcare institutional review board and were coordinated by the Emergency Medicine Network at Massachusetts General Hospital (Boston, MA). Detailed survey methods have been previously reported.[21]

We also used data from the Center for Connected Health Policy to identify states' policy environments with respect to telemedicine. Data were based on state policy in 2014.

2.2 | Survey and administration

The surveys were composed largely of questions that have been used in prior studies.[21,25–27] The telemedicine questions were developed and refined with feedback from community and academic physicians and telemedicine researchers. To capture ED characteristics in the preceding year, the surveys were administered in 2015, 2017, 2018, and 2019, respectively. For example, the survey to capture 2014 characteristics was deployed in 2015. Data were typically collected from January through October in a given year. The surveys were completed on paper, by internet, or by telephone. Surveys were mailed to ED directors up to 3 times during a 2-month to 3-month period. The mailings also included a link to an online version of the survey. We used telephone calls to follow-up with non-responsive sites and worked with volunteer state coordinators to maximize survey participation and obtain responses from as many EDs as possible (appendix). A standard script was used for telephone completion, which included a definition of telemedicine

if needed. Survey data were entered and managed using REDCap electronic data capture tool (Vanderbilt University, Nashville, TN).[28]

2.3 | Outcomes

The primary outcome was ED receipt of telemedicine for each year studied. In 2014, this was based on self-reported response to the survey item "Does your ED obtain consultation via video conferencing equipment? Yes/No." In 2016 to 2018, the survey question was modified for clarity to "Does your ED *receive* telemedicine services for patient evaluation? Yes/No." EDs were classified by their responses to telemedicine receipt (yes/no) in each year studied. As a secondary outcome, we also examined ED provision of telemedicine. This was based on self-reported response to the survey item "Does your hospital/ED *provide* telemedicine services for the evaluation of patients in other EDs? Yes/No/Not sure." This question was included on the 2016 to 2018 surveys.

When responses were unclear or changed from year to year, we performed follow-up calls to the EDs to confirm responses.

2.4 | Other variables of interest

We also collected data on other key ED characteristics related to overall and pediatric visit volumes and the presence of a pediatric area within the ED. We identified academic hospitals based on membership in the Council of Teaching Hospitals.[29] Urban Influence Codes were used to classify EDs as urban (codes 1 and 2) or rural (codes 3–12).[30] We used data from the Center for Connected Health Policy to identify states' policy environments in 2014. We identified presence of any parity law, which is a mandate for reimbursement of telemedicine visits either at a level partially or fully equivalent to in-person visits. Among those with parity laws, we also noted the year the parity law was enacted and state telemedicine "grade" (A, B, C, F). A higher grade was assigned to states with greater openness to telemedicine based on payment for private insurance, Medicaid parity, state employee health plan parity, patient setting restrictions, eligible technologies, distance or geography restrictions, eligible practitioners, and physician-provided services.[31]

2.5 | Analysis

We used descriptive statistics to quantify ED telemedicine use by year. For each year, we determined the number of EDs receiving telemedicine. We also calculated the proportion of EDs receiving telemedicine each year using as the denominator the respective population of EDs for the given year. For example, if an ED responded to the 2017 survey, but not the 2014 survey, that ED would be included for the calculation of the 2017 population despite not being included for 2014.

Next, among EDs that did not receive telemedicine in 2014, we identified the proportion of EDs that adopted telemedicine by 2016, by 2017, and by 2018. We categorized EDs as those receiving telemedicine in 2014, those adopting between 2014 and 2018, and those not receiving telemedicine in 2018. We used descriptive statistics to report the following ED characteristics stratified by these groups: annual visit volume and pediatric visit volume, presence of a dedicated pediatric ED, academic status (based on Council of Teaching Hospitals membership), freestanding ED (satellite and autonomous EDs), rural location, presence of pediatric ED, state, state telemedicine parity law status, and state policy grade.

To better understand characteristics of EDs that received telemedicine in 2014, those that adopted the technology between 2014 and 2018, and those that were persistent non-users in 2018, we also stratified EDs by urban versus rural location and high versus low volume (above vs below the median). We examined proportion of EDs receiving versus not receiving telemedicine in each group over time.

Among all EDs responding in 2014 that did not use telemedicine that year, we performed a hierarchical logistic regression analysis to identify characteristics associated with telemedicine receipt by 2018 (ie, adoption between 2014 to 2018). Covariates of interest at the ED level were determined a priori and included 2014 values for annual ED volume, annual pediatric volume, presence of a dedicated pediatric ED, academic status, freestanding ED, and rural location. We also included the presence of any parity law (dichotomous) as a state-level covariate. We examined variance inflation coefficients to confirm absence of any collinearity among variables in the model.

With respect to missingness, if an ED reported telemedicine use at any point in time and subsequently had missing data in a following year, we assumed continued telemedicine use in the subsequent year. We felt that this was a valid assumption to make because the variable of interest was adoption of telemedicine. If an ED did not use telemedicine in 2014 and did not adopt in 2016 or 2017 and did not have data for 2018, it was excluded from the analysis as we could not be sure that it did or did not adopt telemedicine by 2018. For other variables (eg, academic status, freestanding ED), if a variable was not available for an ED in 2014, we used data from the 2015 NEDI-USA survey.

3 | RESULTS

3.1 | Characteristics of the study population

There were 195 EDs open in 2014 in New England, of which 169 responded to the telemedicine question on our survey (response rate 86%); 82 EDs (49%) reported telemedicine receipt in 2014, and 87 did not (51%) (Figure 1). In 2018, there were 194 New England EDs open, and 167 responded to our survey (response rate 85%) and 166 to the telemedicine question; 126 (76%) reported telemedicine receipt in 2018, and 40 did not (24%) (Figure 2). Detailed response rates and proportions of EDs receiving telemedicine in each year and data stratified by state are presented in the appendix (Table A1 and Figure A5).

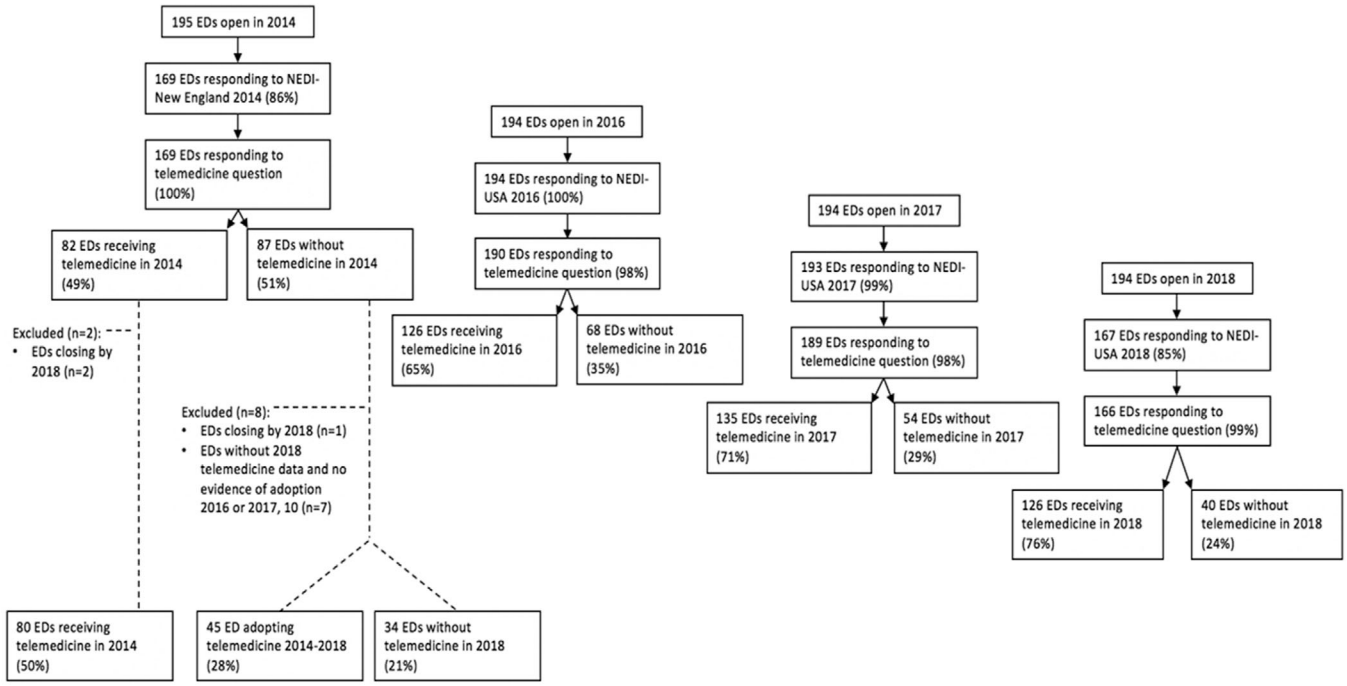

FIGURE 1 Emergency department inclusion flow diagram. EDs, emergency departments; NEDI, National Emergency Department Inventory

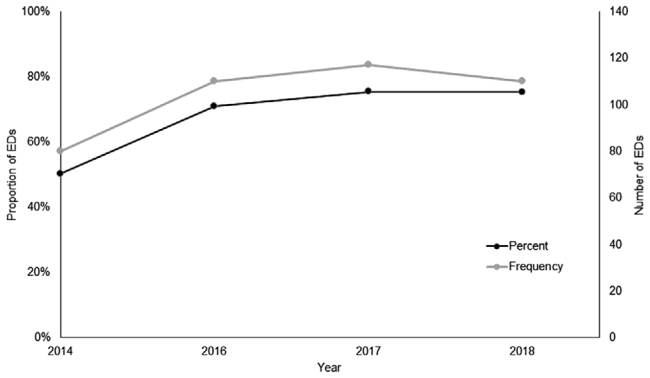

FIGURE 2 Number and proportion of emergency departments receiving telemedicine: 2014–2018. EDs, emergency departments

There were 159 EDs that responded to our NEDI-New England survey in 2014 and also had data on initiation of telemedicine receipt through 2018; this encompasses 82% of the EDs in New England that were open in 2014 and 2018. ED characteristics are outlined in Table 1, and characteristics of EDs that did and did not receive telemedicine in 2018 are detailed in the appendix. Overall, median annual visit volume in 2014 was 29,000 (interquartile range 15,500–51,500); 9 (6%) were academic, 7 (4%) were freestanding, 47 (30%) were rural, and 63 (40%) were in a state with any telemedicine payment parity law.

We divided the EDs into 3 groups: EDs with telemedicine in 2014, EDs adopting telemedicine from 2014 to 2018, and EDs without telemedicine in 2018. Compared with those without telemedicine in 2018, EDs with telemedicine were more likely to have lower annual visit volume, be freestanding, be in a rural location, and to not have a dedicated pediatric ED (Table 1). Patterns also varied by state (appendix). Three states had a positive policy environment, with parity laws enacted in 2009 (Maine, New Hampshire) and 2012 (Vermont). Of EDs with telemedicine in 2014, or adopting by 2018, 41% and 44%, respectively, were in states with parity laws, relative to 29% of EDs that were persistent non-users in 2018.

Of the 34 EDs without telemedicine in 2018, 7 (21%) were providing telemedicine to others in all 3 years that we collected data on this question (2016–2018).

3.2 | Main results

Among the 79 EDs without telemedicine receipt in 2014, 45 (57%) initiated receipt of telemedicine by 2018. Relative to those that still did not use telemedicine in 2018, those initiating receipt of the technology were less often academic and more often freestanding (Table 2).

We then grouped EDs into low-volume urban (n = 58, 36%), high-volume urban (n = 80, 50%), and low-volume rural (n = 21, 13%); there were no high-volume rural EDs. All academic EDs and all EDs with a pediatric ED were in the high-volume urban category. In 2014, the majority of low-volume rural EDs received telemedicine (71%) versus 51% of low-volume urban, and 44% of high-volume urban. From 2014 to 2018, telemedicine receipt increased in all groups. By 2018, nearly all low-volume rural EDs received telemedicine (95%) versus 88% of low-volume urban and 68% of high volume urban.

In our multivariable model, examining odds of initiating telemedicine receipt by 2018 among the 79 EDs without it in 2014, neither annual ED volume, annual pediatric volume, presence of a dedicated pediatric ED, rural location, nor positive state telemedicine policy environment were associated with likelihood of telemedicine

TABLE 1 Emergency department characteristics by telemedicine use

	All EDs, n = 159	EDs receiving TM services in 2014, n = 80	EDs adopting TM between 2014 and 2018, n = 45	EDs not receiving TM services in 2018, n = 34
2014 Annual visit volume, n (%)				
<10,000 visits	16 (10)	8 (10)	5 (11)	3 (9)
10,000–19,999	37 (23)	20 (25)	12 (27)	5 (15)
20,000–39,999	49 (31)	30 (38)	14 (31)	5 (15)
≥40,000 visits	57 (36)	22 (28)	14 (31)	21 (62)
2014 Annual pediatric visit volume, n (%)				
<3000 visits	95 (60)	49 (61)	27 (60)	19 (56)
≥3000 visits	64 (40)	31 (39)	18 (40)	15 (44)
Academic ED, n (%)	9 (6)	1 (1)	0 (0)	8 (24)
Freestanding ED, n (%)	7 (4)	4 (5)	3 (7)	0 (0)
Rural location, n (%)	47 (30)	26 (34)	14 (31)	7 (21)
Presence of a pediatric area in the ED in 2014, n (%)	18 (11)	6 (8)	4 (9)	8 (24)
State, n (row %)				
CT	27 (17)	11 (41)	10 (37)	6 (22)
MA	60 (38)	34 (57)	11 (18)	15 (25)
ME	28 (18)	20 (71)	5 (18)	3 (11)
NH	23 (14)	10 (44)	10 (44)	3 (13)
RI	9 (6)	2 (22)	4 (44)	3 (33)
VT	12 (8)	3 (25)	5 (42)	4 (33)
Positive TM policy environment, n (%)	63 (40)	33 (41)	20 (44)	10 (29)
State TM grade[a]				
Median (IQR)	2.6 (1.9–3.0)	2.6 (1.9–3.4)	1.9 (0.5–2.6)	2.6 (0.5–2.6)
Mean (SD)	2.2 (1.2)	2.5 (1.1)	1.9 (1.2)	2.1 (1.2)

CT, Connecticut; ED, emergency department; IQR, interquartile range; MA, Massachusetts; ME, Maine; NH, New Hampshire; RI, Rhode Island; SD, standard deviation; TM, telemedicine; VT, Vermont.

Data are displayed as n (column %) unless otherwise specified.

[a] A higher grade was assigned to states with greater openness to TM based on payment for private insurance, Medicaid parity, state employee health plan parity, patient setting restrictions, eligible technologies, distance or geography restrictions, eligible practitioners, and physician-provided services.

adoption by 2018. Only academic status was statistically significant, with decreased likelihood of adoption by academic EDs. Likelihood of initiating telemedicine receipt did not vary by state (Table 3).

4 | LIMITATIONS

Our results are limited to the New England region and may not be reflective of trends in the rest of the nation. We characterized EDs' use of telemedicine based on self-reported responses and thus accuracy of this variable is dependent on the respondents' understanding of telemedicine and the capabilities of their ED. However, given that respondents are typically ED directors or other individuals involved in ED operations, these individuals should be reliable sources. Respondents may also have had varying understanding of the definition of telemedicine. Although those completing the survey by phone had clarifying script if necessary, those completing the survey by paper or electronically may have had a different understanding of telemedicine than what was intended. We tried to mitigate this by including an explanatory diagram on the back of the survey and as part of the online survey in 2017 and onward. Furthermore, although the survey questions did distinguish between telemedicine receipt and provision, there was no further delineation between different types of telemedicine. In the examination of the relationship between state policy environment and ED telemedicine adoption, we used state policy data from 2014 because we hypothesized that if a relationship existed between policy environment and ED telemedicine adoption, there would be a lag period between them. Nevertheless, it is possible that inclusion of more recent policy data would have identified a different relationship than the null that we found. Our results also have potential for bias related to non-responders. However, our response rate (ranging from 85% to 100% over the years) is strong, which min-

TABLE 2 Characteristics associated with emergency department adoption of telemedicine from 2014 to 2018 (n = 79)

	EDs not receiving TM services in 2018 (n = 34)	EDs adopting TM between 2014 and 2018 (n = 45)
2014 Annual visit volume, n (%)		
<10,000 visits	3 (9)	5 (11)
10,000–19,999	5 (15)	12 (27)
20,000–39,999	5 (15)	14 (31)
≥40,000 visits	21 (62)	14 (31)
2014 Annual pediatric visit volume, n (%)		
<3000 visits	19 (56)	27 (60)
≥3000 visits	15 (44)	18 (40)
Presence of a dedicated pediatric ED in 2014, n (%)	8 (24)	5 (9)
Academic ED, n (%)	8 (24)	0 (0)
Freestanding ED, n (%)	0 (0)	3 (7)
Rural location, n (%)	7 (21)	14 (31)
State, n (%)		
CT	6 (18)	10 (22)
MA	15 (44)	11(24)
ME	3 (9)	5 (11)
NH	3 (9)	10 (22)
RI	3 (9)	4 (9)
VT	4 (12)	5 (11)
Positive TM policy environment, n (%)	10 (29)	20 (44)
Parity duration (years), median (IQR)	0 (0–6)	0 (0–9)

CT, Connecticut; ED, emergency department; IQR, interquartile range; MA, Massachusetts; ME, Maine; NH, New Hampshire; RI, Rhode Island; TM, telemedicine; VT, Vermont.
Data are displayed as n (column %) unless otherwise specified.

TABLE 3 Characteristics associated with emergency department adoption of telemedicine from 2014 to 2018 in a multivariable model (n = 79)[a]

	Crude[b] OR (95% CI)	Adjusted[b] OR (95% CI)
Annual ED volume in 2014		
<10,000 visits	1.0 (referent)	1.0 (referent)
10,000–19,999	1.44 (0.24–8.46)	0.82 (0.13–5.38)
20,000–39,999	1.68 (0.29–9.75)	0.72 (0.05–10.27)
≥40,000 visits	0.40 (0.08–1.95)	0.23 (0.02–3.39)
Annual pediatric volume in 2014		
<3000	1.0 (referent)	1.0 (referent)
≥3000	0.82 (0.32–2.09)	0.36 (0.08–1.65)
Presence of dedicated pediatric ED	0.32 (0.87–1.16)	0.48 (0.09–2.53)
Academic (reference: not academic)	0.10 (0.03–0.33)	0.12 (0.03–0.46)
Rural (reference: urban)	1.74 (0.61–4.95)	0.67 (0.07–6.19)
Positive policy environment	1.92 (0.75–4.93)	0.81 (0.12–5.31)

CI, confidence interval; ED, emergency department; OR, odds ratio.
[a]A total of 79 EDs are included in this analysis, with 45 adopting telemedicine by 2018 and 34 not adopting.
[b]Adjusted for clustering by state, state random intercepts were not significantly different.

imizes this risk. There may also be biases introduced by our strategy toward missing variables. Among EDs without 2018 data, for our primary analysis we excluded those that did not use telemedicine in preceding years, but kept those EDs that did report telemedicine in preceding years. This may have biased our results toward overreporting telemedicine use in 2018. However, when we separately examined all EDs responding in each year, the prevalence increased over time. Finally, because of our sample size, our multivariable model was not well powered and has relatively wide confidence intervals. Our sample was based on the number of EDs in the region, thus there was not a way to mitigate this limitation despite our strong response rates and representation of the region. The limited sample size also precluded inclusion of other potentially important population-level variables such as the built or social environment. Further examination of these questions in a larger sample during a longer period of time will be important to confirm these findings.

5 | DISCUSSION

To our knowledge, this is among the first longitudinal analyses of ED telemedicine adoption over time. In this sample of New England EDs, we observed rapid uptake of telemedicine from 2014 to 2018, with a quarter of EDs adopting telemedicine, and in total, roughly 3 quarters of EDs now have this technology. Our results are consistent with other reports in the literature describing growth in the use of telemedicine for mental health visits,[32] substance use disorder visits,[33] and stroke care.[34] Previous work has been primarily focused at the patient level, identifying increasing rates of telemedicine consultations in administrative data. In contrast, we focus at the ED level, examining characteristics associated with EDs' adoption of telemedicine.

This ED-level evaluation is particularly valuable for understanding characteristics of EDs that were early adopters, more recent adopters, and those that have not adopted. Although these data cannot provide any insight into the optimal rate of ED telemedicine use, they are valuable to inform our understanding of the current landscape of use and characteristics of early adopters, the early majority, and non-users. Of those that were not receiving telemedicine from 2016 to 2018, ≈1 in 5 were providing telemedicine to other EDs. This suggests that at least some of the EDs not receiving telemedicine had comprehensive resources on site without need for telemedicine receipt. Future work may explore the optimal rate of telemedicine use by more deeply evaluating EDs' resource availability in relation to telemedicine adop-

tion and the relationship between telemedicine adoption and patient outcomes.

Although our results do provide a relatively comprehensive sense of the extent of telemedicine adoption by EDs in New England, we do not have any data on the extent or success of implementation or integration of telemedicine into clinical workflows. Further mixed methods or qualitative work should explore barriers and facilitators of successful implementation of telemedicine in EDs.

It is interesting to note that we did not find an association between state policy environment and ED adoption of telemedicine between 2014 and 2018. There are a few potential explanations for this. It may be that policy environment was a driver for early adopters; however, in more recent years, the early and later majority have recognized the value of telemedicine independent of policy related to payment parity. Alternatively, ED adoption may be driven largely by clinical need and be relatively independent from state payment policy. For example, during the time of this study period, the financial structure of telemedicine use in the ED often did not depend on direct billing to payors and was supported in other ways. Thus, if policy environment is not an important driver of ED telemedicine adoption, then there may be other important strategies to support telemedicine adoption in underresourced EDs, such as grant programs. Further work is needed to explore this question.

6 | CONCLUSIONS

We found that telemedicine use is increasing among New England EDs. By 2018, ≈3 in 4 EDs were receiving telemedicine. Adoption between 2014 and 2018 was less common among academic EDs, and state policy did not appear to contribute to telemedicine adoption during this time period.

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AUTHOR CONTRIBUTIONS

Kori S. Zachrison and Carlos A. Camargo conceived and designed the study. Krislyn M. Boggs, Janice A. Espinola, Ashley F. Sullivan, and Carlos A. Camargo conducted and oversaw data collection. Rebecca E. Cash and Janice A. Espinola performed statistical analysis. All authors reviewed and interpreted the results and contributed to drafting and critical revisions of the manuscript.

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AUTHOR BIOGRAPHY

Kori S. Zachrison, MD, MSc, is Associate Professor of Emergency Medicine at Massachusetts General Hospital and Harvard Medical School and affiliated faculty with the Onnela Lab at Harvard T.H. Chan School of Public Health.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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