Trends in Use of Electronic Health Records in Pediatric Office Settings

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Objectives To determine the prevalence and functionalities of electronic health records (EHRs) and pediatricians' perceptions of EHRs.

Study design An 8-page self-administered questionnaire sent to 1619 randomly selected nonretired US American Academy of Pediatrics members in 2016 was completed by 709 (43.8%). Responses were compared with surveys in 2009 and 2012.

Results The percent of pediatricians who were using EHRs increased from 58% in 2009 and 79% in 2012 to 94% in 2016. Those with fully functional EHRs, including pediatric functionality, more than doubled from 8.2% in 2012 to 16.9% in 2016 ($P = .01$). Fully functional EHRs lacking pediatric functionality increased slightly from 7.8% to 11.1% ($P = .3$), and the percentage of pediatricians with basic EHRs remained stable (30.4% to 31.0%; $P < .3$). The percentage of pediatricians who lacked basic EHR functionality or who reported no EHR decreased (from 53.6% to 41.0%; $P < .001$). On average, pediatricians spent 3.4 hours per day documenting care.

Conclusions Although the adoption of EHRs has increased, >80% of pediatricians are working with EHRs that lack optimal functionality and 41% of pediatricians are not using EHRs with even basic functionality. EHRs lacking pediatric functionality impact the health of children through increased medical errors, missed diagnoses, lack of adherence to guidelines, and reduced availability of child-specific information. The pediatric certification outlined in the 21st Century Cures Act may result in improved EHR products for pediatricians. *(J Pediatr 2019;206:164-71).*

Although surveys of office-based pediatricians in 2009 and 2012 revealed steady increases in the adoption of electronic health records (EHRs) in outpatient settings, they also showed widespread use of EHRs with limited general functionality and lack of pediatric specific functionality such as weight-based dosing or preventive care decision support.[1,2] Core pediatric functionality is required to support the work of child healthcare providers and assure the delivery of quality care to pediatric patients.[3] Based on these findings, the American Academy of Pediatrics (AAP) lobbied congress to include pediatric certification of EHRs in the 21st Century Cures Act, which was passed in December of 2016, and the requirement for pediatric functionality was included[4] (**Figure 1**; available at www.jpeds.com).

Since the 2012 survey, the Agency for Healthcare Research and Quality at the US Department of Health and Human Service has published the Children's EHR Format Enhancement Final Recommendation Report, which prioritized the pediatric EHR functionalities with the intent to inform and educate developers and vendors of EHR software and to encourage the development of better EHRs for child health.[5] Concurrently, the field of EHR vendors continues to consolidate.[6] Immediately before the passing of the 21st Century Cures Act, the AAP conducted another survey of its members with the hypothesis that pediatric functionality in EHRs had further improved since 2012.

Methods

The AAP Periodic Survey of Fellows gathers data for the purpose of informing policy, developing new initiatives, and evaluating existing projects. The survey also collects demographic information and practice characteristics on US nonretired members.[7]

Survey Periodic Survey #95 (2016) addressed the functions of EHRs used by pediatricians, attitudes toward EHRs, and barriers to EHR adoption similar to the surveys conducted in 2009 (Periodic Survey #74) and 2012 (Periodic Survey #83). Periodic Survey #95 was an 8-page self-administered questionnaire sent to 1619 randomly selected nonretired US AAP members from July to December 2016. Seven mailed contacts (cover letter, survey questionnaire, and business reply envelope) were made to nonrespondents. Nonrespondents were also emailed twice with a

AAP	American Academy of Pediatrics
EHR	Electronic health record
ONC	Office of the National Coordinator

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link to complete the survey electronically. By completing the survey, participants implicitly agreed to participate.

Respondents were asked the following inclusion question: "Does your main practice use an EHR or electronic medical record . . . system to provide direct care to patients? Do not include billing record systems." Using the standardized criteria defined in the National Ambulatory Medical Care Survey[8] and by DesRoches et al,[9] we define 3 categories of EHRs used by respondents: (1) any EHR use, (2) use of basic EHRs (demographics, problem lists, prescription orders, laboratory and imaging result viewing, clinical notes, and medication lists), or (3) use of fully functional EHRs (basic plus drug interactions warnings, e-Prescribing, ordering and electronic transmission of laboratory and radiology tests, age-specific laboratory ranges, electronic images returned, medical history, and guideline reminders). Additionally, among those EHRs that are identified as being fully functional, we further classify EHR functionality by identifying pediatric functionality with 2 basic pediatric-supportive features (weight-based dosing, plotting growth charts, and computing body mass index) and 3 additional pediatric-supportive features (tracking recommended well-child visits, tracking immunizations, calculating catch-up immunizations) (**Table I**; available at www.jpeds.com). By using a standardized method of surveying on EHR functionality and adoption, we can compare our findings with those from other national surveys of physicians.[8,9]

In addition to collecting information on EHR functionality, the surveys in 2012 and 2016 also asked respondents to report on perceived barriers to adopting EHR systems (including financial, organizational, legal, and technology barriers), availability of computerized systems that allow patients to complete various activities, the extent to which their EHR system has a major positive impact on their main practice site, and hours spent per day on clinical documentation (2016 only). The surveys also asked respondents to provide demographic and practice characteristics (sex, age, practice type, practice setting, payment mix, etc). Rates between groups were compared using χ^2 tests, with $\alpha = 0.05$ considered statistically significant. Statistical analyses were performed using R.[10]

Results

The survey response was 43.9% (709 respondents, including pediatric residents) in 2016, which compared with a response rate of 54.0% in 2012. A nonresponse analysis showed no differences between respondents and nonrespondents in terms of sex or region in 2016. However, nonrespondents are slightly younger (mean, 43.1 years) than respondents (mean, 46.4 years).After excluding pediatric residents and respondents not involved in direct ambulatory patient care, 482 responses (29.8%) were included in the analysis (**Figure 2**; available at www.jpeds.com). Compared with 2012, respondents in 2016 included more women and fewer pediatricians in solo/2-physician practices, and the number of hospital/clinic-based pediatricians increased (**Table II**; available at www.jpeds.com). In 2012, 42.9% of survey respondents had an ownership stake in their practice; this number decreased to 30.5% in 2016 ($P < .001$).

EHR Use

In 2016, 94.1% of all respondents used an EHR compared with 79.2% in 2012 ($P < .001$) and 58% in 2009 ($P < .001$). Older physicians (≥49 years) were less likely to use EHRs compared with younger physicians (91.1% vs 96.1%; $P < .05$). There was no significant difference of EHR use by sex (**Table II**).

There were no statistically significant differences in EHR use across urban, rural, and suburban practice areas; however, pediatricians employed by medical schools were statistically more likely (98.5%; $P < .001$) than pediatricians in solo/2-physician practices (83%) and group practices/health maintenance organization (94.5%) to use an EHR. There were no differences in EHR use found between pediatricians who spend >50% of their time in general pediatrics and those who spend <50% of their time in general pediatrics, but pediatricians with ≥40% of Medicaid and other public payer patients were statistically more likely to use EHRs (94.8% vs 88.4%; $P < .01$).

EHR Functionalities

Table I lists the features associated with basic functionality, full functionality, and pediatric-specific functionality. Pediatrician EHR usage was categorized into four categories: no basic EHR functionality (including no EHR), basic functionality, full functionality, and full functionality with pediatric-specific functionality. **Table III** provides the availability of the specific components that are included in the functionality definitions in 2012 and 2016. With the exception of the basic feature of viewing imaging results, which only trended from 60.5% to 63.4%, all other functionalities were statistically more likely to be found in the EHRs used by office-based pediatricians in 2016. Ignoring the feature of viewing imaging results, 94% of respondents report that basic functionality was present in their EHR system.

Features most likely missing from the EHRs of office-based pediatricians besides provision of chronic disease management were those related to pediatric functionality, including reminders for interventions and tests for preventive care, adherence to well-child visits, and calculation of catch-up immunizations.[11]

The percentage of pediatricians who reported fully functionally EHRs with pediatric functionality more than doubled from 8.2% in 2012 to 16.9% in 2016 ($P = .01$; **Figure 3**; available at www.jpeds.com). The percentage of pediatricians with fully functional EHRs that lack pediatric functionality increased insignificantly from 7.8% to 11.1% ($P = .3$). The percentage of pediatricians who used basic EHRs remained constant (30.4% to 31.0%; $P = .3$).

From 2012 to 2016, the percentage of pediatricians who had no basic EHR functionality or no EHR decrease (from 53.6% to 41.0%; $P < .001$; **Table IV**). However, 41% of surveyed pediatricians still had no basic EHR capabilities in 2016. More than one-half of the pediatricians in small groups of 1-2 or 3-5 providers still lacked EHRs with basic functionality (60.4% and 67.5%, respectively). Pediatricians in

Table III. Comparison of EHR functionality from 2012 to 2016

		2016				2012				
	Functionality	n	Yes (%)	No (%)	Don't know (%)	n	Yes (%)	No (%)	Don't know (%)	*P* Value*
Patient demographics	(BFxn)	476	95.8	3.8	0.4	548	87.2	7.3	5.5	<.001
Patient problem list	(BFxn)	478	94.4	5.2	0.4	532	84.6	13.2	2.3	<.001
Electronic list of medications	(BFxn)	477	94.5	5.2	0.2	542	81.2	16.4	2.4	<.001
Clinical notes	(BFxn)	478	94.4	5.2	0.4	550	85.5	13.3	1.3	<.001
View laboratory results	(BFxn)	453	93.8	5.5	0.7	551	85.3	12.2	2.5	<.001
View imaging results	(BFxn)	475	63.4	32.4	4.2	547	60.5	34.2	5.3	.383
Orders for prescriptions	(BFxn)	478	95.2	4.6	0.2	551	84.6	12.9	2.5	<.001
If yes—drug interaction warning?	(FFxn)	476	88	8.4	3.6	549	74	20.2	5.8	<.001
If yes—prescriptions transmitted electronically to pharmacy?	(FFxn)	477	92.9	6.5	0.6	548	77.7	20.1	2.2	<.001
If yes—weight-based dosing?	(PedsFxn)	476	63.4	31.9	4.6	539	53.8	37.3	8.9	.002
Orders for laboratory tests	(FFxn)	456	89.5	9.6	0.9	552	78.8	18.3	2.9	<.001
If yes—orders sent electronically?	(FFxn)	473	72.3	26	1.7	548	59.7	38.7	1.6	<.001
Orders for radiology tests	(FFxn)	476	77.5	20.6	1.9	549	69.9	25.9	4.2	.007
Reminders for guideline-based interventions and/or screening tests for preventive care	(FFxn)	477	61.4	26.2	12.4	545	47.3	34.7	18	<.001
Reminders for guideline-based interventions and/or screening tests for chronic disease management	(FFxn)	476	49.6	28.8	21.6	548	34.3	44.7	21	<.001
Track adherence to recommended well-child visits	(PedsFxn)	476	54.4	24.8	20.8	549	47.4	33.5	19.1	.023
Track adherence to recommended immunization schedule	(PedsFxn)	477	68.1	18.4	13.4	545	44.4	55.2	0.4	<.001
Are catch-up immunizations calculated?	(PedsFxn)	478	56.7	24.1	19.2	543	28.9	65.7	5.3	<.001
Plot growth charts or automatically compute height, weight, and BMI percentiles	(PedsFxn)	477	93.1	6.3	0.6	546	80.2	16.3	3.5	<.001

BFxn, basic functionality; *FFxn*, fully functional; *PedsFxn*, pediatric-specific functionality.
For *P* calculation, no and don't know responses were both classified as no.
*Pearson χ^2 test for difference between results in 2012 and 2016.

multispecialty groups and those affiliated with hospitals were more likely to use systems with at least basic functionality (80.8% and 82.7%, respectively).

When looking at increasing levels of complex functionality (basic vs full vs pediatric specific), most demographic groups showed increased adoption of systems with improved functionality. The majority of the statistically significant improvements occurred with pediatric-specific functionalities. The 2 demographic groups that had no significant improvements were pediatricians associated with small groups (<5) and those in rural areas.

Barriers

Compared with sentiments in 2012 on barriers to implementing and using EHRs (**Table V**), in 2016 pediatricians were significantly less concerned about loss of productivity (44.9% vs 38.3%), resistance to adoption from physicians (21.4% vs 16.2%), and obsolete systems (26.4% vs 19.7%). Although the overall percentages were low, the percent of physicians who were concerned about breaches of patient confidentiality (6.5% vs 12.7%) and tampering/hacking of EHRs (6.5% vs 12.7%) almost doubled. Pediatricians were also more concerned about liability risk as a function of patient access to EHRs (5.3% vs 8.7%).

Patient Portal Functionalities

In 2016, pediatricians were significantly more likely to report that adolescents had private access to protected information (33.7%) and that patients and parents had online access to the medical record (68.8%), could make changes/updates to their medical record (33.9%), request appointments online (53.4%), and request refills for prescriptions (61.6%; **Table VI**). The ability of patients to complete previsit forms or review of symptoms or history did not change significantly (33%). Three novel questions asked in the 2016 survey included the ability to exchange secure messages with patients (64.2%), provide handouts/patient education (51.2%), and upload data from mobile devices like glucometers (10.3%).

EHR Impact

The number of pediatricians who reported a major positive impact of the EHR on communication with other providers decreased significantly from 2012 to 2016 (26.3% to 20.0%; **Table VII** [available at www.jpeds.com]). Pediatricians were more likely in 2016 to report a major positive impact of their EHRs on communications with patients/parents (13.4% vs 8.7%), appropriate immunization delivery (19.6% vs 13.4%), and well-child care (15.3% vs 9.4%), measuring or improving quality (39.4% vs 14.9%), and generating new prescriptions and refills (44.4% vs 28.5%). For appropriate chronic illness care (9.5% vs 7.5%) and avoiding of medication errors (17.2% vs 16.4%), pediatricians' perception of major positive impacts remained unchanged. In 2016, two novel questions on the impact of EHRs were asked. Most providers (95.5%) had remote access to the EHR. Pediatricians reported spending a mean time of 3.4 hours per day (median, 3 hours) on clinical documentation on a typical day when seeing patients, with 36% of respondents spending ≤2 hours, 42% spending 3 or 4 hours, and 22% spending ≥5 hours.

Table IV. Basic, fully functional, and pediatric-specific EHR use by pediatrician characteristics

	No basic EHR functionality					Basic EHR functionality					Fully functional EHR					Pediatric-specific EHR				
	2016		2012			2016		2012			2016		2012			2016		2012		
	n	(%)	n	(%)	*P* Value*	n	(%)	n	(%)	*P* Value*	n	(%)	n	(%)	*P* Value*	n	(%)	n	(%)	*P* Value*
Sex																				
Men	67	42.1	101	46.1	.507	48	30.2	75	34.2	.471	14	8.8	16	7.7	.847	26	16.4	18	8.3	**.024**
Women	124	39.6	183	56	**0**	95	30.4	86	26.3	.294	35	11.2	26	8	.209	53	16.9	25	7.6	**.001**
Age, y																				
<49	81	35.2	140	51.3	**0**	82	35.7	80	29.3	.155	24	10.4	25	9.2	.741	40	17.4	20	7.4	**.001**
≥49	111	44.8	148	52.9	.077	63	25.4	83	29.6	.322	28	11.3	17	6.1	**.047**	39	15.7	24	8.6	**.017**
Practice activity type																				
General pediatrician	172	46.1	237	55.8	**.008**	91	24.4	115	27.1	.438	35	9.4	31	7.6	.437	67	18	32	7.5	**0**
Subspecialist	20	19.8	46	38.3	**.004**	52	51.5	47	39.2	.089	15	14.9	11	9.2	.273	12	11.9	10	8.3	.514
Practice type																				
1-2 Pediatricians	32	60.4	77	84.6	**.002**	14	26.4	10	11	**.03**	1	1.9	1	1.1	1	5	9.4	3	3.3	.241
3-5 Pediatricians	52	67.5	73	70.2	.826	14	18.2	19	18.3	1	4	5.2	4	3.8	.944	5	6.5	5	4.9	.884
≥6 Pediatricians	49	48	61	57	.246	24	23.5	34	31.8	.239	10	9.8	7	6.5	.542	15	14.7	4	3.7	**.012**
Multispecialty group/HMO	15	19.2	26	25.2	.437	22	28.2	38	36.9	.285	12	15.4	16	15.5	1	28	35.9	17	16.5	**.005**
Hospital/clinic	18	17.3	31	31.6	**.027**	50	48.1	46	46.9	.983	18	17.3	10	10.2	.209	17	16.3	9	9.2	.191
Practice setting																				
Urban, inner city	27	30	34	42	.141	34	37.8	27	33.3	.656	7	7.8	6	7.4	1	21	23.3	8	9.9	**.033**
Urban, not inner city	38	34.2	63	45.3	.1	41	36.9	50	36	.98	12	10.8	11	7.9	.571	19	17.1	12	8.6	.067
Suburban	105	48.8	162	60.9	**.011**	47	21.9	58	21.8	1	25	11.6	21	7.9	.219	33	15.3	20	7.5	**.01**
Rural	21	37.5	25	42.4	.732	19	33.9	25	42.4	.46	7	12.5	4	6.8	.468	6	10.7	3	5.1	.438
Payment mix																				
<40% Medicaid/SCHIP	81	47.4	140	58.1	**.04**	35	20.5	57	23.7	.519	19	11.1	19	7.9	.346	32	18.7	20	8.3	**.003**
≥40% Medicaid/SCHIP	111	36.2	148	47.4	**.006**	110	35.8	106	34	.689	33	10.7	23	7.4	.185	47	15.3	24	7.7	**.004**
<20% Medicaid/SCHIP	52	52	91	63.6	.093	19	19	31	21.7	.729	9	9	10	7	.741	18	18	9	6.3	**.009**
≥20% Medicaid/SCHIP	140	37	197	48	**.002**	126	33.3	132	32.2	.792	43	11.4	32	7.8	.113	61	16.1	35	8.5	**.002**
Employment status																				
Full or part owner	91	63.6	156	66.7	.625	25	17.5	52	22.2	.329	9	6.3	12	5.1	.805	14	9.8	11	4.7	.089
Employee	95	30.4	124	41.2	**.007**	113	36.1	108	35.9	1	37	11.8	29	9.6	.457	62	19.8	31	10.3	**.002**
Independent contractor	5	31.2	4	40	.974	5	31.2	1	10	.44	4	25	1	10	.665	2	12.5	0	0	.684
Full/part-time work																				
Part time	45	36.6	79	56	**.002**	34	27.6	38	27	1	15	12.2	8	6	.127	24	19.5	10	7.1	**.005**
Full time	147	41.8	206	51	**.014**	109	31	122	30.2	.881	36	10.2	34	8.4	.465	55	15.6	33	8.2	**.002**
All participants	192	41	288	53.6	**0**	145	31	163	30.4	.3	52	11.1	42	7.8	.3	79	16.9	44	8.2	**.01**

HMO, health maintenance organization; *SCHIP*, State Children's Health Insurance Program.
Bolded numbers indicate statistical significance.
Basic EHR functionality numbers exclude EHRs that are fully functional or pediatric specific. Fully functional EHR numbers exclude pediatric-specific EHRs.
*Pearson χ^2 test for difference between results in 2012 and 2016.

Table V. Perceived major barriers to adopting an EHR system

	2016 (n = 475), %	2012 (n = 557), %	*P* Value
Financial barriers			
The amount of capital needed to acquire & implement an EHR	38.9	41.8	.380
Uncertainty about the Return on Investment (ROI) from an EHR	28.6	30.9	.461
Organizational barriers			
Resistance to adoption from practice physicians	16.2	21.4	**.043**
Capacity to select, contract, install and implement an EHR	22.1	23.1	.778
Concern about loss of productivity during transition to the EHR system	38.3	44.9	**.037**
Legal/regulatory barriers			
Concerns about inappropriate disclosure of patient information (ie, breaches of patient confidentiality)	12.7	6.5	**.001**
Concerns about illegal records tampering or hacking	12.7	6.3	**.001**
Concerns about the legality of accepting an EHR that is donated from a hospital	4.3	2.9	.316
Concerns about physicians' legal liability if patients have more access to information in their medical records	8.7	5.3	**.042**
Technology barriers			
Finding an EHR system that meets providers' needs	37.1	40.6	.287
Concerns that the system will become obsolete	19.7	26.4	**.015**

Bolded numbers indicate statistical significance.

Discussion

The EHR has become a regular part of the practicing pediatrician's life. Surveys by the AAP have demonstrated that the adoption of EHRs in in office-based settings increased from 54% in 2009 to 94.1% in 2016, an increase of almost 75% above 2009 reported rates. Better hardware, improved EHR systems, and most important the incentives from the American Recovery and Reinvestment Act, were likely drivers of this development.

Demographics

The respondent characteristics of our survey remained stable from 2012 to 2016, with a few notable exceptions. The proportion of women responding to the 2016 survey increased significantly from 2012, reflecting trends in the pediatric workforce.[12] The trend in the respondents toward employment by hospitals and clinics with fewer pediatricians maintaining full or part ownership of the practice mirrors that seen in the general trends in healthcare.[13] These findings impart confidence that the survey results reflect an accurate sampling of our population of interest, at least by the demographic factors studied in the survey.

EHR Use

The EHR use survey responses were encouraging in that they demonstrated an overall increase in the use of EHRs across almost all populations and types of providers surveyed. This matches Office of the National Coordinator (ONC) data.[14] The use of EHRs in rural and urban settings both increased. The trend of older physicians being less likely to use an EHR than younger counterparts persisted, but it should be noted that, even among older pediatricians, use was >90%. Only solo or 2-practitioner offices reported use rates of <90%.

EHR Functionalities

Pediatricians have long asserted that children have needs and vulnerabilities distinct from adults with regard to clinical management, preventive care, and its associated data. Therefore, to provide good care to children and adolescents, pediatricians need EHRs that provide pediatric functionalities.[3,15,16] The wide range of body weights, sizes, and pharmacologic and physiologic responses demand EHRs that can support workflows required to provide pediatric-specific care that is safe.[17,18] The list of functionalities important to pediatric care is extensive: Children require weight- or surface-based dosing and dose range checking, rounding of medication doses, use of pediatric units of measure, optimization of the dispensing format, adjustments for newborns and premature infants, and the ability to detect erroneously entered weight to ensure safe prescribing.[19-23] EHRs must support preventive care workflows such as Bright Futures, adolescent privacy, biometric-specific norms for growth charts, immunization registry synchronization, documentation of guardians and caregivers, and more.[5]

Table VI. Pediatricians with a computerized system that allows their patients to do the following activities

	2016 (n = 477), %	2012 (n = 553), %	*P* Value
View their medical records online	68.8	38.9	<.001
Allows adolescent patients private access to their protected information	33.7	16	<.001
Make changes to or update their medical records online	33.9	14.1	<.001
Request appointments online	53.4	35.3	<.001
Request refills for prescriptions online	61.6	37	<.001
Complete previsit forms or review of symptoms or history	33	28.6	.149
Upload data from self-monitoring devices (eg, blood glucose readings)	10.3	—	—
Access handouts/patient education	51.2	—	—
Exchange secure messages with patients/parents	64.2	—	—

The use of higher functionality EHRs, particularly those with pediatric-specific functionalities, increased 2-fold in the 4 years between the surveys. The most fundamental pediatric functionalities also became more common in 2016 (weight-based dosing [53.8% vs 63.4%] and growth charts [80.2% vs 93.1%]). Between 2012 and 2016, we saw almost ubiquitous improvements in availability and use across all types of EHR functionalities surveyed.

Although the overall trend in EHR functionality was toward systems with higher functionality, the number of pediatricians reporting pediatric-specific EHR functionalities remained low at 17%. Further, 41% of pediatricians in 2016 reported lack of basic functionality. However, the trajectory is favorable; it seems to demonstrate a migration from more rudimentary systems to more advanced ones. This finding may be a function of either the maturation of specific EHRs, a migration by providers from vendors with less advanced products to vendors with more advanced functionality, or most likely, a combination of both.

EHRs lacking pediatric functionality may impact the health of children through increased medical errors, missed diagnoses, lack of adherence to guidelines, missed opportunities to immunize, and a decreased availability of child-specific information. The AAP's successful effort to include language on pediatric certification of EHRs into the 21st Century Cures Act should continue to place positive pressure on the industry to improve the functionalities in their products. Considering the importance of immunization delivery in pediatrics, the AAP lobbied the ONC in late 2017 to include state immunization registry integration into the regulations and plans to provide public comment once ONC publishes guidelines on certification of pediatric EHRs.

Barriers

When asked about barriers to adopting EHRs, pediatricians responded that financial challenges had not changed significantly, that organizational and technical barriers had decreased slightly, but that pediatricians were increasingly concerned about inappropriate disclosure of patient information and tampering with or hacking of EHRs. It is likely that large-scale hacking events[24] and ransomware attacks targeting healthcare organizations[25] are causing pediatricians to be more concerned about breaches of confidential patient information as they become more knowledgeable and cognizant of cybersecurity concerns.

Patient Portal Functionalities

The majority (5 out of 6) of the patient portal functionalities asked in the both the 2012 and 2016 survey had increased in 2016. This change likely demonstrates the trend to encourage patients to become more active participants in their own care.[26-28]

There remains much room for improvement. First, still only one-third of patients can complete previsit forms or review of systems and history. Obtaining this information before the visit would help to streamline the patient encounter and improve office efficiency. Second, only 10% of systems in 2016 were capable of uploading data from self-monitoring devices such as a blood glucose monitor. With the advance of wearable technology in the consumer market, one would hope and expect this number to increase in the near future. Finally, only one-half of the systems allowed for the distribution of handouts and educational materials. Given that pediatricians interact with young patients and parents, sharing of educational materials electronically would be expected to increase. Each of these functionalities becomes increasingly important as healthcare embraces concepts such as coproduction/cocreation of data/knowledge by both clinicians and patients and "learning health systems" to improve many facets of the healthcare delivery system.[29] Enactment of true coproduction and the learning health system model have the potential to address many issues, but one that may be of particular interest to clinicians (owing to gains in efficiency and satisfaction) is the reduction of data entry at the point of care, which is a common complaint in modern medicine.[30,31]

EHR Impact

Pediatricians felt that the EHR had an increasingly positive impact on different aspects of care delivery, with 1 exception. The percentage of pediatricians who perceived that their EHR had a positive effect on communication with other providers decreased significantly. This finding is not surprising in the light of the delayed implementation of direct messaging in pediatric hospitals and tertiary referral centers, hindering the exchange of patient information at the transition of care.[32] The greatest increase in perception of positive impact was the effect felt on measuring and improving quality.

Only 17% of pediatricians reported a major impact of EHRs on avoidance of medication errors. This number remained unchanged from 2012. Despite increasing evidence that EHRs can decrease medication errors in academic medical centers,[33-35] pediatricians in ambulatory practices do not seem to perceive this benefit, mirroring concerns reported in previous literature about stagnant error rates persisting in healthcare despite efforts over the past 20 years to decrease this type of harm.[33,36]

The Meaningful Use program attempted a number of specific goals including to "improve quality, safety, efficiency, and reduce health disparities, engage patients and family, improve care coordination, and population and public health, and maintain privacy and security of patient health information."[21,37] In the 2016 survey, pediatricians were more likely to report a major positive impact of their EHRs on important workflows supported by Meaningful Use measures such as communications with patients/parents, appropriate immunization delivery and well-child care, measuring or improving quality, and generating new prescriptions and refills. Although these improvements may be secondary to Meaningful Use[38] driving improved EHR functionalities, our survey was not designed to show causality.

On average, pediatricians were spending 3.4 hours per day documenting care in the EHR. This finding is consistent with

previous research, because direct observation time use studies of ambulatory practice physicians have found that nearly one-half of the time during office hours is spent on EHR and desk work activities.[39] The substantial amount of documentation time may be a function of poor EHR design, usability, and workflow, or may be secondary to outdated documentation requirements from the Centers for Medicare and Medicaid Services, which were last updated in 1997 before an extensive number of providers used EHRs.[40]

Limitations

Our study had several limitations. First, our analysis broke down EHR functionalities by practitioner demographics. Some of the groups had small sample sizes, which could have impacted our results. The demographics of our respondents changed to include more women in 2016, which may have confounded the responses.

Second, although there were >1600 surveys sent out to pediatricians, 709 physicians responded resulting in a response rate of 43.9%; a nonresponse analysis indicates no differences between respondents and nonrespondents in terms of sex or region, but nonrespondents are slightly younger (a mean age of 43.3 years for nonrespondents compared with 47.5 years for respondents). Nonresponse bias is a concern for all surveys, but for AAP surveys has been found to be negligible.[41] Third, responses by pediatricians in different settings may be very diverse, which limits generalizability of the aggregate results. Additionally, depending on the practitioner's role with regard to information technology in her or his practice, knowledge about functionality may be limited (ie, less knowledgeable users may think functionality is not present or available when it actually is), which could lead to inaccurate responses.

By including only EHRs that contained all pediatric functionality features (weight-based dosing, tracking of adherence to well-child visits, tracking of adherence to immunization schedule, calculating catch-up immunizations, and plotting and calculating growth percentiles), we arrived at a low number of fully functional EHRs with pediatric functionality (16.9%). It is important to point out, however, that each of the pediatric functionality features were contained in >50% of EHRs.

As discussed in previous surveys, respondents may answer to be more acceptable to themselves, their peers, their employer, or the AAP. Social acceptability bias may lead to overestimations or underestimations of perception-based questions, such as perceived barriers to adopting an EHR system. The survey included only AAP members, and responses may not be generalizable to non-AAP members.

From 2009 to 2016, use of EHRs by office-based pediatricians significantly increased and functionalities of EHRs improved. Despite the Meaningful Use programs, a significant numbers of pediatricians are still working with EHRs that lack basic, full, and/or pediatric functionality. Although the AAP was successful in lobbying Congress to include pediatric certification of EHRs into the 21st Century Cures Act, it is now critical that the AAP work with the ONC to implement this requirement. A future survey following up on this work will show how successful these efforts will prove. ■

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Data Statement

Data sharing statement available at www.jpeds.com.

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HEALTH INFORMATION TECHNOLOGY FOR PEDIATRICS.—Not later than 18 months after the date of enactment of the 21st Century Cures Act, the Secretary, in consultation with relevant stakeholders, shall make recommendations for the voluntary certification of health information technology for use by pediatric health providers to support the health care of children. Not later than 2 years after the date of enactment of the 21st Century Cures Act, the Secretary shall adopt certification criteria under section 3004 to support the voluntary certification of health information technology for use by pediatric health providers to support the health care of children

Figure 1. Section of the 21st Century Cures Act discussing pediatric certification.

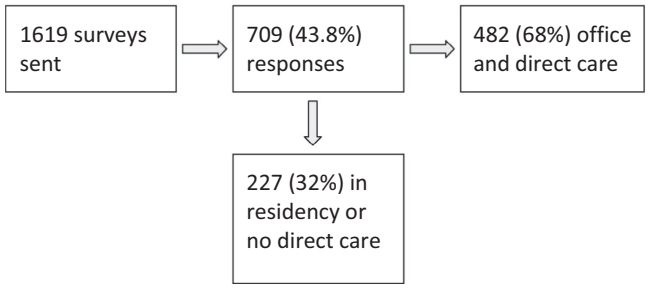

Figure 2. Breakdown of the survey responses.

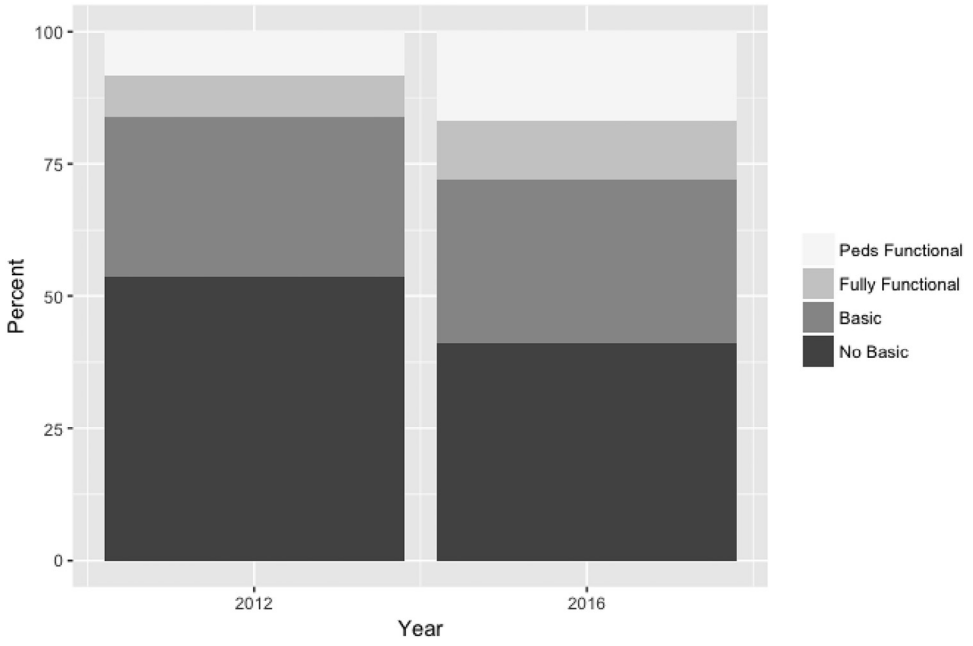

Figure 3. Comparison of EHR type, 2012-2016.

Table I. Functionalities for basic, fully functional, and pediatric functional EHRs

Basic functionalities	Full functionality	Pediatric functionality
Document patient demographics	Basic functionality plus	Full functionality plus
Create problems lists	e-Prescribing	Weight-based dosing*
Create medication lists	Drug interaction checking	Tracking of adherence to well-child visits
Document clinical notes	Ordering laboratory tests	Tracking of adherence to immunization schedule
Ordering of prescriptions	Electronic transmission of results	Calculating catch-up immunizations
View laboratory results	Ordering radiology tests	Plotting and calculating growth percentiles*
View Imaging results	Provision of preventive care reminders	
	Provision of chronic disease management reminders	

*Basic pediatric functionality.

Table II. Demographic characteristics of responding pediatricians (excluding residents)

	2016 (n = 482)	2012 (n = 568)	*P* Value*
Sex (n)	476	560	**.03**
Men	160 (33.6)	226 (40.4)	—
Women	316 (66.4)	334 (59.6)	—
Age, y (n)	476	559	.505
30-39	105 (22.1)	117 (20.9)	—
40-49	124 (26.1)	173 (30.9)	—
50-59	136 (28.6)	167 (29.9)	—
60-69	88 (18.5)	90 (16.1)	—
70-79	12 (2.5)	12 (2.1)	—
Practice activity type (n)	478	558	.833
General pediatrician	377 (78.9)	436 (78.1)	—
Subspecialist	101 (21.1)	122 (21.9)	—
Practice type (n)	426	517	**.017**
1-2 Pediatricians	53 (12.4)	93 (18)	—
3-5 Pediatricians	78 (18.3)	107 (20.7)	—
≥6 Pediatricians	103 (24.2)	110 (21.3)	—
Multispecialty group/HMO	78 (18.3)	106 (20.5)	—
Hospital/clinic	114 (26.8)	101 (19.5)	—
Practice setting (n)	476	559	.287
Urban, inner city	90 (18.9)	83 (14.8)	—
Urban, not inner city	111 (23.3)	142 (25.4)	—
Suburban	217 (45.6)	272 (48.7)	—
Rural	58 (12.2)	62 (11.1)	—
Payment mix (n)	350	446	.398
<40% Medicaid/SCHIP	173 (49.4)	243 (54.5)	—
≥40% Medicaid/SCHIP	177 (50.6)	203 (45.5)	—
<20% Medicaid/SCHIP	101 (28.9)	143 (32.1)	—
≥20% Medicaid/SCHIP	249 (71.1)	303 (67.9)	—
Employment status (n)	476	559	**<.001**
Full or part owner	145 (30.5)	240 (42.9)	—
Employee	315 (66.2)	309 (55.3)	—
Independent contractor	16 (3.4)	10 (1.8)	—
Full/part-time work	479	559	.967
Part time	124 (25.9)	143 (25.6)	—
Full time	355 (74.1)	416 (74.4)	—

HMO, health maintenance organization; *SCHIP*, State Children's Health Insurance Program.
Values are n (%).
*Pearson χ^2 test for difference.

Table VII. Pediatricians reporting a major positive impact from EHR system in the following areas

	2016 (%)	2012 (%)	*P* Value
Communication with other providers	20	26.3	.035
Communication with your patients/parents	13.4	8.7	.037
Delivery of immunizations that meets guidelines	19.6	13.4	.017
Delivery of well-child care at intervals based on health supervision guidelines	15.3	9.4	.011
Delivery of chronic illness care that meets guidelines	9.5	7.5	.364
Measuring or improving quality	39.4	14.9	<.001
New prescriptions and refills	44.4	28.5	<.001
Avoiding medication errors	17.2	16.4	.846