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Original Research

Features and frequency of use of electronic health records in primary care across 20 countries: a cross-sectional study

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ABSTRACT

Objectives: Variation exists in the capabilities of electronic healthcare records (EHRs) systems and the frequency of their use by primary care physicians (PCPs) from different settings. We aimed to examine the factors associated with everyday EHRs use by PCPs, characterise the EHRs features available to PCPs, and to identify the impact of practice settings on feature availability.
Study design: Cross-sectional study.
Methods: PCPs from 20 countries completed cross-sectional online survey between June and September 2020. Responses which reported frequency of EHRs use were retained. Associations between everyday EHRs use and PCP and practice factors (country, urbanicity, and digital maturity) were explored using multivariable logistic regression analyses. The effect of practice factors on the variation in availability of ten EHRs features was estimated using Cramer's V.
Results: Responses from 1520 out of 1605 PCPs surveyed (94·7%) were retained. Everyday EHRs use was reported by 91·2% of PCPs. Everyday EHRs use was associated with PCPs working >28 h per week, having more years of experience using EHRs, country of employment, and higher digital maturity. EHRs features concerning entering, and retrieving data were available to most PCPs. Few PCPs reported having access to

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tools for 'interactive patient education' (37·3%) or 'home monitoring and self-testing of chronic conditions' (34·3%). Country of practice was associated with availability of all EHRs features (Cramer's V range: 0·2 −0·6), particularly with availability of tools enabling patient EHRs access (Cramer's V: 0·6, $P < 0.0001$). Greater feature availability of EHRs features was observed with greater digital maturity.

Conclusions: EHRs features intended for patient use were uncommon across countries and levels of digital maturity. Systems-level research is necessary to identify the country-specific barriers impeding the implementation of EHRs features in primary care, particularly of EHRs features enabling patient interaction with EHRs, to develop strategies to improve systems-wide EHRs use.

Introduction

The adoption of electronic healthcare records (EHRs) has emerged as a pivotal advancement in modern healthcare as the most prominent digital health tool for enhancing primary care services.[1] EHRs use can promote improved quality of care through offering real-time data availability, improved data sharing among healthcare providers, reduced errors and increased standardisation, and support for evidence-based decision-making.[2–4] Improvements in personal and public health are made possible through EHRs features which synthesise and enhance patient data.[5,6] EHRs can facilitate continuous quality improvement by enabling long-term systematic tracking of patient outcomes.[5] At the population level, longitudinal standardised datasets can inform organisational planning through tracking of adherence to clinical guidelines or through designing stratified health interventions.[7]

Although EHRs have been a core component of primary care systems in many middle- and upper-income countries for decades, there is substantial variation between and within countries in the design, implementation, and governance of these systems.[4,6] These differences can manifest as variations in how and how often EHRs are used, potentially resulting in variation in quality of care. Many factors contribute to EHRs adoption, functionality, and use within primary care. There can be specific resource barriers to adoption and implementation of more advanced EHRs features, including tools for patient-engagement and performance tracking, with particular challenges for rural or smaller providers.[7–9] Factors such as government regulations, incentive schemes, and ethical guidelines,[4,7,9,10] and the design of EHRs software and user interfaces,[11] result in different EHRs implementation and use between and within countries. Once adopted, EHRs may be implemented poorly, affecting frequency of EHRs use by clinicians[12] or inaccuracies in data entry leading to effects upon patient care.[13] Lastly, characteristics of primary care physicians (PCPs) can also greatly influence EHRs usage in primary care. PCPs perceptions of EHRs as acceptable, easy, and beneficial, are essential to encourage use.[11] Additionally, in some countries EHRs use is essential for financial viability (i.e., auditing, requirements for pay-for-performance).[14]

Several factors may disincentivise the use of EHRs, such as interruptions to PCP workflow,[12,13,15,16] set up and maintenance costs,[12] perceived effects on patient–clinician relationships,[17,18] concerns about data security,[12,19] and a lack of self-confidence in a PCP's ability to use EHRs systems.[11] Older PCPs may be more resistant to EHRs adoption.[8,10,20]

Currently, there is limited evidence as to how characteristics of PCPs and clinical settings may influence EHRs use. To address this, this article intends to offer insight into EHRs characteristics and utilisation across PCPs from a broad range of primary care settings. Our objectives were to (1) examine the factors associated with everyday EHRs use by PCPs, (2) characterise the EHRs features available to PCPs, and (3) to identify the impact of practice settings on feature availability. Describing EHRs functionalities and predictors of its use can inform identification of the barriers and drivers of variation in EHRs systems. This study aims to contribute to the broader understanding of the design and usage of EHRs technologies and offer avenues for further research into optimising digital health technology utilisation.

Methods

Study design

This study used data from a cross-sectional online questionnaire completed by PCPs, conducted across 20 upper-middle- and high-income countries (Australia, Brazil, Canada, Chile, Colombia, Croatia, Finland, France, Germany, Ireland, Israel, Italy, Poland, Portugal, Spain, Slovenia, Sweden, Turkey, United Kingdom, United States of America). The research was conducted by the inSIGHT Research Group, which includes a consortium of academic primary care researchers from the 20 countries listed.[21]

Data collection

The survey was conducted between June 2020 to September 2020. Participants were eligible if they were practising PCPs in one of the 20 countries listed above, between March and September 2020. National leads in each country invited PCPs through their formal organisations or personal networks via email or social media (Facebook and Twitter). National leads were instructed to recruit a minimum of 50 participants to ensure PCPs from a range of ages, clinical experiences, and types of primary care settings were represented in the sample. The questionnaire was available in English, French, German, Italian, Spanish, and Portuguese. A complete description of the study protocol, including the full questionnaire and power analyses, has been provided elsewhere.[21]

Study variables

PCP and practice characteristics captured by the survey are presented in Supplementary Table 1. The primary outcome of frequency of EHRs use was defined by answers to '*How often do you personally access electronic health records in your practice?*' PCPs who selected 'Everyday' were classified as everyday EHRs users, while all others were described as less than everyday EHRs users.

Digital maturity was assessed using the digital maturity framework developed by Flott et al., which considers the dimensions of usage, resources and abilities (organisational and individual), interoperability, general evaluation methodology, and

impact.[22] The overall digital maturity score was calculated as the sum of the scores for the six dimensions, as previously published.[23] A digital maturity score was calculated for each PCP by granting one point for each statement with which the PCP indicated agreement, giving a possible range of zero to six where a score of six indicates high digital maturity.

A list of ten EHRs features was identified by twenty members of the inSIGHT research group. Availability of EHRs features was evaluated using a multiple-choice question ('*Please tell us if your electronic health record system has any of the following core functions?*"), with Participants able to select 'Yes', 'Partially', or 'No' for each of ten EHRs features (see Supplementary Table 2). Availability of each EHRs feature was categorised for each PCP based on their response into a dichotomous variable of 'Available' ('Yes'/'Partially') or 'Not Available' ('No').

Statistical analysis

This study focuses on an analysis of 1520 participants with access to EHRs and a known frequency of EHRs use, representing 94·7% of the total sample of 1605. To identify the predictors associated with everyday use of EHRs, logistic regression analyses were performed. Univariable logistic regression was performed to determine the PCP and practice characteristics associated with frequency of EHRs use (Supplementary Table 1). Predictors significantly associated with frequency of EHRs use ($P < 0{\cdot}05$) in univariable analysis were included in the final multivariable logistic regression model. As the largest category, Ireland was set as the reference category for country in the multivariable regression analysis. A hierarchical model structured with a random intercept for country of employment was explored; however, given this approach produced a model with very similar performance and coefficient estimates as a non-hierarchical model, it was rejected in favour of a non-hierarchical approach for the sake of interpretability. PCPs who were missing information or preferred not to answer questions on hours worked, teaching activities, age, or gender (n = 26) were excluded from regression analyses. Collinearity of independent variables in the multivariable model was assessed using the variance inflation factor and none was detected.

Analysis of the availability of EHRs features was performed on a sub-sample of 1345 participants who responded to questions on EHRs features (83·8% of the total sample). Cramer's V was calculated to estimate the effect size of the association between the availability of each EHRs feature and each practice factor (i.e., country of employment, urbanicity, and digital maturity score). Effect size was subsequently described as strong (≥0·5), moderate (0·3 to <0·5), or weak (0·1 to <0·3). *P* values for χ^2 tests were adjusted for multiple comparisons using the Holm-Bonferroni method.[24] Heatmaps were created to visualise feature availability by practice factors. Hierarchical cluster analysis using Ward's minimum variance method was performed to order levels of practice country and digital maturity in the heatmap plots by similarity in EHRs feature availability. This was done to formally describe how and which countries or digital maturity levels shared patterns of availability of multiple EHRs features, to aid in interpreting which policy, governance, or infrastructural factors have contributed to the observed patterns of feature availability.

All analyses were performed in R version 4.3.0,[25] and a significance level of 0·05 was used throughout.

Ethics

Ethical approval was granted by the Imperial College Research Ethics Committee (Reference 20IC5956), which oversees health-related research with human participants. Survey participants gave their written informed consent to participate in the study.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

A total of 1520 PCPs were included in this study (Table 1), 91·2% ($n = 1386$) of which reported using EHRs every day. Most (61·2%, $n = 930$) of the respondents were female and 58·3% ($n = 886$) were aged between 30 and 49 years. Almost a third of the respondents had clinical experience of more than 20 years, and over half (55·5%) have been using EHRs for more than ten years. While most were engaged in teaching activities (64·7%, $n = 983$), only about a third had completed training in digital-first technologies. Most of the respondents (62·9%, $n = 956$) worked in practices based in urban areas. The median digital maturity score of their practices as reported by PCPs was 5 (interquartile range, IQR: 3–6), with a range of 0–6.

Country of PCP employment, urbanicity, clinical hours worked per week, duration of EHRs use, and digital maturity score were found to be associated with frequency of EHRs use in univariable analyses and were subsequently retained in the multivariable analysis (Table 2). In multivariable analyses, PCPs who worked more than 28 h per week and those reporting a greater number of years of EHRs use had higher odds of being an everyday user (Table 2). PCPs working in practices with a low digital maturity score were less likely to be everyday EHRs users, compared to those working in practices with a high digital maturity score. No association was found between everyday EHRs use and urbanicity in the multivariable model (Table 2). Substantial associations with country remained in the multivariable model (Table 2). The percentage of everyday EHRs users by country ranged from 69·1% (Turkey) to 99·0% (Italy) (Supplementary Fig. 1).

The features most frequently available to PCPs were '*Entering and storing prescriptions, tests, and other services*' (86·3%, n = 1161), followed by '*Access to new and past test results by providers in multiple settings*' (63·8%, n = 858) (Supplementary Table 2). Although a majority of PCPs reported their EHRs allowed '*Patient-provider communication*' (64·8%, n = 871) or '*Patient access to their EHRs*' (54·3%, n = 730), a minority of PCPs reported features that involved patient-EHRs interaction, such as tools that provide interactive patient education (37·3%, n = 502), and tools to carry out home monitoring or self-testing for chronic conditions (34·4%, n = 462). Of those that reported having features for patient education or self-monitoring, most reported only partial availability of the features (Supplementary Table 2).

Availability of all the individual EHRs features studies was significantly associated with country and with digital maturity score. No significant association was observed with urbanicity. An overview of the effect size estimates, for the associations between each individual EHRs feature and each practice characteristic (i.e., country, digital maturity score, and urbanicity), is provided in Fig. 1 and exact *P* values are provided in Supplementary Table 3.

While country of practice was significantly associated with the availability of all EHRs features studied, the association was strong for the features '*Tools that give patients access to their health records*' (Effect Size 0·6 [95% CI 0·6 to 0·6, $P < 0{\cdot}0001$]), and '*Reminders, prompts, alerts, and computerised decision* support *system*' (Effect Size 0·5 [95% CI 0·4 to 0·6, $P < 0{\cdot}0001$]) (Fig. 1), highlighting the strong variability of the availability of these features across

Table 1
Characteristics of 1520 PCP participants, and their settings, by frequency of EHRs use.

		Less than everyday users ($N = 134$), n (%)	Everyday users ($N = 1386$), n (%)	Total ($N = 1520$), n (%)
Age category				
	Under 30	15 (11.2)	80 (5.8)	95 (6.3)
	30–39	51 (38.1)	448 (32·3)	499 (32·8)
	40–49	30 (22·4)	357 (25·8)	387 (25·5)
	50–59	23 (17·2)	285 (20·6)	308 (20·3)
	60–69	13 (9·7)	197 (14·2)	210 (13·8)
	70+	2 (1·5)	15 (1·1)	17 (1·1)
	Prefer not to answer	0 (0·0)	4 (0·3)	4 (0·3)
Gender				
	Female	88 (65·7)	842 (60·8)	930 (61·2)
	Male	43 (32·1)	536 (38·7)	579 (38·1)
	Other	1 (0·7)	1 (0·1)	2 (0·1)
	Prefer not to answer	2 (1·5)	7 (0·5)	9 (0·6)
Hours of clinical work per week				
	Mean (SD)	30·9 (15·1)	35·2 (12·1)	34·8 (12·5)
	(0, 28)	55 (41·0)	338 (24·4)	393 (25·9)
	(28, 36)	17 (12·7)	369 (26·6)	386 (25·4)
	(36, 40)	42 (31·3)	365 (26·3)	407 (26·8)
	(40, 100)	20 (14·9)	309 (22·3)	329(21·6)
	Unknown	0 (0·0)	5 (0·4)	5 (0·3)
Clinical experience				
	<5 years	38 (28·4)	275 (19·8)	313 (20·6)
	5–10 years	33 (24·6)	307 (22·2)	340 (22·4)
	10–15 years	22 (16·4)	203 (14·6)	225 (14·8)
	15–20 years	11 (8·2)	155 (11·2)	166 (10·9)
	>20 years	30 (22·4)	446 (32·2)	476 (31·3)
Duration of EHRs use				
	Only after COVID-19 outbreak	14 (10·4)	9 (0·6)	23 (1·5)
	Before COVID-19 outbreak, but for less than two years	40 (29·9)	71 (5·1)	111 (7·3)
	2–5 years	29 (21·6)	177 (12·8)	206 (13·6)
	5–10 years	26 (19·4)	311 (22·4)	337 (22·2)
	More than 10 years	25 (18·7)	818 (59·0)	843 (55·5)
Teaching activities				
	Yes	80 (59·7)	903 (65·2)	983 (64·7)
	No	52 (38·8)	475 (34·3)	527 (34·7)
	Prefer not to answer	2 (1·5)	8 (0·6)	10 (0·7)
Completed training digital technologies				
	No	85 (63·4)	863 (62·3)	948 (62·4)
	Yes	49 (36·6)	523 (37·7)	572 (37·6)
Practice urbanicity				
	Urban	99 (73·9)	857 (61·8)	956 (62·9)
	Mixed	19 (14·2)	315 (22·7)	334 (22·0)
	Rural	16 (11·9)	214 (15·4)	230 (15·1)
Practice digital maturity score				
	0	45 (33·6)	172 (12·4)	217 (14·3)
	1	24 (17·9)	88 (6·3)	112 (7·4)
	2	15 (11·2)	120 (8·7)	135 (8·9)
	3	11 (8·2)	248 (17·9)	259 (17·0)
	4	13 (9·7)	266 (19·2)	279 (18·4)
	5	11 (8·2)	230 (16·6)	241 (15·9)
	6	15 (11·2)	262 (18·9)	277 (18·2)

Data are shown as n (%) for categorical variables and mean (SD) for continuous variables. PCP, Primary Care Physician; EHRs, Electronic Healthcare Records; SD, Standard Deviation.

countries. The availability of '*Tools that give patients access to their health records*' ranged from 18·2% (Ireland) to 95·8% (Israel), while '*Reminders, prompts, alerts, and computerised decision* support *system*' ranged between 34·0% (Brazil) and 100·0% (Germany) (Fig. 2).

Overall, two major groups of countries were identified based on hierarchical clustering (Supplementary Fig. 2). The first group (Croatia, Finland, Israel, Spain, Sweden, Turkey, UK, USA) shows an overall high availability of most features, with availability of features allowing patient-provider communication and patient access to their health records being distinctly high compared to the second group (Australia, Brazil, Canada, Chile, Colombia, France, Germany, Italy, Ireland, Portugal, Poland, Slovenia) (Fig. 2). Brazil, Colombia, Chile, Poland, and Slovenia shared lower availability of '*Reminders, prompts, alerts, and computerised decision* support *system*'.

Higher digital maturity score was generally associated with greater availability of most of the EHRs features studied (Fig. 3). Moderate associations were noted with the availability of '*Reminders, prompts, alerts, and computerised decision* support *system*' and '*Efficient, secure, and readily accessible communication among providers*'. Digital maturity was also associated with the availability of all other EHRs features studied, although with a weak effect size (Fig. 1, Supplementary Table 3).

Discussion

PCPs who worked more than 28 h a week, with more years of EHRs use, and with a moderate or high practice digital maturity score were more likely to use EHRs every day, when compared to

Table 2
OR with associated 95% CI for the odds of being an everyday EHRs user, derived from univariable and multivariable logistic regression models.

		Univariable analysis		Multivariable analysis	
		OR (95% CI)	*P*	OR (95% CI)	*P*
Age category			0·095		
	Under 30	0·6 (0·3–1·1)	0·071	..	..
	30–39	1 (REF)		..	..
	40–49	1·4 (0·8–2·2)	0·224	..	..
	50–59	1·3 (0·8–2·3)	0·279	..	..
	60–69	1·6 (0·9–3·2)	0·134	..	..
	70+	0·8 (0·2–5·2)	0·783	..	..
	Prefer not to answer	–		..	
Gender			0·142	..	..
	Female	1 (REF)		..	..
	Male	1·3 (0·9–2·0)	0·147	..	..
	Other	–		..	..
	Prefer not to answer	–		..	..
Practice urbanicity			0·012		
	Urban	1 (REF)		1·0 (REF)	
	Mixed	2·0 (1·2–3·4)	0·011	1·7 (0·9–3·2)	0·104
	Rural	1·6 (0·9–2·9)	0·105	1·0 (0·5–2·0)	0·963
Clinical experience			0·070		
	<5 years	0·8 (0·5–1·3)	0·372	..	..
	5–10 years	1 (REF)		..	..
	10–15 years	1 (0·6–1·8)	0·971	..	..
	15–20 years	1·6 (0·8–3·5)	0·201	..	..
	>20 years	1·6 (0·9–2·6)	0·097	..	..
Teaching activities			0·427		
	Yes	1·2 (0·8–1·7)	0·424	..	..
	No	1 (REF)		..	..
	Prefer not to answer	–		..	..
Hours of clinical work per week			<0.0001		
	(0, 28)	1·0 (REF)		1·0 (REF)	
	(28, 36)	4·1 (2·3–7·9)	<0·0001	4·2 (2·1–8·9)	0·0001
	(36, 40)	1·4 (0·9–2·1)	0·170	1·9 (1·1–3·5)	0·036
	(40, 100)	2·4 (1·4–4·2)	0·001	3·1 (1·–6·2)	0·001
	Unknown	–			
Duration of EHRs use			<0·0001		
	Only after COVID-19 outbreak	0·1 (0·0–0·1)	<0·0001	0·0 (0·0–0·1)	<0·0001
	Before COVID-19 outbreak, but for less than 2 years	0·2 (0·1–0·4)	<0·0001	0·1 (0·0–0·1)	<0·0001
	2–5 years	0·4 (0·2–0·7)	<0·0001	0·2 (0·1–0·4)	<0·0001
	5–10 years	0·1 (0·0–0·1)	0·0009	0·5 (0·2–0·9)	0·014
	More than 10 years	1·0 (REF)		1·0 (REF)	
Training done in digital-first technologies			0·914		
	No	1·0 (REF)		..	..
	Yes	1·0 (0·7–1·5)	0·914	..	..
Digital maturity score			<0·0001		
	0	0·2 (0·1–0·3)	<0·0001	0·3 (0·1–0·7)	0·007
	1	0·2 (0·1–0·3)	<0·0001	0·3 (0·1–0·8)	0·016
	2	0·4 (0·2–0·8)	0·013	0·6 (0·2–1·4)	0·195
	3	1·0 (0·4–2·4)	0·963	1·6 (0·6–4·2)	0·309
	4	1·0 (REF)		1·0 (REF)	
	5	1·0 (0·4–2·2)	0·919	0·8 (0·3–2·1)	0·667
	6	0·8 (0·4–1·9)	0·681	0·8 (0·3–2·0)	0·702
Country of PCP employment			<0·0001		
	Ireland	1·0 (REF)		1·0 (REF)	
	Australia	0·1 (0·0–0·3)	<0·0001	0·3 (0·1–1·0)	0·045
	Brazil	0·1 (0·0–0·3)	0·0001	0·7 (0·2–2·7)	0·653
	Canada	0·3 (0·1–1·1)	0·055	0·6 (0·1–2·5)	0·426
	Chile	0·1 (0·0–0·3)	<0·0001	0·1 (0·0–0·4)	0·001
	Colombia	0·1 (0·0–0·3)	<0·0001	0·3 (0·1–1·0)	0·047
	Croatia	0·7 (0·1–4·5)	0·607	1·6 (0·3–12·4)	0·577
	Finland	1·2 (0·2–23·5)	0·848	1·2 (0·2–22·6)	0·890
	France	0·4 (0·1–2·1)	0·259	0·7 (0·2–3·8)	0·652
	Germany	0·2 (0·1–0·8)	0·013	0·2 (0·0–0·9)	0·029
	Israel	0·3 (0·1–1·2)	0·083	0·6 (0·2–2·4)	0·485
	Italy	2·3 (0·4–42·8)	0·455	8·1 (1·2–164·4)	0·067
	Poland	0·3 (0·1–1·3)	0·091	3·4 (0·8–16·3)	0·104
	Portugal	2·2 (0·4–41·5)	0·473	2·6 (0·4–51·3)	0·392
	Slovenia	0·1 (0·0–0·2)	<0·0001	0·6 (0·2–2·0)	0·380
	Spain	1·1 (0·3–7·8)	0·885	1·3 (0·3–9·9)	0·755
	Sweden	0·2 (0·1–0·7)	0·010	0·5 (0·1–2·0)	0·307
	Turkey	0·1 (0·0–0·1)	<0·0001	0·1 (0·0–0·4)	0·001
	United Kingdom (UK)	0·2 (0·1–0·5)	0·001	0·3 (0·1–0·8)	0·020
	United States of America (USA)	0·2 (0·1–0·8)	0·014	0·2 (0·1–0·8)	0·021

OR, Odds Ratio; CI, Confidence Interval; PCP, Primary Care Physician; EHRs, Electronic Healthcare Records; 'REF' indicates reference categories.

their counterparts. Common features of EHRs included entering and retrieving data on prescriptions and tests, while tools intended for patient use were least frequently reported. Country of PCP employment was found to be strongly associated with both frequency of EHRs use and availability of all EHRs features, with a particularly high degree of country-level variation observed for the availability of tools enabling patient access to EHRs. PCPs practising in settings with a higher digital maturity score generally had greater availability of multiple EHRs features.

Factors associated with increased experience with or access to EHRs were predictors of everyday EHRs use. Being a cross-sectional survey, the directionality of the associations observed cannot be established. Higher frequency of use of EHRs may contribute to PCPs having to work longer hours,[16] or conversely PCPs who worked longer hours have had more time to become aware of various EHRs features. Yet, the availability and use of EHRs features that improve care efficiency through reducing administrative tasks could result in more time allocated towards clinical work instead. More years of experience using EHRs may result in more impactful and efficient use which could contribute to positive perceptions and further usage of EHRs. Similarly, higher digital maturity may contribute to increased usage of EHRs, which, in turn, would increase perceived digital maturity.[23]

There was a high degree of variation in frequency of everyday EHRs by country of employment which may reflect technological, organisational, and policy drivers of EHRs use. In the UK, for example, the remuneration PCPs receive is dependent upon EHRs usage which likely incentivises more frequent use.[14] More broadly, the digital maturity of the wider health system of a country influences EHRs use within primary care, for example by determining the interoperability of primary care EHRs with other patient data management systems.[2,4] Additionally, contract structures applied in different countries may have impacted how the PCPs surveyed reported the frequency of their EHRs use. In countries where it was more common for PCPs to work full-time, greater everyday use could have been reported simply because they spent more time practising relative to countries where PCPs more commonly worked part-time.

EHRs features concerning entering, standardising, and retrieving data, including tests and orders, were commonly reported by PCPs. These features may be considered fundamental to EHRs systems as they underpin PCP workflow and patient care. This interpretation is supported by the finding that these EHRs features were weakly related to either practice country or digital maturity score and were common across practice settings (Fig. 1). In contrast, availability of features for patient education and home monitoring were uncommonly reported (Supplementary Table 2), across all countries (Fig. 2) and even amongst PCPs working in practices with high digital maturity scores (Fig. 3).

Our findings suggest two-way patient interactions with EHRs remain relatively uncommon, despite the demonstrated benefits.[26] The perceptions of some PCPs and patients that EHRs are detrimental to patient–clinician relationships or untrustworthy regarding data security may disincentivise the use of such EHRs features.[18,26] Use of EHRs can introduce a conflict between EHRs-centred data entry and patient-centred care as clinician attention is paid to EHRs in a manner, which is non-collaborative with the patient.[26] Increased implementation of features which enable collaborative patient-EHRs interactions may therefore aid in overcoming such divides between the patient and clinician where EHRs use is mandated.

Patient EHRs access was also relatively uncommon in some countries, with just over half (54·3%) of PCPs having it available, despite access to medical records being a legal right in some countries.[27,28] A lack of patient access to their EHRs is also a potential source of inequity as it may reduce the opportunity for patients to be active stakeholders in the management of their health. Tools enabling patient EHRs access, as well as the EHRs features enabling two-way patient-EHRs interactions (tools for interactive patient education and tools for home monitoring), showed similar availability across digital maturity scores one to five (Fig. 3), rather than an increase in availability with higher digital maturity as seen for many of the PCP-oriented EHRs features. Together these findings suggest that there are specific barriers towards the implementation of EHRs features oriented around patient use and interaction, while PCP-centred features have been prioritised during development of digital infrastructure. For example, data governance restrictions, including interoperability of health systems and legal restrictions on sharing health data, may inhibit the sharing of health information with patients in some areas.[6,29]

The finding that about half of Australian PCPs reported tools for patient EHRs access is surprising given that, as of August 2020, 94% of Australian primary care practitioners were registered to My Health Record,[30] a personal online healthcare record system made op-out for patients as of 2019.[29] This could suggest that Australian PCPs did not perceive external online portals or apps as features of

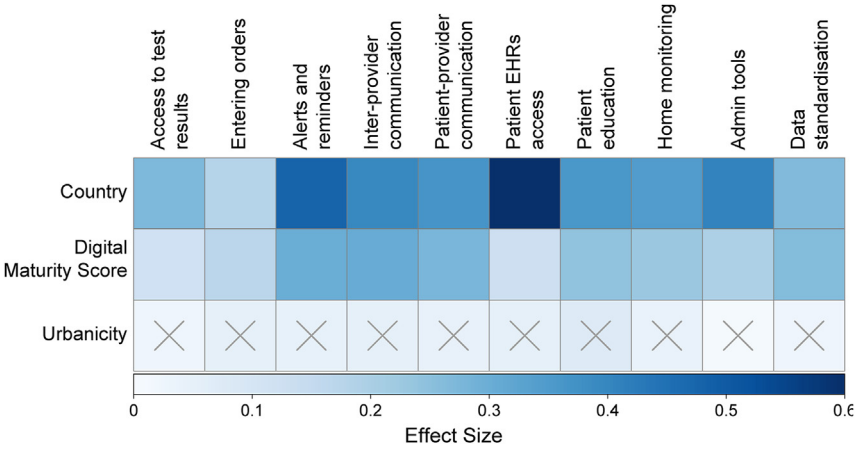

Fig. 1. Associations between availability of EHRs features and practice characteristics. Shading indicates strength of association between each EHRs feature and each practice characteristic (i.e., country, digital maturity, and urbanicity), as measured by Cramer's V. Crosses indicate non-significant associations (adjusted *P*-values from χ^2 tests ≥0·05). EHRs = Electronic Healthcare Records.

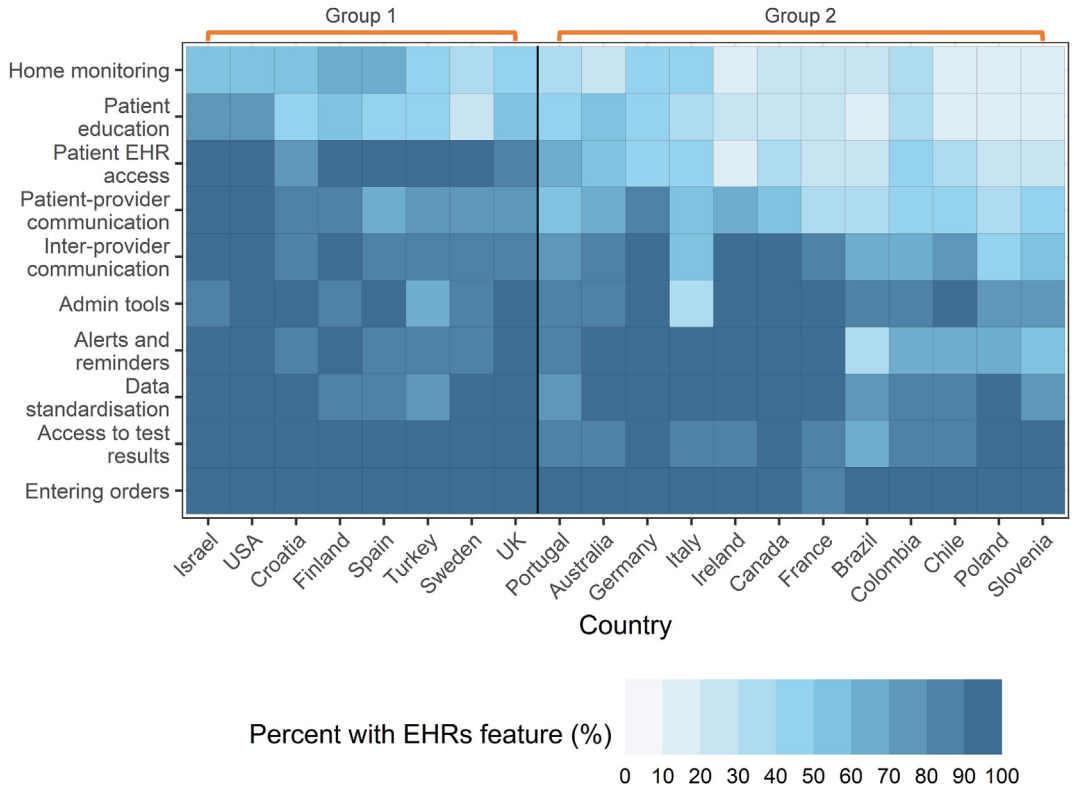

Fig. 2. Heatmap of EHRs feature availability by country of practice for 1345 PCPs. Hierarchical clustering using Ward's method was performed to order countries by similarity in feature availability and identify major group divisions (labelled); associated dendrogram for country is shown in Supplementary Fig. 1. PCPs, Primary Care Physicians.

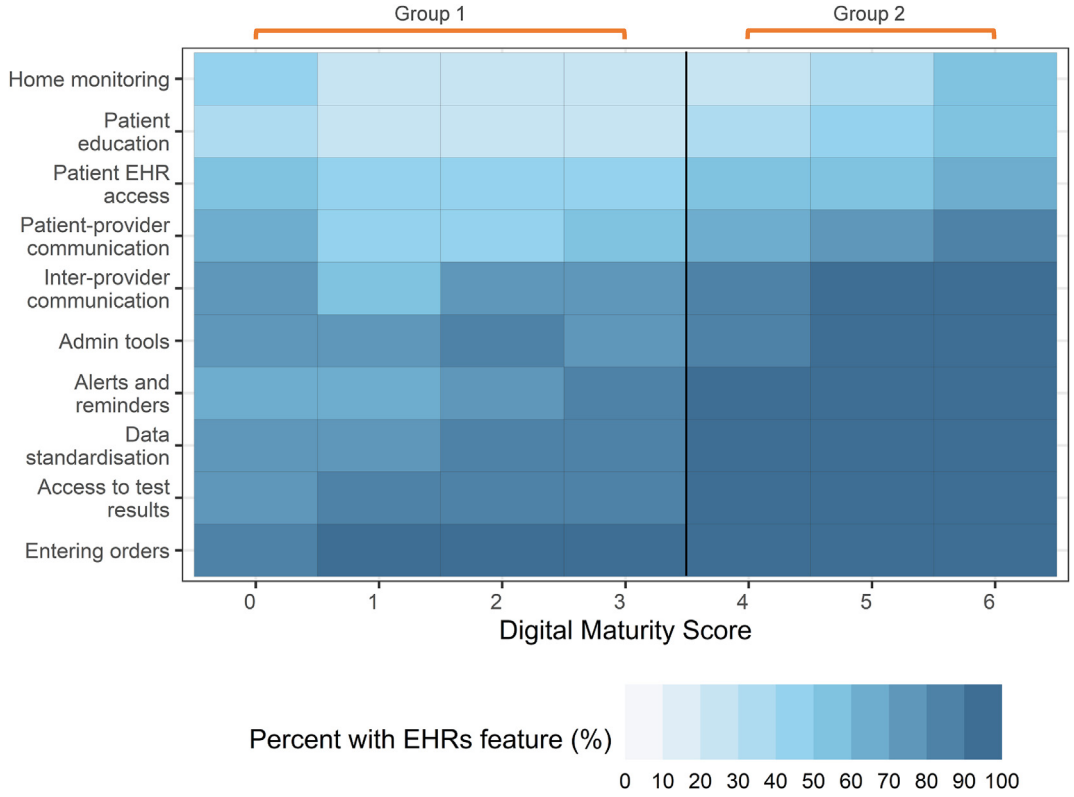

Fig. 3. Heatmap of EHRs feature availability by practice digital maturity score for 1345 PCPs. Hierarchical clustering using Ward's method was performed to order categories of digital maturity score by similarity in feature availability and identify major group divisions (labelled).

their EHRs system that patients could access, despite My Health Record being an EHRs based tool allowing indirect patient access to health records. Such interpretation by PCPs that the survey referred to only direct or non-summarised patient-EHRs interactions may have contributed to the overall low reported availability of tools for providing patients access to their EHRs. Future research into the extent of patient EHRs access across countries and practice settings would be valuable.

Strengths of this study include that a large number of PCPs from over 20 countries were surveyed which has enabled investigation into PCPs from a broad range of primary care settings, ages, and experiences. This study includes PCPs who are the first point of contact with healthcare systems for many patients and thus are a focal point in efforts to improve health service delivery. Hence, understanding of PCP characteristics influencing EHRs use can provide valuable insight into the design and usage of EHRs technologies.

This study carries a few limitations. Firstly, PCPs were surveyed from only upper-middle and high-income countries, restricting the generalisability of the study's findings to the healthcare systems of such countries. Further studies need to focus on upcoming research from the global south as well in terms of EHRs. Second, the study did not consider the type or size of practice along with the magnitude of patients their practice encounters per week. Additionally, digital maturity score was derived based on PCP descriptions of their practices so should not be interpreted as an objective measure of practice digital maturity. Developed by Flott et al. as a framework for measuring digital maturity across the patient care pathway,[22] this score has been previously used in the literature for similar purposes,[23] but is not a validated score. Factors such as data security and privacy,[12,19] workload,[15,16] social influences,[11] self-perceived abilities,[11] and economic concerns,[12] identified in the literature as contributing to frequency of EHRs use were not surveyed here. Due to the quantitative nature of the study, a full breadth of reasons for increased or decreased EHRs usage in this cohort is beyond the scope of this study. The use of an anonymous online survey disseminated through email and social media likely contributed to a sampling bias selecting for PCPs more familiar with online services, and prevented identification of whether PCPs were employed at the same organisation. Most PCPs surveyed had access to EHRs, were everyday users, and worked in urban practices. Although a large sample size was achieved across the 20 countries, recruitment of PCPs via convenience sampling may reduce the representativeness of the sample, limiting the generalisability of the study's findings. Additionally, the survey was not available in all the languages spoken by the twenty countries surveyed, which may have excluded some PCPs from participating or have affected the interpretation of questions. Variable interpretation of survey questions may have resulted from ambiguous wording of survey questions, as previously mentioned. Lastly, the shift to remote care delivery in the months following the survey administration likely motivated improvement of EHRs systems and increased implementation of EHRs tools intended for use by patients. However, as the survey was cross-sectional, we were unable to assess developments over time in EHRs and were limited to discussions of the June to September 2020 period. This study nevertheless highlights patient access to EHRs as a focal area for improvement in primary care digital infrastructure.

In summary, this work contributes to knowledge on the growing digitisation of primary care services by identifying the PCP and practice factors associated with EHRs use and availability of EHRs functions. The EHRs features of tools for patient education or home monitoring were available to a minority of PCPs surveyed, highlighting the need for improvement in implementation of EHRs features enabling collaborative patient–EHRs interaction. Country was a significant predictor of frequency of EHRs use and availability of EHRs features, suggesting systems-wide research into the barriers and facilitators of EHRs implementation would be valuable in informing successful EHRs implementation. Policy makers would benefit from investing efforts into how to increase EHRs accessibility for end-users and improve data interoperability, priorities which if addressed, would make way for further key EHRs features to be introduced. Future research into implementation challenges and practical considerations which influence the use of EHRs features by PCPs, would make for more effective use of limited health information technology-related resources. Systems-level research to highlight country-specific barriers hindering better implementation, would also likely be valuable.

Author statements

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Ethical approval

Ethical approval was granted by the Imperial College Research Ethics Committee (Reference 20IC5956), which oversees health-related research with human participants. Survey participants gave their written informed consent to participate in the study.

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Competing interests

BH also works for eConsult Health Ltd, provider of a platform for online consultations for NHS primary, secondary and urgent/emergency care.

Contributor statement

ALN and the inSIGHT group (JC, AC, CC, SE, MF, GGu, KH, RH, GI, GJ, LL, VL, HL, EM, KN, BO, DP, AS, MU) contributed to the conception and design of the study. GK, NK, and ALN accessed and verified the data, and contributed to data analysis and interpretation. GK, NK, ALN, TB, GGr, EL, and BH contributed to writing the manuscript. All authors provided critical revision and approved the final version of the manuscript.

Data sharing agreement

The dataset analysed can be made available upon reasonable request via email to Gabriele Kerr (gk916@ic.ac.uk). All R code used for the analysis methods applied are available online at GitHub - kerrg012/Features-and-frequency-of-use-of-EHRs.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2024.05.001.

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