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Secondary uses of electronic prescribing and pharmacy data in UK hospital care: a national survey

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ABSTRACT

Electronic hospital pharmacy (EHP) systems are ubiquitous in today's hospitals, with many also implementing electronic prescribing (EP) systems; both contain a potential wealth of medication-related data to support quality improvement. The reasons for reuse and users of this data are generally unknown. Our objectives were to survey secondary use of data (SUD) from EHP and EP systems in UK hospitals, to identify users of and factors influencing SUD.

A national postal survey was sent out to all hospital chief pharmacists with pre-notifications and follow-up reminders. Descriptive statistical analysis was performed. Of 187 hospital organisations, 65 (35%) responded. All had EHP systems (for ≥20 years) and all reused data; 50 (77%) had EP systems (established 1–10 years) but only 40 (80%) reused data. Reported facilitators for SUD included medication safety, providing feedback, benchmarking, saving time and patient experience. The purposes of SUD included audits, quality improvement, risk management and general medication-related reporting. Earlier introduction of SUD could provide an opportunity to heighten local improvement initiatives.

Data from EHP systems is reused for multiple purposes. Evaluating SUD and sharing experiences could provide richer insight into potential SUD and barriers/factors to consider when implementing or upgrading EP/EHP systems.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Generalised benefits relating to secondary use of data (SUD) are known in the literature, but no previous research directly explores what electronic prescribing and electronic pharmacy data is being used in hospitals across the UK. SUD could support the timeliness, efficiency and effectiveness of data access by using existing data from electronic prescribing and pharmacy systems in hospitals.

WHAT THIS STUDY ADDS

⇒ This study identified the reasons for SUD from electronic prescribing and pharmacy systems, explores potential hypothesis based on previous systematic review looking at factors impacting data reuse, and SUD users. This study revealed that all responding organisations reused data from electronic pharmacy systems, however, this was not the case for electronic prescribing data.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study identified the real use cases for SUD data in practice, and revealed existing data is underused in hospitals across the UK; potentially due to SUD not being a focal point in procurement and implementation strategies, hence an opportunity exists for policymakers and project leads to acknowledge the presence of a gap in data reuse and encourage them to explore this option during implementation.

INTRODUCTION

There has been an increased uptake of electronic prescribing (EP) systems in the past decade.[1] The benefits of implementing EP systems include but are not limited to reduction in errors, increasing efficiency and enhancing patient safety[2–10] even though new error types can be introduced via EP systems[11–13] resulting in alterations being made to support workflows to improve electronic systems.[14]

There has been a growing interest in EP implementation over the last 15 years.[15] The use of such technology has been deemed advantageous due to its efficiency as it provides clear data that can be accessed by various healthcare professionals for numerous reasons and wider benefits.[10] A national postal survey conducted in 2011 explored the number of hospital trusts in England with EP systems and identified that 70 of 101 respondents had one form of an EP system (with 39 of these having more than one system in use).[16] A recent study used hospital episode statistics (April 2017 to April 2018) to identify that 77% (of 152) acute National Health Service (NHS) trusts in England had some form of electronic health record implemented; the remaining 23% used paper-based systems.[17]

Secondary use of data (SUD) has been undertaken for many different purposes: evaluation of interventions, audits, analytical epidemiological studies and population health surveillance,[18] predictive risk modelling, surveillance of adverse drug events and

analysis of quality of healthcare.[19] SUD has been defined as 'the reuse of aggregated electronic (clinical or operational) data from an EP or EHP system for purposes other than direct patient care or for its original purpose'.[20]

Processes to access existing electronic data vary across NHS organisations; these include requests to data managers/departments or the use of dashboards available to a wider range of staff. All use must however adhere to NHS governance and data protection policies.

SUD benefits such as low costs, large numbers of available records, long time periods and wide population coverage, as well as the diversity and breadth of the data available.[18] Hence, SUD could potentially support safety, patient-centred approach, timeliness, efficiency, equitable and effectiveness in hospitals. A review exploring literature published in 2016 focusing on the reuse of patient-related data identified only four papers that discussed quality concerns over the data, and issues relating to privacy in shared data sets.[21] Systematic reviews have been conducted internationally to explore the secondary use of medication-related data and more specifically antimicrobial data in secondary care.[20 22 23] One systematic review showed that medication-related data is being reused to reduce medication administration errors, improve prescribing and to improve processes relating to medication safety[20]; while two antimicrobial reviews identified SUD for developing screening tools to identify patients at risk of developing infections[22] and to support or evaluate antimicrobial stewardship activities.[23] However, this is based on published research and may not be a reflective account of all SUD activities in hospitals.

In 2012 an NHS survey of EP implementation was conducted but did not explore how healthcare organisations were using their internal databases for secondary purposes. Limited knowledge currently exists concerning the different ways in which EP and electronic hospital pharmacy (EHP) data are reused, as well as the potential issues/barriers that individuals may have experienced in practice. Knowledge of these factors and potential 'use cases' can support current healthcare professionals, developers and policymakers to reuse data to improve the quality and safety of patient care. No previous national research has explored the specific types of EHP systems implemented while focusing on the role of EHP data for secondary purposes.

In the present study, we conducted a national survey of UK hospitals' SUD from EP and EHP systems. Objectives were to identify the different types of EP and EHP systems within UK hospitals, to discover which healthcare professionals are reusing data from EP and EHP systems and for what purposes and to identify 'use cases' around the reuse of medication-related data.

MATERIALS AND METHODS

A descriptive cross-sectional postal and online survey was sent to all UK acute NHS hospital organisations in 2016.

Setting

The survey was addressed to the Chief Pharmacist of all 160 acute and foundation NHS trusts in England (some of which comprised of more than one hospital), 5 trusts in Northern Ireland and 8 Health and Social Care Boards in Wales. In Scotland there were 14 health boards, each survey was addressed to the relevant Director of Pharmacy. Recipients could complete the survey or delegate appropriately.

Data collection

All mailings (pre-notification letters, covering letter and all reminders) had first-class stamps, a return address and recipients' addresses handwritten with the aim of enhancing the response rate. A pre-survey notification was sent on 3 November 2015, followed by a covering letter and a hard paper copy of the survey printed in colour on 10 November 2015.[24] In total, three reminders were sent at 2-week intervals to all non-respondents; the first two reminders were posted with an uncoloured copy of the survey; if recipients' email addresses were known then an email was sent with the survey attached electronically in addition to the paper copy. For the last reminder, where feasible email addresses were identified for non-respondents who were then sent an email with the survey attached. For the non-respondents whose email addresses could not be identified, a paper copy of the survey was sent with a covering letter with the project page website with access to an electronic copy of the survey.

The survey comprised categorical and 8-point Likert scale items with some additional free-text questions (online supplemental appendix 1). The questionnaire was piloted on three individuals (registered pharmacist and researchers) and then modified to provide further clarity. This study did not include patient and public involvement. Participants gave informed consent to participate in the study before taking part.

Data analysis

All survey data sent back by 29 February 2016 was transcribed, double-checked and analysed using SPSS V.22 and the file access had an encryption on a secure laptop. All trust and health board level data were included for descriptive statistical analysis, any missing data was excluded from the analysis. However, for inferential analysis only trust-level data from England was used; health board data were excluded due to the smaller volume of responses. Free text responses were thematically analysed.

The survey had four sections that asked for information regarding the hospital, EP system, EHP system and secondary use of EP and EHP data for quality improvement. Scaled data, categorical data and free-text data was collected within each of these sections. For scale data, suitable parametric or non-parametric tests were used to determine the association between high-level themes.[25]

Given limited knowledge regarding SUD in practice, we explored specific research questions in our analysis that arose post the completion of a systematic review paper

that identified four factors influencing SUD: organisation, systems, users and policies.[20] For example, do teaching organisations make enhanced SUD in comparison to other types of organisations due to their increased research role? Similarly, does existing data expertise in an organisation (in the form of EP pharmacist roles and/or multiple EP systems) increase the reuse of data?

In line with the study objectives, the following hypotheses were explored using two-tailed χ^2 tests:

1. The extent of reported reuse of data and a number of EP systems implemented within an organisation.
2. Implementation of EP systems by trusts with teaching status (ie, teaching vs non-teaching) and reuse of data by trusts with teaching status.
3. The extent of reuse of data and presence versus the absence of an EP pharmacist within the organisation.

RESULTS

Descriptive results

Characteristics of trusts and health boards

Of the 187 organisations (165 trusts and 22 health boards) invited to complete the survey, 65 (35%) responded (55 trusts and 10 health boards). The majority of respondents were band 8 pharmacists (n=18), followed by band 9 pharmacists,[12] band 7[2] and band 6[1]; 22 did not specify their grade (where band 9 is the highest NHS grade and band 6 is a newly qualified pharmacist). Of the 52 respondents in England and 3 from Northern Ireland, 18 indicated theirs was a teaching organisation. Of the 52 English trusts, 37 were foundation trusts (ie, organisations that have greater managerial and financial freedom). Of the 10 health board respondents in Scotland and Wales, 4 were teaching organisations. The number of full-time equivalent staff, beds and inpatient wards for trusts and health boards is given in table 1.

Reuse of EP and EHP data

All 55 trusts and 10 health boards had implemented EHP systems and all reported SUD from these. Of 65 respondent organisations, 55 had one EHP system, 7 had two, 2 had three and 1 had four systems. The most common EHP systems were JAC, Ascribe, an in-house system and HP (figure 1). The majority had been implemented for more than 20 years (41% n=29).

Of 55 respondent trusts, 42 (76%) had EP systems and of those, 35 (83%) reused data. Of the 10 respondent health boards, 8 (80%) had an EP system and of those, 5 (63%) reused data. Of the 50 trusts and health boards

Table 1 Demographic information of each responding organisation (trusts and health boards)*

	Trusts		Health boards	
Full-time equivalent pharmacy staff	**Frequency**	**Percentage**	**Frequency**	**Percentage**
1–100	24	4	2	22
101–200	23	44	3	34
201–300	4	8	3	33
301–400	0	0	1	11
401–500	1	2	0	0
Total	52	100	9	100
	Trusts		**Health boards**	
Number of inpatient wards	**Frequency**	**Percentage**	**Frequency**	**Percentage**
1–100	51	98	8	89
101–200	1	2	1	11
201–300	0	0	0	0
301–400	0	0	0	0
401–500	0	0	0	0
Total	52	100	9	100
	Trusts		**Health boards**	
Number of beds	**Frequency**	**Percentage**	**Frequency**	**Percentage**
1–500	21	39	1	13
501–1000	23	42	4	50
1001–1500	9	17	3	37
1501–2000	1	2	0	0
Total	54	100	8	100

*Totals do not add up to 55 trusts and 10 health boards because not all the respondents completed each of the questions relating to the information presented in table 1.

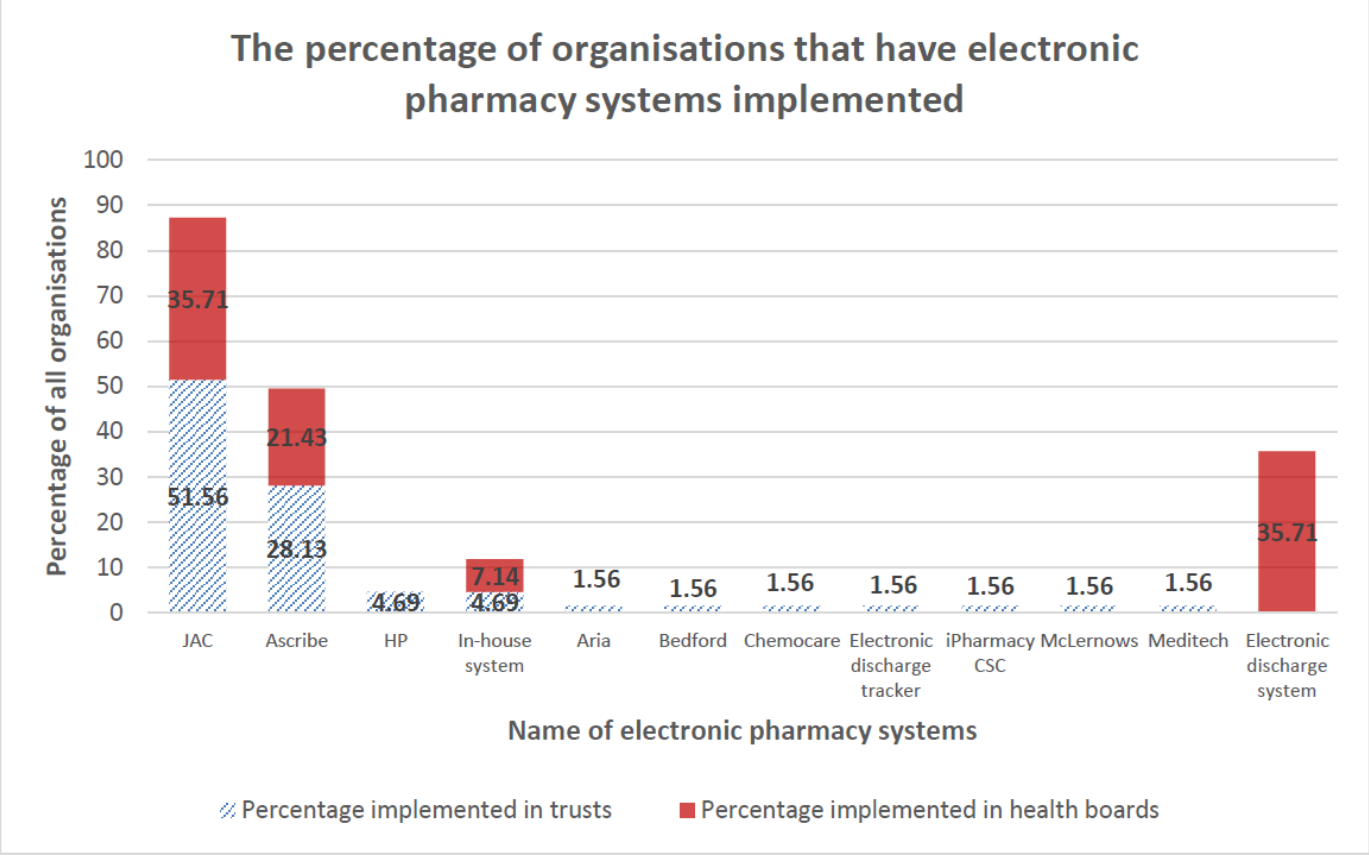

Figure 1 The percentage of organisations (trusts and health boards) that have electronic pharmacy systems implemented.

that had at least one EP system, 23 had one EP system (17 of whom reused data), 19 had two EP systems (16 of whom reused data), 7 had three EP systems (6 of whom reused data) and 1 had four EP systems (and reused data) as shown in figure 2.

Investigation of hypothesis 1 revealed no significant association between the reuse of data between trusts and the number of EP systems (ie, with one EP system or more than one EP system) (p=0.413, two-tailed Fisher's exact test). Investigation of hypothesis 2 revealed no significant association between teaching and non-teaching trusts in terms of the presence or absence of at least one EP system (p=0.470, two-tailed Fisher's exact test). Similarly, the hypothesised association between SUD and organisational teaching status was not supported (χ^2 test; p=0.223). A significant difference was found between trusts reusing data if they had an EP pharmacist (p=0.003, two-tailed Fischer's exact test) supporting our third hypothesis.

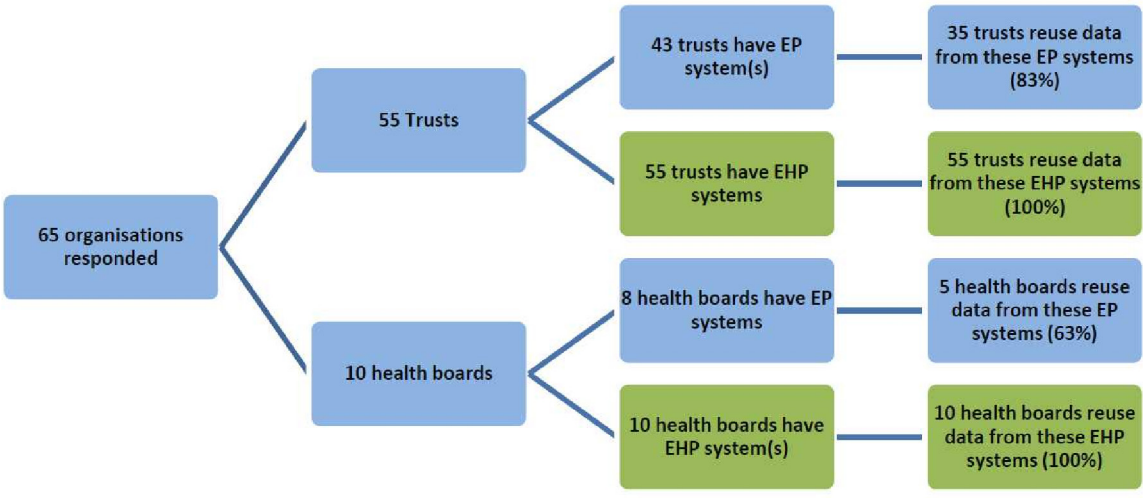

Figure 2 Overview of the number of EP and EHP systems implemented and the number that reuse data (organisational level). EP, electronic prescribing; EHP, electronic hospital pharmacy.

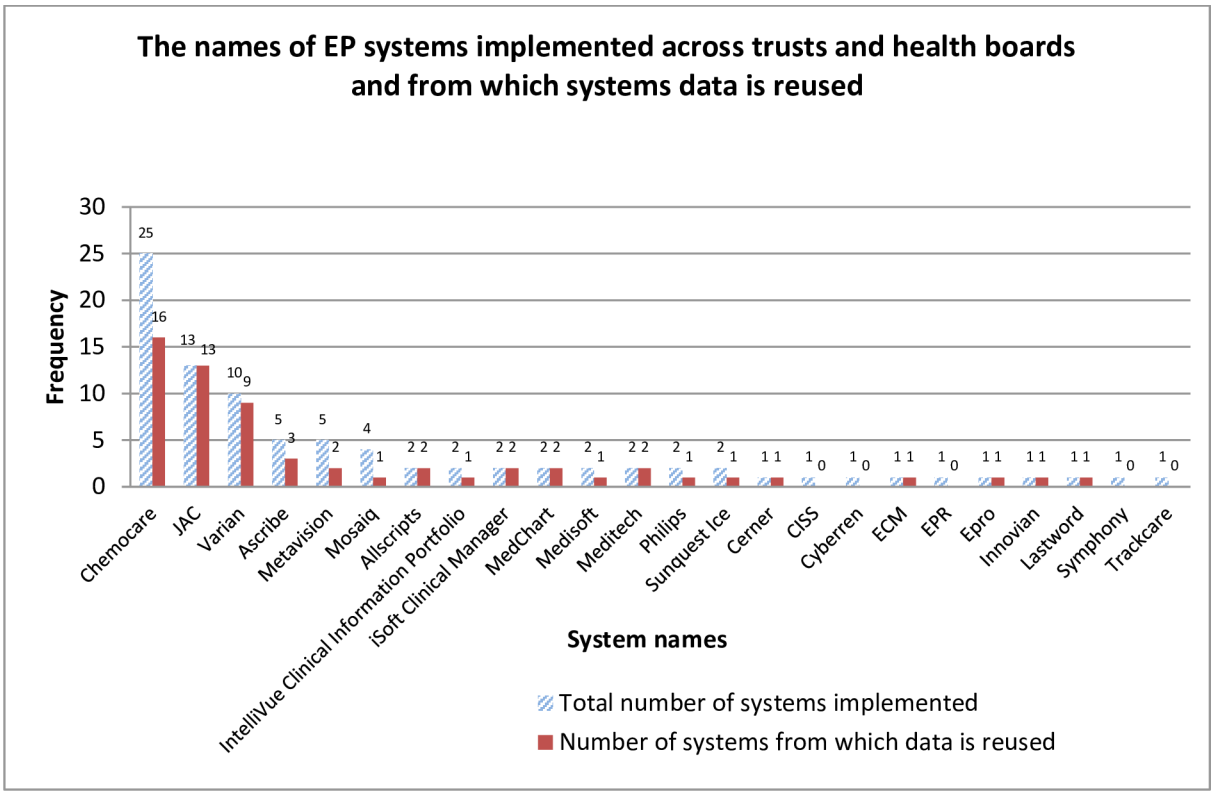

Figure 3 The name and frequency of the electronic prescribing systems implemented in trusts and health boards. EP, electronic prescribing.

All 88 EP systems implemented across the 65 responding secondary care organisations are listed in figure 3. The five most common were Chemocare (n=25), JAC,[12] Varian,[10] MetaVision[5] and Ascribe[5]; most were specialty-specific. The majority of EP systems had been implemented for 1–10 years (76% n=40); where data was reused, the majority had been reused for 1–10 years (66% n=35).

The majority of EP systems were implemented only on certain wards (66% n=41) within both trusts and health boards. Only 27% of trusts/health boards had an EP system implemented across the whole organisation. As might be expected, the majority of specialist EP systems had been implemented across different wards for trusts and health boards (96% and 40%, respectively), whereas the majority of the non-specialist systems were implemented across the whole trust or health board (45% and 67%, respectively).

Of the 65 respondent organisations, 29 had an EP pharmacist (of these 27 (93%) reused data and 2 (7%) did not) and 21 organisations did not have an EP pharmacist (of these 12 (57%) reused data and 9 (43%) did not).

The longest time trusts had reused data was for 20 years, however, the majority of trusts have been reusing data for less than or equal to 2 years (median value of 2 years; mean of 4.2 years). The longest time health boards had been reusing data was for 12 years with a mean value of 5.6 years and a median value of 5 years. There was an average gap of 2.5 years between the time systems were implemented in trusts and the time from which data was reused for secondary purposes from those systems. The difference in the time health boards implemented EP systems and the time they reused data was 0.6 years (6.5 months).

Purposes for which EP system-level data is reused

The purposes for which EP data were reused in the 40 organisations concerned were audits (30), quality improvement projects (20), risk management (20), to improve the safety and/or quality of medication use (18) divisional/board reporting (18), education (18) evaluating interventions to improve services (17), performance (16), academic/clinical research (16), to drive change around pharmacy and prescribing policy (15), identifying quality improvement areas (14) and cost-effectiveness (9).

Out of the 35 responding trusts the most common types of EP data reused were data on adherence to guidelines (23), missed doses (23), length of treatment (22), frequency of medication use (21) and cost of medication prescribed and/or dispensed (14) (figure 4).

The top five incentives (all of which received a median Likert score of 7.00) were to improve medication safety, provide timely feedback, benchmarking, improve the electronic system and patient experience. Health boards presented with a similar top five frequently selected incentives for reusing data from EP systems, however the incentive for improving the electronic system (5.00) was replaced by saving time (6.00).

Respondents from trusts indicated that individuals tend to reuse data from EP systems when they believe it

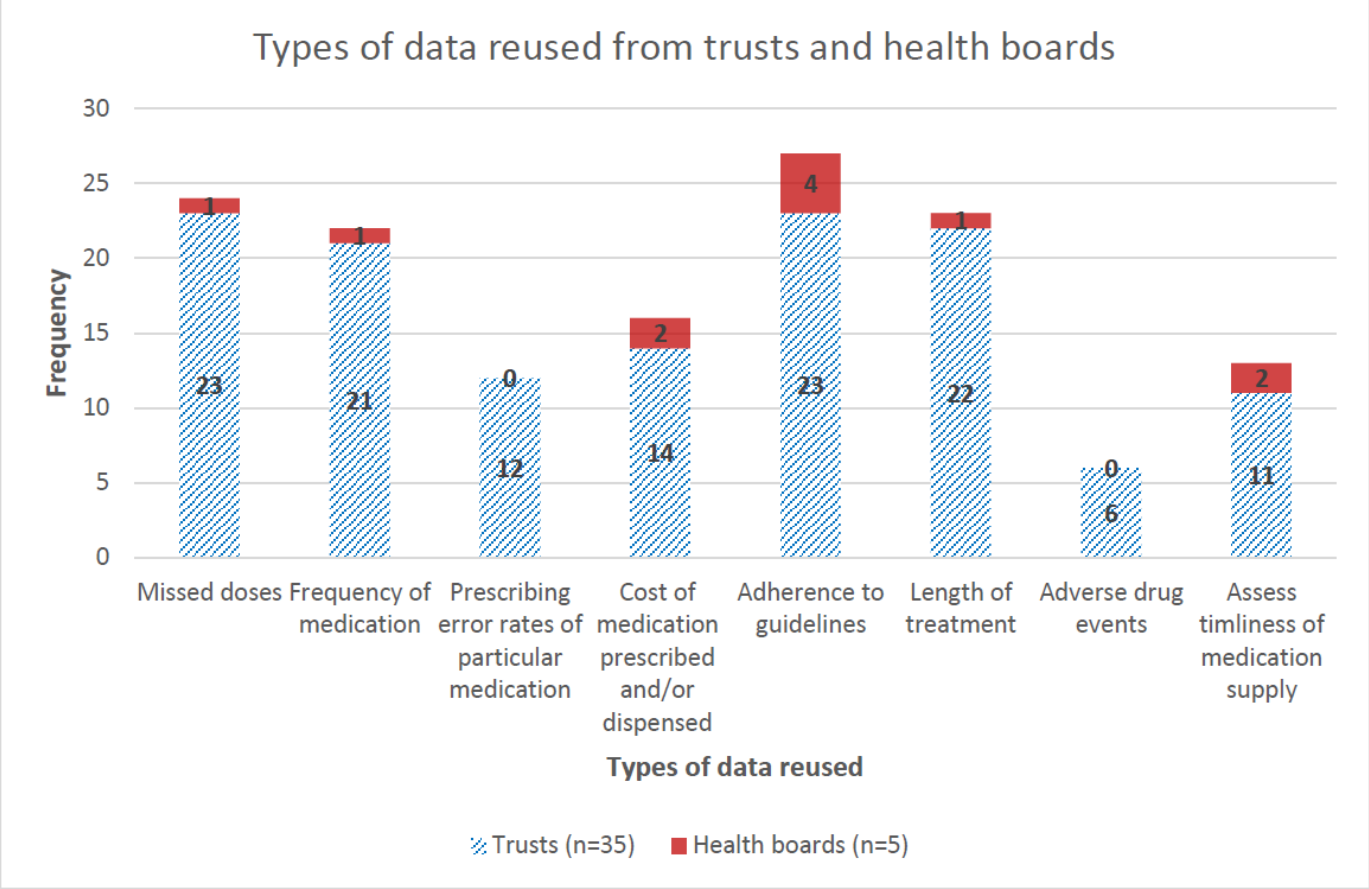

Figure 4 The types of data which is reused from electronic prescribing systems from 40 organisations.

will help them achieve the aims they have set, perceived usefulness of the SUD and the perception that the task is relevant to their job, perceived ease of reusing e-data for secondary purposes, users' experience of reusing data (all with a median value of 7.00) and users being influenced by colleagues view of reusing data (median 6.00). Respondents from health boards also indicated that individuals would tend to reuse data from EP systems when they believe it will help them achieve the aims they have set, perceived usefulness of SUD and the perception that the task is relevant to their job (median value of 7.00). However, lower median scores were identified for perceived ease of reusing electronic data for secondary purposes (median—6.00), users' experience of reusing data (median—5.50) and users being influenced by colleagues' views of reusing data (median—5.50).

Purposes for which EHP system data is reused

The purposes for reusing EHP data were reporting (59 respondents), change in policy (58), audits (55), cost-effectiveness (52), quality improvement projects (50), evaluating interventions (50), identifying quality improvement areas (45), medication use (40), risk management (36), clinical research (30), performance (27) and education (26).

Users of secondary data

Organisations that reused data (n=40) reported that users were pharmacists (40; 100%), followed by doctors (25; 63%), nurses (18; 45%), allied healthcare professionals (8; 20%) and administrative staff (5; 12%).

Categorisation of SUD case studies

The case studies reported by respondents related to drug usage and policy (64 case studies), workflow evaluation or improvement (27), error analysis (13), medicines reconciliation (3) and recruitment for clinical research (1).

DISCUSSION

This study sought to identify the different types of EP and EHP systems implemented within UK hospitals, to discover who is reusing data from EP and EHP systems and for what purposes, to describe secondary use of medication-related data as reported in practice and the factors affecting this. All 65 organisations that responded had at least one EHP system, of which 50 also had an EP system. All organisations reused data from their EHP systems; 40 of 50 reused data from their EP systems. The main incentives for SUD were providing timely feedback, improving medication safety and saving time. The most common types of data reused were prescribing data checking adherence to guidelines, missed doses and

length of treatment. The most common purposes for SUD were risk management, audits and quality improvement projects.

Of the respondents who reused data (n=40), all reported that pharmacists reused data (100%), whereas only 63% stated that doctors did, 45% stated nurses did and only 20% stated allied healthcare professionals did. This variation may be due to different levels of data use across roles or barriers around accessibility to existing data. Further research is required to explore this variation.

As per the hypotheses tested, there was no significant difference in the reuse of data based on the number of EP systems implemented within a trust, nor was there any significant difference between the proportion of teaching and non-teaching trusts reusing data, despite teaching hospitals reporting having been reusing data for a longer period. There was a significant difference in data reuse based on whether organisations had an EP pharmacist, which may be due to individuals having more knowledge and skills about the systems or due to confounding factors such as having an organisation-wide EP system.

Comparison with previous literature

No previous research has explored SUD in a survey format. Previous surveys have examined the number of EP systems implemented.[15] In 2013, Ahmed *et al* conducted an EP survey across England and had a higher survey response with a total of 101 responses (61%); the lower response rate for the present study may be due to the complexity of the SUD topic area.[3] Even though a recent study explored the electronic health record implementation across England (in 2018), they did not specify how organisations are using this data set for secondary purposes.[17] The findings of this study are supported by previous research illustrating the need to consider readily accessible data when implementing or updating electronic systems supporting quality in hospitals via enhancing efficiency, effectiveness and timely data.[26]

Implications for practice

Data from EP and EHP systems can be reused to support improvement in the healthcare provided. This survey has identified many potential use cases for SUD; however, data reuse is relatively underused. This may reflect procurement and implementation strategies for electronic systems, in which SUD may not be an important criterion.[27] Organisations that currently have limited data reuse would benefit from reviewing SUD purposes identified by other organisations, allowing additional ways of reusing their existing data, reducing the cost of new data collection (improving efficiency and timeliness) and potentially enabling better organisational feedback mechanisms supported by local data (enhancing efficiency). Organisations that are currently considering system implementation/upgrade should consider data reuse and ways to overcome the barriers. SUD policies can be embedded in organisations by leaders in healthcare; organisation structure and factors influencing SUD should be considered locally by policymakers to optimise data use from the perspectives of users of data.

Implications for research

All respondent organisations reused data from EHP systems, hence it would be interesting to determine why this data is used more compared with EP and whether this could be based on the ownership of the system, easier or more established reporting capability, the fact EHP systems have been around for longer or perhaps the systems are well-established systems within the organisations. This survey was conducted pre COVID-19, this survey could be repeated to determine how the trusts and health boards have progressed in using existing EP and EHP data. Internationally, it would be interesting to determine whether the UK findings will generalise to other healthcare organisations; whether EHP and/or EP systems data is reused and for what purposes.

Strengths and limitations

Most of the surveys conducted within the UK that focus on EP systems are mostly conducted within England,[15 16] but this study's strength is that it addressed a large gap in the knowledge base around how EP and EHP systems data is reused in practice across the UK. It identified the different types of systems implemented, length of implementation and SUD cases. The findings of this would be applicable not just to the UK, but to other countries that have similar systems implemented. Another strength of this study was the postal survey method; this was selected based on the evidence of a higher response rate compared with electronic surveys.[28]

The limitations of this survey include that it was conducted in one country and aspects of our analysis were exploratory as there was no previous study to base the prior effect size for this study, hence it may be underpowered. The response rate was 35% hence a larger sample of organisations could provide further insights into the phenomenon reported here.

The data were collected in 2016; nevertheless, this survey is the first of its kind to explore SUD in EP and/or EHP systems across trusts and health boards. Other countries that have implemented EP and EHP systems from the same vendors as those in the UK, may find their experience of reusing data to be similar as well.

CONCLUSIONS

Data is being used for secondary purposes from EP and EHP systems across the UK. Case studies of SUD reported by respondents related to workflow evaluation or improvement, medicines reconciliation, drug usage and policy, error analysis and recruitment for clinical research.

Enhanced use of existing data could be used to support the quality of patient care. The results of this survey illustrate there is a further opportunity available for organisations to reuse data from EP systems. It is important to understand the pitfalls or difficulties experienced by organisations in reusing EP data post EP system

implementation. Organisations should place SUD in the forefront when planning EP and EHP implementation, to ensure they can facilitate SUD post implementation in a seamless manner reducing any potential barriers and allocating services in place to support data reuse across the whole organisation.

Contributors The study was planned by NTC with input and revision from JB and BDF. NTC carried out the survey and entered the data into SPSS. NTC completed the data analysis with a review from BDF and JB. All authors contributed towards the writing of the manuscript. NTC is acting as guarantor for the overall content presented.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The survey was considered service evaluation by The Joint Research Compliance Office (JRCO) at Imperial College/Imperial College NHS Trust and therefore did not require Ethics Committee approval. The code for service evaluation was: SE73. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement No data are available.

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