Original Research

Linking NHS data for pediatric pharmacovigilance: Results of a Delphi survey

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Abstract

Background: Adverse drug events are a major cause of patient safety incidents. Current systems of pharmacovigilance under-report adverse drug reactions (ADRs), especially in children, leading to delays in their identification. This is of particular concern, as children especially have an increased vulnerability to ADRs.
Objectives: The objective was to seek consensus among healthcare professionals (HCPs) about barriers and facilitators to the linkage of routinely collected health data for pediatric pharmacovigilance in Scotland.
Methods: A Delphi survey was conducted with a random sample of HCPs including nurses, pharmacists and doctors, working in primary or secondary care, in Scotland. Participants were identified from sampling frames of the target professionals such as an NHS workforce list for general practitioners and recruited by postal invitation. A total of 819 HCPs were invited to take part. Those agreeing to participate were given the option of completing the questionnaires online or as hard copy. Reminders were sent twice at a fortnightly interval. Questions content included description of professional role as well as testing for the willingness to support the proposed project and was informed by the Theoretical Domains Framework of Behavior Change (TDF) and earlier qualitative work. Three Delphi rounds were administered, including a first round for item generation.
Results: 121 of those invited agreed to take part (15%). The first round of the Delphi study included 21 open questions and generated over a 1000 individual statements from 61 participants that returned the questionnaires (50.4%). These were rationalized to 149 items for the second round in which participants rated their views on the importance (or not) of each item on a 9-point Likert scale (strongly disagree – strongly agree). After the third round, there was consensus on items that focused on professional standards, and practical requirements, overall there was support for data linkage and a multi-professional approach.
Conclusions: It would be acceptable to stakeholders to introduce a data linkage system for pharmacovigilance as long as identified concerns are addressed. Concerns included adherence to current professional, legal and ethical standards, as well resolving practical issues.
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Keywords: Mixed methods; Data linkage; Pharmacovigilance; Delphi

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Introduction

It is generally acknowledged that, despite a range of local or national incident reporting schemes, the true rate of adverse drug reactions (ADRs) is still significantly under-reported,[1,2] especially in children. This under-reporting is a concern, as it delays the identification of drug related side effects.

Patients at the extreme ends of the age spectrum are at greater risk of ADRs.[3] Certain enzyme functions or organs are not fully developed in young patients, especially children and babies.[4,5] Although in the UK, licensing requirements for medication include mandatory safety data,[6] this does not necessarily increase the safety of drug treatment for children,[7,8] as pediatric medication was and is still not fully subjected to the current licensing system in the UK.[7] Many of the drugs used in children do not have a license for pediatric use, and are therefore 'unlicensed'; this unlicensed use is associated with an increased likelihood of ADRs.[9,10] Reported figures differ, but it is estimated that five out of eight severe ADRs in pediatric inpatients are linked to off-label use of drugs in children.[11]

A systematic review of papers published between 1986 and 2006 on the views of healthcare professionals (HCPs) towards ADR reporting found that under-reporting was related to lack of knowledge of the reporting system (95%), lack of time or similar reasons (77%), fear of filing an inappropriate report (72%), indifference and uncertainty about causality (67%), and the perception that licensed drugs are safe (47%).[1] Factors associated positively with reporting were training and medical specialty. For example, hospital pharmacists were more likely to report an ADR if they had received specific training.[12]

In the UK doctors, pharmacists, nurses and patients can all report suspected ADRs by the 'yellow card' system.[13] The yellow card system is a spontaneous reporting system in the UK to collect information from both HCPs and the general public on suspected side effects or ADRs to a medicine. Despite a recommendation that all reactions associated with medication used in children must be reported, spontaneous analysis of data for 1999–2003 shows only 7–13% of all reports relate to children, suggesting that ADRs are under-reported in children too.[14]

An alternative approach to spontaneous reporting of suspected ADRs, not dependent on patient or HCP reporting, could be through the linkage of routinely collected health care data in primary and secondary healthcare settings. CHIMES (Child Medical Records for Safer Medicines) was a project that investigated the acceptability and validity of linking datasets derived from routinely collected NHS data. In Scotland, such linkage is possible due to the use of a unique patient identifier, the community health index (CHI) number, recorded for all National Health Service (NHS) patient contacts. The proposed sets for data linkage included the Scottish Morbidity Records (SMR, datasets that collect key aspects of health care related activity within NHS Scotland), as well as data held on attendance in accident and emergency departments, data held on death, the prescribing information available from the Practice Team Information[15] as well as the Prescribing Information Service[16] and GP data held at the Primary Care Clinical Informatics Unit (PCCIU).[17] Linking datasets from primary and secondary care would permit following patients in real time, providing denominators as well as avoiding duplication of signals, i.e. reporting the same reaction twice. Routine data linkage would permit creation of a continuous virtual cohort to monitor for long-term outcomes, for example after exposure to pharmacotherapy, and enable a more efficient screening for side effects or ADRs due to an ever increasing data pool.[18] Creating a cohort big enough can sometimes be challenging in children if the group of patients is below 1000, as can be the case for orphan drugs or rare conditions.[19] Combining existing datasets could maximize the potential to identify safety issues around pediatric medication.[20]

A recent review summarized the views and opinions of HCPs to the secondary use of routinely collected data, for a range of clinical purposes, by either data sharing or linkage across settings. The views were in general positive toward data sharing. Identified barriers included costs, governance issues and a perceived interference with the prescriber and patient relationship. Factors likely to facilitate data sharing were involvement of relevant HCPs in designing the system and perceived usefulness of the system, particularly if HCPs recognized the potential for improving quality of care and patient safety.[12]

Attempts to implement new initiatives for identification or reporting of ADRs are likely to fail if potential barriers are not addressed.[21] Whilst data linkage for pharmacovigilance would not contravene current ethical, legal and practical guidance,[22–25] it is unclear whether frontline

HCPs would support the use of pediatric clinical data for pharmacovigilance. Two qualitative studies conducted with HCPs prior to the work reported in this paper[26,27] found that in general views of the proposed data linkage were positive, but there were also many potential concerns such as confidentiality and access to data.

For successful implementation of the proposed data linkage system, it is essential that frontline HCPs do not change their current behavior and continue to collect and record data. The Theoretical Domains Framework of Behavior Change (TDF)[27] is a theory-based approach that allows areas of concern associated with a particular behavior to be systematically explored. It was identified as an appropriate framework to use to identify the various concerns associated with the introduction of the proposed data linkage system for pharmacovigilance, which would need to be addressed before full implementation of the system.[21,28–31] Delphi surveys are an iterative consensus technique by which issues are progressively refined and reduced in number to reflect the view of the majority.[32] The aim of this study was to use a Delphi survey based on the TDF to seek consensus among HCPs about the barriers and facilitators to linking routinely collected data for pharmacovigilance purposes.

Methods

The study design was a three round Delphi survey, based on the TDF, distributed to a sample of HCPs (doctors, nurses, pharmacists) in Scotland. The behaviors under investigation were those that would 'facilitate the proposed data linkage' and which were specified as three distinct actions: (1) continuing to record data as usual, (2) requesting consent and/or explaining opt-out, and (3) reassuring the patients or their representatives, i.e. explaining the purpose of the linkage to patients/parents. The twelve TDF domains were: (1) knowledge, (2) skills, (3) social and professional role and identity, (4) beliefs about capabilities, (5) beliefs about consequences, (6) motivation and goals, (7) memory, attention and decision process, (8) environmental context and resources, (9) social influences, (10) emotion, (11) behavioral regulation, and (12) nature of behaviors.[33] The study was approved by the North of Scotland Research Ethics Service and NHS Research and Development.

Participants

Doctors, nurses, and pharmacists currently registered to practice in Scotland and whose scope of practice included pediatrics were eligible for participation in the study. HCPs who had participated in preparatory related qualitative work (interviews or focus groups[26,27]) were excluded.

Within a Delphi survey, experts are considered to be "informed experts by reason of their day-to-day involvement" with the question at hand.[34] In the case of this Delphi study, experts were considered to be frontline HCPs, i.e. HCPs currently working as pharmacists, medics or nurses within primary and secondary care, as this Delphi survey aimed to explore potential (if any) barriers and facilitators to the planned data linkage at grassroots level.

Identification, sampling & recruitment

A random sample of doctors ($n = 300$), pharmacists ($n = 300$) and nurses ($n = 300$) was drawn from national sampling frames of the target professionals (NHS Information Services Division workforce list for general practitioners and practice nurses; community pharmacies from a list of registered premises supplied by the Practitioner Service Division (Scotland); pediatricians via the Scottish Pediatric Society; pediatric nurses via the clinical nurse managers of the main Scottish children's hospitals (Aberdeen, Dundee, Edinburgh, Glasgow)). They were invited to take part as described below (see questionnaire administration).

The Delphi Survey

The original authors of the Delphi technique stated that "consensus is assumed to have been achieved when a certain percentage of the votes fall within a prescribed range".[32] The consensus percentage for this Delphi study was set at 66.7% or more (40% or more for preference items, i.e. questions that indicate a preference or a choice) for Round 2 and for 90% or more for Round 3.

Questionnaire development Round 1 – item generation round

The development of the initial items for Delphi Round 1 was informed by results from previously conducted interviews[29] and focus groups[30] exploring a range of issues including potential barriers. Twenty-one draft items were discussed with a panel of experts (health psychologists,

$n = 12$) to check the comprehensibility of the questions and to classify them into the 12 TDF domains. Disagreements were resolved by discussion. Fourteen items were clearly coded into a theoretical domain. Four required discussion before being assigned to a domain and two were considered to relate to two or more domains. All 12 domains were represented (Table 1). Three items concerning ownership of the unlinked and linked data were considered project rather than behavior related. The final Round 1 questionnaire consisted of a mixture of 21 open-ended questions for item generation and multiple choice questions for background and demographic data (all questionnaires are available on request).

Questionnaire development Round 2

Answers to the free-text questions in Round 1 were paraphrased into individual statements by the lead author (YH). Item reduction followed the method described by Prior et al[36] using item *de-duplication, item reduction* and removal of *content overlap*. The final list of items were presented in Round 2 and participants were asked to rate their agreement with these statements on a 9-point, Likert scale (as shown in Fig. 1). Each statement was classified according to the principles outlined in Table 2 with the majority of the statements further grouped under an appropriate overarching statement.

Questionnaire development Round 3

Following the consensus criteria described above, items that generated 66.7% or more (40% or more for preference questions) of either agreement or disagreement in Round 2 were taken forward to Round 3. For each item, the scores from Round 2 were presented to participants before they were asked to rate their agreement again on a scale from 1 (strongly disagree) to 9 (strongly agree) as shown in Fig. 1 (bottom).

Questionnaire administration

All potential participants received an invitation letter, a study information sheet, and a consent form. Two reminders were sent. Those agreeing to take part were asked to indicate on the consent form whether they would prefer a paper or an online version of the questionnaire. For each round participants were sent the appropriate survey either as a paper copy by post or as a web-link by email. Regardless of response to earlier rounds all participants were sent materials for each round. A closing date for each round was provided.

Data management and analysis

Snap® Surveys software was used to generate the questionnaires (both paper based and online) as well as to manage data entry. Data from completed paper based questionnaires were entered online using a specific link for each round. All questionnaire data was then directly imported into a *Snap* database, then exported to SPSS 19[37] for statistical analysis, and to an Excel file (Excel version 2007) to facilitate qualitative analysis of free-text answers. Comparison of answers between different healthcare professions was performed using cross-tabulation. Wilcoxon matched pair test was performed on all items to test for statistically significant shifts in opinion for the Delphi-specific analysis after Round 3, i.e. the analysis of responses from participants who answered both Rounds 2 and 3.

Quality assurance

All questionnaires were piloted prior to distribution in order to assess accessibility of the web-link, understanding, and layout as well as coverage of theoretical domains. Round 1 was piloted amongst GPs ($n = 30$) and community pharmacists ($n = 30$) local to the University to test the suitability of the materials and to gauge response rates. Round 2 was piloted in a focus group consisting of 8 participants with a mixed professional background (experience with TDF $n = 3$, GPs $n = 2$, Pharmacist $n = 1$, Nurse $n = 1$, Psychology $n = 1$). Three members of the previous focus group testing Round 2 materials agreed to pilot the Round 3 materials as well. This ensured consistency with the Delphi process (repeated exposure).

Inclusion of items for Round 2 was discussed with members of the project team (JF, CB) who also contributed to the item reduction process between Rounds 1 and 2. The categorization of the items in Round 3 into theoretical domains was performed independently by the researcher (YH), one supervisor (JF) and a health psychologist (ED) with experience in the use of the TDF. Disagreement was resolved by discussion.

Results

The Delphi survey was conducted in three Rounds from August 2011 to February 2012. The Round 1 participants ($n = 61$) provided 1006 individual answers to free-text questions. These were paraphrased into 1148 individual statements by

Table 1
Initial Item Generation for Round 1 (only items related to the TDF are listed)

Domain	Item
Knowledge (Describe my experience and awareness of the issue/procedure/technique in question)	• Do you have any experience with data linkage? • Have you heard about these datasets before?
Skills (My own competence and ability to perform a task or behavior)	• Have you used these datasets before?
Social/Professional role and identity (Description of my professional role)	• Are your professional standards in conflict with the proposed data linkage?
Belief about capabilities (Belief about whether I am able to perform the target behavior)	• How confident would you feel to facilitate the proposed data linkage?
Belief about consequences (What will follow the introduction of the proposed data linkage from my point of view)	• What would be the benefits/drawbacks of the proposed data linkage? • How long will it take for these (benefits and drawbacks) to show?
Reinforcement* (What could increase my intention/willingness to facilitate the proposed data linkage)	• Would it make you more likely to facilitate the proposed data linkage if you were to receive a financial incentive/results or feedback?
Intention# (Testing my willingness to perform a specific task/procedure/technique)	• If the proposed data linkage infrastructure were to be available, would you facilitate it?
Goal# (Testing potential interference of the planned intervention to my own objectives)	• Would facilitating the proposed data linkage interfere with anything you would like to achieve in your professional practice?
Memory, attention and decision process (Exploring the thought processes behind my decisions and behavior, whether it is something that requires me to focus on performing the behavior in question, and if so, would I forget to do so if I am distracted or busy)	• Would facilitating the proposed data linkage require your particular attention during a consultation with a patient or in your day-to-day work?
Environmental context and resources (Exploring any barriers to the proposed data linkage due to given circumstances and availability of resources)	• Are the necessary resources available for the proposed data linkage? • Which are they?
Social influences (Influences on my behavior by patients, peers, ethical norms)	• To what extent would other people's views influence your own opinion about the proposed data linkage?
Emotion (Consideration of feelings that might be involved with the task in question)	• Would you have any worries or concerns about the proposed data linkage? • What are they?
Behavioral regulation (Examination of steps required to enable the proposed task)	• Who would need to do what in preparation for the proposed data linkage?
Nature of behaviors (Description of the behavior required for the proposed task and investigating whether a behavioral change is required to accommodate the proposed task/intervention)	• Do you have any experience with data linkage? • How different is the proposed data linkage from what you have experienced before? • Can you explain the differences?

Column one denotes the domain (*NB*: in a more recent version of the TDF 'Reinforcement'* is part of the domain 'Belief about Consequences', and 'Intention'# and 'Goal'# are part of the domain; 'Motivation & Goals'.[35]

You provided plenty of information on the expected consequences of facilitating the data linkage:

**Q4   Please indicate your level of agreement with the following statements
(SD = Strongly Disagree / SA = Strongly Agree):**

Facilitating the linkage would result in the early identification of problems with paediatric medication.

Facilitating the linkage would result in the licensing of more medication for children.

Facilitating the linkage would result in safer prescribing.

Facilitating the linkage would lead to improved patient safety.

Facilitating the linkage would provide an evidence base for prescribing in children.

Facilitating the linkage would result in identifying risky prescribing patterns.

Facilitating the linkage would increase my workload.

Facilitating the linkage is beneficial for patient care.

Facilitating the linkage might interfere with the patient's goal of the consultation.

Facilitating the linkage would create pooled information from all sectors for analysis.

Facilitating the linkage might prolong a consultation and hence reduce the number of patients I can see in a day.

Please indicate your level of agreement with the statements (SD = Strongly Disagree / SA = Strongly Agree):

1   Facilitating the linkage is NOT in conflict with my professional standards if the data is anonymised.
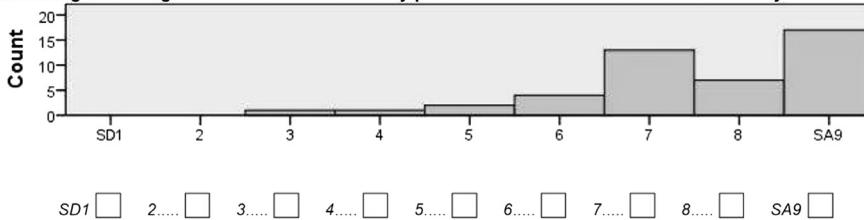

Fig. 1. Example for the layout of questions in Round 2 (top) and 3 (bottom).

the lead author (YH); item *de-duplication* removed 383 statements, *item reduction* removed a further 108 statements, and removal of *content overlap* a further 488 statements, leaving 169 statements. During the pilot of the Round 2 questionnaire, all participants reported that a block of questions ($n = 20$) was too complicated and did not add to the value of the questionnaire. This block of questions was subsequently removed, leaving 149 items for inclusion in Round 2. A total of 46 items qualified for inclusion in Round 3.

Response rates

Of 819 valid invitations sent, 121 participants agreed to take part (15%) and 189 declined (23%). Response rates varied throughout the rounds, with 50.4% for Round 1 ($n = 61$), 35.7% for Round 2 ($n = 46$), and 37.9% for Round 3 ($n = 50$). An overview of the questionnaires sent and returned through the rounds is presented in Table 3.

Demographics

An overview of key demographic data for each round is presented in Table 4. A total of 27 participants provided data for both Round 2 and 3 ('Delphi' Group). The majority of these participants were between the age of 45–65 (77.8%, $n = 21$) and female (80.8%, $n = 21$; one participant chose not to answer). Medical doctors were the biggest respondent group with 40.7% ($n = 11$), followed by nurses (37%, $n = 10$). Participants were employed in seven different health boards, with most from Greater Glasgow and

Table 2
Categories for statements after paraphrasing individual answers from Round 1 (first column states the category; the second column gives examples of usage)

Result (no further action)	These statements were straightforward results (i.e. not requiring further interpretation), an example are the answers provided to the question 2 ("Who do you think these datasets belong to?")
Round 2	These statements were moved onto Round 2 directly, e.g. "It is necessary that patients have the chance to opt-out" (answer to question 24)
Round 2 with adaptation	For statements that dealt with a similar concept, e.g. the items 'The NMC would have to comment on the policies and procedures.' 'GP bodies would have to consent on the data linkage.' Were combined to "The respective professional bodies would have to approve the linkage."
Instructions/Front page	As several answers to different questions were "I would need more information before I can make a decision." more detailed information on e.g. the planned linkage was provided in the instruction for Round 2.
Excluded	Statements were excluded if referring to irrelevant answers such as "I do not have time in my daily practice to consider further paperwork." [*NB*: Facilitating the linkage is not linked to further paperwork.]

Clyde (29.6%, $n = 8$), closely followed by Grampian (25.9%, $n = 7$).

Quantitative results Round 1

Only a small proportion (4.9%, $n = 3$) of participants reported that the proposed data linkage would be in conflict with their professional standards. The majority of medical doctors (70.8%, $n = 17$) considered the proposed linkage to be in line with their professional guidance compared with 40% ($n = 6$) of pharmacists and 38.1% ($n = 8$) of nurses. None of the participants who felt that their professional standards were in conflict with the proposed data linkage provided further explanation when prompted.

The majority of participants (67.2%, $n = 41$) reported no prior experience with linked datasets. A third of participants were either 'confident' (32.8%, $n = 20$) or 'very confident' (4.9%, $n = 3$) that they would be comfortable in facilitating the proposed data linkage. However, participants would facilitate the linkage conditionally with 42.4% ($n = 25$) for the whole cohort including 22% ($n = 13$) of unconditional support.

The majority of respondents indicated that a financial incentive would make no difference to their willingness to facilitate the linkage (62.3%, $n = 38$). Pharmacists (33.3%, $n = 5$) were more inclined to want a financial incentive compared to 4.8% ($n = 1$) of nurses. The majority (63.3%, $n = 38$) also reported being in favor of receiving general feedback of results in return for facilitating the linkage.

Just over one-third (38.3%, $n = 23$) reported that resources, such as access to computers, would not be available for the linkage. A summary of all answers are shown in Fig. 2.

A third of the participants ($n = 19$) provided free-text comments indicating that further information on the datasets used and the proposed data linkage would be required for participants to reach a firm conclusion:

> "This is an interesting project, but it would be useful to know more details of what datasets will be linked and how."(GP, C20)

Additional information on this and other points arising from free-text entries were subsequently taken into account in the production of the subsequent two Delphi rounds.

Results Round 2

A total of 46 items (31%) matched the pre-defined inclusion percentage of 66.7% after Round 2.

Consensus after Round 3

The 13 items for which consensus were greater than 90% in the Delphi group were included in the final analysis (Table 5).

Table 3
Numbers of questionnaires sent out and received for each round

	Number of questionnaire sent			Number of questionnaires received			Response rate (%)
	Postal	Online	Total	Postal	Online	Total	
Round 1	35	86	121	18+1[a]	43+3[b]	61+1[a]+3[b]	50.4
Round 2	42	87	129	17+3[c]	29	46+3[c]	35.7
Round 3	42	90	132	19	31	50	37.9

  [a] Spoilt.
  [b] Duplicates.
  [c] Received after data closing.

Coverage of Theoretical Domains Framework

Using the TDF of Behavior Change to structure Round 1, the domain 'nature of behaviors' was omitted after Round 2. A further two domains, 'emotion' and 'memory, attention and decision process' were omitted after Round 3.

For Round 3, consensus was achieved for allocation of 18 items to one of the prior agreed theoretical domains. For an additional 20 items (43%) two of the three assessors agreed and the majority decision was accepted. Consensus for eight items was reached by discussion and 10 could not clearly be attributed as they described conditions related to the behavior rather than factors that might influence the behavior itself (the latter being a requirement for TDF classification[33]).

Nine of the 12 domains were populated. Two items were allocated to two domains; "*The appropriate IT resources would need to be in place before I can facilitate the linkage*" and "*The government would need to provide funding for the information to be collated and the website to be designed and built*" could either be part of 'behavioral regulation' and 'environmental context and resources'.

Items allocated to five theoretical domains, namely "Social Influences", "Social Role & Identity", "Knowledge", "Behavioral Regulation" and "Environmental Context & Resources", were included in 11 of the 13 items in the >90% agreement group; the two remaining items were classified as 'conditionals' (as shown in Table 5).

Discussion

Main findings

Participants were generally willing to facilitate data linkage as long as adherence to their respective professional standards was maintained and they were given reassurance about the practical aspects of implementation.

Table 4
Tabulated demographics for respondents of the final two rounds

	Round 1	Round 2	Round 3	Delphi Group[b]
Number of respondents	61	46	50	27
Age (45–65 years of age)[a]	72.1% (44/61)	79.4% (27/34)	70.8% (34/48)	77.8% (21/27)
Gender (female)[a]	71.9% (41/57)	87.9% (29/33)	78.7% (37/47)	80.8% (21/26)
Professional background[a]				
Medical doctors	40.0% (24/60)	32.4% (11/34)	39.6% (19/48)	40.7% (11/27)
Nurses	35.0% (21/60)	47.1% (16/34)	39.6% (19/48)	37.0% (10/27)
Pharmacists	25.0% (15/60)	20.6% (7/34)	20.8% (10/48)	22.2% (6/27)
Main setting[c]				
Primary care	62.0% (n = 38)	56.0% (n = 19)	50.0% (n = 25)	52.0% (n = 14)
Secondary care	41.0% (n = 25)	47.0% (n = 16)	48.0% (n = 24)	52.0% (n = 14)
Health boards responding	11	10	10	7
Median No of children [IQR]	3 [1–3]	3.5 [2–4]	3 [1–3]	3 [1–3]

  [a] Demographic data not available for full cohort, numbers in brackets show respondents over the available denominator.
  [b] This column describes the participants who answered Round 2 and Round 3.
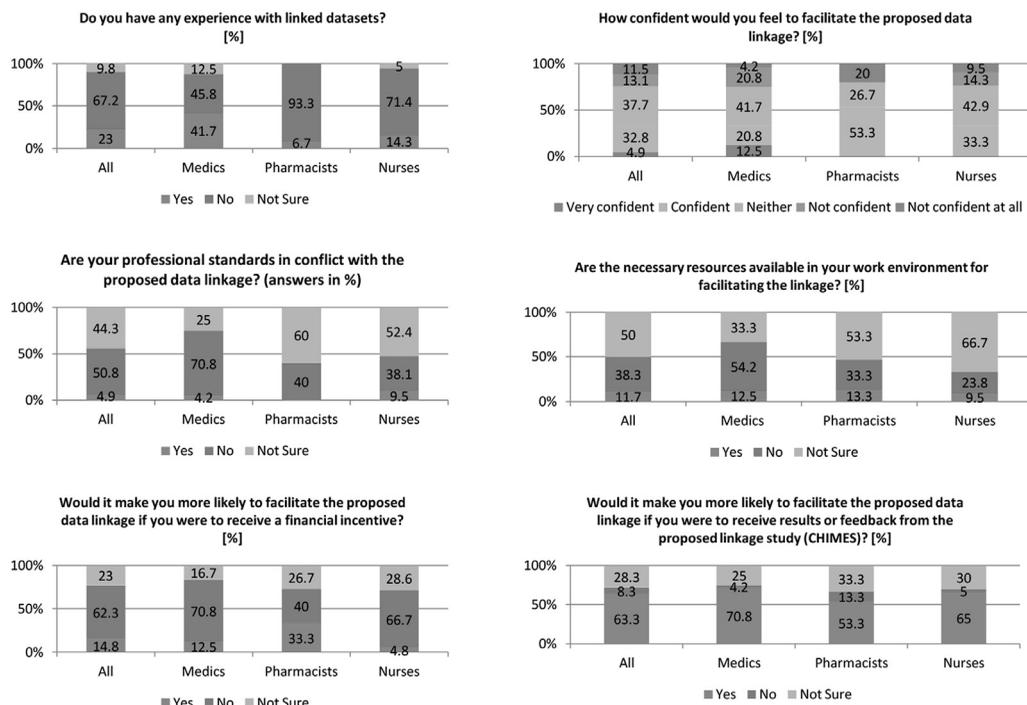 [c] Participants could work in more than one setting, not all participants provided an answer.

Fig. 2. Results of quantitative questions in Round 1.

Strengths and limitations

Due to the large number of questions asked in Round 1 and in order to cover all relevant TDF domains a systematic data reduction exercise was applied to keep the length of the following rounds manageable.[36] Emphasis was on retaining as much of the original wording and context as possible and care was taken to include minority and majority statements in Round 2.[38] However as in all such Delphi exercises item reduction may result in the loss of some subtleties and nuances contained in Round 1.

Not all participants who contributed to Round 1 completed subsequent rounds and, based on submitted study ID numbers of respondents, participants who were not involved in Round 1 contributed to Rounds 2 and 3. However this was unlikely to compromise the study as Round 1 was designed to create a list of statements that could be rated in the consecutive rounds and the Delphi analysis (i.e. the repeated rating of the same statements) only included participants who contributed to both rounds 2 and 3. Previous Delphi studies have described different participant samples for consecutive rounds[34,39] or have replaced the initial

qualitative round, with a literature review in order to generate statements for the quantitative rounds.[40]

Although the questionnaire instructions included information about the potential datasets that could be used in the proposed linkage, comments provided in the questionnaires indicated that participants did not understand some of the terms and abbreviations used-indicating that more information besides the explanation of the abbreviation would have been helpful. Although the current lack of awareness about available clinical and administrative datasets that are routinely collected limits the interpretation of some of the expressed views it highlights the need for effective communication of the proposed and future linkages and training needs of HCPs.

This Delphi survey was initially planned as a large scale survey, with a target sample of 300 participants. Contributions were received from 61 participants only in Round 1. Poor response rates have been reported before with Delphi surveys, attributed to the immense effort that is required by participants such as repetitive questioning, not seeing the relevance or justification for questions.[34,41] However, the sample in this study

Table 5

Consensus items by percentage agreement (participants answering 7, 8, or 9)

Item No	Item [TDF domain]	Agreement (%)
9[a]	When working as part of a team it is important to consider the views of all team members. [Social influences]	100
2[a]	Facilitating the linkage is not in conflict with my professional standards if the data is anonymized. [Social role & identity]	96.3
103[a]	The agencies that currently hold the different datasets need to agree to the sharing of the data. ['Conditionals'[b]]	96.3
105	A good understanding amongst health professionals of the purpose and the benefits of the linkage is required. [Knowledge]	96.3
107	The appropriate IT resources would need to be in place before I can facilitate the linkage. [Behavioral regulation]	96.3
121	Adverse events in secondary care need to be recorded electronically. [Environmental context & resources]	96.3
128[a]	Employers would have to support the facilitation of the linkage. [Behavioral regulation]	96.3
106	Ethical approval for the data linkage is required. [Behavioral regulation]	92.6
109	Prescribers would have to accurately record the indication for the treatment for the data linkage to be successful. [Behavioral regulation]	92.6
3[a]	My professional guidelines do not conflict with my facilitation the linkage. [Social role & identity]	92.5
104[a]	A general awareness of the importance of accurate data handling would be required. ['Conditionals']	92.2
129[a]	A multi-professional approach would be required for initiating necessary changes. [Behavioral regulation]	92.2
4[a]	Facilitating the linkage is not in conflict with my professional standards as long as confidentiality is ensured. [Social role & identity]	92.2

[a] marks items with a significant shift between Rounds 2 and 3 (Wilcoxon matched pair test).

[b] 'Conditionals' do not represent a current domain of the TDF but are included here for completion.

included participants from all relevant professional backgrounds and the majority of Scottish Health Boards and participant numbers were well within the range of previously reported Delphi studies.[34,40]

Planned cross-tabulation for associations of responses in professional grouping could not be performed due to small numbers.

Views of healthcare professionals towards facilitating data linkage

Despite the majority of HCPs reporting in this study that they had no experience with data linkage, a third would still facilitate the proposed data linkage. Low confidence seemed to be associated with a lack of understanding of the proposed data linkage details of what would be expected of the participants, i.e. patients. Previous studies have shown that unawareness of data sharing procedures[42] and lack of knowledge as to how routine data would be used[43] could become a barrier to the implementation of health information exchange. Participants expressing confidence in facilitating the proposed data linkage additionally requested further training and information.

Previous investigations of potential data linkage systems have identified finances, concerns over data governance, and technical problems as barriers to an effective linked pharmacovigilance system.[12] However, none have taken a behavioral approach. Participating in an effective and robust data linkage system would require HCPs to do things differently, i.e. to change their behavior. Hence a recently developed theoretical model designed to identify barriers to changing HCP behavior was used here. The advantage of applying this model is that it provides an evidence base by identifying theoretical determinants of behavior that could then be targeted by interventions to support practice change.[44]

Coverage of all theoretical domains occurred in Round 1, indicating that a comprehensive range of potential issues had been identified in the qualitative studies conducted prior to the Delphi. Over three rounds, there was a reduction in the number of domains resulting in identification of a sub-set

of domains most relevant to the implementation of the new system namely 'behavioral regulation', 'social/professional role & identity', 'belief about consequences', 'environmental context & resources' and 'Belief of consequences (reinforcement)'. This reduction of relevant domains allowed the identification of ways in which identified barriers could be addressed, as discussed in more detail below.

The domain associated with the largest single number of items (*n* = 5) was 'Behavioral Regulation', which identified that ethical approval (item 106), support from employers (item 128) and the accurate recording of indication for treatment (item 109) would be needed before HCPs would give their support. Participants agreed that a multi-professional approach (item 129) would be necessary to implement such a system and encourage the reporting of adverse reactions not only by medical doctors but all HCPs, including specialist nurses and pharmacists authorized to prescribe and monitor.[45]

Consensus items within the domain 'social/ professional role and identity' discussed whether the proposed data linkage was consistent with professional responsibility or professional guidance. The results in the present study demonstrated that participants felt that their own professional standards of practice would not be in conflict with the proposed data linkage.

Although several items relating to the domain 'beliefs about consequences' (e.g. 'facilitating the linkage would result in safer prescribing' or 'facilitating the linkage would result in identifying risky prescribing patterns') fulfilled the predefined criteria for inclusion in Round 3, on further ranking the level of participant agreement decreased. This could have been due to the growing awareness that the proposed linkage would not result in a patient-level identifiable database for prescribers, i.e. a database where individual patients could be identified, but rather a national resource for signal generation to identify potential ADRs.

Statements about resources and the environmental context were apparent through all rounds and identified perceived barriers due to the given circumstances within the NHS and the availability of resources conditions as well as lack of local IT resource and access. Requests for required resources centered on IT and the need to record and check data relating to their own practice and more specifically to the identification and reporting of ADRs electronically despite the availability of the current 'Yellow Card' system in paper and electronic format.[13] The quality of the potentially available data for linking in terms of its completeness and comparability remained an issue although previous research has demonstrated that the data quality of linked data bases can be increased by employing strict internal quality controls and validation.[46,47] These consistent views of HCPs involved in direct patient contact points to an important need to involve them more directly in system design and to encourage their active participation by demonstrating the advantages of using linked aggregated national and large scale regional linked data to address important quality and public health concerns such as prescribing and drug safety.

The requirements identified by the participants in addition to the work conducted prior to the Delphi study[26,27] showed that HCPs would need reassurance before giving full support for the proposed use of linked health data. The "conditional" statements were about the necessity for accurate data recording by frontline HCPs and official procedures for data sharing. However, these statements did not fit the TDF as they did not relate to the participants' willingness (or intention) to facilitate the proposed data linkage but rather the need for the results of linkage studies to provide information directly relevant to their own clinical practice. For example, clinically useful results from the analysis of the linked data could create a stimulus for HCPs to facilitate the proposed linkage. Participants in favor of receiving this kind of incentive thought that data linkage should provide useful audit tools thereby encouraging their participation. However, participants who answered that they were not more likely to facilitate data linkage after receiving such feedback indicated their general support of the linkage regardless of any incentives.

Although financial incentives were not perceived as a facilitator *per se*, pharmacists in particular commented that financial incentives would increase support whereas this was only mentioned by a very small percentage of nurses. This difference could reflect the fact that the majority of pharmacists in the sample were working in community pharmacy settings and who were well used to remuneration for services.

Most items regarding data ownership were dismissed as they did not reach the pre-defined agreement rate, with the exception of the following statement that 'the agencies that currently hold the different datasets need to agree to the sharing of the

data', thus indicating a belief that datasets belonged to the data collector and that consent to the use and sharing of the data by these designated data guardians was important. However, the fact that data ownership was not identified as a major problem might be due to the reported lack of awareness of current data owners and guardians.

Identification of essential system components for data linkage

HCPs commented that the proposed data linkage and system design would have to take account of multi-disciplinary working in the clinical care of children and would have to address legal, ethical, and practical issues including recognition by their line managers of the required time commitment to data verification and data quality.

HCPs would support the data linkage if it complied with their professional standards including working principles (for pharmacists), duties (for medical doctors), or codes (for nurses). Each professional body offers additional guidance on those points, specifying further details. The guidelines of the General Pharmaceutical Council (GPhC) for pharmacists, for example, states that pharmacists should comply with "*relevant legislative requirements*",[48] providing as examples the Data Protection Act and common law principles. Compliance is also expected with non-statutory guidelines that might apply to clinical practice, such as NHS policies or Caldicott principles. Caldicott stands for a set of principles and processes which provide a framework of quality standards for the management of confidentiality and access to patient identifiable information under the leadership of so-called Caldicott Guardians (named responsible person). The extended guidelines concerning confidentiality as published by the General Medical Council (GMC) also state that doctors are expected to follow local policies and guidelines as well as comply with relevant legislation.[49] Complying with professional standards that could inadvertently result in identification of individual patients would require some form of patient involvement prior to data linkage. This does not imply the need for an opt-in system but could allow a readily identifiable opt-out system as long as patients, in this case children and their parents or guardians, were informed about the purpose of the linkage, how the data would be linked and stored and what the linked data would be used for. Relevant parts of the Data Protection Act and the Common Law Duty of Confidentiality for data processing and anonymization also need to be considered in system designs.

HCPs identified evidence of ethical approval for the linkage as an absolute requirement. However, details of the ideal process still need discussion. Who could or would provide ethical approval for the data linkage, and what would the scope be, for example for single studies only or as umbrella approval for all signal generation studies? For the UK, a proportionate review for the use of medical data has been proposed.[50]

Employees who indicated their support also acknowledged that their participation would be dependent on their employer's opinion suggesting the need to convince/win over not only the frontline HCPs responsible for data collection but also higher level stakeholders, including managers and administrators within the NHS/ healthcare system about the potential benefit of data linkage for pediatric pharmacovigilance. The support requested was not specified other than the need for training and provision of necessary IT resources. Although the majority of IT resources would be needed for the construction of the linked datasets, results of the Delphi suggested that participants wanted to be able to record suspected ADRs and indications for medication directly on the electronic data management system relevant to their practice. Although this is currently done in paperless primary care practices, albeit to a varying degree, ADRs are not routinely recorded in hospitals in an electronic and hence accessible and linkable format.

The lack of knowledge about existing clinical and administrative datasets available for linkage within NHS Scotland could explain in part the perceived need for data sharing agreements from current data owners. The shift between rounds might well be a result of participants being swayed towards selecting a higher score. Another possible reason for this change could be that the time between rounds which allowed participants to reflect and possibly research the issue at hand.

Conclusion

In general, the health care practitioners surveyed here indicated intention to facilitate the proposed data linkage, albeit with some reservations. Some system requirements were identified that might be necessary to secure more active support from frontline HCPs for the proposed data linkage. Professional standards were identified

as important, together with a need to adhere to multiple legal and ethical considerations. Three levels of requirements for system design would have to be addressed namely adherence to current legal and ethical standards, support from higher level stakeholders in the NHS and associated employers, and the practical requisites for the data linkage including server space and locally accessible IT resources to record data electronically.

Acknowledgments

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