ABSTRACT

Introduction Genomic sequencing is increasingly enabling precision care across medical specialties; however, the discovery of genomic ‘secondary findings’ (SFs) unrelated to the patient’s primary indication remains a profuse, unintended consequence. Existing practices within the continuum of SF identification, analysis and management are numerous, inconsistent and sometimes contradictory across health conditions and regions. Final decisions are often at the discretion of the genomic sequencing laboratory, bioinformatician or treating physician. This difference in healthcare delivery causes inconsistent information, disclosure and downstream impacts required to manage SFs and patient outcomes. Improving our understanding of the SF health policy landscape can determine components of the SF policy continuum spanning generation through to management that are in conflict, limitations of current guidance and existing needs across clinical settings.

Methods and analysis We will carry out a systematic review to catalogue and appraise current guidance directing the identification, analysis, and management of SFs for participants receiving genomic sequencing globally. We will conduct a comprehensive search of Medline (Medline R, Medline Epub Ahead of Print and Medline-In-Process & In-Data-Review Citations), Embase and Cochrane databases (n=5, inception to Feb 2022) and a grey literature search of international genomics websites (n=64; inception to May 2022). Key inclusion criteria include: guidance produced by health organisations, bioethics committees and professional associations, outlining recommendations for: (1) SF identification, (2) SF analysis or (3) SF management. Non-English language articles and conference abstracts will be excluded. Guidance will be critically appraised with the Appraisal of Guidelines for Research & Evaluation Instrument (AGREE II) tool. We will interpret our findings by process and across populations using a qualitative descriptive approach.

Ethics and dissemination Our systematic review evaluates published data and does not require ethics review. Our findings will be disseminated through peer-reviewed publications, conference presentations and workshops with precision medicine stakeholders. PROSPERO registration number CRD42022316079.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This systematic review will offer the highest level of rigorous, evidence synthesis of the most comprehensive set of international guidance for the identification, analysis and management of secondary findings (SF).

⇒ This systematic review will only consider English-language articles, introducing a potential language bias that may result in missing relevant SF health policy from non-English-speaking countries and international organisations.

⇒ This systematic review will critically appraise the quality and rigour underlying global SF guidance in clinical practice, for the first time, to inform future policy development for the identification, analysis and management of SF.

INTRODUCTION

Over the last decade, the widespread integration of genomic profiling across medical disciplines through programmes like the 100,000 genomes project has dramatically improved our understanding of how to diagnose, manage and treat disease, heralding a new era for precision medicine globally.2–4 This vast expansion of next-generation sequencing (genome, exome and large targeted panel sequencing) has consequently led to the incidental and sometimes opportunistic discovery of ‘secondary findings’ (SFs), genomic variants thought to be unrelated to a patient’s presenting clinical condition. Current guidance relating to (a) the identification of such SFs (ie, which SF genes should actively be interrogated), (b) SF analysis methods including bioinformatic standard practices and (c) downstream SF clinical management (ie, disclosure, screening, surveillance, etc) is incongruous. Legal, ethical and social implications brought about by SF interrogation have led to
numerous SF policies that fluctuate in their recommendations across patients, health conditions and geographic regions globally. 5–8 For instance, the European Society of Human Genetics has taken a cautious approach to SF analysis, similar to that of the Canadian College of Medical Geneticists, 9 whereby the active interrogation or clinical return of SFs is not recommended. 9–11 This is contradictory to parallel recommendations released by the American College of Medical Genetics and Genomes (ACMG) guidelines in 2013 12 (and subsequently updated to recommend a minimum list of 73 SF gene–disease pairs, 13 which represented the first tangible clinical SF disclosure practices and management 5–6 have been unremunerated due to the widespread practice of the genomic sequencing laboratory, bioinformatician or treating physician. This variation leads to differences in healthcare delivery across patients, which can cause inconsistent information, disclosure and downstream impacts required to manage SFs and outcomes for patients.

There are a myriad of SFs which can be categorised into the following ‘bins’: medically actionable genes and pharmacogenomic variants, common disease risk variants, Mendelian disease genes, early onset neurodegenerative disorder genes and carrier status results. 14 However, even genes within these SF categories may differ in their prevalence and impact across patient populations (ie, prenatal, neonatal, paediatric, adult, etc), and these differences should be accounted for by recommended bioinformatic SF analysis pipelines and clinical practice guidelines.

Moreover, significant research efforts to better understand SF analysis and disclosure preferences among patients, clinicians and other healthcare professionals internationally have been conducted; most studies concluded that all three parties favour the analysis and disclosure of clinically relevant findings. 15–16 Parallel research efforts to synthesise evidence surrounding clinical SF disclosure practices and management have been unremunerated due to the widespread practice variation and disparate reporting across studies that limit study generalisability and comparison. Although key policies such as the ACMG V.3.0 guidelines identify a subset of SFs for investigation and report some recommendations for SF disclosure, gaps in guidance remain across the continuum of SF identification, analysis and management, and with respect to how these processes link together. An improved understanding of the landscape of SF health policy is necessary to identify existing gaps and inconsistencies and to inform future policy work.

To address this unmet need, we propose a systematic review of the literature that synthesises current international guidance directing healthcare providers on the identification, analysis and management of SFs. Our systematic review addresses the following question: What are the current health policies guiding the identification, analysis and management of SFs for individuals undergoing genomic sequencing, and how do they vary internationally?

METHODS AND ANALYSIS

Design and registration

This systematic review will follow the 2020 Preferred Reporting Items in Systematic Reviews and Meta-Analyses (PRISMA) guidelines 20–21; and the protocol adheres to the PRISMA-Protocols guidelines. 22–23 The systematic review protocol was registered in the International Prospective Register of Systematic Reviews database on 10 March 2022. Any revisions to the systematic review protocol will be reported in the primary review publication. The PRISMA-P checklist and locations for their corresponding application to this protocol are found in online supplemental appendix.

Eligibility criteria

A complete outline of the PICOS eligibility criteria is found in table 1.

Population

We will include articles that report policy for human participants receiving genomic sequencing. Participants can be healthy or disease-affected individuals or mixed cohorts and can include adult, paediatric, neonatal, prenatal or mixed populations.

Intervention

Only articles which reference (whole) exome-wide, targeted and/or genome-wide sequencing or profiling will be included. Articles do not need to evaluate a comparator group. Included articles must also discuss genomic secondary findings from genomic sequencing, defined as genomic findings to secondary to the primary clinical indication for testing including secondary incidental, additional, unsolicited or unexpected, findings, variants or results. However, articles evaluating policy surrounding the incidental discovery of parental consanguinity through genomic sequencing are beyond the scope of this review and will be excluded.

Outcomes

Articles included must also encompass written guidance (guidelines, policy or statements) produced by international, national and regional governmental and non-governmental health organisations, bioethics committees or professional associations, societies or colleges. Articles which evaluate or build on guidance or policy previously published can be included. Three primary processes will be evaluated. These include written guidance regarding the (a) identification (ie, classes of SFs recommended for evaluation), (b) analysis pipeline for genomic secondary findings (such as bioinformatic pipelines used, filtering and masking procedures, etc) and (c) policy regarding their return and management to individuals or families undergoing genomic sequencing. Secondary processes considered include age-specific distinctions in policy.
Table 1  Eligibility criteria for the systematic review of health policy guiding the investigation and disclosure of genomic secondary findings

<table>
<thead>
<tr>
<th>Inclusion</th>
<th>Exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Population</strong></td>
<td>Articles that do not focus on humans (eg, animal, model organism, in vitro studies).</td>
</tr>
<tr>
<td>Individuals of all ages and disease indications (including healthy populations) receiving genomic sequencing.</td>
<td></td>
</tr>
<tr>
<td><strong>Intervention</strong></td>
<td>Article populations that do not receive exome or genome sequencing or profiling (eg, articles that only involve analysis such as chromosomal microarray (CMA), genotyping, single-gene testing, karyotyping).</td>
</tr>
<tr>
<td>Identification of secondary findings through genomic sequencing (next-generation sequencing such as genome, exome, or targeted genomic sequencing). Secondary findings are defined as secondary incidental, additional, unsolicited, or unexpected, findings, variants or results.</td>
<td>Exclude articles in which secondary findings are not referenced (eg, studies that reference guidance of only primary genomic results/analyses). Articles regarding the incidental discovery of parental consanguinity through genomic sequencing.</td>
</tr>
<tr>
<td><strong>Comparator</strong></td>
<td>Review articles, editorials, commentaries whereby none of the study aims are to develop the relevant guidelines. However, reference lists of relevant excluded articles will be reviewed for any references missed by the search strategy. Non-English language articles. Conference abstracts.</td>
</tr>
<tr>
<td>No comparator groups.</td>
<td></td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
<td></td>
</tr>
<tr>
<td>Written guidance (guidelines or statements) produced by international, national, and regional governmental and non-governmental health organisations, bioethics committees or professional associations relating to the process and/or identification, analyses and/or disclosure of secondary findings to individuals/families undergoing genomic sequencing. Evidence that reports one or more of these processes will be included.</td>
<td>Articles that do not encompass written guidance (guidelines, policy, or statements) produced by international, national, and regional governmental and non-governmental health organisations, bioethics committees or professional associations, societies or colleges. Articles that do not reference the identification, analyses or return of genomic secondary findings.</td>
</tr>
<tr>
<td><strong>Study design</strong></td>
<td>Review articles, editorials, commentaries whereby none of the study aims are to develop the relevant guidelines. However, reference lists of relevant excluded articles will be reviewed for any references missed by the search strategy. Non-English language articles. Conference abstracts.</td>
</tr>
<tr>
<td>All articles (empirical and non-empirical evidence) that address documentation comprising guidelines (such as clinical practice guidelines, reporting guidelines), legislation, position papers, consensus statements and other reports will be included. Review articles (eg, scoping, systematic, etc), editorials, commentaries will be excluded unless one of the aims of the study was to develop the aforementioned guidelines. However, their reference lists will be reviewed for any references missed by the search strategy. Only English-language and full-text articles will be included.</td>
<td></td>
</tr>
</tbody>
</table>

Study design

All articles (empirical and non-empirical evidence) that address documentation comprising guidelines (such as clinical practice guidelines, reporting guidelines), legislation, position papers, consensus statements and other reports will be included. Review articles (eg, scoping, systematic, etc), editorials, commentaries will be excluded unless one of the aims of the study was to develop the aforementioned guidelines. However, their reference lists will be reviewed for any references missed by the search strategy. Only English-language and full-text articles will be included.

Information sources

A professional librarian will run an extensive search in the following databases (n=5; from inception to February 2022): Medical Literature Analysis and Retrieval System Online (MEDLINE; including R, Epub Ahead of Print, In-Process & Other Non-Indexed Citations), Excerpta Medical dataBASE (EMBASE; OvidSP) and Cochrane (Wiley). We will also run a grey literature search of International Federation of Human Genetics Societies (IFHGS) member websites (n=64; from inception to May 2022).

Search strategy

The electronic database search strategy proposed was developed by a professional librarian in MEDLINE and adapted for each of the other databases as needed. Both subject headings and text-word terms for “Gene sequencing” AND “incidental findings” AND “policy” were used. For grey literature searching, terms related to ‘genetic testing’, ‘secondary findings’, ‘analysis’, ‘disclosure’ and ‘management’ will be used to search for records on the search box of all IFHGS member websites. We will include all languages and years covered in the databases but excluded conference abstracts. All references will be saved in an EndNote library used to identify duplicates. The remaining unique references will be reviewed against our inclusion criteria. The references of included articles will be hand-searched for relevant publications that were not identified in the search. Preliminary searches and strategies across all databases, conducted in February 2022, are found in online supplemental appendix table S1–S5.

Data management

All search results will be saved and deduplicated in an EndNote 20.3 library. Records will be transferred to Covidence (www.covidence.org) where record management, screening and data extraction will be conducted.

Screening and data extraction

Each article will be screened independently by two members of the review team (n=6) at each stage (title/abstract, followed by full-text screening) based on the predefined inclusion/exclusion criteria. Conflicts will be resolved through discussion, leading to consensus opinion, and subsequent inclusion of a third reviewer where needed. Reasons for exclusion will only be recorded at the full-text screening phase. The Cohen’s kappa coefficient will be calculated to assess the inter-rater agreement on the study eligibility and full-text screening.
Kappa metric will be calculated to capture inter-rater reliability during screening phases.

Next, two reviewers will independently extract data for each article that is included after full-text screening. Data for extraction include: (a) bibliographic information (publication title, authors, affiliations, date, country of origin in addition to other countries referenced by the article), (b) participant population described (age, sex/gender, race/ethnicity/ancestry, disease phenotype for primary indication), (c) genomic sequencing indicated (type of sequencing such as genome or exome, etc) and (d) processes which include guidance about SF identification and analysis methods (variant analysis and interpretation methods and pipelines, SF categorisation or classification methods, etc), and policy surrounding SF management and disclosure to individuals/families undergoing genomic sequencing (time of disclosure, participants involved, settings, etc).

Risk of bias
Each of the included policies will subsequently undergo critical appraisal. Thus, we will use the Appraisal of Guidelines for Research & Evaluation Instrument (AGREE) II tool, an international tool to assess the quality and reporting of practice guidelines, to identify areas of strength and weakness across the guidance we identify. The AGREE-II tool will evaluate the guidance development processes and the rigor with which each guidance was developed. Specifically, the AGREE tool evaluates six distinct domains: scope and purpose—overall aim of the guideline, stakeholder involvement—role and expectations of stakeholders, rigour of development—gathering and summarising the evidence, clarity of presentation—technical guidance, applicability—barriers and facilitators to implementation, editorial independence—identifying potential biases. Each domain includes items that are scaled from 1 to 7. A quality score is calculated for each of the domains, with an overall score calculated by summing all the domains. Two members of the study team will independently appraise each study. Conflicts will be resolved through discussion and inclusion of a third reviewer if needed.

Evidence synthesis
A qualitative descriptive approach will be used to synthesise and summarise core elements identified across SF guidance. Guidance will be synthesised across target populations and key stakeholders involved in SF genomic sequencing. The recommendations will be coded using an inductive approach to first understand the topics covered within the guidance. Next, key themes underlying these topics will be summarised. Finally, we will compare our themes across populations and stakeholder subgroups (healthcare providers, laboratories, regulatory bodies, researchers, etc) to identify commonalities and differences. The qualitative synthesis from our review will enable us to understand the core elements defined across policy for the identification, analysis and management of SFs and pertaining to various stakeholders and patient populations. We will also describe the topics of guidance that are most debated within the field, presenting all views and policy characteristics (demographics, date of publication, etc) and participant populations referenced. Written guidance pertaining to each of the primary processes will be compared and represented to depict the landscape of SF health policy internationally and across age groups. Overall quality of the included studies from the critical appraisal process will be summarised and used inform final conclusions drawn regarding SF investigation, analysis and management guidance identified internationally.

Patient and public involvement
None.

Ethics and dissemination
The proposed study is a planned systematic review of published data and thus does not contain clinical studies or patient data. There are no ethical or safety concerns. The study findings will be disseminated in a peer-reviewed journal article and conference presentations.

DISCUSSION
The proposed systematic review will report the most comprehensive and up-to-date synthesis of guidance across the entire continuum of SF generation through to management. It will be the only existing review to characterise the quality of guidance produced by organisations and regulatory institutions and identify gaps for future iterations of SF health policy. Our review will search several existing databases in addition to website of international human genetics associations to capture the global health policy landscape for SFs. Existing heterogeneity across SF health policy in genomic precision medicine demonstrates that a singular SF policy cannot sufficiently address all of the components in the SF policy continuum (from identification through to management) and for all patient groups; therefore, we will integrate a qualitative descriptive perspective to interpret and contextualise the results to understand core elements and areas of debate defined across policy for the identification, analysis and management of SFs.

Although our systematic review aims to capture and integrate global perspectives, it will only consider English-language articles. This limitation is particularly relevant for human genetic association websites that are not written in English or house English language articles, as they will not be adequately searched or included. Notwithstanding, we will make note of the non-English websites and articles encountered to better understand how significantly our results are limited and to ensure any conclusions specifically state and adequately represent the countries and perspectives reported.

Author affiliations
1Medical Biophysics, University of Toronto, Toronto, Ontario, Canada
REFERENCES

**Appendix 1.** PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review protocol* applied to the current systematic review protocol

<table>
<thead>
<tr>
<th>Section and topic</th>
<th>Item No</th>
<th>Checklist item</th>
<th>Page number where information was reported</th>
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<td>Identify the report as a protocol of a systematic review</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1b</td>
<td>If the protocol is for an update of a previous systematic review, identify as such</td>
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</tr>
<tr>
<td>Registration</td>
<td>2</td>
<td>If registered, provide the name of the registry (such as PROSPERO) and registration number</td>
<td>Abstract &amp; Design and Registration</td>
</tr>
<tr>
<td>Authors:</td>
<td>3a</td>
<td>Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author</td>
<td>Title Page</td>
</tr>
<tr>
<td></td>
<td>3b</td>
<td>Describe contributions of protocol authors and identify the guarantor of the review</td>
<td>Authors’ Contributions</td>
</tr>
<tr>
<td>Amendments</td>
<td>4</td>
<td>If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments</td>
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<tr>
<td>Support:</td>
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<tr>
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<td>5b</td>
<td>Provide name for the review funder and/or sponsor</td>
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<tr>
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<td>5c</td>
<td>Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol</td>
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<td><strong>INTRODUCTION</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Rationale</td>
<td>6</td>
<td>Describe the rationale for the review in the context of what is already known</td>
<td>Introduction</td>
</tr>
<tr>
<td>Objectives</td>
<td>7</td>
<td>Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)</td>
<td>Introduction</td>
</tr>
<tr>
<td><strong>METHODS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eligibility criteria</td>
<td>8</td>
<td>Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review</td>
<td>Methods &amp; Analysis (Eligibility Criteria)</td>
</tr>
</tbody>
</table>
| Information sources     | 9       | Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage | Methods & Analysis (Information Sources) }
<table>
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<tr>
<th>Search strategy</th>
<th>10</th>
<th>Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated</th>
<th>Supplementary Tables S1-5 &amp; Methods &amp; Analysis (Search Strategy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study records:</td>
<td>11a</td>
<td>Describe the mechanism(s) that will be used to manage records and data throughout the review</td>
<td>Methods &amp; Analysis (Data Management)</td>
</tr>
<tr>
<td>Data management</td>
<td>11b</td>
<td>State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)</td>
<td>Methods &amp; Analysis (Screening and Data Extraction)</td>
</tr>
<tr>
<td>Selection process</td>
<td>11c</td>
<td>Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators</td>
<td>Methods &amp; Analysis (Screening and Data Extraction)</td>
</tr>
<tr>
<td>Data collection process</td>
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<td>List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications</td>
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<td>Data items</td>
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<td>List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale</td>
<td>Methods &amp; Analysis (Eligibility Criteria &amp; Screening and Data Extraction)</td>
</tr>
<tr>
<td>Outcomes and prioritization</td>
<td>14</td>
<td>Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis</td>
<td>Methods &amp; Analysis (Risk of Bias)</td>
</tr>
<tr>
<td>Risk of bias in individual studies</td>
<td>15a</td>
<td>Describe criteria under which study data will be quantitatively synthesised</td>
<td>Methods &amp; Analysis (Risk of Bias &amp; Evidence Synthesis)</td>
</tr>
<tr>
<td>Data synthesis</td>
<td>15b</td>
<td>If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I², Kendall’s τ)</td>
<td>N/A</td>
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<tr>
<td></td>
<td>15c</td>
<td>Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)</td>
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<tr>
<td></td>
<td>15d</td>
<td>If quantitative synthesis is not appropriate, describe the type of summary planned</td>
<td>Methods &amp; Analysis (Evidence Synthesis)</td>
</tr>
<tr>
<td>Meta-bias(es)</td>
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<td>Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)</td>
<td>Methods &amp; Analysis (Risk of Bias)</td>
</tr>
<tr>
<td>Confidence in cumulative evidence</td>
<td>17</td>
<td>Describe how the strength of the body of evidence will be assessed (such as GRADE)</td>
<td>Methods &amp; Analysis (Risk of Bias)</td>
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**Supplementary Table S1.** Search strategy for MEDLINE (OvidSP).

<table>
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<th>Results</th>
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### Supplementary Table S2. Search strategy for Medline Epub Ahead of Print (OvidSP).

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<td>((gen* or antibod* or antigenic) adj2 (variat* or divers* or variat* or heterogeneit* or mutation* or polymorphism* or service* or test or tested or testing or screen* or counsel*)).ti,ab,kf.</td>
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<td>exome*.ti,ab,kf.</td>
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<tr>
<td>9</td>
<td>(medical adj2 genetic*).ti,ab,kf.</td>
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<td>pharmacogenetic*.ti,ab,kf.</td>
<td>205</td>
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<td>or/1-10</td>
<td>10971</td>
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<td>11 and 16</td>
<td>99</td>
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<tr>
<td>18</td>
<td>guideline*.ti,ab,kf.</td>
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<td>(international adj2 (cooperat* or &quot;co-operat&quot;).ti,ab,kf.</td>
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<td>((african or european) adj2 union*).ti,ab,kf.</td>
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<td>((international or medical) adj2 (exchange* or mission*).ti,ab,kf.</td>
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<td>(((organizational or organisational or public or health) adj2 (policy or policies)).ti,ab,kf.</td>
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<td>(privacy or confidentialit* or disclosure* or (parent* adj2 (notify* or notification*)) or &quot;duty to warn&quot;).ti,ab,kf.</td>
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<td>((professional* or physician* or dentist* or clinical*) adj2 (competen* or &quot;practice pattern&quot;).ti,ab,kf.</td>
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## Supplementary Table S3. Search strategy for Medline In-Process & Other Non-Indexed Citations (OvidSP)

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<tr>
<td>9</td>
<td>(medical adj2 genetic*).ti,ab,kf.</td>
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</tr>
<tr>
<td>10</td>
<td>pharmacogenetic*.ti,ab,kf.</td>
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<td>or/1-10</td>
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## Supplementary Table S4. Search strategy for Embase Classic and EMBASE (OvidSP)

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<td>&quot;haplotype map&quot;/</td>
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### Supplementary Table S5. Search strategy for Cochrane

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<td>MeSH descriptor: [Disease Susceptibility] explode all trees</td>
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