The composition and capacity of the clinical genetics workforce in high-income countries: A scoping review

Supplemental Appendix

Database Search Strategy

We chose to limit the included studies to data collected in January 2010 onwards to focus on recent research and capture changes in the genetics workforce as a response to changes in technology and utilization driven by the advent of next-generation sequencing. However, publication date was not a condition for the database searches, since publication year fields can be inaccurately or incompletely populated in literature databases; instead, studies ineligible for inclusion due to publication before 2010 were excluded manually using the results spreadsheet. We used database-specific vocabulary (MeSH and Emtree terms) combined with keywords to capture a broad conceptualization of the genetics workforce. Database searches were performed on April 16, 2019. We searched MEDLINE and Embase through Ovid.

In addition to CADTH recommendations, sources for grey literature were professional organizations related to genetics workforce. When there was the potential for paid content for members (ie: professional practice surveys) we contacted the organization by email or through their website contact form to request access to the documents.

Example: Complete MEDLINE Search

Concept	Keywords	MeSH terms (MEDLINE)
Workforce **S1**	workforce OR manpower OR personnel OR FTE OR Full-time equivalent* OR human resources OR human capital OR profession* OR supply model OR occupation* OR education OR bioinformatician* OR bio-informatician* OR pathologist* OR geneticist* OR counsellor* OR counselor* OR physician* OR doctor* OR clinician* OR counsel*or assistant* OR counsel*ing assistant* OR counse*lor extender* OR counsel*ing extender* OR genetic counsel*ing student OR genetic counsel*ing training OR salary OR	

	salaries OR compensation OR wage* OR workload OR caseload	
S2		workforce/ or health manpower/ or health personnel/ or allied health personnel/ or physician assistants/ or medical laboratory personnel/ or nurses/ or nurse practitioners/ or family nurse practitioners/ or pediatric nurse practitioners/ or nurse specialists/ or nurse clinicians/ or nurses, pediatric/ or nurses, neonatal/ or nursing staff/ or nursing staff, hospital/ or personnel, hospital/ or medical staff, hospital/ or hospitalists/ or laboratory staff/ or laboratory tech/ or pharmacists/ or physicians/ or allergists/ or anesthesiologists/ or assisted reproduction/ or cardiologists/ or dermatologists/ or endocrinologists/ or gastroenterologists/ or general practitioners/ or geriatricians/ or nephrologists/ or neurologists/ or oncologists/ or ophthalmologists/ or otolaryngologists/ or obstetricians/ or gynecologists/ or pathologists/ or pediatricians/ or psychiatrists/ or psychologists/ or neonatologists/ or physicians, family/ or physicians, primary care/ or pulmonologists/ or rheumatologists/ or urologists/ or biochemical disease
S1 OR ***S2*** = ***S3***		
Genetic services/ Medical genetic services/ Clinical genetic services **S4**	geneticist* OR genetic* service* OR genetic counsel* OR genetic test* OR laboratory service* OR laboratory medicine OR genomic test* OR sequenc* OR familial mutation* OR target* mutation* OR chromosom* OR	

	karyotyp* OR prenatal diagnosis OR prenatal test* OR mutation test* OR gene panel* OR exome sequencing OR genome sequencing OR epigenetic test* OR pharmacogen* OR pharmaco-gen* OR genetic risk OR genomic risk OR recurrence risk OR genetic* consultation OR genomic consultation OR clinical geneticist* OR medical geneticist* OR biochemical geneticist* OR biochemical disease* specialist* OR metabolic specialist* OR metabolic disease* specialist* OR genetic* clinic OR biochemical disease* clinic OR metabolic disease* clinic OR newborn screening OR neonatal screening OR carrier screening OR carrier testing OR cascade testing OR cascade screening OR prenatal screening OR genetic* referral* OR family history	
S5		Genetic Counseling/ OR exp Genetic Services/ OR Genetics, Medical/ OR Diagnostic services/ OR Clinical laboratory services/ OR direct-to-consumer screening and testing/ OR Exp genetic testing/
S4 OR S5 = S6		
S3 AND S6= S7		
Workforce (title) **S8**	(workforce OR manpower OR personnel OR worker* OR	

	labo*r OR human resources OR human capital OR profession* OR supply model OR occupation* OR staff* OR training OR education* OR certification OR licensing OR recruitment OR hiring OR retention OR full-time OR part-time OR time OR salar* OR compensation OR wage* OR workplace* OR work setting* OR job location* OR work location* OR work site* OR job site* OR supervision OR workload OR caseload OR FTE).m_titl	
Service delivery models **S9**	service delivery model* OR service model* OR distribution model* OR healthcare delivery OR healthcare system* OR healthcare administration	
S10		"delivery of health care"/ or "delivery of health care, integrated"/ or health services accessibility/ or healthcare disparities/ or practice patterns, nurses'/ or practice patterns, physicians'/ or professional practice gaps/ or telemedicine/ or remote consultation/ or telepathology/ or telehealth/ or telegenetics/ or uncompensated care/
Healthcare administration & economics **S11**	health planning* OR healthcare administration* OR strategic plann* OR workforce analysis OR supply model OR demand model OR efficiency OR	

	workforce plann*	
S12		economics/ or "compensation and redress"/ or economics, medical/ or fees, medical/ or economics, nursing/ or health care sector/ or health planning/ or health care rationing/ or health resources/ or organizational case studies/ or health planning organizations/ or health planning councils/ or "state health planning and development agencies"/ or health systems agencies/ or policy/ or health services administration/ or intersectoral collaboration/ or "organization and administration"/ or capacity building/ or hospital administration/ or personnel management/ or personnel administration, hospital/ or personnel turnover/ or "salaries and fringe benefits"/ or staff development/ or workplace/ or planning techniques/ or strategic planning/ or professional practice/ or group practice/ or health manpower/ OR health personnel/ OR workforce/
Trends/Forecast **S13**	(forecast* OR future OR projection* OR trend* OR predict* OR attrition OR turnover).m_titl.	
S8 OR S9 OR S10 OR S 11 OR S12 OR S13= S14		
FINAL SEARCH: S7 AND S14		

Grey Literature Search Strategy

We used the Canadian Agency for Drugs and Technologies in Health's (CADTH) Grey Matters checklist to keep track of sources searched. Sources include health technology assessment (HTA) agencies, health economics websites, databases, health statistics, practice guidelines, government agencies and genetic counselling/medical genetics associations/organizations. We searched professional association/organization websites for workforce reports. When applicable, we contacted professional organizations by email to request workforce reports. Since most websites and databases only have simple searches available, our search strategy included several variations of key phrases. If advanced searches were available, key terms were combined. We included searches of Google and Google Scholar and reviewed the first 100 hits as sorted by relevance. We also incorporated suggestions from team members of sources and organizations to contact for workforce reports.

Key search phrases (simple search)	Key search terms (advanced search)
- genetic services - laboratory services - laboratory workforce - genetic workforce - genetic counselling (or counseling) - workforce - report - survey	(genetic OR genomic) AND (workforce OR manpower OR personnel)

Search terms for Google and Google Scholar search (review first 100 hits):

- intitle:genetic services workforce
- intitle:genetic test workforce
- intitle:genetic counselling workforce
- intitle:genetic counselling supply

- genetic services workforce pdf
- genetic test workforce pdf
- genetic counselling workforce pdf
- genetic counselling supply pdf

Data Extraction

Included studies were randomly assigned to one of two coders for primary data extraction. Both reviewers completely primary data extraction on 20% of the total number of included studies and the extraction was assessed by a third reviewer for agreement. A subset of fields were chosen to compare for agreement. These were chosen based on items that would likely be used in the table of included studies (eg., year of publication, country of origin, study design, sample size, category of workforce outcome (internal designation), practice setting, and clinical indication). For data categories with disagreements, the coders arrived at consensus, discussed new definitions, and created new categories when appropriate. Following the agreement process, data was extracted from the remaining 80% of studies by either one of the two reviewers. Once the primary data extraction was completed, the included studies were grouped by main category and secondary data extraction was completed within each category for specific outcomes of interest. For example, time needed for tasks was extracted in more detail from studies that reported this metric. Table 1 and the supplementary table of included studies were both based on our data extraction master sheet; however, each study was reviewed again during the creation of these tables to double check the accuracy of the data.

We included all empirical peer-reviewed papers regardless of source in order to be as broad as possible with our scoping review. We excluded papers that were commentaries or editorials. We included grey literature from government, public, and private professional organizations if they reported relevant workforce outcomes. We did not perform any formal measures of appraisal for individual sources of evidence, since this was a scoping rather than a systematic literature review. We limited our grey literature search to CADTH recommendations and professional organizations.

List of High Income Countries (World Bank)

High-income economies are those that had a GNI per capita of $12,376 or more in 2018 (n=80).

Andorra	Denmark	Kuwait	Saint Kitts and Nevis
Antigua and Barbuda	Estonia	Latvia	Saint Martin
Aruba	Faroe Islands	Liechtenstein	San Marino
Australia	Finland	Lithuania	Saudi Arabia
Austria	France	Luxembourg	Seychelles
Bahamas, The	French Polynesia	Macao SAR, China	Singapore
Bahrain	Gibraltar	Malta	Sint Maarten
Barbados	Greenland	Monaco	Slovakia
Belgium	Germany	Netherlands	Slovenia
Bermuda	Greece	New Caledonia	Spain
British Virgin Islands	Guam	New Zealand	Sweden
Brunei Darussalam	Hong Kong SAR, China	Northern Mariana Islands	Switzerland
Canada	Hungary	Norway	Taiwan, China
Cayman Islands	Iceland	Oman	Trinidad and Tobago
Channel Islands	Ireland	Palau	Turks and Caicos Islands
Chile	Isle of Man	Panama	United Arab Emirates
Croatia	Israel	Poland	United Kingdom
Curacao	Italy	Portugal	United States
Cyprus	Japan	Puerto Rico	Uruguay
Czech Republic	Korea, Rep.	Qatar	U.S. Virgin Islands

Source: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

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