Identifying Evidence-Based Pharmacy Practices for the Implementation of Pharmacogenomics Through a Scoping Review

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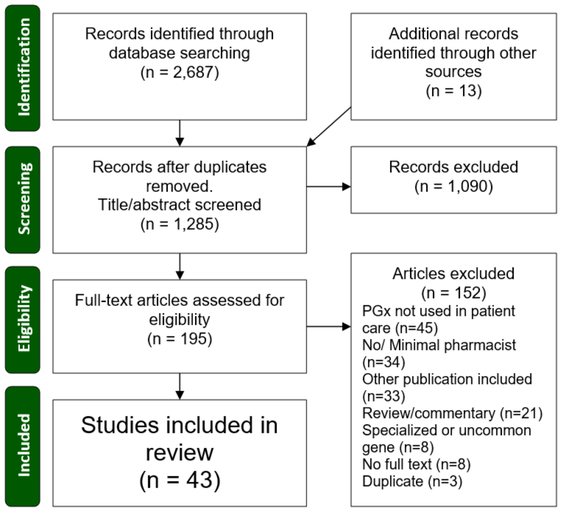
INTRODUCTION

Worldwide, approximately 20% of patients may experience an adverse drug reaction, contributing to up to 30% of hospital admissions.[1] In Canada, this may cost our healthcare system at least $1.1 billion annually.[2] Genetic variation, known as polymorphisms, can occur in the sequences for the translation and/or regulation of metabolizing enzymes, receptors, transporters, and other off-target proteins. The consequential changes in proteins produced can lead to the differences in efficacy or side effects experienced by patients to the same medications.[3] Pharmacogenomics (PGx) can therefore provide valuable pharmacokinetic and pharmacodynamic information for the pharmacist's assessment of drug therapy. No review has comprehensively mapped pharmacists' use of PGx in practice-based research. Doing so would allow future researchers, practitioners, and policy-makers to identify the ideal populations and settings for PGx implementation within the pharmacy.

RESEARCH QUESTIONS

1. **What implementation models for PGx have been studied in pharmacy practice to date?**
2. **What age groups, conditions, or medication classes should community pharmacists focus on for PGx services?**
3. **What common themes or processes exist in studied pharmacist implementation models for PGx?**
4. **What outcomes have been demonstrated in the implementation of PGx in pharmacy practice?**

PRISMA FLOW DIAGRAM[4]



METHODS

SEARCH TERMS
(pharmacist* OR pharmacy OR pharmacies)
AND
(pharmacogen* OR personal?ed medicine* OR personali?ed health OR precision medicine* OR genetic medicine* OR genomic medicine* OR pgx)
AND
(test* OR implement* OR pilot*)

DATABASES
MEDLINE (Ovid)
Embase (Ovid)
Scopus
CINHAL
Web of Science

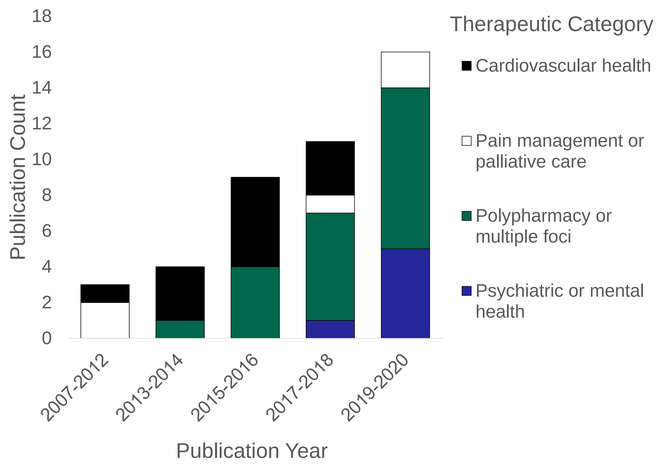
EXCLUDED
Oncology and transplant

INCLUDED
Journal articles & conference abstracts
Studies of pharmacists using PGx in patient care

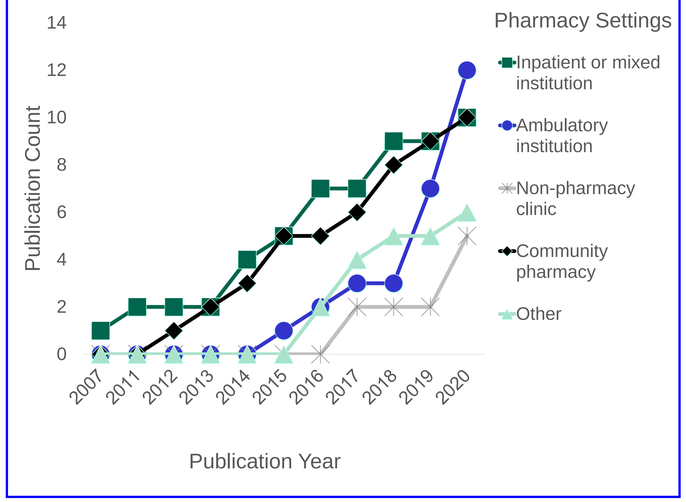
DATA EXTRACTION
Source characteristics
Pharmacy characteristics
Patient demographics
PGx testing methods
Genotyping results
Drug-gene interactions (DGIs)
Medication recommendations
Clinical, economic, and humanistic outcomes
Barriers and facilitators

RESULTS

Pharmacy PGx Research: Therapeutics



Pharmacy PGx Research: Settings



Clinical Outcomes & Target Populations

- ***CYP2C19* with antiplatelets** has high clinical utility
  - 26-38% of patients within studies had a loss-of-function allele
  - Loss-of-function allele-carriers have a more than doubled risk of major adverse cardiovascular events when prescribed clopidogrel vs. alternative antiplatelets (HR 2.26; 95% CI 1.18 to 4.32, p=0.013)[5]
- **Panel testing older polypharmacy patients** have a demonstrated ~50% decrease in hospitalizations and emergency department visits within included studies
- **Panel testing polypharmacy and psychiatric patients** have more drug gene interactions than other therapeutics (most studies with ≥ 1 DGI/patient vs. < 1)
  - Generally, the number of DGIs increases proportionally with the number of genes tested
- **Clinical/symptom benefit** also seen in analgesia selection, proton-pump inhibitor dosing, initial warfarin dosing, and antidepressant treatment with PGx testing in pharmacy settings

Feasibility & Facilitators

- **Collaboration with physicians** improves success
  - Successful studies had pre-existing collaborative relationships
  - ?role of pharmacist prescribing – not discussed in literature but implied use in 2 studies allowed for prompt drug changes
- **Pharmacist education** is imperative
  - 61.4% of pharmacist recommendations accepted by prescribers in studies with defined pharmacist education, vs. 32.7% without education
  - Education included residencies, seminars, exams, board certification, and e-learning
  - Studies without defined education indicated this as a limitation
- **Decision software** facilitated the identification of drug-drug-gene interactions and phenoconversion, however a pharmacist was still necessary to interpret results in team models
- **Time was a consideration:**
  - Single-gene tests take less pharmacist time than multi-gene (≤ 15 minutes vs. ≥ 60 minutes)
  - Slow test turnaround or physician response also delayed patient care in some studies

SUMMARY & CONCLUSIONS

Clinical pharmacogenomics research in pharmacy practice has increased through the last decade. This research occurs in a wide variety of settings within numerous medications classes. *CYP2C19* testing in antiplatelet selection appears to benefit a large proportion of patients tested and was shown to improve cardiovascular outcomes. Single-gene tests such as this are particularly suitable in settings with less time or compensation compared to multi-gene analyses. Panel tests, however, can identify more drug-gene interactions, increasing proportionally with the number of genes tested. Additionally, when used in the older polypharmacy population, panel tests may have greater clinical impact as demonstrated by a reduction in hospitalizations and emergency department visits. Clinical benefit has also been observed in psychiatry, pain management, anticoagulation, and gastrointestinal medicine. Key supports identified in the implementation of pharmacogenomics in pharmacy practice are effective pharmacist training, interprofessional collaboration, and the use of clinical decision support technology.

FUTURE DIRECTIONS

PGx has demonstrated feasibility and improved medication outcomes in many indications within pharmacy practice. This information can be used to target ideal patient populations in future implementation models. Further PGx research should be directed towards models within these indications, especially those with pharmacist education, leveraged technology, inter-professional collaboration, and pharmacist prescribing.

ACKNOWLEDGEMENTS

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