Indicators for Monitoring Cannabis-Related Health Outcomes

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Key Findings

- The 24 studies included in this review assessed the following cannabis-related health outcomes: emergency department (ED) visits, calls to poison centres, hospitalizations, motor vehicle fatalities, substance-use treatment admissions, opioid deaths and suicides.

- The most commonly used indicators of cannabis-related health outcomes were number of cannabis-related ED visits and number of cannabis-related calls to poison centres.

- All articles studied US jurisdictions. Colorado was the most commonly studied US state.

Scope

- This rapid review answers the following question: What indicators have been used to assess cannabis-related health outcomes in studies of non-medical cannabis legalization?

- This review focuses on studies of non-medical cannabis legalization. The indicators used to assess medical cannabis legalization may be different and these are not discussed here.

- While there are a number of possible impacts related to legalization of non-medical cannabis, this review focuses on cannabis-related health outcomes, rather than cannabis use itself or other types of outcomes, such as justice system outcomes.

- The findings of this review will inform public health professionals who wish to identify indicators that can be used to monitor the impacts of non-medical cannabis legalization.

Background

In October 2018, the Canadian federal government legalized the use and supply of non-medical cannabis.[1] Prior to legalization, cannabis was already one of the three most commonly used substances, alongside alcohol and tobacco. For example, in 2017, 15% of Canadians aged 15 years and older reported past-year cannabis use.[2] Cannabis use was also more prevalent among younger Canadians than among older age groups; 19% of youth aged 15 to 19 and 33% of young adults aged 20 to 24 reported past year use in 2017, compared with 13% among adults aged 25 and older.[2]

One objective of Canada's recent legalization of cannabis for non-medical purposes is to improve public health outcomes by protecting public health and safety.[1,3] To understand the impact of this policy change on the health of Canadians, systematic monitoring and evaluation is required. Developing common measures and indicators will standardize reporting and interpretation, enhancing the assessment and monitoring of impacts of non-medical cannabis legalization on population-level health outcomes.

Colorado and Washington became the first US states to legalize non-medical cannabis in 2012.[4] To date, most of the research on non-medical cannabis legalization has been conducted in Colorado, where retail sales of non-medical cannabis to individuals aged 21 and over was initiated in January 2014.[5] Legalization of the use and supply of non-medical cannabis needs to be monitored and evaluated, as there is a gap in knowledge on the impacts of this policy change on population-level health outcomes; however, it is unclear which cannabis indicators are important to monitor. Therefore, the objective of this rapid review is to identify indicators of cannabis-related health outcomes that are used in jurisdictions that have studied non-medical cannabis legalization. This information can support decision-makers in other jurisdictions, as they work to identify indicators to better understand the health impacts of legalization. In Ontario, the review findings can help to inform ongoing monitoring of the health impacts of non-medical cannabis legalization.

Methods

- A rapid review is a form of knowledge synthesis based on the steps of a systematic review, making certain compromises in those steps in order to be timely. In this case, a rapid review was the most practical way to systematically review the most recent evidence.

- To identify the evidence, PHO Library Services conducted an electronic database search in MEDLINE, Embase, CINAHL, and Scopus. The search was conducted on February 2, 2019. Articles from all databases were combined and duplicates were removed.

- A grey literature search was conducted to include unpublished articles. The grey literature search used six search strings in each of the following: a general web search, seven custom search engines including government domains, organization domains, education domains, US state government websites, Canadian Government Publications, Canadian Provincial and Federal Health Departments and Agencies and International Public Health. After each search string was entered, a minimum of six pages of results were screened in the general web search and the government, organization and education domains. A minimum of two records were reviewed after each search string in the government and public health websites.

- The searches included evidence available from January 2014 to January 2019. English language articles were eligible if they examined the impact of non-medical cannabis legalization by comparing jurisdictions that have legalized non-medical cannabis to those that have not or by assessing the same jurisdiction before and after legalization. Articles also had to assess population-level health indicators.

- All titles and abstracts were screened by a single reviewer. A second staff reviewer screened a random 10% sample of the titles and abstracts for verification. Any disagreements were resolved by discussion. Full-text articles that met inclusion criteria were retrieved and reviewed by one reviewer. A second reviewer screened a random 10% sample of full-text articles for verification. A total of 24 articles met all eligibility criteria and were included in this review. Information was extracted from each article by one reviewer. A second reviewer verified data extraction from all articles.

- Information was extracted on the type of article (e.g., study design), jurisdiction analyzed, years analyzed and the indicators used to assess health outcomes in relation to non-medical cannabis legalization. The indicator data was grouped by health outcome (e.g., emergency department visit, hospitalization, poisoning).

- The results of studies on the health effects of legalization were not included in the scope of this review (our focus was on the indicators used to measure outcomes), so data on study results and conclusions were not extracted. Likewise, quality appraisal was not performed, as study quality pertains to confidence in the results, but not necessarily the selection of indicators.

Results

- A total of 4,511 articles were identified across the published literature and grey literature searches. The published literature search identified 4,462 articles, of which 11 met inclusion criteria. The grey literature search identified 49 articles, of which 13 met inclusion criteria. A total 24 articles met inclusion criteria (see Appendix A for PRISMA flow diagram). Most articles that were excluded did not address the impact of non-medical cannabis legalization.

- The 24 included articles included 11 published papers, comprising five retrospective cohort studies, [6, 7, 8, 9, 10] one prospective cohort study,[11] one interrupted time series analysis, [12] one narrative review article,[13] two perspective articles,[14,15] and one letter to the editor.[16] The remaining 13 articles were from the grey literature, comprising eight reports,[17,5,18,19,20,21,22,23] one policy statement,[24] one guideline,[25] one health impact assessment,[26] and two sets of presentation slides.[27,28]

- All 24 included articles focused on the United States. Most articles focused on Colorado, with a much smaller number focusing on Washington and Oregon.

- The most commonly used health outcome indicators were the number and rate of ED visits and the number of calls to poison centres for cannabis exposure, followed by number of drivers testing positive for tetrahydrocannabinol (THC) in fatal vehicle collisions, number and rate of hospitalizations, number and rate of addiction treatment admissions, number of opioid-related deaths (e.g., hypothesized that opioid use and harms will decrease in association with legal cannabis access) and number of suicide deaths with positive tests for cannabis (Table 1). The indicators are summarized by the health outcomes they were intended to measure.

Table 1. Overview of articles that met inclusion criteria (n = 24)

Health outcome	Indicator	Number of articles	Reference numbers
Emergency department (ED) visits	Number and rate of ED visits related to cannabis	18	5-9, 13-20, 24-28
Calls to poison centres	Number of calls to poison centres for cannabis exposure	18	5, 6, 9, 10, 13-15, 17-25, 27, 28
Motor vehicle fatalities	Number of fatalities with driver testing positive for THC	11	5, 11, 13, 18-22, 24-26
Hospitalizations	Number and rate of hospitalizations related to cannabis	10	5, 9, 14, 15, 17, 19, 20, 25, 27, 28
Treatment	Number and rate of cannabis	7	5, 13, 19-22, 28

Health outcome	Indicator	Number of articles	Reference numbers
admissions	treatment admissions		
Opioid deaths	Number of deaths that tested positive for opioids	4	12, 18, 20, 25
Suicide	Number and percentage of all suicide deaths that tested positive for cannabis	2	5, 20

Emergency Department (ED) Visits

- **Indicators:** The most commonly reported indicators were the annual count of cannabis-related ED visits and the rate of cannabis-related ED visits per 100,000 visits.[5-9, 13-15, 17-20, 24, 26, 27]

- **Data sources:** The most common data source for these ED indicators was Colorado Hospital Association discharge data.[5, 7-9, 15-18, 20, 24, 27, 28]

- **Stratifiers:** These indicators were stratified by age, sex, county, disposition, source, product involved (e.g., baked goods, candies) and race/ethnicity.[6, 7, 17, 27, 28]

- **Case identifiers:** Cannabis-related visits were defined using ICD-9-CM and ICD-10-CM codes for cannabis dependence, abuse or poisoning (the ICD-9-CM codes for poisoning are for a group of hallucinogens and are not specific to cannabis).[5-9, 16, 17, 20, 27]

Calls to Poison Centre

- **Indicators:** The most common way that the articles reported calls to poison centre was in the number of calls for cannabis exposure per year.[5, 9, 10, 13-15, 17, 19-23, 27, 28]

- **Data sources:** The National Poison Data System (NPDS) is the most common data source for these indicators. While the data is accessed from NPDS, the data itself mainly consists of calls made to regional poison control centres, such as the Rocky Mountain Poison and Drug Center.[5, 6, 9, 10, 13, 15, 17, 18, 20, 27, 28]

- **Stratifiers:** These indicators were stratified by age, sex, intent for exposure, origin of call (e.g., private residence, health care facility), site of exposure (e.g., private residence, school), level of care received (e.g., health care facility), clinical outcome, product involved (e.g., smoked, edible) and county.[5, 6, 9, 10, 17, 20-23, 27, 28]

- **Case identifiers:** Codes used to identify cannabis exposure reported to poison centres included the NPDS generic code for marijuana (0083000).[6, 9, 17, 27]

Drivers who Tested Positive for THC in Fatal Crashes

- **Indicators:** The most commonly reported indicators were the annual number of fatalities with drivers testing positive for THC and the percentage of fatalities that were cannabis-related.[5, 11, 13, 18-22, 24-26]

- **Data sources:** A common data source for these indicators was the National Highway Traffic Safety Administration's Fatality Analysis Reporting System.[5, 11, 18, 24]

- **Stratifiers:** These indicators were stratified by age, type of THC (e.g., active THC, carboxy-THC) and Delta-9 THC level.[5, 21]

- **Case identifiers:** Cannabis-related traffic fatalities were identified as those in which the driver tested positive for THC.[20, 25] Delta-9-THC is the main compound in cannabis that produces psychoactive effects, but quickly dissipates from the blood. Another active compound is 11-OH-THC, but also dissipates quickly. THC-COOH is an inactive compound that is detectable for a longer period of time. It is not always possible to identify which compound was tested using available data sources.[5]

Hospitalizations

- **Indicators:** The most commonly reported indicators were the annual count of cannabis-related hospitalizations and rate per 100,000 hospitalizations.[5, 9, 14, 15, 17, 19, 20, 27]

- **Data sources:** The most common data source for these indicators was Colorado Hospital Association discharge data.[5, 9, 15, 17, 20, 27, 28]

- **Stratifiers:** These indicators were stratified by age, sex, county and race/ethnicity.[17]

- **Case identifiers:** Cannabis-related hospitalizations were defined using ICD-9-CM and ICD-10-CM codes for cannabis dependence, abuse or poisoning (the ICD-9-CM codes for poisoning are not specific to cannabis).[5, 9, 17, 19, 20, 27]

Addiction Treatment Admissions

- **Indicators:** The most common indicators were the annual number of treatment admissions where cannabis was the primary drug used, the percentage of total admissions where cannabis was the primary drug used and treatment rates per 100,000 people.[5, 13, 19, 20-22, 28]

- **Data sources:** Data sources for treatment admissions indicators consisted of state-level offices including the Colorado Department of Health Services' Office of Behavioral Health and Washington's Department of Social and Health Services.[5, 20, 22]

- **Stratifiers:** The indicators were stratified by age, sex, race/ethnicity, county, clinical impression of severity of cannabis use, referral source and treatment modality (e.g., residential, outpatient).[5, 13, 19, 20, 21, 28]

- **Case identifiers:** One article defined treatment admissions using mandatory data collected from licensed providers as a requirement under the Substance Abuse and Mental Health Service Administration, which includes the three primary drugs used, demographics, referral source, referral reason, time in treatment and more.[5]

Opioid Deaths

- **Indicators:** The articles reported the number of monthly opioid-related deaths, percent change in deaths since legalization or the opioid overdose death rate.[12, 18, 20, 25]

- **Data sources:** Data sources for this indicator included the Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research system and state-level offices, such as Colorado Department of Public Health and Environment.[12, 20]

- **Stratifiers:** The only stratifier was whether death was caused by a pharmaceutical opioid or heroin.[20]

- **Case identifiers:** One article defined opioid-related deaths as any ICD-10 code indicating opioid poisoning (both pharmaceutical and non-pharmaceutical).[12]

Suicide

- **Indicators:** The two articles reported the number of suicide deaths positive for cannabis and the percent of all suicide deaths that were positive for cannabis.[5, 20]

- **Data sources:** The two data sources used to retrieve these indicators were the Colorado Department of Public Health and Environment's Violent Death Reporting System and data from Colorado's Coroner's Office.[5, 20]

- **Stratifiers:** Age was the only stratifier. [20]

- **Case identifiers:** The two articles utilized toxicology reports testing positive for THC to identify cannabis-related suicide deaths.[5, 20]

Discussion

- The most commonly measured indicators were number and rate of ED visits related to cannabis and cannabis-related calls to poison centres.

- Drivers testing positive for THC in fatal crashes, hospitalizations related to cannabis, cannabis-related treatment admissions, opioid deaths and suicides were also examined in included articles.

- This review provides an understanding of indicators used to monitor health outcomes in the first jurisdictions to legalize non-medical cannabis.

- Data availability and access, as well as specific indicator development, may influence how the use of these approaches could apply in Ontario.

- Monitoring relevant indicators improves understanding of the health impacts of cannabis legalization and can inform policies and programs.

- Measuring the health impacts of cannabis legalization is still in its early stages. More research and surveillance needs to be conducted to better understand the implications of this major policy change.

Limitations and Strengths

- This is a rapid review and may not include every article that assessed non-medical cannabis legalization.

- Some indicators are defined using ICD-9 codes that are not specific to cannabis. Therefore, cannabis may not have been the cause of ED visits, hospitalizations or calls to poison centres in these cases.

- Indicator selection in the included articles was dependent on data availability in those jurisdictions and may not include the data most indicative of cannabis-related health impacts.

- As no articles outside the US were identified, results may be less relevant to other countries that may have different data collection systems and indicator availability.

Conclusion

- The articles included in this rapid review provide examples of indicators of cannabis-related health outcomes that can be used to assess the impact of legalization of non-medical cannabis.

- This review will help inform the development of indicators among researchers, epidemiologists and data analysts who plan to estimate changes in cannabis-related health outcomes following legalization of non-medical cannabis.

Appendix A – PRISMA
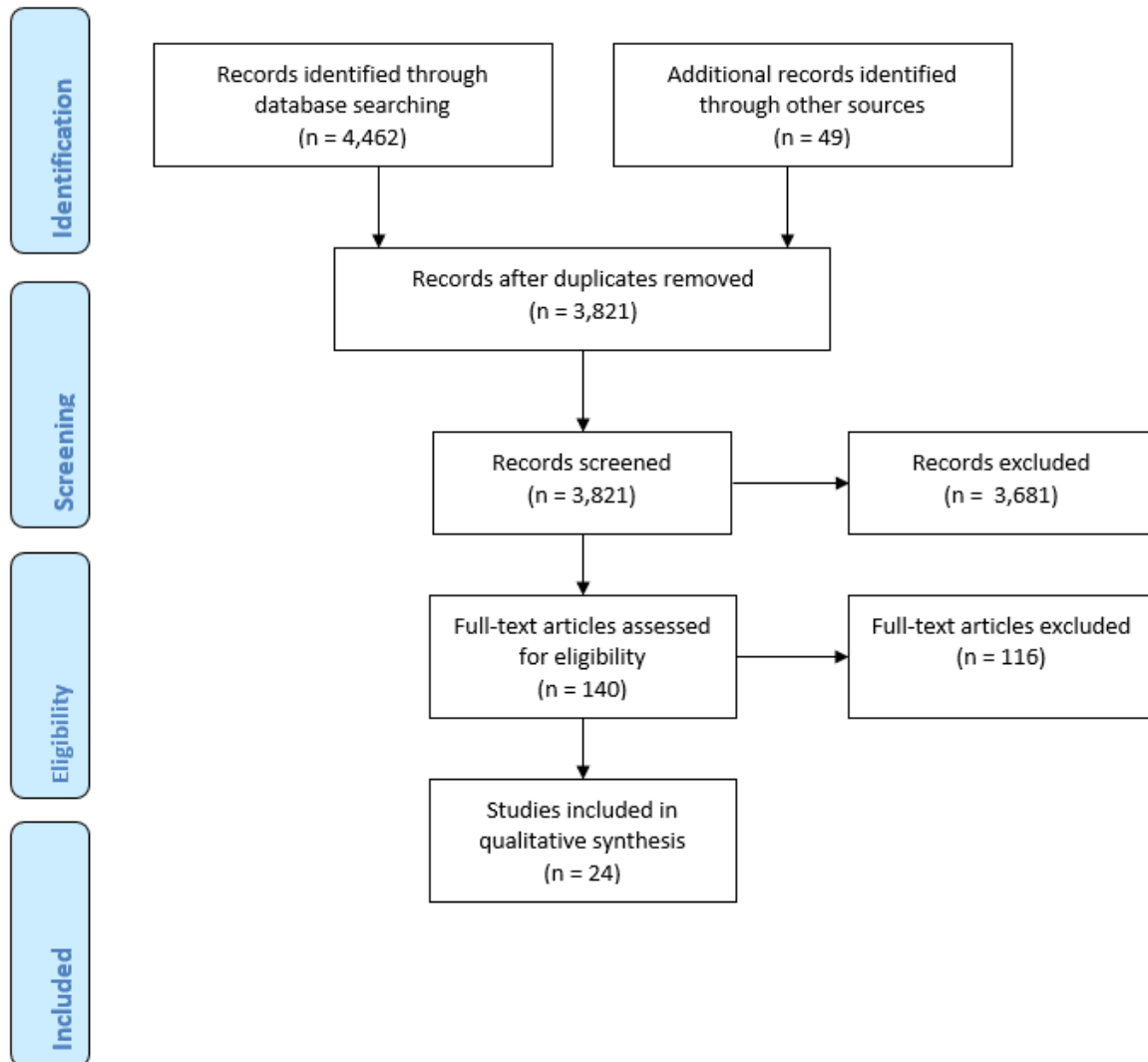
Adapted with permission from: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med. 2009;6(7): e1000097. Figure 1, Flow of information through the different phases of a systematic review. Available from: http://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1000097.

Appendix B – Diagnosis Codes

ICD-10-CM (2016 release) [29]

F12   Cannabis related disorders

        Includes: marijuana

        F12.1   Cannabis abuse

                Excludes1: cannabis dependence (F12.2-), cannabis use, unspecified (F12.9-)

                F12.10 Cannabis abuse, uncomplicated

                F12.12 Cannabis abuse with intoxication

                        F12.120 Cannabis abuse with intoxication, uncomplicated

                        F12.121 Cannabis abuse with intoxication delirium

                        F12.122 Cannabis abuse with intoxication with perceptual disturbance

                        F12.129 Cannabis abuse with intoxication, unspecified

                F12.15 Cannabis abuse with psychotic disorder

                        F12.150 Cannabis abuse with psychotic disorder with delusions

                        F12.151 Cannabis abuse with psychotic disorder with hallucinations

                        F12.159 Cannabis abuse with psychotic disorder, unspecified

                F12.18 Cannabis abuse with other cannabis-induced disorder

                        F12.180 Cannabis abuse with cannabis-induced anxiety disorder

                        F12.188 Cannabis abuse with other cannabis-induced disorder

                F12.19 Cannabis abuse with unspecified cannabis-induced disorder

        F12.2   Cannabis dependence

                Excludes1: cannabis abuse (F12.1-), cannabis use, unspecified (F12.9-)

                Excludes2: cannabis poisoning (T40.7-)

                F12.20 Cannabis dependence, uncomplicated

                F12.21 Cannabis dependence, in remission

                F12.22 Cannabis dependence with intoxication

                        F12.220 Cannabis dependence with intoxication, uncomplicated

                        F12.221 Cannabis dependence with intoxication delirium

                        F12.222 Cannabis dependence with intoxication with perceptual disturbance

                        F12.229 Cannabis dependence with intoxication, unspecified

                F12.25 Cannabis dependence with psychotic disorder

                        F12.250 Cannabis dependence with psychotic disorder with delusions

                        F12.251 Cannabis dependence with psychotic disorder with hallucinations

                        F12.259 Cannabis dependence with psychotic disorder, unspecified

                F12.28 Cannabis dependence with other cannabis-induced disorder

                        F12.280 Cannabis dependence with cannabis-induced anxiety disorder

                        F12.288 Cannabis dependence with other cannabis-induced disorder

                F12.29 Cannabis dependence with unspecified cannabis-induced disorder

        F12.9   Cannabis use, unspecified

                Excludes1: cannabis abuse (F12.1-), cannabis dependence (F12.2-)

                F12.90 Cannabis use, unspecified, uncomplicated

                F12.92 Cannabis use, unspecified with intoxication

                        F12.920 Cannabis use, unspecified with intoxication, uncomplicated

                        F12.921 Cannabis use, unspecified with intoxication delirium

                        F12.922 Cannabis use, unspecified with intoxication with perceptual disturbance

                        F12.929 Cannabis use, unspecified with intoxication, unspecified

                F12.95 Cannabis use, unspecified with psychotic disorder

F12.950 Cannabis use, unspecified with psychotic disorder with delusions

F12.951 Cannabis use, unspecified with psychotic disorder with hallucinations

F12.959 Cannabis use, unspecified with psychotic disorder, unspecified

F12.98 Cannabis use, unspecified with other cannabis-induced disorder

F12.980 Cannabis use, unspecified with anxiety disorder

F12.988 Cannabis use, unspecified with other cannabis-induced disorder

F12.99 Cannabis use, unspecified with unspecified cannabis-induced disorder

T40 Poisoning by, adverse effect of and underdosing of narcotics and psychodysleptics [hallucinogens]

Excludes2: drug dependence and related mental and behavioral disorders due to psychoactive substance use (F10.-F19.-)

The appropriate 7th character is to be added to each code from category T40

A - initial encounter

D - subsequent encounter

S - sequela

T40.7 Poisoning by, adverse effect of and underdosing of cannabis (derivatives)

T40.7X Poisoning by, adverse effect of and underdosing of cannabis (derivatives)

T40.7X1 Poisoning by cannabis (derivatives), accidental (unintentional)

Poisoning by cannabis NOS

T40.7X2 Poisoning by cannabis (derivatives), intentional self-harm

T40.7X3 Poisoning by cannabis (derivatives), assault

T40.7X4 Poisoning by cannabis (derivatives), undetermined

T40.7X5 Adverse effect of cannabis (derivatives)

T40.7X6 Underdosing of cannabis (derivatives)

ICD-9-CM (2011 release) [30]

304   Drug dependence

Excludes: nondependent abuse of drugs (305.1-305.9)

The following fifth-digit subclassification is for use with category 304:

0 unspecified

1 continuous

2 episodic

3 in remission

304.3 Cannabis dependence

[0-3]

Hashish

Hemp

Marihuana

305   Nondependent abuse of drugs

Note: Includes cases where a person, for whom no other diagnosis is possible, has come under medical care because of the maladaptive effect of a drug on which he is not dependent and that he has taken on his own initiative to the detriment of his health or social functioning.

Excludes: alcohol dependence syndrome (303.0-303.9)

drug dependence (304.0-304.9)
drug withdrawal syndrome (292.0)
poisoning by drugs or medicinal substances (960.0-979.9)
The following fifth-digit subclassification is for use with codes 305.0, 305.2-305.9
0 unspecified
1 continuous
2 episodic
3 in remission
305.2   Cannabis abuse
[0-3]

969   Poisoning by psychotropic agents
Use additional code to identify:
drug dependence (304.0-304.9)
nondependent abuse (305.0-305.9)
969.6   Psychodysleptics [hallucinogens]
Cannabis (derivatives)
Lysergide [LSD]
Marihuana (derivatives)
Mescaline
Psilocin
Psilocybin

E854   Accidental poisoning by other psychotropic agents
E854.1 Psychodysleptics [hallucinogens]
Cannabis derivatives
Lysergide [LSD]
Marihuana (derivatives)
Mescaline
Psilocin
Psilocybin

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Public Health Ontario

Public Health Ontario is a Crown corporation dedicated to protecting and promoting the health of all Ontarians and reducing inequities in health. Public Health Ontario links public health practitioners, front-line health workers and researchers to the best scientific intelligence and knowledge from around the world.

Public Health Ontario provides expert scientific and technical support to government, local public health units and health care providers relating to the following:

- communicable and infectious diseases

- infection prevention and control

- environmental and occupational health

- emergency preparedness

- health promotion, chronic disease and injury prevention

- public health laboratory services

Public Health Ontario's work also includes surveillance, epidemiology, research, professional development and knowledge services. For more information about PHO, visit: publichealthontario.ca.

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