

## EVIDENCE BRIEF

# Foraged Mushroom Consumption in Ontario



November 2019

## Key Messages

- Wild mushrooms are widespread in Ontario, and are harvested by individual hobbyists and commercial enterprises for public consumption. Many species are poisonous. Health effects of such species can range from mild to severe, including death. However, serious poisonings are rare.
- There are no simple tests to determine if a mushroom is poisonous. Safe consumption of wild mushrooms and other wild foods requires they be correctly identified by knowledgeable harvesters. Over a thousand calls were made to the Ontario Poison Centre (OPC) over a recent 5-year period that were mushroom-related, with at least 90 cases resulting in hospital admission.
- There are no reported cases of poisoning linked to commercial foraging. However, currently there is no mechanism for licensing or accrediting wild mushroom foragers.

- Wild mushrooms are found in Ontario's farmers' markets. Certain farmers' market food vendors are exempt from the Food Premises Regulation. However, assessments and inspections may be carried out to ensure compliance with the Health Protection and Promotion Act.

## Issue and Research Question

Foraging of wild mushrooms occurs in diverse communities, including some within Ontario.<sup>1-3</sup> Foraged mushrooms may be sold in farmers' markets, grocery stores, health food stores, restaurants, and online.

There are reported cases of adverse health outcomes from consuming foraged mushrooms.<sup>1</sup> Public health units in Ontario have requested advice from Public Health Ontario in response to concerns of potential adverse health effects from consumption of wild foraged mushrooms being sold in their regions.

This evidence brief examines the:

- Practice of wild mushroom foraging in Ontario.
- Potential health hazards of consuming foraged mushrooms.
- Regulatory framework that may pertain to the sale of foraged mushrooms in Ontario.

## Methods

A review of literature on mushroom poisoning in Canada was conducted using PubMed. The search was limited to literature published in English from January 1, 1968 to August 30, 2018. The search terms were: mushroom and (edible or forage\* or wild) and (poison\* or intox\* or toxic\* or death or hospital\* or health or injury or harm) and (Canada or Ont\* or North America or United States). This search resulted in 83 results. Titles and abstracts were screened for relevance to health effects from consumption of foraged mushrooms, resulting in 19 results. Additional information was identified through cited reference searching of full-text articles.

We performed an additional search of grey literature through Google. The search terms were edible OR foraged OR wild mushrooms, Ontario, Canada, poison\*, toxic\*. The search was performed on September 10, 2018, and the first 10 pages of results were reviewed.

Species that are known by Ontario mycologists to have caused poisonings were examined in biomedical databases for geographically relevant case reports.

An unpublished checklist of over 650 mushroom species collected over more than 25 years by members of the Mycological Society of Toronto at their annual Roy Cain Fall Foray was consulted (see recent years' lists at <https://www.myctor.org/forays/cain/caincollections>), as was Prof. George Barron's *Mushrooms of Ontario and Eastern Canada*.<sup>4</sup>

Lastly, we obtained data from the Ontario Poison Centre (OPC) for call data related to mushrooms over the years 2013-2017, although it is recognized that a 5-year window may not capture the multi-year variability typically seen in mushroom species abundance, and thus not fully reflect potential for mushroom poisoning.

## Main Findings

### Wild Mushrooms in Ontario

Mushrooms are the spore-bearing fruiting bodies of fungi and consist of interwoven and fused hyphae.<sup>4</sup> They arise from a network of absorptive hyphae embedded in soil or decaying organic matter such as wood or animal dung. Many species form symbiotic relationships with tree roots where they establish extensive networks of underground mycelium. These networks typically bear mushrooms on annual cycles whose timing is species-dependent. However, many species fruit at far less frequent intervals, subject to environmental factors such as seasonal weather trends, fires and other perturbations.<sup>4</sup>

There are estimated to be thousands of different species of mushrooms in Ontario.<sup>4</sup> Some are found throughout the province, while others are present only in specific regions. As many fungi have symbiotic relationships with trees, the geographic distributions of mushrooms vary to a great extent on the distribution of tree species. Paradoxically, forests with low tree diversity can exhibit high mushroom diversity. Other factors that affect the diversity of mushroom species in the forest include the age of the forest, soil type and climatological conditions, particularly precipitation.

The ‘ideal’ edible wild mushroom species for beginning foragers is easy to recognize, hard to misidentify, has no toxic look-a-likes, is consumed without ill effects, and is readily available.<sup>4</sup> The ability to recognize an edible mushroom, and not mistake edible for poisonous, requires knowledge and experience. There are no simple tests that yield accurate information on the toxicity of a mushroom<sup>4</sup> despite myths to the contrary<sup>5</sup>

### Common Myths Used to Determine Mushroom Toxicity<sup>5</sup>

- Poisonous mushrooms are brightly coloured whereas edible mushrooms are not.
- Poisonous mushrooms blacken garlic/onion or tarnish silver cutlery when boiled together whereas edible mushrooms do not.
- All mushrooms that peel easily are edible.
- The presence of insects or bite marks from animals indicate a mushroom is edible.
- Soaking poisonous mushrooms in salt or boiling water will eliminate any toxicity.

A list of edible mushrooms sought by Ontario collectors is given in the Appendix, [Table 1](#), and illustrates that commonly sought wild mushrooms have look-a-likes that, when consumed, may cause adverse health effects.

There is a wide variety of poisonous mushrooms in Ontario that may be mistaken for edible species; symptoms of poisoning vary depending on the type of mushroom.<sup>4</sup> In general, symptoms include gastrointestinal symptoms, neurotoxicity, kidney toxicity, and liver toxicity. Some poisonings may be fatal. A selection of toxic mushrooms that grow in Ontario implicated in mistaken identity and subsequent poisoning is presented in the Appendix, [Table 2](#).

## Mushroom Foraging in Ontario

Foraging for wild mushrooms occurs across Canada, including Ontario.<sup>6,7</sup> though the prevalence and extent is unknown. A number of groups offer amateurs the opportunity to learn about foraging. For example, Ontario Nature, a charitable organization that engages in nature conservation activities, offers a series of edible wild plant workshops in the fall in Thunder Bay, including one on wild mushrooms.<sup>8</sup> These workshops are well attended and increasing in popularity.<sup>9</sup> Inexperienced foragers are reported to be contacting well-established amateur naturalist societies, such as the Mycological Society of Toronto, for guidance on consumption of foraged mushrooms.<sup>9</sup>

Recent trends found in North American ‘foodie’ culture have served to popularize foraging as a facet of the ‘farm-to-table’ ideal, with certain municipalities raising alarms about the subsequent health hazard implications.<sup>10</sup> Commercial-scale enterprises that forage, package and sell wild mushrooms also exist in Ontario.<sup>11</sup> This suggests that foraging is well established and likely to be increasing in popularity.

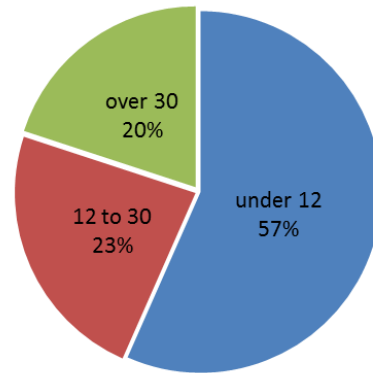
## Health Hazards of Foraged Mushroom Consumption in Ontario

There are limited data regarding the prevalence of cases of illness or death related to foraged wild mushroom ingestion in Ontario and in Canada. It was reported that in 1967, 183 cases of mushroom poisoning occurred in Canada, 11 of which required hospitalization. Seventy-five percent of all cases occurred in Ontario.<sup>12</sup> From our literature search, this represents the most recent snapshot of mushroom poisoning cases in Canada.

More recent data are available from the United States (US). Annually in the US, approximately 6,000 exposures to poisonous mushrooms are reported, most of which were associated with mild symptoms.<sup>13</sup> A recent study in the US compiled data from the National Poison Data System (NPDS) and found over the years 1999-2016, an average of 7,428 ingestions per year were reported, representing about 0.2% of total calls, with stable incidence over that time period.<sup>3</sup> An average of 3 deaths per year has occurred from foraged mushroom ingestions, with the majority of those identified (84.6%, 11/13) as being *Amanita* species.<sup>3</sup> The authors note that these are due to misidentified species consumed by foragers.<sup>3</sup>

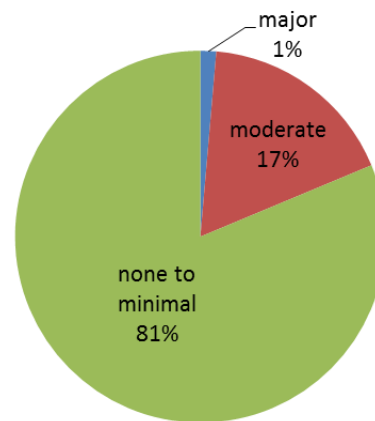
Data from the Ontario Poison Centre (OPC) on exposures to mushrooms were obtained regarding all mushroom-related calls for the years 2013-2017, of which an unknown proportion were from wild mushrooms.<sup>14</sup> These data resemble those given in the NPDS study.<sup>3</sup> The data reveal the following:

- 0.3% of all calls received over the 5-year period were related to mushrooms (1,043/362,536), similar to the proportion found in the US.<sup>3</sup>
- **Figure 1** shows the distribution of cases by age group in the 1,012 cases where age was documented. The majority of cases (57%, 573/1,012) are younger than 12 years of age, which likely reflects accidental ingestions resulting in limited toxicity.<sup>15</sup>
- Nearly a quarter of cases (23%, 237/1,012) are within the age group of 12-30, which may include individuals seeking psychedelic mushrooms.<sup>3</sup>
- The remaining cases (20.0%, 202/1,012) were over 30 years of age and may comprise the bulk of the ‘foragers,’ as suggested by authors describing similar US data.<sup>3</sup>



**Figure 1 Distribution of mushroom-related calls by age group, 2013-2017**

- **Figure 2** shows the medical severity of cases (168 cases out of 1,043 were lost to follow up or deemed to not be mushroom-related). The majority (81%, 712/875) reported minimal to no clinical effect. 17.4% (152/875) were reported to have moderate effects, and 1.4% (12/875) were reported to have major effects. No deaths were reported.
- The majority of the critical care admissions (73%, 16/22), non-critical care admissions (70%, 33/47), and psychiatric admissions (76.2%, 16/21) were male. The percentage of males in hospital admissions is consistent with the published data from several US studies.<sup>3,15,16</sup>



**Figure 2 Distribution of mushroom-related calls by medical severity, 2013-2017**

A number of case reports of confirmed mushroom foraging-associated poisonings in Ontario were identified:

- In 2006 and 2014, Toronto Public Health published advisories in response to hospitalizations resulting from consuming foraged *Amanita bisporigera*.<sup>17,18</sup> In the 2006 advisory, details were provided of a 44-year-old man requiring hospitalization for poisoning from consuming *Amanita bisporigera*; the document also mentions a previous Ontario case of a fatal poisoning in a 62-year-old female from wild mushroom consumption (*Lepiota subincarnata*) in 2003.<sup>17</sup>
- In 2015, a case of *Amanita bisporigera* poisoning resulting in liver failure was reported in a Canadian journal.<sup>19</sup> In this instance, the mushroom was foraged in a Toronto park by a 55-year-old immigrant with prior experience in wild mushroom collection.<sup>20</sup> This scenario has been reported in poisonings elsewhere<sup>15,21</sup> and one report specifically attributed the mushroom being mistaken for edible paddy straw mushrooms (*Volvariella volvacea*) that grow in Southeast Asia.<sup>22</sup>

In other North American reports where severe poisonings have been documented and the culprit species identified, *Amanita* spp. have represented the vast majority.<sup>1,3,22-33</sup> Species of mushrooms containing amatoxins, which includes *Amanita*, *Galerina*, and *Lepiota*, are responsible for the majority of worldwide mushroom-related fatalities.<sup>1</sup> The deadliest of these, *Amanita phalloides*, is an invasive European species not yet known to occur in Ontario or Quebec (although it has been implicated in a fatal poisoning in BC in 2016<sup>33</sup>). Case reports of kidney failure resulting from ingestion of foraged *Cortinarius* and *Amanita* species were reported in Alberta and British Columbia, respectively.<sup>21,23</sup> Barron recommends avoiding all species of *Amanita* given the severe risks that some species pose.<sup>4</sup> Internationally, reports of severe and fatal mushroom poisonings have been increasing.<sup>2</sup>

Some poisonous species in Ontario resemble edible species that occur in other places; therefore, poisonings by certain mushroom species may disproportionately affect individuals coming to Ontario from areas where the edible species is foraged. In particular, orange *Amanita* species may be mistaken for the edible Caesar's mushroom found in southern Europe (*Amanita caesarea*), while poisonous *Amanita* and *Lepiota* species found in Ontario may be mistaken for the paddy straw mushroom, *Volvariella volvacea* or edible *Macrolepiota* species found in southeast Asia.

## Regulation of Mushroom Foraging in Ontario

Food premises in Ontario are subject to Ontario Regulation 493/17 (Food Premises) and the Health Protection and Promotion Act.<sup>34</sup> For farmers' markets, certain food vendors are exempt from the Food Premises Regulation where "the majority of the persons operating the stalls or other food premises are producers of farm products who are primarily selling or offering for sale their own products."<sup>35</sup> However, assessments and inspections may be carried out to ensure compliance with the Health Protection and Promotion Act.

The Ministry of Agriculture, Food and Rural Affairs regulates the sale of produce including edible fungi under Ontario Regulation 119/11 under the Food Safety and Quality Act, 2001.<sup>36</sup> Edible wild mushrooms



harvested for commercial purposes would be considered “edible fungi” and therefore included as “produce” under this regulation. The onus is on the forager or seller to demonstrate compliance.

If a wild mushroom variety is inedible then it is not regulated under Ontario Regulation 119/11. Inedible mushrooms would be regulated by Canada’s Food and Drug Act and Ontario’s Health Protection and Promotion Act which prohibit the sale of food that contains poisonous or harmful substances or is unfit for human consumption.<sup>37,38</sup>

There are no legislated standards for wild mushroom foraging, such as the licensing of foragers. Individuals who purchase wild mushrooms are relying on the skill and competency of the forager for the safety of the product. Generally, a small set of very easily identified mushrooms, most notably chanterelles, edible boletes, honey mushrooms, morels, hen-of-the-woods, puffballs, and hedgehog mushrooms make up most of the foraged mushrooms sold in Ontario. This ‘picker conservatism’ differs sharply from market stall mushroom vendors in other regions such as Finland or inland China, who may offer dozens of seldom-seen mushroom species.

## Conclusions

- The foraging of wild mushrooms is a common practice in many parts of the world. Demand for wild mushrooms in settings such as farmers’ markets is likely to continue.
- There is no simple test to reliably distinguish between edible and poisonous mushroom species, and mistaking poisonous for edible mushrooms may result in adverse health effects.
- Though the majority of all mushroom-related calls to the Ontario Poison Centre from 2013-2017 were deemed to have minimal to no clinical effect, there were at least 90 cases requiring hospitalization, including intensive care. From all sources of information obtained, at least one death and at least three severe poisonings (and as many as 10) related to foraged mushroom consumption have occurred in Ontario within the last 20 years (James Scott, personal communication, September 5, 2019). None of these were associated with purchased mushrooms.
- Foraged mushrooms in Ontario that are easy to recognize, hard to misidentify, and harvested by a knowledgeable and competent forager are not likely to be poisonous. However, the extent to which foragers (particularly commercial foragers) meet these criteria is unclear.
- Case reports of severe harm in Ontario highlight the potential to mistake a poisonous mushroom in Ontario for an edible variety that grows elsewhere. A nuanced communication strategy may have greater effectiveness than messaging broadly condemning the collection and consumption of wild mushrooms. The latter may alienate those at greatest risk.
- The Food Premises Regulation regulates food premises that sell foraged mushrooms. However, farmers’ market sellers may be exempt from this regulation, though compliance with the Health Protection and Promotion Act is still required.

## Implications for Practice

The scale and magnitude of the risk associated with consumption of foraged mushrooms is unclear; however, documented cases of illness, supported by Canadian and US poison data, indicate that poisonings do occur. Therefore, caution should be exercised when foraging or purchasing wild mushrooms for consumption. Knowledgeable and experienced individuals can safely forage wild mushrooms, particularly certain species that are more easily identified (e.g. chanterelles, edible boletes, honey mushrooms, morels, etc.) in Ontario. If any concerns with mushroom identification arise, a mycologist may be consulted. Targeted education to at-risk groups may decrease the incidence of future poisonings.

## Additional Resources

### Field Guides:

1. Barron G. Mushrooms of Ontario and eastern Canada. Craig L, editor. Partners Publishing; 2016.
2. Miller OK. North American mushroom: A field guide to edible and inedible fungi. Falcon Guides; 2006.
3. Spahr D. Edible and medicinal mushrooms of New England and eastern Canada. North Atlantic Books; 2009.

### Grey literature articles on wild mushrooms in Ontario and Canada:

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2. Mohammed GH. Non-timber forest products in Ontario: An overview. [Internet]. 1999 [cited 2018 Sep 4]. Available from: [https://www.pmtech.ca/Pubs/OMNR-OFRI\\_NTFP\\_Report\\_145.pdf](https://www.pmtech.ca/Pubs/OMNR-OFRI_NTFP_Report_145.pdf)



## Appendix

**Table 1.** Examples of edible wild mushrooms foraged in Ontario (provided for illustrative purposes, not intended for use in identification; courtesy of Hutchison L, Scott J, and Summerbell R.)<sup>4,39</sup>

Edible Species	Common name	Ontario fruiting season	Habitat	Other parts of the world where gathered	May be mistaken with
<i>Armillaria spp.*</i>	Honey mushroom	Fall	On wood or stumps	Widely sought, prized in Central and Eastern Europe	Deadly <i>Galerina (Galerina autumnalis)</i> : deadly <sup>40</sup>
<i>Boletus edulis</i>	King bolete or porcini	Mid-summer to fall	On the ground under conifers or in mixed woods	Widely sought, prized in Central and Eastern Europe	Some bolete species can cause gastrointestinal symptoms <sup>4</sup>
<i>Calvatia gigantea</i>	Giant puffball	Late summer to fall	In fields, woods, gardens, banks of streams	Widely sought	Button-stage of destroying angel ( <i>Amanita virosa</i> ): deadly <sup>41</sup>
<i>Cantharellus cibarius</i>	Chanterelle	Mid-summer to fall	On the ground in woods	Widely sought, prized in Central and Eastern Europe	False chanterelle ( <i>Hygrophoropsis aurantiaca</i> ): gastrointestinal symptoms; <sup>4</sup> Jack O'Lantern ( <i>Omphalotus olearius</i> ): poisonous <sup>42</sup>
<i>Entoloma abortivum</i>	Hunter's hearts	Mid-summer to fall	On or near rotting wood in mixed woods <sup>4</sup>	<i>Entoloma abortivum</i>	Hunter's hearts
<i>Fistulina hepatica</i>	Beefsteak fungus	Late summer to fall	On oak and other hardwoods	–	<i>Hapalopilus nidulans</i> : poisonous

Edible Species	Common name	Ontario fruiting season	Habitat	Other parts of the world where gathered	May be mistaken with
<i>Grifola frondosa</i>	Hen of the woods	Mid-summer to fall	On the ground in mixed woods in southern Ontario	Southern Europe and East Asia	Any somewhat similar species are too leathery in texture for consumption
<i>Hydnum repandum</i>	Hedgehog mushroom	Mid-summer to fall	On the ground in mixed woods	Southern and Central Europe	<i>Bankera fuligineo-alba</i> : inedible, not poisonous <sup>43</sup>
<i>Lactarius deliciosus</i>	Orange milk cap / Delicious Lactarius	Mid-summer to fall	On ground under conifers	Southern, Central and Eastern Europe	<i>Lactarius chrysorheus</i> : poisonous, severe gastrointestinal symptoms <sup>4</sup>
<i>Laetiporus sulphureus</i>	Chicken of the woods	Mid-summer to fall	On standing moribund or dead oak or other broadleaf trees	Central Europe	Cinnabar polypore ( <i>Pycnoporus cinnabarinus</i> ): non-poisonous <sup>44</sup> ; <i>Hapalopilus nidulans</i> : poisonous
<i>Leccinum aurantiacum</i>	Orange bolete	Mid-summer to fall	On ground under birch and poplar trees	–	Some bolete species can cause gastrointestinal symptoms <sup>4</sup>
<i>Lepista nuda</i>	Blewit	Late summer to fall	On ground in woods	Western and Central Europe	Genus <i>Cortinarius</i> : variably poisonous <sup>45</sup>

Edible Species	Common name	Ontario fruiting season	Habitat	Other parts of the world where gathered	May be mistaken with
<i>Macrolepita procera</i>	Parasol	Mid-summer to early fall	On the ground in grassy areas and open woods	Central- and Eastern Europe and East Asia	Small-statured species in the <i>Lepiota subincarnata</i> group (“Fatal Dapperling”): deadly; and the green-spored <i>Chlorophyllum molybdites</i> : gastrointestinal symptoms
<i>Marasmius oreades</i>	Fairy ring mushroom / Scotch bonnet	Early summer to fall	In grass and open areas	–	<i>Leucocybe candicans</i> , <i>L. connatum</i> , <i>Clitocybe rivulosa</i> , found in forests and forest margin grasses: poisonous
<i>Morchella elata</i> and <i>Morchella esculenta</i>	Morels (black and yellow)	Spring	On the ground in woods	Widely sought	False morel ( <i>Gyromitra esculenta</i> ): poisonous, potentially deadly <sup>4</sup>
<i>Pleurotus ostreatus</i>	Oyster mushroom	Spring to early summer	On dead logs, stumps, and standing trees	Widely sought	Angel’s Wings ( <i>Pleurocybella porrigens</i> ): generally regarded as edible, questionable toxicity <sup>46</sup>
<i>Tricholoma magnivelare</i>	Matsutake / pine mushroom	Mid-summer to fall	In 2-needle pine barrens, pine and spruce plantations	East Asia (especially Japan and Korea)	<i>Entoloma subsinuatum</i> : poisonous

\* Honey mushroom/*Armillaria* spp. has to be cooked to ensure it is safe.

**Table 2.** Examples of poisonous wild mushrooms in Ontario (provided for illustrative purposes, not intended for use in identification; courtesy of Hutchison L, Scott J, and Summerbell R.)<sup>4</sup>

Species	Common name	Occurrence in Ontario	Documented harm
<i>Amanita bisporigera</i> , <i>Amanita virosa</i>	Destroying angel	Widespread, common	Verified cases in Ontario (OPC) including hospitalization with significant liver and kidney damage <sup>17-19,45</sup>
<i>Amanita muscaria</i> complex	Fly Agaric	Widespread, very common	Many verified cases in Ontario (OPC); Nausea and vomiting; may be detoxified by parboiling and eaten safely. Probably less toxic than red European populations <sup>46</sup>
<i>Entoloma</i> spp.: <i>E. subsinuatum</i> ( <i>E. lividum</i> ), <i>E. rhodopolium</i> , etc.	Lead poisoner	Widespread	Gastrointestinal symptoms <sup>47</sup>
<i>Galerina autumnalis</i>	Fall Galerina / Funeral bell	Southwestern region	Amatoxin poisoning <sup>48</sup>
<i>Galerina marginata</i>	Deadly Galerina	Southwestern region, uncommon	Amatoxin poisoning <sup>48</sup>
<i>Gyromitra esculenta</i>	False morel	Widespread	Many verified cases in Ontario; fatalities in Europe <sup>4</sup>
<i>Hapalopilus nidulans</i>	Purple dye polypore	Widespread, uncommon	Suspected case in eastern Ontario (OPC 2015); neurological and gastrointestinal symptoms, impaired kidney function (purple urine)
<i>Inocybe risa</i> or <i>Inocybe fastigiata</i>	Fibre head	Widespread, common	Hospitalization with full recovery of 14 cases in USA <sup>49</sup>

Species	Common name	Occurrence in Ontario	Documented harm
<i>Lepiota subincarnata</i>	Fatal dapperling	Southern region, uncommon	Verified cases including several fatalities in Ontario (OPC 2003, 2006 & 2010) <sup>50</sup> and Illinois <sup>51</sup>
<i>Omphalotus olearius</i>	Jack o' lantern mushroom	Widespread, common	Many verified cases in Ontario (OPC); nausea and vomiting, no deaths reported in North America <sup>40</sup>
<i>Panaeolina foenisecii</i>	Haymaker's mushroom	Widespread, common	Verified cases in Ontario (OPC); mild poisoning if any; some collections may have traces of psilocybin, despite reports to the contrary. <sup>52</sup>

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## Specifications and Limitations of Evidence Brief

The purpose of this Evidence Brief is to investigate a research question in a timely manner to help inform decision making. The Evidence Brief presents key findings, based on a systematic search of the best available evidence near the time of publication, as well as systematic screening and extraction of the data from that evidence. It does not report the same level of detail as a full systematic review. Every attempt has been made to incorporate the highest level of evidence on the topic. There may be relevant individual studies that are not included; however, it is important to consider at the time of use of this brief whether individual studies would alter the conclusions drawn from the document.

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