A Guide to Hazard Identification and Risk Assessment for Public Health Units

Public Health Emergency Preparedness Protocol

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Ministry of Health and Long-Term Care
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Forward

This document is intended to provide guidance to public health units on how to complete hazard identification and risk assessments, in accordance with the Public Health Emergency Preparedness Standard and Protocol.
1. Introduction

The Guide to Hazard Identification and Risk Assessment for Public Health Units is intended to support and provide guidance to public health units (PHUs) on the hazard identification and risk assessment (HIRA) process.

HIRA is a process by which the hazards facing a particular PHU are identified and assessed in terms of their probability and consequence(s) that they pose. Based upon this risk assessment, PHU can effectively plan and prepare for dealing with potential public health emergencies or emergencies with public health significance.

The HIRA process is a key component of a comprehensive emergency preparedness program and assists PHUs in establishing their priorities for emergency preparedness activities.

2. Key Steps

The hazard identification and risk assessment process comprises four steps including:

1) Establish the context
2) Identify potential hazards
3) Determine the risk for each hazard
4) Record potential hazards on a risk assessment grid
3 Establish the Context

The purpose of this step is to describe the characteristics of the PHU as this will influence both the probability and consequence of a public health emergency or an emergency with public health significance. This may include looking at population size, demographics, main industries, geographic characteristics, transportation avenues etc.

3.1 Methodology

PHU should consider relevant aspects of their areas that may have an impact on a public health emergency. These aspects may include, but are not limited to:

- Demographic, ethnic and socio-economic composition of the community
- Geographic dispersion of population
- Classification of area (i.e. rural, urban, mixed)
- Vulnerable populations
- Main transportation avenues
- Main industries
- Critical service suppliers (i.e. electricity, telecommunications, gas)

3.2 Additional Planning Tools

There are a number of planning tools PHUs may find helpful during the HIRA process including:

- Topographical maps
- Maps of main communities illustrating key facilities, institutions and transportation avenues etc
- Relevant historical data in relation to past public health emergencies or emergencies with public health significance

4. Hazard Identification

The purpose of this step is to review the generic 37 hazards identified by Emergency Management Ontario (EMO) hazards list (see Appendix 1) and to identify additional hazards specific to the PHU. Many of the hazards will already have been identified through the municipal/regional HIRA process. It is important that PHUs review the identified hazards through a public health lens as well as consider additional hazards that may not have appeared in the municipal review but are of public health significance.
The following definitions are fundamental to the HIRA process:

**Hazard** - (1) A risk that is a threat; (2) An event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss.

**Hazard Identification**: The process of defining and describing a hazard, including its physical characteristics, magnitude and severity, probability and frequency, causative factors, and locations/areas affected. 

The identified hazards will fall into the following three categories:

1) Natural Hazards - Natural hazards are unexpected or uncontrollable natural events which affect a group of people by disrupting their activities and potentially causing loss of life;

2) Technological Hazards - Technological hazards refer to a wide range of conditions emanating from the manufacture, transportation, and the use of modern technology and substances such as chemicals, explosives, flammables, and radioactive materials; and

3) Human-caused Hazards - Human-caused hazards are threats having an element of human intent, negligence, or error or involving a failure of a system.

### 4.1 Methodology

The PHU should record all identified hazards in a table. This will provide for an easy-to-follow format that can accommodate additional information determined during later stages of the HIRA process. In addition, the table will capture all relevant information that should be attached to the PHUs emergency response plan.

Below is an example of a table used to capture the findings of the HIRA (Table 1).

**Hazard Identification and Risk Assessment**

<table>
<thead>
<tr>
<th>Item</th>
<th>Hazard Category</th>
<th>Hazard</th>
<th>Risk Analysis</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Natural Hazard</td>
<td>Flooding</td>
<td>Determined in Step 3</td>
<td>Community located on flood plain on the east side River Smith</td>
</tr>
</tbody>
</table>

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The column for additional information may be used to identify specific vulnerable populations and/or sensitive areas where an identified hazard may have a greater impact.

5. Risk Assessment

The next step is to consider the overall risks presented by these hazards. This is achieved by looking at and assessing both the probability and the consequence of the identified hazard.

The following definition is fundamental to the HIRA process:

Risk – A chance or possibility of danger, loss, injury, or other adverse consequences.\(^2\)

5.1 Methodology: Assessing Probability

In order to determine the probability of a hazard it is necessary to look at past history:

- Has it happened before?
- What is the frequency with which it has occurred?; and
- How long since the last occurrence?

Probability may be expressed in terms of the likelihood of an event occurring within a given time period. Once this has been determined for each hazard, a probability rating of 1 through 4 is assigned (Table 2).

In addition, PHUs may wish to consider seasonal variation. The likelihood of occurrence of various hazards can be contingent on seasonal variation. Different seasons have different climates, trigger different patterns of behaviour and have other unique features that contribute to making different events more or less prevalent.

Question to ask include:

- Does the particular event occur more frequently during one or two seasons?

Table 2:

<table>
<thead>
<tr>
<th>Probability Rating</th>
<th>Description</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Low</td>
<td>No history of incidents in the last 10 to 15 years</td>
<td></td>
</tr>
<tr>
<td>2 Moderate</td>
<td>Greater than Five (5) years since last incident</td>
<td></td>
</tr>
<tr>
<td>3 High</td>
<td>One (1) incident in the last Five (5) years</td>
<td></td>
</tr>
<tr>
<td>4 Extreme</td>
<td>Several incidents in the last Five (5) years</td>
<td></td>
</tr>
</tbody>
</table>

Once the probability rating has been determined, it can be recorded in the Table 1 under the risk analysis column.

It is important to note that, for new and evolving threats (e.g. SARS), looking at the historical data from the last 15 years may not adequately describe the risk. Events that happened prior to 15 years (e.g., Influenza Pandemic), and new, events could happen. PHUs should use the best available information (i.e., expert advice, academic journals) to determine probability.

5.2 Methodology: Assessing Consequence

The purpose of this step is to determine the overall risk presented by each hazard. The consequence of a hazard is determined by the impact the hazard has on life, physical infrastructure and the economy. In determining the potential impact of a hazard, it is important to keep in mind the type or nature of the impact and the scale.

EMO has compiled a list of factors to consider when determining the consequence of a hazard. This is not an exhaustive list; however, it is a good starting point for PHUs.

- Concentration of people;
- Concentration of economic activity;
- Critical transportation corridors and associated vulnerable infrastructure such as bridges;
- Special populations and their needs for shelter-in-place vs. evacuation (i.e., children and the elderly);
- Key facilities for emergency services, response and evacuation;
- Transportation systems and resources;
- Time factors for response, evacuation, mitigation, and recovery;
- Space factors for response, evacuation, mitigation, and recovery;
- Health, safety and property implications;
- History of prevailing meteorological conditions;
- Industry screening models or dispersion models if available;
- Identification of sensitive environmental areas; and
- Identification of ministry critical infrastructure.

A brief description of the consequence rating has been provided below. PHUs will each need to further define each of these categories. Key factors that are useful in determining the consequence ratings are: extent of injury, death, displacement, disruption of basic and essential services, environmental damage, negative economic impact, etc.

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To obtain a full understanding of the potential consequence of each hazard, PHUs may find it helpful to organize the above list of key factors into broad categories such as human, economic and physical infrastructure impacts. The Center for Excellence in Emergency Preparedness has created a public health risk assessment tool that PHUs may wish to adopt (Appendix 2). The ranking from each category can be compiled to obtain the overall consequence rating for the hazard.

When the impact has been determined, a consequence rating from 1 – 4 is assigned (Table 3) and should be recorded in the Table 1 under the risk analysis column.

<table>
<thead>
<tr>
<th>Consequence Rating</th>
<th>Description</th>
<th>Details (PHU to further define)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No impact</td>
<td>(i.e., no or limited injuries/illness, deaths in community, no impact to health human resources, no economic disruptions or infrastructure damage)</td>
</tr>
<tr>
<td>2</td>
<td>Limited</td>
<td>(i.e., minor injuries/illness/deaths, minor health human resources disruption, economic disruption and infrastructure damage)</td>
</tr>
<tr>
<td>3</td>
<td>Substantial</td>
<td>(i.e., significant injuries/illness, significant health human resources, economic disruption and infrastructure damage)</td>
</tr>
<tr>
<td>4</td>
<td>High</td>
<td>(i.e., high probability of death, extensive health human resources impact, infrastructure damage and economic impact)</td>
</tr>
</tbody>
</table>

6. Recording Potential Hazards on a Risk Assessment Grid

The purpose of this step is to plot the probability and consequence determined in Step 3 on the Risk Assessment Grid. A four by four matrix (Table 4), using the ratings for probability and consequence recorded in Table 1, illustrates the results of the risk assessment.

6.1 Methodology

The probability and consequence ratings in Table 1 are used to position all the identified hazards on the risk assessment grid. An example on how information determined in the previous stages of the HIRA process is used to position identified hazards in the grid is provided below:

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Energy Emergencies

Probability: 3 High

PHU is a major industry hub and home to a large population. As such, its energy demands are high, and often exceed the supply, which can lead to an energy emergency. In August 2003, PHU was among the areas impacted by the largest blackout in North America’s history. Electricity was cut to 1 million people in PHU. Streetlights went out, business had to close and refrigeration equipment went dead.

Consequence: 2 Limited

PHU may experience utilities loss and technological failures. There is also a potential for capacity overload; since restaurants, doctors offices, etc., will be without power for a period of time.

Risk Assessment: 3,2

The probability and consequence for the hazard Energy Emergencies results in a score of 3, 2, which is illustrated in the PHU risk assessment grid

By placing hazards on the assessment grid, according to probability and consequence, PHUs will be able to identify their priorities. The grid does not provide a precise calculation of risk, however, it does assist PHUs in determining those hazards posing the greatest risk. An example of prioritization used by the Federal Emergency Management Agency (FEMA) is illustrated below in Table 5. The level of risk spans from red coloured squares which depicts the hazards with the highest level of risk to blue coloured squares which depicts the hazards with the lowest level of risk.
Table 5: Qualitative Risk Assessment Matrix – Level of Risk

<table>
<thead>
<tr>
<th>Probability</th>
<th>Extreme</th>
<th>High</th>
<th>Moderate</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4, 1</td>
<td>3, 1</td>
<td>2, 1</td>
<td>1, 1</td>
</tr>
<tr>
<td></td>
<td>4, 2</td>
<td>3, 2</td>
<td>2, 2</td>
<td>1, 2</td>
</tr>
<tr>
<td></td>
<td>4, 3</td>
<td>3, 3</td>
<td>2, 3</td>
<td>1, 3</td>
</tr>
<tr>
<td></td>
<td>4, 4</td>
<td>3, 4</td>
<td>2, 4</td>
<td>1, 4</td>
</tr>
</tbody>
</table>

Consequence

There will be situations in PHUs where the probability is low based on past occurrence but the consequence is high due to the nature of the event. For example, the last pandemic occurred 40 years ago but there was widespread worldwide illness, deaths and economic disruptions. This may cause the event to be considered a lower priority during the initial review; however, it is recommended that PHUs review any risks that have a ranking of 4 for either probability or consequence to determine if the hazard should receive additional attention.

7. Conclusion

Identification, assessment and prioritization of hazards and risks through the HIRA process is fundamental to the public health emergency preparedness program for each PHU. This process helps each PHU to clearly lay out the preparedness program priorities for developing plans to ensure a seamless response during public health emergencies or emergencies with public health significance.
References


Appendices

Appendix 1: ONTARIO’S HAZARDS
Emergency Management Ontario

Natural Hazards

Agriculture and Food Emergencies (Plant Disease & Pest Infestations, Food Emergencies, Animal Disease)

Atmospheric Hazards (Severe Weather)
- Extreme Heat/Cold
- Fog
- Hailstorms
- Hurricanes/Tropical Storms
- Ice/Sleet Storms
- Lightning Storms
- Snowstorms and Blizzards
- Tornadoes
- Windstorms

Forest Fires (Wildfire)

Geological Hazards
- Earthquakes
- Landslides
- Land Subsidence

Human Health Emergencies and Epidemics

Hydrologic Hazards
- Drought/Low Water
- Erosion
- Flooding (Storm Surges, River Flooding, Great Lakes Flooding)
- Water Quality Emergencies

Technological Hazards

Building/Structural Collapse
Critical Infrastructure Failures
Dam Failures
Energy Emergencies (Supply)
Explosions/Fires
Hazardous Materials – Fixed Site Incident
Hazardous Materials – Transportation Incident (road, rail, air, marine)
Mine Emergencies (Operating/Abandoned)
Nuclear Facility Emergencies
Oil, Natural Gas Emergencies – Pipeline, Oil/Natural Gas Wells, Storage/Distribution Systems
Radiological Emergencies
Space Object Crash
Transportation Emergencies (Air, Marine, Rail, Road)

**Human-Caused Hazards**

Civil Disorders
Sabotage
Special Events
Terrorism
War and International Emergencies
Appendix 2: Public Health Risk Assessment Tool
The Centre for Excellence in Emergency Preparedness

http://www.ceep.ca/cbrn_course/Doug's%20Final%20Lectures/PHD%20hazard%20analysis%20tool%20final.doc