



An Evaluation of National Capacity regarding Chemical Event Management under the International Health Regulations: a Case of Thailand, 2022

Hirunwut Praekunatham*, Kowit Boonmephong

Division of Occupational and Environmental Diseases, Department of Disease Control, Ministry of Public Health, Thailand

*Corresponding author email: phirunwut@gmail.com

Received: 23 Apr 2023; Revised: 8 Aug 2023; Accepted: 6 Sep 2023

<https://doi.org/10.59096/osir.v16i3.262562>

Abstract

Chemical hazard is deemed substantial for global health security. Effective emergency management could mitigate the adverse effects of chemicals or pollutants. This study aims to describe the country's capacity focusing on chemical events using the Joint External Evaluation (JEE) tool, and determine strengths and challenges to provide recommendations to improve chemical emergency management in Thailand. A descriptive qualitative study of the JEE process was conducted in 2022 using the JEE tool, third edition (2022). Chemical event was one of the 19 technical areas that had two indicators to be evaluated. Activities for JEE process included document compilation and an internal multi-sectoral self-assessment to discuss country capacities, strengths, and gaps before the JEE workshop with the external evaluators. The capacity scores of chemical events for the two indicators were 4 and 5 (out of 5), suggesting that Thailand had decent capacities in response to chemical emergencies at the national and intermediate levels; however, more strengthening was needed at the primary public health level and points of entry (POE). To achieve sustainable capacity, a national action plan for health security should be developed. Capacity building for chemical emergency response should be promoted among staff at the primary public health level and POE.

Keywords: evaluation, chemical event management, International Health Regulations, Thailand

Introduction

International Health Regulations (IHR) 2005 are a legally binding mechanism that addresses global health security among countries to help them develop and maintain capabilities to detect, assess, report, and respond to public health events, including chemical hazards.¹ In order to assess a country's public health capacity, the World Health Organization (WHO) developed the International Health Regulations (2005) Monitoring and Evaluation Framework, which consists of four components: States Parties Self-Assessment Annual Reporting, Joint External Evaluation (JEE), After Action Review, and Simulation Exercise (SimEx).² States Parties Self-Assessment Annual Reporting is mandatory, while the other three are voluntary. The JEE component is a multi-sectoral, comprehensive approach to evaluate and measure a country's capacity to prevent, detect and rapidly respond to

public health threats according to 19 technical areas under four categories, namely prevent, detect, respond, and other IHR-related hazards and points of entry.³⁻⁵

Of the 19 technical areas, chemical event is deemed substantial for global health security since the production and use of chemicals is growing, resulting from economic prosperity.⁶ In Thailand, the Division of Occupational and Environmental Diseases (DOED) reported a total of 236 chemical events, including 122 fires, 42 chemical spills 42 transportation events, 15 illegal dumping events, 14 explosions and one chemical contamination, in the past five years from 2018 to 2022.⁷ The majority of the chemical events occurred in the eastern region of Thailand where many factories and industrial estates are located. Uncontrolled international movement of chemicals and their hazardous wastes or disposal could potentially pose a threat to global health.⁸ Generally,

a chemical event is considered to be complex since effective chemical event management requires an active multi-sectoral collaboration among many related stakeholders from both health and non-health sectors to engage in widely distinctive activities in all stages of the chemical event management cycle (prevention, preparation, detection, response, and recovery). Additionally, many relevant policies and laws, such as licensing of hazardous sites and transport routes, labour health and safety, emergency planning and response, and control of contaminated environment, are involved in all chemical management activities to protect people from chemical hazards.

In 2017, Thailand hosted the first one-week workshop on the JEE component of IHR from 26–30 Jun 2017 where a group of external experts from around the world assessed Thailand's public health capacities.⁹ Two indicators regarding the technical area of chemical events (CE) were evaluated. The first indicator (CE1) aimed to assess mechanisms established and their functionality for detecting and responding to chemical events or emergencies, while the second indicator (CE2) focused on enabling environments for chemical event management. The levels of capacities were given a score of 4 out of 5 for both indicators, suggesting Thailand had demonstrated sufficient capacity on chemical event management. The priority actions focusing on

improving information-sharing mechanisms, strengthening the national preparedness system, and integrating all plans into a single national chemical management plan, were recommended.⁹

In 2022, the second JEE event in Thailand was conducted from 31 Oct to 4 Nov 2022. Since studies concerning chemical emergency management in Thailand remained limited, this study aimed to describe the country's capacity regarding chemical events using the JEE tool, determine strengths, gaps and challenges to provide recommendations to improve chemical emergency management in Thailand.

Methods

Study Design and Tool

A descriptive qualitative study of the JEE process (see Figure 1) was conducted in Thailand in 2022 using the JEE tool, third edition (2022).³ The tool is composed of 19 technical areas, and 48 indicators. The measurement of each indicator was performed using a capacity score criteria ranging from 1 to 5: 1=no capacity, 2=limited capacity, 3=developed capacity, 4=demonstrated capacity, 5=sustainable capacity. A chemical event (CE) was one of the 19 technical areas that had two indicators—namely CE1 and CE2, to be evaluated. The capacity level criteria of the two indicators, and contextual and technical questions for chemical event are shown in Supplementary table 1 and 2.

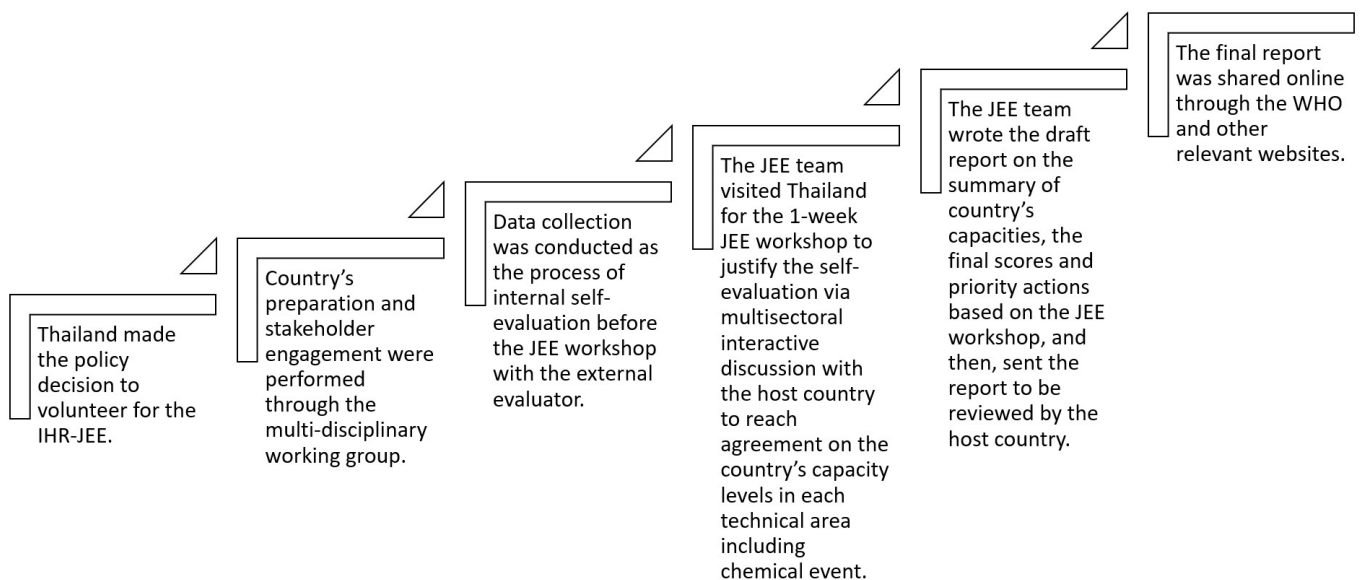


Figure 1. The steps of the International Health Relations Joint External Evaluation (IHR-JEE) process in Thailand

Participant Selection

A multi-disciplinary working group for assessing technical areas of chemical events was established in order to exchange information regarding mechanisms

and functions on chemical management among the relevant key stakeholders. The list of twelve chemical event-related organizations and their roles are shown in Supplementary table 3.

Data Collection

Data collection in the IHR-JEE process was started by the DOED, as the secretariat of the working group, sending the JEE tool regarding chemical events, which consisted of five contextual questions and 21 technical questions, to 12 organizations. After two months, the relevant data and related documents were collected from the stakeholders and were summarized by the DOED. For triangulation, meetings among the working groups were held twice to review and discuss the summarized data gathered and prepared. As suggested by some members of the working group, three other related organizations that might potentially have a role in chemical management in some specific industries, including Department of Agriculture, Department of Fisheries, and Department of Livestock Development, were furthered invited to be additional key informants at the meetings. After that, the DOED prepared and sent the country's internal evaluation report with the related documents to the external subject-matter experts to review prior to the IHR-JEE workshop.

In Thailand, the second IHR-JEE workshop to discuss in detail about country's capacities between the external experts and the host country was held from 31 Oct to 4 Nov 2022. The external evaluators consisted of 24 members from renowned agencies as shown in Supplementary table 4. Regarding chemical events, an expert on chemicals and poisons from United Kingdom Health Security Agency was designated to be the team leader. The session for scientific discussion and debate on chemical events was held on 3 Nov 2022. At the beginning of the session, the DOED gave a 10-minute presentation summarising chemical event management covering background information, key implemented activities, resources, strengths and gaps in Thailand including the scores for CE1 and CE2 proposed by the internal stakeholders. Any unclear points of discussion on chemical events were raised by the external evaluators. The internal stakeholders collaboratively provided additional information for further clarification. At the end of the session, the capacity scores for the two indicators for chemical event (CE1 and CE2) were graded based on a complete agreement between the external and internal stakeholders using the criteria shown in Supplementary table 1. Priority areas for action and recommendations were also concluded.

Data Analysis

The summarized data to answer the contextual questions and technical questions for CE1 and CE2,

prepared by the DOED, and the contents discussed and debated among the internal key stakeholders and the external evaluators during the JEE workshop were reviewed. Data analysis was performed through a description of overall chemical management in Thailand as a case study using an inductive approach. The findings were concluded based on four categories: (1) background information or context, consisting of national plans, legislative control and related international agreements, (2) key implementation activities, (3) strengths, and (4) strengthening needed and challenges. Additionally, the JEE final scores for chemical events, discussed until an agreement was reached by both external evaluators and key internal stakeholders, were also reported.

Results

Background Information or Context

National plans

The National Disaster Risk Management Plan 2021–2027 was developed to be a comprehensive incident management strategy with all relevant agency involvement, providing well-defined roles in the national response plan in Thailand.¹⁰ Furthermore, this plan would serve as a master plan to formulate the disaster risk management plans or multi-hazard specific plans at the provincial or district levels.

Legislative control

Chemical safety assessment has been carried out for more than five years under the relevant laws, including the Hazardous Substance Act B.E. 2535 (1992), the Factory Act B.E. 2535 (1992), the Drug Act B.E. 2510 (1967), the Food Act B.E. 2522 (1979), the Enhancement and Conservation of the National Environmental Quality Act B.E. 2535 (1992), and the Occupational Safety, Health and Environment Act B.E. 2554 (2011).^{11–15} Moreover, the Control of Occupational Diseases and Environmental Diseases Act B.E. 2562 (2019) was passed in order to provide care to those who are exposed to environmental pollutants.¹⁶ Thailand conducted basic public health assessments to support responses to chemical incidents. A brief description of Thailand's laws and regulations related to chemical event management is shown in Table 1.

International agreements

Thailand has ratified and entered into force the Rotterdam-Stockholm-Basel Conventions, and the Minamata Convention on Mercury.^{8,17–19} Besides, Strategic Approach to International Chemicals Management was adopted for strengthening chemical safety.²⁰

Table 1. Brief descriptions of Thailand's laws and regulations related to chemical event management

Law and legislation	Construction/ Principle	Governance (Responsible organizations)	Substance
Hazardous Substance Act B.E. 2535 (1992)	Control and trade of hazardous substances	Ministry of Industry	Four chapters divided into 93 sections Chapter 1: the establishment of the Committee on Hazardous Substances Chapter 2: hazardous substance control Chapter 3: duties and civil liabilities Chapter 4: penalties
Factory Act B.E. 2535 (1992)	Prescription in Ministerial Regulations categorizing factory of any type, kind, or size	Ministry of Industry	Three chapters divided into 65 sections Chapter 1: factory operation Chapter 2: factory supervision Chapter 3: penalties
Drug Act B.E. 2510 (1967)	Provisions for the issuance of licences to produce or sell drugs	Ministry of Public Health	Fourteen chapters divided into 126 sections Chapter 1: drug board Chapter 2: application for and Issue of a licence concerning modern drug Chapter 3: duties of a licensee concerning modern drugs Chapter 4: duties of a pharmacist a first - class modern medical practitioner in the branch of medicine, dentistry, midwifery of nursing, or a veterinary practitioner Chapter 5: application for and issue of a licence concerning traditional Drugs Chapter 6: duties of a licensee concerning traditional drugs Chapter 7: duties of a traditional medical practitioner Chapter 8: fake drugs, sub-standard drugs, deteriorated drugs Chapter 9: notices Concerning drug Chapter 10: registration of a drug formula Chapter 11: advertisement Chapter 12: officials Chapter 13: suspension and revocation of a licence Chapter 14: penalties
Food Act B.E. 2522 (1979)	Food safety and hygiene, food production, trade in food	Ministry of Public Health	Eight chapters divided into 78 sections Chapter 1: food commission Chapter 2: applications for licences and the granting of licences Chapter 3: duties of a licensee concerning food Chapter 4: control of food Chapter 5: product registration and advertisement of food Chapter 6: competent officer Chapter 7: suspension or revoke of licence Chapter 8: punishment
Enhancement and Conservation of the National Environmental Quality Act B.E. 2535 (1992)	Measures on environment protection and control of various forms of pollution	Ministry of Natural Resources and Environment	Seven chapters divided into 115 sections Chapter 1: national environment board Chapter 2: environmental fund Chapter 3: environmental protection Chapter 4: pollution control Chapter 5: promotional measures Chapter 6: civil liability Chapter 7: penal provisions

Table 1. Brief descriptions of Thailand's laws and regulations related to chemical event management (cont.)

Law and legislation	Construction/ Principle	Governance (Responsible organizations)	Substance
Occupational Safety, Health and Environment Act B.E. 2554 (2011)	Measures to control, supervise and manage safety, occupational health and working environment for employees	Ministry of Labor	Eight chapters divided into 74 sections Chapter 1: general provisions Chapter 2: administration, management and operation on occupational safety, health and environment Chapter 3: occupational safety, health and environment committee Chapter 4: control, supervision and administration Chapter 5: safety inspector Chapter 6: occupational safety, health and environment fund Chapter 7: occupational safety, health and environment promotion institute Chapter 8: penal provisions
Control of Occupational Diseases and Environmental Diseases Act B.E. 2562 (2019)	Surveillance, early detection, prevention and control of certain occupational and environmental diseases	Ministry of Public Health	Eight chapters divided into 115 sections Chapter 1: general provisions Chapter 2: occupational disease and environmental disease control commission Chapter 3: provincial occupational disease and environmental disease control committees and Bangkok metropolitan occupational disease and environmental disease control committee Chapter 4: occupational medicine and environmental medicine Chapter 5: surveillance of occupational diseases and environmental diseases Chapter 6: prevention and control of occupational diseases and environmental diseases Chapter 7: officer Chapter 8: penalties

The contents in the table were compiled based on the original statements of each act.

Key Implementation Activities

Laws and regulations

Laws and regulations: Thailand has undergone implementation through law enforcement in accordance with the acts mentioned in the previous section, including factory inspections, self-declaration by factories, chemical risk assessment and management. Several inter-ministerial committees, aiming to implement chemical management activities, were established to promote coordination among various agencies via two mechanisms as follows:

- Inter-ministerial bodies, appointed by the cabinet to perform policy formulation, monitoring and evaluation, and decision-making of particular chemicals. The National Coordinating Committee on Chemical Safety is an example of the inter-ministerial body in charge of developing a national master plan for chemical management.

- Standing Committees, established by the relevant acts to regulate and manage chemicals in various facets covering all parts of chemical life cycle, such as the Hazardous Substances Committee, the National Environment Board, and the subcommittees are also set up under each Standing Committee to perform specific activities and deal with problematic issues.

Chemical emergency preparedness and response

To deal with chemical emergencies, Thailand used a prevention, preparedness, response and recovery approach for chemical event management.²¹ Moreover, Thailand developed occupational and environmental health services at all levels of healthcare facilities to take care of persons suffering from diseases or conditions after being exposed to toxic chemicals.²²

Surveillance

Theoretically, comprehensive surveillance and monitoring systems related to chemicals in Thailand were developed based on a source-pathway-receptor model, consisting of (1) hazard surveillance (the continuous measurement or monitoring of chemicals or pollutants in the environment), (2) exposure surveillance aiming to determine the amount of chemicals that at-risk populations are exposed to, (3) health surveillance, e.g., health check-ups for workers based on their risk of exposure to toxic chemicals, and (4) epidemiological surveillance, e.g., implementing a reporting system for poisoning cases or chemical events.²³ Also, Thailand developed occupational and environmental health profiles, by linking the aforementioned four kinds of surveillance together to comprehensively assess the situation and chemical risk at the local level. In other perspectives, chemical incident surveillance can be divided into four main sectors as shown in Supplementary table 5.²⁴

Human resource development and empowerment

Thailand provides several training courses for public health staff at the local level, for example, control of occupational and environmental diseases, chemical emergency response, and the safety of officers working in factories.

Resources

Human resources

Besides firefighters, police, and frontline rescuers working at the scene, in October 2021, Thailand had sufficient health and medical officers in response to chemical events, including 236 certified occupational medicine board physicians; 1,691 physicians completing a 2-month basic occupational medicine training course, 2,655 occupational health nurses and more than 34,000 public health technical officers.²⁵ Additionally, in response to various public health emergencies, the Surveillance and Rapid Response Team (SRRT) was set up consisting of at least one team per district. The SRRT's responsibilities include performing surveillance on unusual events that might pose a threat to public health, conducting field investigations, and taking immediate prevention and control measures. Most of the SRRT have more experience in terms of response to biological hazards than chemical hazards due to the higher number of infectious disease outbreaks in Thailand. However, a SRRT for chemical events, called the SRRT-C, was also set up in high risk areas, particularly eastern Thailand.

Finance

For emergency response, an emergency fund exists for any identified disaster in each province according to the Disaster Prevention and Mitigation Act B.E. 2550 (2007) and the Finance Department Notification on Emergency Funds for Disasters.²⁶ Thailand also has a Workmen's Compensation Fund aiming to give prompt and equitable protection against work-related injuries, disease, disability, and death.²⁷

Facilities

All provincial hospitals in Thailand can provide diagnoses and treatment for those suffering from chemical poisoning. Thailand has several governmental agencies that can provide laboratories for testing both human and environmental samples. There are at least four governmental reference laboratories for testing chemicals from human samples, including (1) Chulabhorn Research Institute, (2) Faculty of Medicine, Ramathibodi Hospital, (3) Department of Medical Sciences, and (4) Division of Occupational and Environmental Diseases, Department of Disease Control.²⁸⁻³¹ Additionally, Thailand has two national poison centers: (1) Ramathibodi Poison Center and (2) Siriraj Poison Control Center, both of which can provide advice and toxicology treatment guidelines for other health facilities in Thailand.^{29,32}

Strengths

1. Thailand has national policies, plans or legislations for chemical event surveillance, an alert and response system with a multisectoral coordination body, and collaboration among relevant agencies and networks.
2. There are sufficient resources such as manuals, guidelines, surveillance databases, poison centers, and health facilities for persons exposed to toxic chemicals.
3. Two national poison centers provide information services nationwide.
4. Environmental and occupational health services are implemented at all levels of public health care, including subdistrict health promotion hospitals, to care for persons exposed to toxic chemicals by giving first aid or primary care before referring to the nearest secondary or tertiary care hospital.
5. An Incident Command System is active for emergency responses at all levels.

6. A comprehensive surveillance and monitoring system related to chemical events that links data on hazards, exposure and health together at the local level exists, and surveillance data are shared online.
7. Community participation mechanisms are implemented through public hearings in the process of environmental impact assessment or environmental health impact assessment.

Strengthening Needed and Challenges

1. Chemical laboratories were set up in high-risk areas such as Bangkok, the eastern part of Thailand, and some large provinces such as Chiang Mai and Khon Kaen. However, chemical laboratories have not yet been set up to cover all risk areas.
2. Although environmental and occupational health services are implemented at all levels of health care, competencies of staff at the primary health care level are limited. In order to readily respond to chemical emergencies, specific training modules are required for them.

Final JEE Scores for Chemical Events

The indicator score for CE1 was 4 (demonstrated capacity), while the score for CE2 was 5 (sustainable capacity) out of 5.

Discussion

It is generally accepted among WHO member states and international agencies that JEE is an effective process that can help to determine a country's public health capacity including strengthening needed and challenges, and to monitor progression after IHR was implemented in the country. The Joint External Evaluation is a peer-to-peer review process, promoting transparency and a multi-sectoral approach between the host country and the external subject-matter expert team.^{4,5} Although JEE is voluntary, over 100 WHO member states have accomplished the first JEE since 2016.³³ Likewise, after completing the first round in 2017, Thailand was ready for the second round in 2022 using the third edition of the JEE tool, published in 2022.^{3,9}

Comparing the first and the second JEE in Thailand for the technical area of chemical events, the two indicators, CE1 and CE2, remained the same in terms of name, number and brief description of the indicators. However, a minor change was made on the capacity score criteria of 5 for CE1. In the JEE tool that Thailand used in 2017, the criteria of level 5 for CE1 was "Adequately resourced poison centre(s) are in

place", whereas the criteria to reach level 5 for CE1 for the JEE in 2022 was "Adequately resourced poison centre(s) are in place and the country has a demonstrated ability to respond to chemical emergencies at national, intermediate and primary public health levels".^{3,34}

Compared to the scores received from the JEE in 2017 of 4 for both CE1 and CE2, the final scores for chemical event concluded from the JEE workshop in 2022 were shown to be slightly elevated as 4 for CE1 and 5 for CE2. The finding suggested that the capacity on chemical emergency management in Thailand improved from the previous evaluation. Regarding CE1, based on the discussion in the workshop, Thailand has just two national poison centers, but can provide advice and toxicology treatment guidelines for other health facilities in Thailand 24 hours a day.^{29,32} Additionally, Thailand has the ability to respond to chemical emergencies at national and intermediate levels; however, the country still needed strengthening at the primary public health level and points of entry.

To compare the capacity scores for chemical events among countries, the JEE mission reports published on the WHO websites were reviewed. However, most of the data are available for only the first round conducted during 2016–2019. Regarding the assessment of chemical emergency management capacities in Southeast Asia, four countries, namely Brunei Darussalam, Malaysia, Singapore, and Thailand, received scores of 4 to 5 for CE1 and CE2.^{9,35–37} However, the remaining countries earned scores of 3 or below for chemical events.^{38–44} Furthermore, some countries such as Australia, Belgium, and New Zealand, received scores of 5 for both CE1 and CE2 in the first round.^{45–47}

The JEE process may have some limitations since the capacity grading was somewhat subjective depending on time limitations, in-depth discussion and debate among the external experts and the host country, or the related document provided. Additionally, the technical area of chemical events was quite broad and involved many organizations. The data gathered in this study mostly came from government agencies and academia. Thus, the perspectives from private sectors or non-governmental organizations remain limited. For example, the Thailand Environment Institute (TEI), which is a non-governmental organization, plays an important role in raising public awareness and helping communities on environmental sustainability. Additionally, TEI takes part in many environmental policy formulations and implementations in Thailand.

Public Health Action and Recommendations

Chemical hazard is considered as one of the most important issues for global health security. Competent chemical emergency management can alleviate the adverse effects caused by chemicals and pollutants. Thailand showed “demonstrated” to “sustainable” public health capacity to deal with chemical events based on the JEE scores. However, to improve its capacity, our recommendations for the Ministry of Public Health are as follows. A National Action Plan for Health Security (NAPHS) should be developed based on the JEE to be a roadmap for improving the country’s capacities across 19 technical areas, including chemical events. Continuous capacity building for chemical emergency response and essential resource allocation should be promoted at the primary public health level and points of entry. Exercises in chemical emergency preparedness should be conducted regularly in more diverse scenarios. Toxicological laboratories should be expanded to cover all high-risk areas. Finally, due to limited time to validate the self-evaluation by the external evaluator, the host country volunteering for a JEE should meticulously plan ahead accordingly. Self-assessment and related document preparation should be carried out early to provide considerable time for the external evaluator to conduct a thorough review before the JEE workshop in the host country.

Acknowledgements

We would like to express our sincere thanks to key stakeholders, namely Department of Industrial Work, Pollution Control Department, Department of Disaster Prevention and Mitigation, Department of Health (Bangkok Metropolitan Administration), Defence Science and Technology Department, Ramathibodi Poison Center, Siriraj Poison Control Center, Office of the Permanent Secretary Ministry of Public Health (represented by the Division of Public Health Emergency Management), Thai Food and Drug Administration, Department of Medical Sciences, Department of Medical Services, Department of Agriculture, Department of Fisheries, and Department of Livestock Development, for their assistance with preparation of relevant data regarding chemical emergency management.

Suggested Citation

Praekunatham H, Boonmephong K. An evaluation of national capacity regarding chemical event management under the International Health Regulations: a case of Thailand, 2022. OSIR. 2023 Sep;16(3):119–29. doi:10.59096/osir.v16i3.262562.

References

1. World Health Organization. International health regulations (2005) [Internet]. Geneva: World Health Organization; 2016 [cited 2023 May 1]. <<https://www.who.int/publications/i/item/9789241580496>>
2. World Health Organization. International health regulations (2005) monitoring and evaluation framework [Internet]. Geneva: World Health Organization; 2018 [cited 2023 May 1]. <<https://www.who.int/emergencies/operations/international-health-regulations-monitoring-evaluation-framework>>
3. World Health Organization. International health regulations (2005) joint external evaluation tool, third edition [Internet]. Geneva: World Health Organization; 2022 [cited 2023 May 1]. <<https://www.who.int/publications/i/item/9789240051980>>
4. Bell E, Tappero JW, Ijaz K, Bartee M, Fernandez J, Burris H, et al. Joint external evaluation-development and scale-up of global multisectoral health capacity evaluation process. *Emerg Infect Dis*. 2017;23(13):S33–9. doi:10.3201/eid2313.170949.
5. Kandel N, Sreedharan R, Chungong S, Sliter K, Nikkari S, Ijaz K, et al. Joint external evaluation process: bringing multiple sectors together for global health security. *Lancet Global Health*. 2017;5(9):e857–8. doi:10.1016/S2214-109X(17)30264-4.
6. World Health Organization. Health security [Internet]. Geneva: World Health Organization; [cited 2023 May 1]. <https://www.who.int/health-topics/health-security#tab=tab_1>
7. Division of Occupational and Environmental Diseases. Chemical incidents in Thailand [Internet]. Nonthaburi: Division of Occupational and Environmental Diseases; 2023 [updated 2023 Apr 22; cited 2023 May 1]. <<https://lookerstudio.google.com/reporting/b63cd1a8-d48f-4582-ac5c-c95ae2e321b5/page/eEs4C>>
8. United Nations Environment Programme. Basel Convention & Basel Protocol on Liability and Compensation [Internet]. Geneva: United Nations; 2020 [cited 2023 May 1]. <<http://www.basel.int/TheConvention/Overview/TextoftheConvention/tabid/1275/Default.aspx>>

9. World Health Organization. Joint external evaluation of IHR core capacities of the Kingdom of Thailand: mission report: June 26–30, 2017 [Internet]. Geneva: World Health Organization; 2017 Oct 26. 73 p. Contract No.: WHO/WHE/CPI/REP/2017.38.
10. Asian Disaster Reduction Center. Information on Disaster Risk Reduction of the Member Countries: Thailand [Internet]. Kobe: Asian Disaster Reduction Center; c2019 [cited 2023 May 1]. <<https://www.adrc.asia/nationinformation.php?NationCode=764&Lang=en&NationNum=09>>
11. Hazardous Substance Act B.E. 2535 (1992) [Internet]. Bangkok: Department of Industrial Works; [cited 2023 May 1]. 35 p. <<https://www.diw.go.th/webdiw/law-haz/>>
12. Factory Act B.E. 2535 (1992) [Internet]. Bangkok: Ministry of Industry; [cited 2023 May 1]. <<http://law.industry.go.th/laws/detail/32669>>
13. Food Act B.E. 2522 (1979). Nonthaburi: Thai Food and Drug Administration; [cited 2023 May 1]. 17 p. <https://www.fda.moph.go.th/sites/kbs/SitePages/Appoint_FDA_Food.aspx>
14. Enhancement and Conservation of the National Environmental Quality Act B.E. 2535 (1992) [Internet]. Bangkok: Pollution Control Department; [cited 2023 May 1]. 33 p. <<https://www.pcd.go.th/laws/5406>>
15. Occupational Safety, Health and Environment Act B.E. 2554 (2011) [Internet]. Bangkok: Office of the Council of State of Thailand; [cited 2023 May 1]. 26 p. <http://web.krisdika.go.th/data/outside/outside21/file/OCCUPATIONAL_SAFETY_HEALTH_AND_ENVIRONMENT_ACT,B.E._2554.pdf>
16. Control of occupational diseases and environmental diseases act, B.E. 2562 (2019) [Internet]. Nonthaburi: Department of Disease Control; [cited 2023 May 1]. 21 p. <<https://ddc.moph.go.th/law.php?law=5>>
17. Secretariat of the Rotterdam Convention. Rotterdam convention on the prior informed consent procedure for certain hazardous chemicals and pesticides in international trade: text and annexes (revised in 2019) [Internet]. Geneva: United Nations Environment Programme; 2020 Aug [cited 2023 May 1]. 52 p. <<http://www.pic.int/TheConvention/Overview/TextoftheConvention/tabid/1048/>>
18. Secretariat of the Stockholm Convention. Stockholm Convention on persistent organic pollutants (POPs): text and annexes (revised in 2019). Geneva: United Nations Environment Programme; 2020 Sep [cited 2023 May 1]. 77 p. <<http://www.pops.int/TheConvention/Overview/TextoftheConvention/tabid/2232/Default.aspx>>
19. United Nations Environment Programme. Minamata convention on mercury: text and annexes [Internet]. Geneva: United Nations; 2019 Sep [cited 2023 May 1]. <<https://minamataconvention.org/sites/default/files/2021-06/Minamata-Convention-booklet-Sep2019-EN.pdf>>
20. United Nations Environment Programme. Strategic Approach to International Chemicals Management [Internet]. Geneva: United Nations Environment; 2020 [cited 2023 May 1]. <<https://www.saicm.org/>>
21. World Health Organization. Emergency cycle [Internet]. Geneva: World Health Organization; [cited 2023 May 1]. <<https://www.who.int/europe/emergencies/emergency-cycle>>
22. Center of occupational and environmental health service development and accreditation. Occupational and environmental health services guideline for hospital in Bangkok Metropolitan area (health worker version) [Internet]. Nonthaburi: Department of Disease Control; 2021 [cited 2023 May 1]. 73 p. <<http://klb.ddc.moph.go.th/dataentry/handbook/form/127>>
23. Binns J. Source-Pathway-Receptor from a pollution assessment and risk control perspective [Internet]. London: RRC International; 2021 May 6 [cited 2023 May 1]. <<https://blog.rrc.co.uk/2021/05/06/source-pathway-receptor-pollution-assessment-risk-control-perspective/>>
24. Division of Occupational and Environmental Diseases. Operating Guideline for Occupational and Environmental Health Profiles (OEHP). Nonthaburi: Division of Occupational and Environmental Diseases, Department of Disease Control, Ministry of Public Health; 2020 [cited 2023 May 1]. 76 p. <<https://ddc.moph.go.th/uploads/publish/1319520220921081846.pdf>>. Thai.

25. Strategy and Planning Division, Ministry of Public Health of Thailand. Information system for health resources [Internet]. Nonthaburi: Ministry of Public Health of Thailand; [cited 2023 May 1]. <<http://gishealth.moph.go.th/healthmap/index.php>>
26. Office of the Council of State of Thailand. Disaster Prevention and Mitigation Act B.E. 2550 (2007) [Internet]. Bangkok: Office of the Council of State of Thailand; 2007 Aug 28 [cited 2023 May 1]. 24 p. <http://web.krisdika.go.th/data/document/ext838/838096_0001.pdf>
27. Tongsamsi K, Tongsamsi I. The role of workmen's compensation fund on labor protection. *Hatyai Academic Journal*. 2021;19(1):175–91.
28. Chulabhorn Research Institute [Internet]. Bangkok: 28. Chulabhorn Research Institute; [cited 2023 May 1]. <<https://research.cri.or.th/>>
29. Ramathibodi Poison Center [Internet]. Bangkok: Faculty of Medicine Ramathibodi Hospital, Mahidol University; [cited 2023 May 1]. <<https://www.rama.mahidol.ac.th/poisoncenter/>>
30. Department of Medical Sciences, Ministry of Public Health. Nonthaburi: Department of Medical Sciences of Thailand; [cited 2023 May 1]. <<https://www3.dmsc.moph.go.th/page-view/27>>
31. Reference Laboratory and Toxicology Center, Division of Occupational and Environmental Diseases [Internet]. Nonthaburi: Department of Disease Control of Thailand; [cited 2023 May 1]. <<https://ddc.moph.go.th/doed/pagecontent.php?page=1007&dept=doed>>. Thai.
32. Siriraj Poison Control Center [Internet]. Bangkok: Faculty of Medicine Siriraj Hospital, Mahidol University; [cited 2023 May 1]. <<https://www.si.mahidol.ac.th/th/division/shtc/index.asp>>. Thai.
33. World Health Organization. Voluntary joint external evaluations (JEE) prompt much-needed multisectoral dialogues for health security: case study. Geneva: World Health Organization; 2021. 4 p.
34. World Health Organization. International health regulations (2005) joint external evaluation tool, first edition [Internet]. Geneva: World Health Organization; 2016 [cited 2023 May 1]. 98 p. <<https://extranet.who.int/sph/joint-external-evaluation-tool-1st-edition>>
35. World Health Organization. Joint external evaluation of IHR core capacities of Brunei Darussalam: mission report, 28 October–1 November 2019. Geneva: World Health Organization; 2020. 86 p.
36. World Health Organization. Joint external evaluation of IHR core capacities of Malaysia: mission report, 21–25 October 2019. Geneva: World Health Organization; 2020. 82 p.
37. World Health Organization. Joint external evaluation of IHR core capacities of Singapore: mission report: 16–20 April 2018. Geneva: World Health Organization; 2018. 59 p. Contract No.: WHO/WHE/CPI/REP/2018.25.
38. World Health Organization. Joint external evaluation of IHR core capacities of the Republic of the Union Myanmar: mission report, 3–9 May 2017. Geneva: World Health Organization; 2018. 60 p. Contract No.: WHO/WHE/CPI/REP/2018.5.
39. World Health Organization. Joint external evaluation of IHR core capacities Republic of the Philippines: mission report: 10–14 September 2018. Geneva: World Health Organization; 2019. 76 p. Report No.: WHO/WHE/CPI/2019.57.
40. World Health Organization. Joint external evaluation of IHR core capacities of the Democratic republic of Timor-Leste: mission report, 19–23 November 2018. Geneva: World Health Organization; 2019. 64 p. Contract No.: WHO/WHE/CPI/2019.56.
41. World Health Organization. Joint external evaluation of IHR core capacities of the Kingdom of Cambodia: mission report, 26 August–2 September 2016. Geneva: World Health Organization; 2017. 63 p. Contract No.: WHO/WHE/CPI/2017.11.
42. World Health Organization. Joint external evaluation of IHR core capacities of the Lao People's Democratic Republic: mission report, 17–24 February 2017. Geneva: World Health Organization; 2017. 64 p. Contract No.: WHO/WHE/CPI/REP/2017.35.
43. World Health Organization. Joint external evaluation of IHR core capacities of Viet Nam: mission report, 28 October–4 November 2016. Geneva: World Health Organization; 2017. 75 p. Contract No.: WHO/WHE/CPI/2017.21.

44. World Health Organization. Joint external evaluation of IHR core capacities of the Republic of Indonesia: mission report, 20–24 November 2017. Geneva: World Health Organization; 2017. 86 p. Contract No.: WHO/WHE/CPI/REP/2018.9.
45. World Health Organization. Joint external evaluation of IHR core capacities of Australia: mission report, 24 November–1 December 2017. Geneva: World Health Organization; 2018. 83 p. Contract No.: WHO/WHE/CPI/REP/2018.8.
46. World Health Organization. Joint external evaluation of IHR core capacities of the Kingdom of Belgium: mission report, 19–23 June 2017. Geneva: World Health Organization; 2017. 76 p. Contract No.: WHO/WHE/CPI/REP/2017.37.
47. World Health Organization. Joint external evaluation of IHR core capacities of New Zealand: mission report, 26–30 November 2018. Geneva: World Health Organization; 2019. 79 p. Contract No.: WHO/WHE/CPI/2019.63.