Federal Ministry of
Health and Social Welfare
Federal Republic of Nigeria

NATIONAL GUIDELINES FOR CHEMICAL EVENTS SURVEILLANCE IN NIGERIA

2025

National Guidelines for Chemical Events Surveillance in Nigeria 2025

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FOREWARD

It is with great pleasure that I introduce the "National Guidelines for Chemical Events Surveillance in Nigeria." These guidelines serve as a comprehensive framework for enhancing chemical events surveillance systems across the country. They are designed to ensure the safety and well-being of our citizens by promoting effective monitoring, control, and response mechanisms for hazardous chemicals.

The importance of chemical events surveillance cannot be overstated, as chemicals play a critical role in various sectors of our economy, including manufacturing, agriculture, mining, healthcare, research etc. However, improper handling, storage, transportation, or disposal of these chemicals can pose significant risks to human health, animal health, the environment, and overall public safety.

The second Joint External Evaluation (JEE) - a voluntary, multi-sectoral process to assess the country's capacity to prevent, detect and rapidly respond to public health risks under the IHR was conducted in Nigeria in 2023. Nigeria was assessed with limited capacity (score of 2) in detecting and managing chemical events under the JEE indicators for chemical events. To improve this score to developed capacity (Level 3), key actions include establishing a surveillance system with strategies, guidelines and Standard Operating Procedures (SOPs) for the detection and response to chemical events.

Nigeria, as a developing nation, recognises the need to establish robust systems that can effectively manage and mitigate chemical-related hazards. These guidelines have been developed through extensive consultation and collaboration with key stakeholders, including Federal and State Ministries, Departments, and Agencies, as well as academia and professional bodies. The objective is to provide a clear roadmap for implementing and strengthening chemical events surveillance practices in Nigeria.

The collaboration and unity displayed throughout the process reflect our shared goal of strengthening Nigeria's capacity to address chemical events and safeguard public health. This guideline serves as a critical tool for building a more resilient health system, capable of responding effectively to chemical threats.

I salute the efforts of the Chemicals Management Programme of the Federal Ministry of Health and Social Welfare, in collaboration with other relevant bodies, for spearheading the development of these guidelines with support from the United Kingdom Health Security Agency (IHR Strengthening Project), Resolve to Save Lives, and the National Committee on Chemical Surveillance and Emergency System. Their commitment to promoting chemical safety were evident in this comprehensive document.

I urge all stakeholders, including regulatory agencies, industry operators, emergency responders, healthcare professionals, and the general public, to familiarize themselves with these guidelines and actively participate in their implementation.

Professor Muhammad Ali Pate, CON
Coordinating Minister,
Federal Ministry of Health & Social Welfare,
Abuja.
July, 2025

PREFACE

The Federal Ministry of Health and Social Welfare is committed to safeguarding public health through effective surveillance, prevention, and management of chemical events. The National Guidelines for Chemical Events Surveillance in Nigeria serve as a crucial tool in achieving this objective, providing a structured approach for detecting, reporting, and responding to chemical incidents nationwide.

Chemical events, whether accidental or intentional, pose significant threats to human health, the environment, and national security. Recognising these challenges, this document has been developed to enhance multi-sectoral collaboration, strengthen early warning systems, and improve risk assessment methodologies. By integrating best practices and aligning with international health regulations, the guidelines aim to build a robust surveillance system capable of mitigating chemical hazards.

Developed through extensive stakeholder engagement, these guidelines provide clear directives for government agencies, healthcare professionals, emergency responders, environmental bodies, and industry operators. They outline roles, responsibilities, and implementation strategies to ensure an effective and coordinated response to chemical events.

Furthermore, this document serves as a foundation for future advancements in chemical event surveillance. By fostering research, innovation, and continuous improvement, Nigeria can develop a more resilient public health system that effectively addresses emerging chemical threats. Strengthening data collection, analysis, and dissemination mechanisms will be key to driving evidence-based decision-making and improving health outcomes nationwide.

The Federal Ministry of Health and Social Welfare acknowledges the invaluable contributions of all partners involved in the formulation of this document. Successful implementation of these guidelines requires collective effort, and I encourage all stakeholders to apply them diligently in their respective capacities to promote a safer and healthier Nigeria.

Daju Kachollom, mni.
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July, 2025

ACKNOWLEDGEMENT

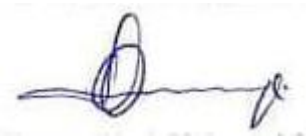
On behalf of the Federal Ministry of Health and Social Welfare, I extend my heartfelt appreciation to all Ministries, Departments and Agencies, academia and organizations who contributed to the successful development of the National Guidelines on Chemical Events Surveillance in Nigeria.

The technical and funding support of the Federal Ministry of Health and Social Welfare, the United Kingdom Health Security Agency (UKHSA) IHR Strengthening Project since the inception of the document can't be overemphasized and also Resolve to Save Lives (RTSL), which joined the train towards the tail end. We are deeply grateful.

Finally, our profound gratitude also goes to the Director and Head of the Chemicals management programme- Mr. Fatai S. Olanrewaju and his unique team in coordinating the preparation, development, and finalisation of this document.

We recognize and celebrate the collective effort and support of all involved, and we look forward to continued collaboration as we implement this guideline to achieve a safer and healthier Nigeria.

Thank you for your exceptional contributions to this endeavour.



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Institute of Public Analysts of Nigeria (IPAN)

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National Emergency Management Agency (NEMA)

Federal Fire Service (FFS)

Nigerian Nuclear Regulatory Authority (NNRA)

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Abbreviations

AAR	After Action Review
ADR	The Agreement concerning the International Carriage of Dangerous Goods by Road
CBS	Community Based Surveillance
DHIS2	District Health Information Software 2
EBS	Event Based Surveillance
FMA&FS	Federal Ministry of Agriculture and Food Security
FMEnv	Federal Ministry of Environment
FMoH&SW	Federal Ministry of Health and Social Welfare
GHG	Greenhouse Gases
IBS	Indicator Based Surveillance
IDSR	Integrated Disease Surveillance and Response
IHR	International Health Regulations (2005)
INEHSS	Integrated National Environmental Health Surveillance System
ISP	Incident Specific Plan
ITSON	Integrated Training of Surveillance Officers of Nigeria
JEE	Joint External Evaluation
LGA	Local Government Area
LIMS	Laboratory Information Management System
MDAs	Ministries, Departments and Agencies
MoU	Memorandum of Understanding
NADIS	National Animal Diseases Information and Surveillance
NAFDAC	National Agency for Food and Drug Administration and Control
NARICT	National Research Institute for Chemical Technology
NAQS	Nigeria Agricultural Quarantine Service
NCCSES	National Committee on Chemical Surveillance and Emergency System
NCDC	Nigeria Centre for Disease Control and Prevention
NGO	Non-governmental Organizations
NESREA	National Environmental Standards and Regulations Enforcement Agency
NesPAM	NESREA Environmental Permit, Audit and Management Portal
NRCTWG	National Risk Communication Technical Working Group
ODS	Ozone-Depleting Substances

OHCSF	The Office of the Head of the Civil Service of the Federation
OSH	Occupational Safety and Health
PCB	Polychlorinated Biphenyl
PHEMC	Public Health Emergency Management Committee
PHEOC	Public Health Emergency Operations Centre
PHEPRP	Public Health Emergency Preparedness and Response Plan
POPs	Persistent Organic Pollutants
RRT	Rapid Response Team
SDGs	Sustainable Development Goals
SON	Standards Organization of Nigeria
SORMAS	Surveillance Outbreak Response and Management Analysis System
WHO	World Health Organization

GLOSSARY

Acute Exposure	Refers to a single or short-term exposure to a toxic substance that causes immediate adverse effects. The effects of acute exposure are usually seen within hours or days after exposure and may vary depending on the type of toxicant and the dose. Acute toxicity can manifest as a range of symptoms, including nausea, vomiting, headache, dizziness, respiratory distress, skin irritation, and convulsions. Acute exposure can be the result of accidental or intentional exposure to a toxic substance, such as a spill or ingestion of a poison.
Alert	This is a warning or signal that something might be wrong or dangerous. It's like an early notice that helps people take action to prevent harm or respond to an incident.
Biomonitoring	Biomonitoring is the measurement and analysis of chemicals or their metabolites in biological specimens, such as blood, urine, or breast milk, to assess exposure to environmental contaminants.
Chemical surveillance	Means the ongoing, systematic monitoring of chemical substances in the environment, food, and human and animal bodies. It involves collecting, processing, analysing, and interpreting data on the presence and levels of various chemicals, including pollutants, toxins, and other substances of concern in the above-mentioned (environment, food, and human and animal bodies).
Chemical Hazard	Refers to any forms of chemical substance that has the potential to cause harm to human health or the environment.
Chemical Exposure	A process by which a person comes into contact with a chemical, leading to absorption through inhalation, ingestion, injection or skin contact.
Chronic Exposure	Refers to repeated or long-term exposure to a toxic substance that causes adverse effects over time. Chronic exposure can result from continuous or intermittent exposure to a toxic substance, often occurring at low levels over a prolonged period of time.
Community	Community is a group of people who live, work, or interact in the same area or share common interests, values, or goals. Communities can be based on location (like a neighbourhood), shared identity (like a cultural or religious group), or shared activities (like an online group or club). Members of a community often support and rely on each other for various needs.
Event	Events refer to incidents or occurrences involving chemicals that may have a potential impact on health, safety, or the environment. These events can include chemical spills, leaks, explosions, accidental exposures, or the release of toxic substances into the air, water, or soil. They may be accidental or intentional and often require a response to manage risks and prevent harm.
Event-Based Surveillance	Event-based surveillance is the organized and rapid capture of information about events that are of potential risk to public health.
Hazardous Chemicals	Means substances or mixtures that have the potential to cause harm to human health, the environment, or both. These chemicals may be toxic, flammable, corrosive, reactive, or explosive, and can pose a risk to human health or the environment, if not used or handled properly. Examples of hazardous

	chemicals include pesticides, solvents, acids, bases, heavy metals, and many others.
IHR (2005)	The International Health Regulations (IHR, 2005) are a set of legally binding rules established by the World Health Organization (WHO) to help countries prevent, detect, and respond to public health threats that could cross borders and pose a global risk.
Health outcome	Adverse health effect resulting from long-term (chronic) and/or short-term (acute) exposure to a substance. Chemicals can have acute and chronic effects and impact the systems of an organism, such as: respiratory, reproductive, cardiovascular, urinary, nervous, immune and metabolic. They can also cause allergies and cancer.
Key stakeholders	The key stakeholders in chemical surveillance in Nigeria are multi-sectoral and aim to work in line with the One Health approach and the provisions of the IHR Chemical Event Core Capacity.
Indicator-Based *Surveillance (IBS)*	Indicator-based surveillance comprises the collection of specific predetermined or standardised types of data (indicators) such as detection of specific diseases, concentrations of specific chemicals in human samples, in food or the environment.
Pharmacovigilance	Pharmacovigilance is the science and activities relating to the detection, assessment, understanding and prevention of adverse effects or any other medicine-related problem.
Probable case	Means a probable case refers to a person who exhibits symptoms or signs that are consistent with a particular disease or medical condition, and for whom there is strong clinical evidence to support the diagnosis, even in the absence of confirmatory testing. The term is often used in situations where diagnostic testing is not available or feasible, or where the test results are inconclusive or not yet available.
Suspected case	Means a suspected case refers to a person who exhibits symptoms or signs that are consistent with a particular disease or medical condition but has not yet been confirmed through diagnostic testing or other methods. The term is often used in the context of a preliminary diagnosis or screening, where further investigation is needed to confirm or rule out the diagnosis.
Syndromic Surveillance	Syndromic surveillance in chemical surveillance refers to the monitoring of groups of symptoms or clinical signs that may be indicative of exposure to a chemical agent or toxin.
Toxicovigilance	Toxicovigilance is a type of surveillance that monitors data on poisonings and toxic exposures in order to track trends, identify high-risk populations, and develop interventions to prevent poisonings and reduce their impact.
Trigger	This is something that causes an event to happen. It could be a situation or an action that sets off a chemical incident, such as a spill, leak, or explosion. Think of it as the "starting point" of the problem.

CHAPTER ONE

1 Introduction

1.1 Background to Chemical Events / Incidents and Chemical Exposures

A public health chemical incident is defined as "*the uncontrolled release of a toxic substance, resulting in (potential) harm to public health and the environment… where two or more members of the public are exposed (or threatened to be exposed) to a chemical*"[1]. According to the World Health Organization (WHO), approximately two million lives and 53 million disability-adjusted life-years were lost in 2019 due to exposures to selected chemicals[2].

Over 850,000 people in 12 Nigerian states, including Niger, Osun, and Zamfara, are at risk of mercury poisoning due to artisanal and small-scale gold mining activities. Mercury, a toxic chemical, is commonly used in these processes, leading to widespread environmental and health impacts[3].

Many chemical incidents are visible (e.g. plume/odour/ spillage) and are quickly recognised, such as a fire at or a large leak from a chemical plant. Some chemical releases may, however, become apparent only with the presentation or reporting of a number of cases with similar signs and symptoms, who have a common history and are linked in time and location. The timely identification of the cause of clusters or suspected outbreaks associated with exposure to chemicals may require a detailed investigation involving clinical, toxicological, epidemiological, environmental and laboratory analytical approaches[1].

There are two types of public health chemical incidents: acute and chronic exposures, and people can be affected in a number of ways. Exposure to various chemicals occurs through multiple routes such as ingestion, inhalation, skin contact and via the placenta to the unborn child. Chemical incidents can have many manifestations, stemming from different events, which may be technological or natural in origin. For instance, technological events include an explosion at a chemical factory, a spillage during transport or storage, or a release resulting from conflict or from criminal or terrorist activity. Examples of incidents arising from a natural source include groundwater contamination with arsenic or fluoride, exposure to chemicals released during wildfires or other natural disasters. Chemical incidents may occur and/or impact upon any setting, including industrial and commercial sites, public spaces and homes[4].

In addition to chemical incidents, individual exposures to chemicals result in illness and deaths, and unintentional (accidental) poisoning is a significant global public health problem. Chemicals such as heavy metals, pesticides, solvents, paints, detergents, kerosene, carbon monoxide and drugs lead to unintentional poisonings at home and in the workplace. Unintentional poisonings are estimated to cause 193,000 deaths annually worldwide, with the major part being from preventable chemical exposures[4]. Poisoning data facilitates the identification of unanticipated and new hazards of chemicals and products, increases knowledge about the toxicity of different agents and helps to identify failures in risk management and to form the basis for prevention. In certain cases, a cluster of individual poisonings can by definition become a chemical event, e.g. from environmental contamination with a chemical or via contamination of pharmaceuticals or consumer products, highlighting the importance of toxicovigilance data (see section 3.4). Hence, for these guidelines, reported individual poisoning cases (e.g. from biomonitoring or toxicovigilance) where there is the potential for multiple exposure will be considered chemical events and reportable. Similarly, environmental monitoring results (e.g. drinking water, food) which indicate the potential for the public to be exposed would meet the criteria for a chemical event.

Indiscriminate disposal of chemicals is a prevalent technological event in Nigeria, and it is attributed to insufficient chemical waste disposal knowledge, poor waste disposal practices and disposal at illegal, unauthorised dump sites.

1.2 Chemical Events in Nigeria

Nigeria is home to several industries, including oil and gas, agriculture, and manufacturing, which have the potential to expose people to hazardous chemicals, such as pesticides, heavy metals, and industrial pollutants. Examples of past chemical events are provided in Table 1.

Appropriate surveillance and information systems combined with suitable response arrangements can strengthen capacity to prevent, detect and respond to these chemical threats. To ensure that the chemical burden is controlled and monitored, effective chemical management systems must consider hazards throughout the entire life cycle of chemicals, from raw material extraction, through production and use, to the final stage of waste disposal.

Table 1 : Examples of past chemical events in Nigeria[5].

Place	Year	Event description
Koko PCB Dump Site, Delta State	1980s	A large quantity of Polychlorinated biphenyls (PCB)-contaminated waste was illegally dumped in Koko, a town in Delta State, Nigeria. The waste was dumped by a company that had imported the PCBs for use in the manufacture of electrical transformers. The dumping resulted in widespread contamination of the surrounding environment, including soil, water, and air. The contamination has had severe health impacts on the local population, including reproductive problems, birth defects, and cancer.
Zamfara State	2010	A lead poisoning outbreak resulted in the deaths of over 400 children and significant health impacts for many more. The outbreak was linked to the processing of lead-rich gold ore by artisanal miners, who were using unsafe and unregulated methods that released toxic levels of lead into the surrounding environment.
Ogoniland, Niger Delta	2011	Widespread environmental contamination, which included PCBs, was linked to decades of oil exploration and production by multinational oil companies. The contamination has had severe health impacts on the local population, including skin diseases, respiratory problems, and cancer.
Niger State	2015	The lead poisoning outbreak affected at least 28 children. The source of the lead exposure was traced to a gold processing site in the area, where children were exposed to lead-contaminated dust and soil.
Yammama, Zamfara State	2015	A pesticide poisoning outbreak resulted in the deaths of at least 50 people and significant health impacts for many more. The outbreak was linked to the consumption of contaminated rice that had been treated with a highly toxic pesticide called "galmicide."
Jos	2015	The Lamingo water treatment tank leakage, where chlorine gas was exposed to the public.
Gombe State	2018	A pesticide poisoning outbreak affected at least 30 people. The outbreak was linked to the consumption of contaminated beans that had been treated with a highly toxic pesticide called "sniper."
Ogun State	2019	A pesticide poisoning outbreak affected at least 40 people. The outbreak was linked to the consumption of contaminated vegetables that had been treated with a highly toxic pesticide called "ogbooro."
Sokoto & Zamfara	2024	Initially, an unknown illness, primarily affecting children (and some adults) residing in two States in Nigeria. These incidents were investigated in 701 suspected cases and forty-five (45) deaths were reported in fourteen (14) LGAs in Sokoto State. Similar cases were also reported in Zamfara State affected 677 suspected cases and seventeen (17) deaths have been recorded from fourteen (14) LGAs as of August 2024. After a field investigation, a clear presence of heavy metal poisoning was indicated, possibly linked to industrial or mining activities and contaminated water and soil, among other sources.
Jigawa	2024	Majiya Fuel tank explosion that occurs 15th October, causing fatalities with over 170 deaths.

1.3 Global Context

The International Health Regulations (IHR) require countries to take actions to enable effective prevention, detection, response and management of public health incidents of potential international concern. To meet their obligations for chemical events, Member States must establish and maintain structures and systems for timely detection and effective response to potential chemical risks and events. This would entail Member States having surveillance capacity and effective communication and collaboration across sectors responsible for chemical safety, including health, occupational health, emergencies, environment, transportation and safe disposal, agriculture/veterinary, as well as industries.

Controlling chemical events and reducing the burden of chemical exposures are vital for achieving many of the Sustainable Development Goals (SDGs), in particular:

- **SDG 3: Good health and wellbeing - Target 3.9**: By 2030, to substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.
- **SDG 6: Clean water and sanitation - Target 6.3**: By 2030, to improve water quality by reducing pollution, eliminating dumping and minimising the release of hazardous chemicals and materials.

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, the Stockholm Convention on Persistent Organic Pollutants and Minamata Convention on Mercury are part of the international action being taken to promote the sound management of chemicals throughout their life cycle in ways that lead to the prevention and minimization of significant adverse effects on human health and the environment from hazardous chemicals and waste. They aim, for example, to enhance monitoring and control of transboundary movements of hazardous wastes and chemicals, and Persistent Organic Pollutant (POP) concentrations in humans and the environment.

The Montreal Protocol on Substances that Deplete the Ozone Layer regulates nearly 100 ozone-depleting substances. Similarly, the Kyoto Protocol mandates countries to track and reduce greenhouse gas emissions (GHGs). Together, both protocols rely on national data for effective monitoring of Ozone-Depleting Substances (ODSs) and greenhouse gas (GHG) emissions to assess compliance and environmental impact.

1.4 The Aim and Objectives of the National Guidelines for Chemical Events Surveillance

The guidelines aim to promote the protection of health and the environment by identifying and monitoring chemicals of public health concern in the environment and the potential for exposure to these chemicals, with a view to improving the management of such incidents and exposures to protect public health.

The objectives of these guidelines are:

- To develop and describe the implementation of a chemical surveillance system in line with IHR that supports real-time detection, assessment and response mechanisms for chemical events (e.g. from air, water, food and land).
- To enhance the provision of surveillance data and the assessment of the risks associated with exposure to key chemicals of public health concern.

- To help with the identification of other chemicals of public health significance.
- To leverage national and international standards in the collection, collation, analysis, interpretation and dissemination of data related to chemical incidents/events and exposures.
- To promote collaboration and information sharing among stakeholders to improve the efficiency and effectiveness of the response to chemical events and exposures.
- To provide data and information to guide risk communication to the public and decision-makers.

1.5 Scope

Chemical surveillance should be conducted at the local, regional, and national levels and involves collaboration between government agencies, security agencies, industry, academia, and other stakeholders. The methods and tools used for chemical surveillance include laboratory testing, chemical detectors, biomonitoring, exposure assessment, risk assessment, and data analysis & interpretation. The National Guidelines for Chemical Events Surveillance aim to provide guidance to government agencies, security agencies, industry, and other stakeholders on how to conduct systematic and effective chemical surveillance. This includes information on the collection, collation, analysis, interpretation and communication of data/information on chemical events with potential public health impacts in Nigeria for public health action. The chemical events surveillance guidelines rely on the data collection processes of the collaborating Ministries, Departments and Agencies (MDAs) to rapidly collect data of public health interest arising from chemical events.

This document should not be used in isolation but alongside the following national surveillance-related technical guidelines:

- Integrated National Environmental Health Surveillance System - INEHSS (Federal Ministry of Environment (FMEnv))
- National Integrated Disease Surveillance and Response (IDSR) Technical Guidelines (Nigeria Centre for Disease Control and Prevention (NCDC))
- Guidelines for the National Animal Disease Information System - NADIS (Federal Ministry of Agriculture and Food Security (FMA&FS)
- National Integrated Guidelines for Foodborne Disease Surveillance and Response (FMoH&SW, FMA&FS, FMEnv)

Other potentially useful documents include:

- National Public Health Multi-Hazard Emergency Preparedness and Response Plan - NPHMHEPRP (NCDC)
- National Chemical and Biological Emergency Preparedness and Response Plan – NCBEPRP (National Emergency Management Agency (NEMA))
- National Action Plan for the Reduction and Eventual Elimination of Mercury Use in Artisanal and Small-scale Gold Mining (ASGM) in Nigeria (FMEnv)

IDSR considers the One Health perspective, which addresses a shared health threat at the human-animal-environment interface, based on collaboration, communication and coordination across all relevant sectors and disciplines. The ultimate goal is to achieve optimal

health outcomes for humans and animals alike. The One Health approach is intrinsic to and strongly reinforced by WHO's IHR (2005) and other global health frameworks and applies to the local, regional, national, and global levels.

Integration of chemical events and poisoning surveillance is advocated for, and support can be leveraged for integrating this type of data into systems such as IDSR, District Health Information Software (DHIS2), Surveillance Outbreak Response Management Analysis System (SORMAS) and INEHSS, where already in place.

1.6 Intended Audience

These guidelines are intended for use by those collecting, receiving, analysing and reporting on surveillance data in health and environmental roles across all levels of the health system (Federal, State, LGA and health facilities), as well as technical officers of institutions and industries who are involved in detecting, monitoring or reporting chemical hazards/events. Of particular importance are the following:

Staff of relevant MDAs, including:

- Health professionals at healthcare facilities
- Staff working at emergency services (e.g. Fire Service) and at Poison Information Centres
- Environmental Health Officers (EHOs) - Federal, State and LGA levels
- Veterinary Surveillance Officers and Focal Points – all levels
- Laboratory personnel - Federal and State levels
- Disease Surveillance and Notification Officers (DSNOs) – State and LGA levels
- State Epidemiologists
- Community Health Workers
- Other relevant government agencies responsible for the detection of chemicals at borders and ports

CHAPTER TWO

2 Chemical Events Surveillance in Nigeria

Chemical events, whether accidental or intentional pose a significant risk to public health, the environment and national security. Developing a robust chemical event surveillance system in Nigeria is crucial for early detection, effective mitigation, and rapid response to such incidents.

Chemical events surveillance is information collection, management and action related to:

- **Chemical hazard** – refers to any form of chemical substance that has the potential to cause harm to human health or the environment.
- **Chemical Exposure** – a process by which a person comes into contact with a chemical, leading to absorption through inhalation, ingestion, injection or skin contact.
- **Health outcome** – adverse health effect resulting from long-term (chronic) and/or short-term (acute) exposure to a substance. Chemicals can have acute and chronic effects and impact the systems of an organism, such as respiratory, reproductive, cardiovascular, urinary, nervous, immune and metabolic. They can also cause allergies and cancer.

Chemical events surveillance requires the engagement and coordinated input of multiple stakeholders, including the health and environmental sectors, the public, emergency responders, researchers, NGOs, the media, security agencies and policy makers.

Some limited collaboration and information sharing between relevant MDAs in Nigeria currently exists in relation to chemical events surveillance. In the event of a chemical incident, individual MDAs would usually respond within their respective sectors at a local or State level. When a major health event occurs, however, a multi-sectoral approach is adopted to coordinate the response via the NCDC's Incident Management System.

Effective coordination of evidence generation and reporting on chemical and environmental health determinants and related services is essential for the successful operation of chemical events surveillance.

2.1 Roles of Key Stakeholders in Chemical Surveillance in Nigeria

The key stakeholders in chemical surveillance in Nigeria are from different sectors and aim to work in line with the One Health approach and the provisions of the IHR Chemical Event Core Capacity.

2.1.1 Human Health

The National Action Plan for Health Security (NAPHS 1.0) has identified the **Chemicals Management Programme (CMP) under the Federal Ministry of Health and Social Welfare (FMoH&SW),** Food and Drug Services Department as the lead to coordinate activities of all stakeholders under the IHR Chemical Events Core Capacity. The multi-sectoral **National Committee on Chemical Surveillance and Emergency System (NCCSES)**, facilitated by FMoH&SW, acts as a forum of relevant stakeholders

under the Chemical Events Core Capacity of the IHR.

- The National Centre for Disease Control and Prevention (NCDC) has responsibility, among others, to: Maintain the highest state of alertness to detect and respond to disease outbreaks, public health disasters, mass morbidity and mortality, due to pathogenic, chemical or biological agents.
- Develop and coordinate capabilities, measures and activities to control outbreaks and mitigate the health impact of public health disasters.

- Develop and coordinate an information network for the reporting and notification of communicable diseases.

It coordinates the surveillance systems for human health in line with IDSR, and supports States in managing small outbreaks. The NCDC also leads the response to large disease outbreaks and public health events of chemical origin with a potential public health impact.

The National Agency for Food and Drug Administration and Control (NAFDAC) regulates and controls the manufacture, importation, exportation, distribution, advertisement, sale and use of food, drugs, cosmetics, medical devices and packaged water and chemicals (referred to as regulated products). NAFDAC has a Chemical Evaluation and Research Department for monitoring chemical incidents and has been involved in investigating chemical events related to chemicals, food, drugs, cosmetics and pesticides. They also monitor for processed and packaged foods both periodically and on a routine basis through their Post Market Surveillance (PMS) Programme. Additionally, NAFDAC develops national chemical regulations and guidelines and enforces these regulations. NAFDAC also responds to chemical incidents, conducts investigations on the chemical substance, traces the source from the importation, importation, manufacture, distribution, seal and final use/end use. Ensures chemical safety and security throughout the supply chain.

The Nigerian Institute of Medical Research (NIMR) carries out research on communicable and non-communicable diseases of public health importance. They also carry out compositional analysis of pharmaceutical products. NIMR has a toxicology laboratory with the capability to analyse biological and environmental samples for chemicals, particularly during incidents.

The National Institute for Pharmaceutical Research and Development (NIPRD) is charged with the responsibility for research and development of drugs, vaccines, phytomedicines, commodities and diagnostics aimed at improving sustainable access to safe, affordable and high-quality healthcare. They provide analytical laboratory support to assess poisonings and undertake toxicological studies. The Institute researches the detection of heavy metals in medicinal plants, animal and food products. It is also involved in the quality assessment of drugs in the country.

Poison and Drug Information Services

The Toxicology Information Centre (TIC) is managed by the Ministry of Innovation, Science, and Technology through the Raw Materials Research and Development Council (RMRDC). It is an operational poison information centre providing clinical toxicology and pharmacovigilance advice via phone inquiries.

The National Hospital Abuja has a Drug Information Service Centre at the Department of Pharmacy, which gives out information about medication use at therapeutic doses that cause adverse effects. They have various online sources of information and dedicated staff to answer telephone enquiries. There is the potential for this service to be expanded to a Poison and Information Centre as the FMoH&SW has mapped them as a pilot centre for the establishment of the PIC.

The University of Abuja Teaching Hospital currently treats numerous clinical cases of poisoning, but does not have the facilities and dedicated staff to answer poison information inquiries. It has the potential to become a poison information centre in future, as also described for NHA.

2.1.2 Environment

The Federal Ministry of Environment (FMEnv) formulates policies, serves as the Designated National Authority for chemicals-related Multilateral Environmental Agreements (MEAs). It also coordinates all activities relating to chemical management and safety, with FMoH&SW co-chairing the National Committee on Chemical Management in Nigeria, across participating agencies and Organizations. The Integrated National Environmental Health Surveillance System (INEHSS), domiciled in FMEnv, is to identify, report and investigate key environmental indicators and hazards. They also have the capability to undertake routine environmental monitoring of certain parameters, including chemicals in air, water and soil.

The National Environmental Standards and Regulations Enforcement Agency (NESREA) is the regulatory and enforcement agency for chemicals legislation and the environmental sector, excluding the oil and gas sectors. NESREA conducts environmental compliance monitoring, environmental audits, sanctions and maintains a list of industrial sites and facilities.

The National Oil Spill Detection and Response Agency (NOSDRA) is responsible for the surveillance and detection of oil spills in the petroleum sector. Coordinates the implementation of the National Oil Spill Contingency Plan, which also incorporates the National Oil Spill Contingency System for Nigeria.

The Federal Ministry of Water Resources and Sanitation (FMWR&S) is responsible for water supply, irrigation, freshwater and aquaculture and has a standard laboratory for water quality testing and detection.

2.1.3 Animal Health and Agriculture

Similar to the human health surveillance system, the animal health sector has a parallel system for priority animal diseases of public health concern.

The Federal Ministry of Agriculture and Food Security (FMA&FS), through the Department of Veterinary and Pest Control Services now in **Federal Ministry of Livestock Development (FMLD)**, receives periodic and monthly reports from all States and the Federal Capital Territory on animal disease surveillance through the National Animal Disease Information Service (NADIS). It ensures food security in crop, livestock, and fisheries, and oversees the control, distribution, and safe handling of pesticides. FMLD and the National Veterinary Research Institute (NVRI) are involved in chemical incidents, especially in the agricultural sector and operate both toxicology and animal health laboratories, including one in Kaduna.

The National Veterinary Research Institute (NVRI) carries out research on communicable and non-communicable diseases of public health importance in animals. NVRI has a toxicology laboratory with the capability to analyse biological samples for chemicals, particularly during incidents in animals.

2.1.4 Industry

The Ministry of Solid Minerals Development (MSMD) are responsible for monitoring related to mines, industrial effects on miners, closures and reclamation of abandoned mines, field inspections and fuel storage plants (in collaboration with the FMEnv Environmental Impact Assessment department).

The Ministry of Petroleum Resources (MPR) and the Petroleum Regulatory Agency (PRA), monitor operations at various petroleum sites, including drilling locations, production platforms, refineries, storage depots and pipelines.

The Federal Ministry of Labour and Employment (FMoL&E), through its Safety and Health department, carry out routine inspections at industrial facilities regarding safe working conditions and environment, and therefore has a list of reported hazards, accidents and injuries from unsafe working facilities across Nigeria. Safety standards may be established for specific products or industries. For example, the Occupational Safety and Health Administration (OSHA) establishes safety standards for workplace exposure to hazardous chemicals.

2.1.5 Import/Export

The Nigerian Customs Service (NCS) oversees the quality of products imported and exported into the country, and it alerts relevant stakeholders about any potential unauthorised or contaminated products entering the country.

2.1.6 Other Key Stakeholders

The **National Emergency Management Agency (NEMA)** is responsible for disaster management and coordinates the plans and programmes for efficient and effective response to disasters at the national level; and monitors the state of preparedness at the subnational levels.

The **Standards Organization of Nigeria (SON)** evaluates quality assurance activities, including certification of systems, products, and laboratories across Nigeria. SON oversees quality control of products and investigates product quality, and enforces standards. It also registers and regulates standard marks and specifications, compiles an inventory of products requiring standardisation, and ensures compliance with Nigerian standards for regulated products before export.

The National Research Institute for Chemical Technology (NARICT) an agency under the Federal Ministry of Innovation, Science and Technology has established a Chemical, Biological & Radiological Decontamination Laboratory that have facilities for chemical samples analysis and for training professionals in Disaster Preparedness & Response and Environmental Security as well as provide Integrated Medical Management of Casualties in Chemical, Biological and Radiological Agent Events.

CHAPTER THREE

3 Surveillance Methods and their Current Implementation in Nigeria

A defining characteristic of surveillance is a direct and immediate link between the outputs of surveillance systems and operational or policy response. There should be an explicit mechanism whereby surveillance outputs feed into operational response, often in real time and ideally with defined criteria (trigger points) for response, or planning and policy making, usually through analyses undertaken over longer periods. It is therefore important to involve a number of different sectors and stakeholders in any surveillance strategy developed, as well as making clear the roles and responsibilities of all involved. The approach for conducting public health investigations and management should be clearly defined and should therefore refer closely to Chemical Incident and Emergency Response Plans and other relevant documents, see section 1.5.

The NCDC has an established disease surveillance system for priority diseases within the human health sector – IDSR – which includes both indicator and event-based surveillance to ensure the early detection of priority diseases. However, the system could be strengthened by integrating chemical hazards.

IDSR considers the One Health approach, which is a strategy that addresses events at the intersection of human, animal, and the environment. To implement the One Health approach effectively, a multi-sectoral collaboration is essential, where all three systems work together and share surveillance data. This information will help with undertaking informed routine risk analysis to identify strategies for controlling and preventing chemical exposures and their adverse health effects in both humans and animals.

3.1 Indicator-based Surveillance (IBS)

Indicator-based surveillance comprises the collection of specific predetermined or standardised types of data (indicators) such as the detection of specific diseases, concentrations of specific chemicals in human and animal samples, in food or the environment. It may also include planned non-targeted testing or laboratory analysis, such as in cases where the intention is to screen, for example, a water or food sample for the presence of chemicals[6].

3.1.1 Environmental Monitoring

Environmental monitoring is a key component of indicator-based surveillance and is the process of collecting and analysing samples of air, water, soil, and other environmental equipment or media to assess the presence and levels of pollutants or other substances of concern. Environmental monitoring is used to evaluate the quality of the environment, identify potential sources of pollution, and assess the effectiveness of pollution control measures. It can also be used in early warning alerts and to inform emergency response efforts in the event of environmental disasters or incidents, such as oil spills or chemical releases.

In Nigeria, laboratory-based data for environmental and other matrices is collected by various Organizations based on their mandates, but mainly by FMEnv, FMWR&S, MMSD, NESREA, NAFDAC, Federal Ministry of Innovation, Science and Technology (FMIS&T) and as described in subsections below. There are considerable overlaps, particularly in consumer product surveillance, with no “lead” stakeholder on environmental surveillance. The recorded data is currently fragmented and generally stored in separate databases by each MDA. Therefore, there is a need to harmonise the recording and reporting processes across agencies.

FMEnv monitors transboundary movement of hazardous chemicals and wastes and issues permits for export or import of restricted chemicals under relevant multilateral environmental agreements. NESREA, an environmental regulatory agency of the FMEnv, collects data on

chemicals throughout their life cycle, such as chemical spills at import and manufacture and has a record of all facilities they regulate. All data reported by these facilities (quarterly compliance monitoring, audit reports every three years from accredited consultants and immediate reports of incidents) is collated on an electronic platform called NesPAM. The NESREA laboratories are located in Kano (reference laboratory) and Port Harcourt, which both have stationary and portable equipment for chemical analysis. FMEnv and its agencies (NESREA and NOSDRA) collect information about unusually high concentrations of chemicals found in monitoring of environmental media, such as surface water, air and soil, but do not currently have procedures in place to routinely alert other agencies. Similarly, NESREA may be notified of chemical releases at the industrial facilities they regulate.

NAFDAC, an agency under the FMoH&SW, have a monitoring and evaluation department for chemical incidents, and they monitor the quality and investigate chemical events related to food, drugs, cosmetics and chemicals periodically, on a routine basis and during incidents. NAFDAC also undertakes appropriate investigations into the importation, production premises and raw materials for food, drugs, cosmetics, medical devices, bottled water and chemicals, including certification of the production sites and of the regulated products. The NAFDAC laboratories are located in Oshodi (Central Laboratory Complex), Yaba, and Agulu, with Area Laboratories in Kaduna, Maiduguri and Calabar.

3.1.1.1 Water

Water contamination in Nigeria, in general, has been due to a variety of activities, including oil exploration, agricultural and mining activities, domestic activities, fishing, and inadequate waste and wastewater management. These include challenges with management of landfill sites, illegal waste dumping, commercial slaughterhouses and other industrial activities. Hydrogeological interactions also lead to the possibility of the presence of heavy metals (such as lead, arsenic and barium) in groundwater in many locations across the country. Water quality information is generally only shared between stakeholders via specific requests or during incident investigations. Water monitoring is currently undertaken by several stakeholders, as described in the sections below.

3.1.1.2 Drinking Water

The FMWR&S and their state counterparts are responsible for water resources and sanitation (water supply) and have a water quality laboratory, which carries out some chemical water quality analysis and detection of water contaminants. In addition, water utilities analyse drinking water using private laboratories. NAFDAC has the mandate to monitor the quality of packaged (e.g. bottled) water and routinely samples most water producing companies and uses LIMS (Laboratory Information Management System) covering all laboratories for data storage. The Nigerian Standard for Water Quality (NSDWQ) is the legally recognised framework for ensuring the safety of drinking water in Nigeria and includes guidelines on acceptable chemical components, among other parameters, to safeguard public health.

3.1.1.3 Groundwater and Surface Water

Routine monitoring of groundwater quality is not generally undertaken; however, NESREA samples groundwater following incidents and during investigations before being analysed in NESREA's accredited laboratories. Water audits are also carried out for groundwater every three years. All data is collated on an electronic platform called NesPAM. NESREA uses the FMEnv regulatory standards for environmental guidelines for risk assessment, but these are less relevant for assessing risk to human health (e.g. those using water for recreational purposes). The Rural Water Supply and Sanitation Agency (RUWASA) supervises and regulates water supply services across rural areas.

3.1.1.4 Wastewater

The FMEnv are responsible for regulating sewage, and NESREA undertakes non-routine monitoring of effluent (liquid waste) from regulated facilities. All data reported by the facilities regulated by NESREA is collated on an electronic platform called NesPAM and comprises quarterly compliance monitoring, auditory reports every three years by accredited consultants and immediate reports of incidents. NESREA does not undertake routine risk assessments as part of this process, but investigates any complaints or non-compliances. Water treatment companies utilise private laboratories for testing and maintain in-house databases of records of water quality.

3.1.1.5 Air

Common sources of air pollution in Nigeria include domestic emissions from burning of fuel and wastes, generator use, vehicle emissions, indoor air pollution relating to particulate matter (PM) and carbon monoxide (CO), as well as open burning of domestic, municipal and industrial wastes. Localised air pollution includes cement kiln dust and other industrial emissions such as oil and gas production. The regulatory authorities for air quality include NESREA and FMEnv. The only operational air quality monitoring station in Nigeria is located in Port Harcourt, operated by FMEnv. In addition, NESREA has some portable air quality monitoring devices and the Nigerian National Ambient Air Quality Standards are used to trigger action.

Air quality parameters are self-monitored at various industrial facilities, which report their results to NESREA every quarter. If the monitored levels exceed the acceptable limits, the facilities notify NESREA, prompting the agency to take necessary action. All collected data is compiled on NESREA's electronic platform, NesPAM.

3.1.1.6 Food

In Nigeria, food surveillance aligns with the National Integrated Guidelines for Foodborne Disease Surveillance and Response, which should be leveraged at the first instance following a chemical (or suspected chemical) food contamination incident. The Guidelines include useful information on responding to organophosphates/organochlorides and mycotoxins contamination incidents as priority foodborne disease causes and contain guidance for foods contaminated with heavy metals. In addition, the INEHSS system contributes to food surveillance as part of integrated surveillance.

NAFDAC, which focuses on food safety for processed and packaged foods, conducts registration and periodic sampling and surveillance of such food items. This includes general surveys of food products in open markets across villages, cities, at both the local and State levels. Additionally, data on imported food from all points of entry are analysed at the central laboratory in Oshodi, which handles food and chemical analysis at the national level. NAFDAC also runs a Post Market Surveillance (PMS) Programme. The guidelines and standards used for risk assessments include the Maximum Residue Limit (MRL) of the Codex Alimentarius and EU guidelines.

NAFDAC issues public alerts when necessary and conducts risk assessments in response to incidents, informing the NCDC as required. All laboratory test results are stored in the LIMS.

The FMLD (Veterinary and Pest Control Services Department) collects surveillance data from abattoirs for unprocessed meat, from veterinary officers at the State and LGA levels and collects fisheries surveillance data from local to national levels across the country.

NAQS also analyses data on imported animals and crops, and monitors fresh produce such as grains, fruits, and vegetables.

3.1.2 Pharmacovigilance / Pharmaceuticals

Medicines have transformed the prevention and treatment of diseases. However, they may also cause side effects, which can be undesirable or unexpected. Pharmacovigilance is the science and practice of detecting, assessing, understanding and preventing adverse effects or other medicine-related problems. Certain side effects may become apparent when medicines are used by the general population, particularly in individuals with concurrent diseases over extended periods[7].

Pharmacovigilance activities are coordinated by NAFDAC under the supervision of the FMoH&SW and are implemented under the Nigerian National Pharmacovigilance Policy and Implementation Framework[8]. This covers the role of the National Pharmacovigilance Centre (operated by NAFDAC) and zonal / state pharmacovigilance centres/units. The policy outlines plans for passive (e.g. Adverse Drug Reaction (ADR)) and active pharmacovigilance. The policy also states that traditional/herbal medicine practitioners/clinics should also report adverse effects to NAFDAC.

NAFDAC's Greenbook records all registered drugs that have been analysed and includes a track-and-trace system for monitoring drugs from importation to the point of use. NAFDAC also conducts Post Marketing Surveillance (PMS) by sampling specific products across the country, excluding manufacturing facilities. This information is used for risk assessment of drugs, household chemicals and related products. Additionally, NAFDAC undertakes pharmacovigilance to monitor drug use and is currently receiving training to establish "cosmetovigilance" for monitoring the safety of cosmetic products.

Information for alert is also collected from health care facilities through MedApp Safety Reports and Yellow Forms (for drugs). All data is stored in LIMS, which integrates data from all laboratories and their test results. NAFDAC has implemented e-reporting of ADRs via their website and a Medicines Safety Application to track ADRs. Relevant information about ADRs is disseminated by NAFDAC to health professionals and the public.

NIPRD has laboratory capacity to analyse manufactured pharmaceutical products (including fake, sub-standard and adulterated medicine) and has laboratory test data for all manufactured drugs and consumer products in Nigeria.

3.1.3 Consumer Products (Non-Pharmaceutical)

The extensive use of various chemicals in consumer products (such as toys, household and cosmetic products) can lead to exposure to chemical contamination from these products in Nigeria. Some contaminated or banned consumer products may come into the country, prompting NAFDAC to conduct routine analyses on consumer products. In particular, NAFDAC carries out investigations and incidental sampling in response to public complaints or alerts from other MDAs, such as the Customs or health facilities. Whilst regulated products are relatively well monitored by NAFDAC, which tracks information about chemicals used in their manufacturing, online trade presents particular challenges for consumer product surveillance. A significant amount of illegal trade is believed to occur online, where small, unregistered traders can purchase chemicals, mix them and sell the products online without any control over their quality or composition.

NESREA undertakes ad-hoc monitoring of imported toys, usually following receipt of alerts from the Customs. There are chemicals related to chemicals in paint manufacturing, since approximately 90% of paint manufacturers mix paints themselves. NESREA also currently has an ongoing project which involves the analysis of Persistent Organic Pollutants (POPs) in plastics.

3.1.4 Emergency Services

Following an environmental incident, emergency services, such as the medical emergency services (SMoH), Environmental health services (SMEnv), Civil Defence (NSCDC), police and fire service are often among the first responders. Examples of such incidents include transport accidents involving chemicals or petroleum leaks from pipelines or drilling operations. Currently, the fire service lacks advanced detection, identification and monitoring equipment for unknown gases or vapours. However, there may be other indicators at the scene such as chemical containers with labels, CAS (Chemical Abstracts Service) numbers and obvious signs of environmental contamination such as petrol spills. Similarly, the police may be called to incidents involving theft of hazardous chemicals or where chemicals are involved in criminal activities.

3.1.5 Non-Governmental Organizations (NGOs)

There are a number of NGOs and similar Organizations working on the front lines to respond to outbreaks and emergency health situations, primarily related to infectious diseases. Organizations like Médecins Sans Frontières (MSF) provide medical humanitarian assistance to victims of conflict, natural disasters, epidemics or healthcare exclusion. Similarly, the Red Cross operates emergency first aid teams within local communities and is considered an emergency responder. As part of this role, they may often be the first to become aware of environmental or chemical issues if the local population presents with unusual symptoms potentially linked to chemical exposure or becomes aware of environmental hazards such as illegal waste dumping or chemical spills. They may also be the first to respond if individuals suffer acute symptoms from chemical exposure, such as caustic burns.

3.1.6 Import

The majority of chemicals used in Nigeria are imported. There are administrative and regulatory controls in place based on categories such as banned products (e.g. banned chemicals list by FMEnv, NAFDAC and Customs), as well as restricted and permitted products. The National Customs Service (NCS) collects data on the importation of all products, including quantities, quality, origin, safety information, declarations and any seizures undertaken. The Government of Nigeria has a platform called the Single Window Portal for Trade, which provides access to all relevant agencies involved in trade. When the NCS suspects or identifies non-compliance with regulations, they refer the case to the relevant MDA in the area for further investigation and action. Relevant regulatory agencies take the necessary actions, including sampling, analysis and final measures, if required. For example, NAFDAC and NESREA carry out sampling of suspected, banned, controlled and random imported products, based on their mandates as described above. The collated data is stored in the respective MDA databases. Information is shared as the need arises. The NCS are also working on developing a laboratory and envisages covering various areas in the future, especially ports.

The Standards Organization of Nigeria (SON) are tasked with the daily monitoring of the conformance of imported regulated products to applicable regulations, using transparent NCS clearing tools (NICIS), thus facilitating compliant trade through Nigeria's ports and borders.

The NCS, NAFDAC and NESREA alert other relevant parties, such as FMoH&SW, FMEnv and FMA&FS, when products potentially posing a public health risk have been imported and further action is required.

3.1.7 Biomonitoring

Biomonitoring is the measurement and analysis of chemicals or their metabolites in biological specimens, such as blood, urine, or breast milk, to assess exposure to environmental contaminants. Biomonitoring provides a direct measure of the amount of a substance that has

entered the body, as opposed to environmental monitoring, which measures the number of contaminants in air, water, or soil. Biomonitoring can help to identify and quantify exposure to environmental contaminants, such as heavy metals, pesticides, and other toxic substances. It can also provide information on the distribution of these substances in the population and help to identify groups that may be at higher risk of exposure. It can be used to evaluate the effectiveness of interventions aimed at reducing exposure to environmental contaminants or pollutants, as well as to identify new or emerging environmental health concerns. Biomonitoring data can also be used to inform regulatory decisions related to the safety and use of chemicals and other substances. For example, biomonitoring data can be used to set exposure and permissible limits or standards for environmental contaminants, or to identify chemicals that may pose a risk to public health and require further evaluation or regulation.

The National Health Research Ethics Committee (NHREC), under the FMoH&SW, is the regulatory agency for biomonitoring in Nigeria. In general, MDAs do not measure chemical exposure as part of their routine sampling. NIMR and NIPRD have biomonitoring capacity (including toxicological tests for acetylcholinesterase, CO, methemoglobinemia and a variety of heavy metals (like lead, mercury, cadmium, arsenic), organophosphates, carbamate, chromium, calcium carbide, chloride, cyanide, ammonium hydroxide, urea, dichlorvos, bromate, and drugs of abuse). NVRI also carries out biomonitoring in animals. However, these are usually only carried out on request from the Federal or State government, or academic institutions, and are not generally carried out routinely. In addition, some hospitals can carry out biological testing at the state level, but are often not able to undertake the chemical-specific tests mentioned above. Certain forensic laboratories also have some capability for chemical-specific testing, but these are typically utilised following fatalities, so could be less relevant for typical surveillance.

Risk assessments to determine if biomonitoring data requires reporting (see also section 4) are undertaken at State (state-owned laboratories) and Federal (federal institutions such as NIMR and NIPRD) levels using national, WHO and US CDC guidelines. When an exceedance is recorded, NIMR, for instance, escalates it to the head of the Organization, who then reports to the report's owner. All relevant MDAs are informed through NCDC (such as FMoH&SW, FMEnv), when necessary, such as in a major incident. Biomonitoring data storage is fragmented among MDAs and not stored in a single repository. Currently, most biomonitoring data is domiciled at NIMR, NIPRD and some hospitals, but the latter have limited capacity for chemical-specific testing.

3.2 Event-based Surveillance

Event-based surveillance is an organised and rapid capture of information about events that are of potential risk to public health. The sources of information are wide and can include official reporting systems as well as media reports, internet sources, rumours, emergency services, regulators and poisoning reports, for instance. Events that may pose a risk to human health, such as chemical spills, contaminated food or clusters of unexpected illness/deaths, may be captured. Information is initially captured as an alert, considered by the early warning and response system as representing a potential acute risk (such as an outbreak) to human health. All alerts may not necessarily become real events, and as such, need to be triaged and verified before a response is initiated. For guidance, EBS has been broken down into three sections below to reflect the information captured at different levels.

3.2.1 National Events-based Surveillance

In Nigeria, EBS for public health events is conducted at the national level by the NCDC, but it extends to the State level officers through SITAware (Situation Aware), which is a web-based, incident logging system to enhance documentation of public health incidents, with the system having focal persons in all states. EBS is undertaken daily and in different languages. Signals

are received from various channels, such as reports found in news reports, social media like X, rumours, hotlines, phone calls, text and WhatsApp messages. Receiving multiple signals for the same event is used as a criterion for triggering further investigation to confirm if it is a true event.

3.2.2 Community-based Surveillance (CBS)

A community-based surveillance system relies on the community members' capacity to identify and report public health problems to the nearest health facility or the LGA health department in case of a serious event. Any community member appointed by the community can be a community informant or agent. Once selected, the community informants/ agents receive training and are given supportive supervision on how to recognise certain health conditions or potential chemical events for the purpose of reporting suspected cases and chemical incidents, using relevant case definitions. Case definitions at the community level are usually simplified and are used to facilitate rapid detection of priority diseases, events and conditions or other hazards in the community. Case definitions at this level use key signs and symptoms to help the community recognise when they should refer a person with these signs and symptoms for treatment and notify the health facility.

3.3 Syndromic Surveillance

Syndromic surveillance in chemical surveillance refers to the monitoring of groups of symptoms or clinical signs that may be indicative of exposure to a chemical agent or toxin. This function is carried out by the Public Health Department of the Ministry of Health, the Veterinary and Pest Control Service Department of the Federal Ministry of Livestock Development. This type of surveillance involves the systematic collection and analysis of health-related data from various sources, such as emergency departments, hospitals, poison centres, and other health care providers, to detect unusual patterns or clusters of symptoms that may indicate a chemical-related event. Syndromic surveillance may be undertaken routinely or in response to an incident.

Identification of cases in outbreaks will use the syndromic surveillance approach, where case detection will be based on clinical features without any initial laboratory diagnosis. During a chemical event, once the source or exposure is identified, cases may continue to be classified as either suspected or confirmed. An additional tier classification, that is "probable case definition", may be added if officials feel that conducting laboratory tests on every patient with a consistent clinical picture and a history of exposure is not required.

3.4 Toxicovigilance (Poison Centres)

Toxicovigilance is a type of surveillance that monitors data on poisonings and toxic exposures in order to track trends, identify high-risk populations, and develop interventions to prevent poisonings and reduce their impact. Toxicovigilance is a key function of poison centres, as analysis of the inquiries received by a poisons centre provides information on the toxic agents involved in poisonings, the populations at risk and the frequency of certain types of poisoning. Poisoning surveillance systems can be used to identify emerging threats, such as new drugs of abuse or novel toxicants, or hazardous consumer products and to evaluate the effectiveness of interventions aimed at preventing poisonings, such as public education campaigns or regulations on toxic substances. They can also be used to target interventions to high-risk populations, such as children, older adults, or individuals with substance use disorders.

In Nigeria, currently, there is only one functioning Poison Centre, which is the Toxicology Information Centre (TIC), located within the Raw Materials Research and Development Council (RMRDC) in Abuja. However, two proposed poison centres have been identified by the FMoH&SW for further development as pilot centres (National Hospital Abuja and University of Abuja Teaching Hospital, Gwagwalada). The TIC collects data on chemical

exposures (time, nature and toxic agent of exposure), poisoning cases, and related health effects from both healthcare professionals and the public.

3.5 Other Sources of Chemical Surveillance Data

3.5.1 Industry and Occupational Health Data

Living registers or databases of hazardous sites held by NESREA, such as identification of waste sites, land contamination or sites of high accident potential, may also be classified as sources of surveillance data and provide useful information for public health alerting, investigation and management.

The information collated by NESREA, following appropriate filtering/Organization, could be further recorded on the INEHSS platform. Other stakeholders who may report this type of information to NCDC and INEHSS may include, for instance, Occupational Safety and Health agencies (such as the Occupational Safety and Health (FMoL&E), NAFDAC, Public Health Departments, Faculty of Veterinary Medicine/Veterinary teaching hospitals in addition to environmental agencies.

The Occupational Health, Safety and Environment (OHSE) Department in the Office of the Head of the Civil Service of the Federation (OHCSF) undertake monitoring of occupational health risk and work environment for Public Servants. They are responsible for reporting accidents and injuries.

CHAPTER FOUR

4 Risk Assessment in Chemical Surveillance

Joint risk assessment of chemical hazard at the human, animal and environmental interface is key to the prevention and management of chemical events. It helps characterise the nature and probability of adverse effects on the health of humans and animals who may be exposed to chemicals directly or via contaminated environmental media. For surveillance, the key practical purpose is to identify a trigger for reporting to the MDA receiving the result/information. This could be an environmental trigger (e.g. a specified concentration in food, air, water or soil) that exceeds relevant Nigerian or international (such as WHO) exposure guidelines, also considering typical background concentrations found in the environment.

A similar approach can be used for interpreting biomonitoring (e.g. blood/urine) concentrations to identify individuals or populations that have been exposed to a potentially toxic quantity of a chemical.

These are described in subsequent sections of this chapter, and a comprehensive datasheet for all key chemicals of public health concern can be found in Annex E. An example datasheet is provided in Annex E. These datasheets could be utilised at all tiers (local, state, federal) of the surveillance system to assist with risk assessments and reporting. These datasheets define standard case definitions for suspected and confirmed cases for each priority chemical and list potential sources of the chemical to help relevant authorities in investigating links to a potential chemical source.

Exposure to some environmental chemicals (or classes of chemicals) and poisons may result in a constellation of signs and symptoms characteristic of the toxicity of a given chemical agent or family of agents, referred to as a toxidrome. Examples of clinical presentations associated with one of the priority chemicals (arsenic), together with examples of potential sources of the chemical, are presented in Annex E. Ideally, the identification of a toxidrome should be discussed with a poisons centre or clinical toxicologist.

Further guidance in relation to risk assessment during the response phase can be found in the NCDC Multi-Hazards plan, the operational tool of joint risk assessment, the WHO Human Health Risk Assessment Toolkit: Chemical Hazards and the WHO Manual for Chemical Incidents.

For other sources of non-indicator-based surveillance data (e.g. toxicovigilance, syndromic surveillance, community-based surveillance), the decision to report a chemical event should always be guided by the definition of a chemical incident "*…resulting in (potential) harm to public health and the environment where two or more members of the public are exposed (or threatened to be exposed) to a chemical*".

Once a trigger level has been exceeded and reported upwards in the surveillance system to other MDAs, as indicated, a more detailed risk assessment will likely need to be undertaken as part of the response to the incident

4.1 Priority Chemicals of Public Health Concern

There are tens of thousands of industrial chemicals in commerce worldwide, of which about 6000 account for most of the total volume, some of which can severely damage our health. Therefore, countries are expected to prioritise chemicals based on their overall public health impact. Based on this, the National Committee on Chemical Surveillance and Emergency System (NCCSES) has identified 16 priority chemicals of public health concern as shown below. Additional information on the priority chemicals is included in Annex B.

- Air pollutants (SO_x, NO_x, CO)
- Aluminium
- Ammonia
- Arsenic
- Cadmium
- Cyanide
- Dioxins and dioxin-like substances,
- Polychlorinated Biphenyls (PCBs)
- Highly hazardous pesticides
- Lead
- Mercury
- Monosodium Glutamate
- Nickel
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Toxic Alcohols
- Volatile Organic Compounds (VOCs)

The prioritisation list is intended to be reviewed periodically and revised, as necessary.

Some unique characteristics and initial effects for recognising and diagnosing health effects of chemicals (predominantly chemical warfare agents), as well as associated recommendations for decontamination and management of exposed patients, are also provided in the National Technical Guidelines for IDSR.

The analysis and interpretation contain generic information about the minimum data elements to collect, analyse and interpret, such as time, place and person.

4.2 Alert Threshold

Alert thresholds are useful for deciding when to report chemical events during surveillance activities for priority chemicals of public health concern, an outbreak or event is suspected where there is unusual cluster, pattern, or increase in the number of cases when compared with previous periods, or a chemical incident with potential public health impact is reported/suspected. This should prompt a response such as a preliminary risk assessment, investigating clusters and identifying what might have caused the unusual event, if unknown. If laboratory confirmation is needed, specimens or/and relevant environmental samples should be collected for laboratory confirmation.

Generic standards are used to assess whether the levels of substances in environmental media, human or animal specimens, are acceptable for protecting human and animal health, considering both short-term and long-term exposure. These guideline values serve as "trigger values," indicating when the level of risk may be unacceptable. If concentrations in environmental media or biological samples exceed these levels, it suggests the possibility of significant harm to human or animal health. Exceedance of the guideline values is intended as an early warning mechanism to alert relevant stakeholders to a potential problem. An example of these trigger values for arsenic is presented in Annex E.

Some examples of what incidents are reportable are listed in Table 2 below. Note that this table is not exhaustive, but should help guide the risk assessment process.

Table 2: Examples of reportable chemical events

Scenario (note when "high" this means an exceedance of trigger threshold)	Is the incident reportable under surveillance?	Reasoning
Lead level above the drinking water standard found in well	Yes	Likely multiple people using drinking well, so potential public health issue
Lead level in excess of the drinking water standard in groundwater	Possibly	Is there a potential linkage between groundwater and human exposure? Further local investigation and development of a conceptual site model are required
Arsenic urinary and blood concentrations were very high in 5 patients living in the same community	Yes	Public health impact as multiple poisonings from a likely single source (e.g. food/water)
Arsenic urinary and blood levels were very high in one patient. Suspected environmental exposure.	Yes	Although only one case, potential to be a public health impact if environmental exposure (e.g. water/air)
The paracetamol blood level was very high in one patient following deliberate overdose. The patient has liver failure; reported to Poisons Centre.	No	As only one individual was exposed, a poisoning is not a public health issue. Data may be useful to establish the frequency of paracetamol poisonings in Nigeria.
Petrol odour coming from the local river, dead fish noted. Noticed by the INEHSS system.	Yes	Odour and possible exposure to those using the river or living nearby
High mercury content detected in skin lightening creams by NAFDAC.	Yes	If the product has been distributed in Nigeria, there is a potential for multiple exposures and public health issues.
The child has a very high carboxyhaemoglobin level on presentation to the hospital. Suspected to have occurred at school.	Yes	Potential for multiple exposures if exposure happened at school.
An individual is exposed to carbon monoxide from deliberate exhaust fume exposure from a vehicle.	No	Only one person was exposed to car single occupancy. Data may be useful to establish the frequency of carbon monoxide poisonings in Nigeria.
6 workers in a car garage became very drowsy, and 1 fell unconscious following the use of a generator indoors. Carbon monoxide poisoning is strongly suggested	Yes	Multiple exposures to CO. The Public health impact is so reportable
Two children from different households have accidentally drunk some bleach. Reported to Poisons Centre.	No	These are two individual exposures to bleach, hence not one chemical event but a poisoning incident.
Three people working at the mine have very high manganese levels in their blood following suspected exposure to contaminated dust.	Yes	Occupational exposure, but potential for dust to have been tracked to their homes, so potential public health issue for their families.
The individual has fallen into a container containing organophosphate pesticide. Now at the hospital.	No	Occupational exposure and only one person was exposed so it is a poisoning incident.
The individual has fallen into a container containing organophosphate pesticide. Now at the hospital. Staff at the hospital and other public in the hospital are also showing signs of organophosphate poisoning.	Yes	History indicates that secondary contamination has occurred, so it meets the definition of chemical event/incident.

The surveillance sectors (as per section 2 of the report) and relevant MDAs are summarised in Table 6. Reporting MDAs of Chapter 5 below. It is anticipated that the listed MDAs would undertake risk assessments as per the preceding sections and report to the agencies listed (primarily NCDC). Annex A, C and D contain example reporting templates that should be used when an alert threshold is met.

4.3 Action Threshold

A confirmed chemical incident or event should prompt an appropriate response such as activating and deploying RRTs, providing information and communication about preventing and controlling the exposures/chemical release, decontamination, strengthening medical case management, investigation to identify the source of the outbreak, activating any protection measures such as evacuation, shelter-in-place, product recall process, seizures at points of entry, if appropriate. Further guidance on responding to chemical events can be found in the NCDC Multi-hazards plan.

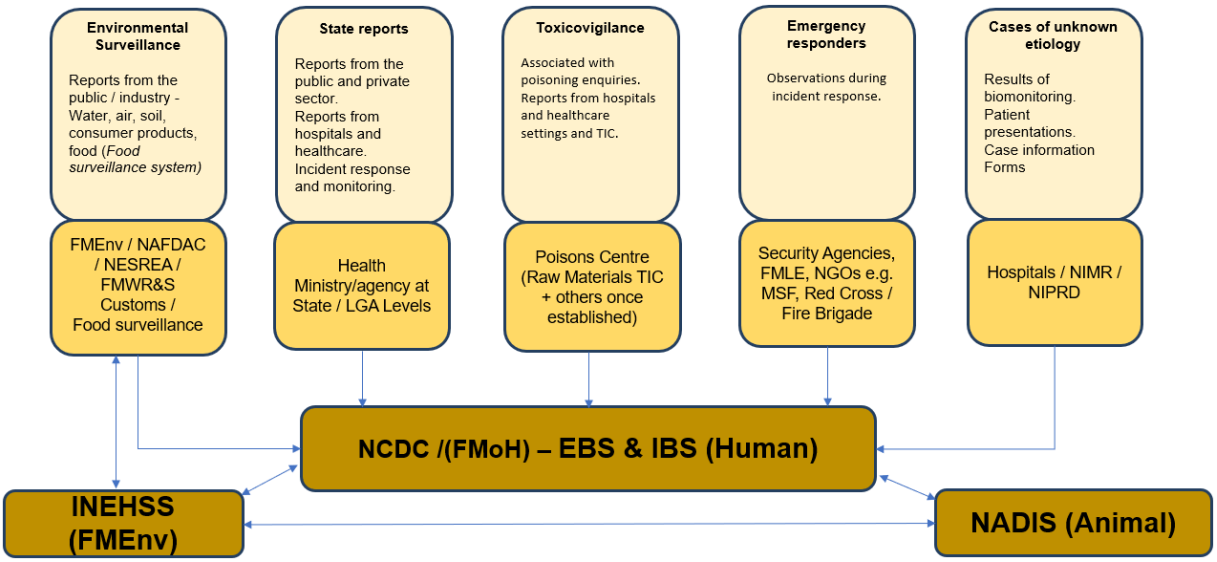
CHAPTER FIVE

5 Implementation of the Guidelines

Chemical Event Surveillance will be implemented based on the IDSR[22] strategy and will incorporate both Indicator-based Surveillance (IBS) and Event-based surveillance (EBS) approaches for early detection of priority chemical events using standard event definitions and community definitions. This section gives guidance on establishing EBS and using the approach for the detection and verification of chemical events. It also describes the role of laboratories in chemical event surveillance and response.

Incorporating all relevant data from the various areas of chemical surveillance is important to make the system comprehensive and effective. A diagram proposing how chemical surveillance data between MDAs is captured and shared, as illustrated in Figure 1.

The flow of information follows the same reporting lines, i.e that is from community to ward/LGA level and state to national level, therefore being applied at all levels of the health system (Figure 2) and finally, stored into respective databases as shown in Table 3.



*NAFDAC also has the infrastructure in place to alert the public and relevant agencies about consumer products (packaged water, drugs, food and chemicals)

Figure 1: Suggested structure of the chemical events surveillance

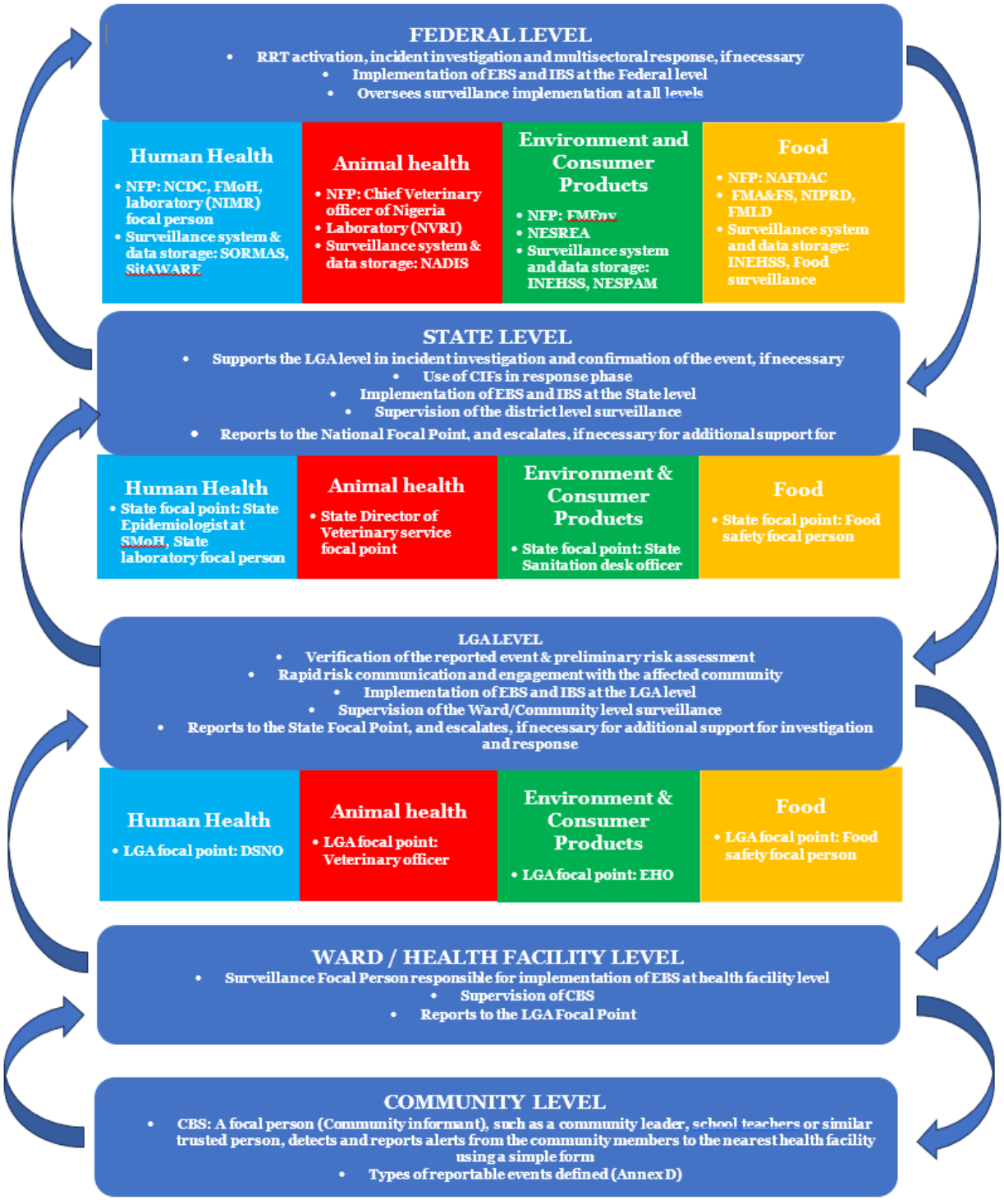


Figure 2. Levels of implementation and reporting of chemical events data

5.1 Local level

Community Focal Points, informants, such as religious/community leaders, schoolteachers, or other trusted persons, receive notifications from the community members who have been trained to understand the types of events (as described in section 5.7) that need reporting. Additional potential methods of sensitising the community to the types of reportable events may be achieved, for example, via posters and town hall meetings.

The Community Focal Point further reports the event using a simple reporting form to a Ward / Health Facility Focal Point, who can then further escalate it to the relevant LGA Focal Point.

At the LGA level, a One Health approach should be considered to permit efficient and coordinated horizontal information flow between the human health, animal health, environment and food surveillance sectors. The role of the LGA Focal Point is to verify the possible event and undertake a preliminary risk assessment and quickly communicate the risks and associated protective measures (e.g. avoid contaminated areas, stop eating suspect food) to the affected community. They are also responsible for carrying out an initial investigation, including sampling, if capacity exists and /or otherwise escalating it to the State level.

5.2 State level

At the state level, the focal point (dependent on the sector involved) will provide support or undertake the investigation and response activities, when necessary. The State Focal Point (e.g. environmental health reporting officer and the state epidemiologist) is responsible for reporting findings of the investigation to the Federal Focal Point, such as (FMEnv, NCDC and FMLD) in accordance with the relevant One Health mechanism. During chemical events, the State assists in organising the public health emergency state-level rapid response teams (RRT) and ensures functionality for both the state and LGAs levels.

5.3 National level

At the National level, the NCDC leads the multi-sectoral coordination of chemical events through the public health emergency operation centre (PHEOC) for coordination of preparedness and response activities of a public health event, including an incident management system, plans and procedures, is undertaken. It supports investigation of suspected or confirmed chemical events detected through surveillance, whilst also conducting overall supervision, monitoring and evaluation of surveillance activities. At the national level, the federal focal points shall have the responsibility to share anonymised data with line ministries and agencies, as well as with development partners and international agencies, academia and other such institutions, in accordance with defined standard triggers and for data sharing. Triggers for data sharing are discussed in the risk assessment section (see section 4) with some chemical-specific information (see Annex C and Annex E) to assist those in the reporting process at all levels.

5.4 Collaboration and Communication across Levels

Surveillance focal points at the LGA, State and National levels should collaborate with emergency response bodies at each level to plan relevant public health response actions and actively seek opportunities for combining resources supporting activities at each level. All surveillance activities need to be coordinated and streamlined, and resources combined to optimise the collection, management and analysis of information at a single focal point at each level. This approach is more effective than maintaining multiple surveillance systems with separate vertical and horizontal activities.

Information will be shared with National and Local levels, i.e horizontal and vertical levels, via the state focal person (e.g. state sanitation desk officer, director of veterinary service, state epidemiologist). This will be done using phones and tablets to feed into Surveillance Outbreak Response Management and Analysis System (SORMAS) and then disseminated to the LGA and then to the community/household as appropriate. Feedback shall be in the form of acknowledgement of information receipt, corrections, suggestions or actions from higher levels to lower levels. It shall form part of the continuous review of the system, and the continuous monitoring and evaluation mechanism, as well as form the content of supportive supervision from the higher level to the lower level. Feedback to the household and community

may be provided in the form of town hall meetings and announcements using traditional information channels.

5.5 Data Management System

Surveillance data collected by MDAs is stored in their respective databases (Table 3). However, in an ideal situation, a secure central database should be created to house the data from each sector via a One Health platform. The data storage site should be transparent and available for update and access 24/7. It is important to note that there should be transparency regarding the data ownership – in general, it is owned by the generator, and there should be clear definitions agreed on what data is shareable. For instance, all relevant ministries under the One Health approach should agree about data sharing and create one MoU at a senior (e.g. at Director General level) level to agree to share anonymised (not patient identifiable) data in line with the Data Protection Act

Table 3: Data reporting for chemical events

Sector	Surveillance activity	Surveillance system/database	Reporting stakeholders
Environment - Hazards	Reports of environmental and chemical hazards, hazardous installations, events and contamination. Routine, periodic, targeted and incidental monitoring results (air, water, soil, food*, consumer products, pharmaceuticals*).	INEHSS is domiciled with FMEnv. SITAware is domiciled with the NCDC.	FMENv (PCEH), NESREA, NAFDAC, FMAF&S, FMWR&S, FMoL&E, NCDC, Environmental Health Council of Nigeria
Human health – Exposures and health effects	Laboratory biomonitoring data from disease-based surveillance, data from poison centres, toxicological laboratories, and tertiary health centres.	SORMAS and SITAware are domiciled with the NCDC.	NCDC, NIPRD, NIMR, TIC, PICs, state laboratories
Animal health – Exposures and health effects	Periodic and routine reports of priority animal diseases of public health concern	NADIS is domiciled with FMLD	FMAF&S (FDFA), NAQS, FMLD (FDVPCS), NVRI, VCN

*Note that separate surveillance systems are well established for both pharmacovigilance and food incidents

All sectors involved shall agree and document the information product (situation report, hazard mapping report, epidemiological bulletin) to be shared at least every quarter:

In addition, the minimum data requirements (such as unique identifiers, dates of sample collection and submission, sample types, sampling location, context for collection, appropriate laboratory testing characterisation, details of the illness and patient) for each sector for the submission of data for an integrated surveillance system need to be agreed.

To support the provision of appropriate reportable data, Annex A contains the chemical events Case Investigation Form (CIF). Annex C contains example data fields for biomonitoring, food, water and soil, whilst Annex D contains information that could be collected for large-scale incidents (e.g. for emergency services).

Triggers to inform stakeholders, such as laboratories, about when the threshold is exceeded or reached, e.g. a certain contaminant concentration measured in an environmental medium or drugs being recorded above certain numbers may indicate a potential public health issue (see

section 4). In practice, incident parameters are to be defined for all relevant stakeholders to know what data is analysed and when to report it to both individual databases, including INEHSS, the central one health database and to relevant stakeholders at local, state and national levels.

5.6 Detect and Record Cases of Priority Chemical Events

Detection of chemical events will be focused on acute incidents related to priority chemicals for Nigeria to maintain the sensitivity of the surveillance systems, as inclusion of non-priority chemicals would clog the system. Chemical events can originate from mining areas, industrial sites, farms, natural events, manufacturing sites, where chemicals are stored, research centres, universities, open burning of dumpsites, and contamination of water sources from human activities.

Since chemicals are ubiquitous in the environment, there are several possible ways events associated with chemicals can be detected. These include Health workers reporting poisoning in humans, animals, and the environment; Poison Information Centres staff reporting on poisoning in communities or facilities; Environmental Health workers reporting on environmental contamination with chemicals; Laboratories detecting chemicals from samples from humans, animals or the environment. Other sources are from environmental monitoring, as well as monitoring of consumer products and ports of entry. Additional sources like social media, as well as public and private institutions, whose jobs involve various aspects of chemical management. These guidelines focus only on the detection of exposures in humans but highlight the linkage with other surveillance systems such as INEHSS and NADIS, where hazards and exposures to animals and the environment.

There are two main types of surveillance which contribute to the early warning and response to chemical events: Indicator-based Surveillance (IBS) and Event-based Surveillance (EBS). The two systems complement each other and are only differentiated by the type of information collected.

a. **Event-based Surveillance -** Describe the event that helps detect chemicals, e.g smoke, explosion, mining, dead fish, colour changes.
b. **Indicator-based Surveillance -** Describe the standard case definition of individual chemical poisoning in humans. symptoms and signs of chemical poisoning. Or in samples sent to labs

5.7 Establishing EBS for chemical events

Event Based Surveillance for Chemical Events is the organised and rapid capture of structured and unstructured (e.g. rumour or social media posts) information about chemical events that are of potential risks to public health. Information about chemical events is initially captured as an alert transmitted through the formal (established routine reporting system) and informal (e.g. media, health workers, communities) channels. This alert may be hazardous within the community. Since not all hazards may translate into exposure and health outcomes, all alerts should be verified before a response is initiated. The EBS, therefore, provides the opportunity for early detection of the hazards and or exposures that have occurred. The chemical event surveillance system should leverage on established EBS at the national and subnational levels.

5.7.1 Definition of Hazards Associated with Chemicals

Chemical hazards can be in the form of:

a) Banned or restricted chemicals being imported or used inappropriately
b) Indiscriminate disposal of chemicals/waste
c) Open burning of waste that contains or releases priority chemicals

d) Emissions from industries, machines, vehicles
e) Chemical reactions arising from the spoilage of food or the containers in which they are stored
f) Deliberate use of some chemicals either in food, cosmetics or drugs
g) Pollution or contamination arising from mining activities
h) Accidental discharge of chemicals from industrial facilities and while in transit
i) Deliberate discharge of effluents and waste
a) The malicious release or use of chemicals to harm people or the environment (criminal or CBRN exposures)

These hazards can be identified and reported by different MDAs that regulate either the entry or exit of these chemicals into the country, distribution, use, and disposal. For instance, Customs are required to identify and report banned and restricted chemicals entering and leaving the country. Similarly, NAFDAC is required to monitor the use of these chemicals in food, drugs, cosmetics, and pesticides.

The indiscriminate disposal of these chemicals/products should be identified by the communities and reported.

At the points of entry, chemical event surveillance should focus on priority chemicals/chemical products entering or leaving the country. A chemical event for Customs would include the identification of banned or restricted chemicals/chemical products.

FMENV should make available to Customs a list of the following chemicals for enhanced surveillance at Border control:

a. List of internationally banned chemicals which are of public health importance under various chemical-related multilateral environmental agreements to be provided by FMENV.
b. List of internationally restricted chemicals, accompanied by a list of their acceptable uses under various chemical-related multilateral environmental agreements to be provided by FMENV.
c. A list of nationally banned and restricted chemicals and products, accompanied by a list of acceptable uses for the restricted chemicals to be provided by FMEnv and NAFDAC.

5.7.2 Establishing EBS at Community Level

1. Identify focal persons in the community who should be focal persons for human health surveillance, environmental health surveillance or animal health surveillance.
2. Train focal persons on the priority chemical events, how to identify them, whom to report to, and how to provide feedback to the community.
3. These focal persons will be provided with reporting tools (phones and phone numbers of whom to report)
4. Focal Persons should be visited periodically to see how they are doing and to provide on-the-job training and feedback to them.
5. Focal Persons should also be engaged to support any investigation of a chemical event and the provision of feedback or awareness campaign to the community.

5.7.2.1 Community Case Definitions for Chemical EBS

The approach for the Community will be Syndromic surveillance, where most of the cases are expected to be reported based on the pathway of the exposure. The following community case

definitions are to be used to train community members on what to report if suspected chemical exposure or poisoning occurs.

1. Community informants for chemical surveillance should include community members such as community leaders, health workers, traditional healers, retired health workers, patent medicine vendors, and religious leaders who may have already been organised into a group of community informants by other health or political programmes.
2. Inform these informants about the priority chemical events that can occur in their area.
3. Use key signs and symptoms of the case definition and the context in which exposure can occur to describe the case definition.

Table 4 shows some selected case definitions which can be used to help the community to recognise cases of suspected exposure to or poisoning by chemicals.

Table 4: Community Case Definitions from different routes of exposure

Route of Exposure	Community Case Definition	Related Priority Chemicals
Ingestion	Anyone with stomach pain, vomiting, diarrhoea, confusion, drowsiness, or headaches after drinking water or alcohol, or eating food (like cassava)	Heavy metals (Arsenic, Cadmium, Lead, Mercury, Nickel, Aluminium), Cyanide, Toxic Alcohols (Methanol, Ethylene Glycol). ***Reference**:* WHO and CDC guidelines on heavy metal poisoning. CDC and WHO guidance on toxic alcohols.
Inhalation	Anyone with trouble breathing, who feels dizzy or tired, or experiences vomiting or confusion after inhaling smoke, fumes, or gases (e.g., from fires, pesticides, or generators).	Air Pollutants (CO, SOx, NOx), Pesticides, Volatile Organic Compounds (VOCs), PAHs, Cyanide ***Reference:** WHO guidelines on pesticide exposure. WHO air quality guidelines. WHO and CDC guidelines on VOC exposure. Environmental health guidelines on PAH exposure. WHO and CDC guidelines on cyanide exposure.WHO guidelines on persistent organic pollutants.*
Contact (Skin Exposure)	Anyone with skin irritation (itching, pains, burning, scaling, etc.) or rashes after touching chemicals like paint, fuel, solvents, or transformer oil.	Persistent Organic Pollutants (Dioxins, PCBs), VOCs *WHO guidelines on persistent organic pollutants*

5.7.2.2 Standard Case Definitions for Priority Chemical Events

The definition of a chemical event is described in section 1.1, but it can include exposures where there is a risk of the public being exposed to a chemical. At health facilities, chemical event surveillance will focus on describing exposures and health outcomes arising when humans contact chemicals via all inhalation, ingestion, and skin contact. All suspected cases are expected to be reported to the site focal persons or to the disease surveillance and notification officer (DSNO) of the LGA where the case is found. Standard case definition of priority chemical events is as shown in Table 5; further detailed information on risk assessment, including trigger and alerting thresholds, is described in section 4. It should be highlighted that for chemicals, clear case definitions based on symptoms (i.e clear toxidromes

only exist for a small set of chemicals), so biomonitoring and environmental monitoring are key in determining this process.

Table 5. Standard Case Definition of Priority Chemical Events

PRIORITY CHEMICAL EVENTS

Priority Chemical Group	**Standard Case Definitions for Suspected Cases**
Arsenic	***Suspected Case***: Any person presenting with symptoms such as vomiting, abdominal pain, diarrhoea, numbness, muscle cramps, rapid weight loss and skin changes, especially if exposed to contaminated water or food. ***Confirmed Case***: A person with several of the above symptoms who has confirmed laboratory evidence of elevated arsenic levels in blood or urine, taken at least 5 days after the last consumption of fish or seafood. ***References:*** WHO Fact Sheet on Arsenic[10], ATSDR TSP[23], TOXBASE®[16].
Cadmium	***Suspected Case:*** Any person presenting with abdominal cramps, severe nausea, vomiting, diarrhoea, musculoskeletal pain, flu-like symptoms, kidney dysfunction and anaemia, particularly if there is a history of inhalational exposure in an industrial setting, or from industrial waste or contaminated water. ***Confirmed Case***: A person with several of the above symptoms and confirmed high levels of cadmium in the blood. ***References*:** WHO Exposure to Cadmium: A major health concern[24], ATSDR TSP Cadmium[25].
Lead	***Suspected Case***: Any individual with headaches, stomach cramps, constipation, muscle/joint pain, fatigue, or trouble sleeping, particularly in mining communities or areas with known lead contamination. ***Confirmed Case***: A person with several of the above symptoms and elevated blood lead levels, confirmed through laboratory testing. ***References***: WHO Fact Sheet on Lead[26], WHO Guidelines for Clinical Management of Exposure to Lead[27].
Dioxins & Dioxin-like Substances	***Suspected Case:*** Any person presenting with skin lesions (chloracne, patchy darkening of the skin) or altered liver function after exposure to transformer oil or open burning of waste. ***Confirmed Case***: A person with several of the above symptoms and laboratory-confirmed presence of dioxins in blood, fat tissue, or environmental samples from the area of exposure.

	References: WHO Fact Sheet on Dioxins[28], WHO environmental health guidelines on dioxins[29], linking to transformer oil and burning practices.
Mercury	***Suspected Case***: Any individual presenting with headaches, difficulty sleeping, dizziness, abdominal pain, flu-like symptoms, muscle weakness, mood swings, or kidney damage, especially those frequently exposed to seafood or involved in artisanal mining. ***Confirmed Case***: A person with several of the above symptoms and elevated mercury levels in blood or urine. ***References***: WHO Fact Sheet on Mercury[30], WHO reports on mercury exposure, particularly in artisanal mining[31] and contaminated seafood. TOXBASE®[16].
Highly Hazardous Pesticides (e.g., Dichlorvos)	***Suspected Case***: Any person presenting with miosis or salivation, lacrimation, urination, defecation, gastrointestinal distress or emesis (SLUDGE) symptoms following agricultural pesticide exposure. ***Confirmed Case***: A person with several of the above symptoms and low erythrocyte/plasma cholinesterase activity, or positive laboratory tests for pesticide residues in blood or environmental samples. ***References***: CDC EPR Document[32] on organophosphates, TOXBASE®[16].
Cyanide	***Suspected Case***: Any person with chest pain, cherry red skin, drowsiness, confusion, dizziness, difficulty breathing and increased blood lactate, particularly after intentional ingestion, exposure to smoke or contaminated/inappropriately prepared foods (e.g., cassava processing). ***Confirmed Case***: A person with several of the above symptoms and elevated cyanide levels in blood, or confirmation of cyanide in environmental samples. ***References***: WHO Cyanide Fact Sheet[33], ATSDR TSP[34]
Polycyclic Aromatic Hydrocarbons (PAHs)	***Suspected Case:*** Any individual presenting with eye irritation, nausea, vomiting, or confusion, especially after inhaling contaminated air or consuming PAH-contaminated food. ***Confirmed Case***: A person with several of the above symptoms and laboratory confirmation of elevated levels of PAH-DNA adducts in blood or tissues. ***References:*** ATSDR TSP[35] and WHO Indoor Air Quality guidelines[36],
Air Pollutants (e.g., CO, SOx, NOx)	***Suspected Case:*** Any individual with fatigue, headaches, confusion, dizziness, palpitations, psychiatric disturbances or neurological symptoms after exposure to vehicle exhaust fumes, generators, or poorly ventilated buildings.

	Confirmed Case: A person with several of the above symptoms and blood tests confirming elevated carboxyhemoglobin levels or other biomarkers of air pollutant exposure. ***Reference:*** WHO air quality guidelines[37], especially those dealing with pollutants like carbon monoxide.
Polychlorinated Biphenyls (PCBs)	***Suspected Case***: Any person presenting with nausea, vomiting, respiratory irritation, or skin lesions after exposure to contaminated electrical equipment (e.g., transformer oil) or old fluorescent lighting fixtures. ***Confirmed Case***: A person with several of the above symptoms and laboratory-confirmed PCB levels in blood or fat tissue. ***References***: ATSDR TSP[38] materials on PCB exposure risks.
Nickel	***Suspected Case***: Any individual with nausea, vomiting, diarrhoea, cough, or shortness of breath, particularly after exposure to nickel-containing industrial emissions. ***Confirmed Case***: A person with several of the above symptoms and confirmed elevated nickel levels in blood or urine. ***References***: UK Health & Safety Executive[39], ATSDR TSP[40], TOXBASE®[16].
Aluminum	***Suspected Case***: Any individual with ongoing gastrointestinal upset, lip ulceration, hemorrhagic gastritis or multi-organ dysfunction, particularly in regions with high aluminium contamination in water or food. ***Confirmed Case***: A person with several of the above symptoms and elevated aluminium levels in blood or urine. ***References***: ATSDR TSP[41], TOXBASE®[16].
Ammonia	***Suspected Case***: Any person with a burning sensation in the eyes, nose, or throat, accompanied by lacrimation or coughing, especially after exposure to agricultural or industrial sources. ***Confirmed Case***: A person with several of the above symptoms and with evidence of ammonia release from the environment. ***References***: ATSDR TSP[42], and WHO chemical fact sheet[43].
Monosodium Glutamate (MSG)	***Suspected Case***: Any person with headaches, nausea, or allergic-like reactions after consuming food with added MSG. ***Confirmed Case***: A person with several of the above symptoms and confirmed excessive consumption of MSG through dietary analysis. ***Reference:*** Research on MSG and its health effects, including symptoms such as headaches and allergic reactions.
Volatile Organic Compounds (VOCs)	***Suspected Case***: Any person with irritation to the eyes, nose and throat or breathing difficulties, abdominal pain or central nervous

	system symptoms (e.g., fatigue, confusion) after exposure to VOCs such as benzene or toluene. ***Confirmed Case***: A person with several of the above symptoms and elevated VOC levels in blood, urine, or breath samples. ***Reference***: WHO guidelines on the health effects of VOCs[37].
Toxic Alcohols (e.g. Methanol / Ethylene Glycol	***Suspected case:*** Nausea, vomiting, stomach pain. Confusion, ataxia, hallucinations, convulsions and coma. May occur following ingestion of contaminated medicines of counterfeit alcohol products ***Confirmed case:*** A person with the above symptoms with elevated methanol or ethylene glycol concentrations. An elevated osmolal or anion gap may also assist with diagnosis. Reference: TOXBASE®[16], ATSDR Methanol[44], ATSDR Ethylene Glycol[45]

5.7.3 Steps for Establishing Community Chemical EBS at the National, State and Local Government Levels

Step 1. **Establish telephone hotlines** at the NCDC that community members can call to report events. The Chemical Event Surveillance Systems can leverage existing hotlines or any of the existing poison information centre hotlines.

a) The hotlines must be freely available to the public.
b) It should be a short number that the public can remember.
c) Should be able to have connections to social media such as WhatsApp, and receive SMS messages.
d) The hotline should be widely disseminated.
e) The call handlers should be trained employees who operate for 24 hours a day and have the capacity to respond to calls and requests for information from the community.
f) Responders should be trained on frequently asked questions, how to be courteous, and how to document alerts reported by the community.
g) Hotlines should be established at the national level and should be linked to State and Emergency Operation Centres.

Step 2: Alert Detection

This is a process of capturing potential chemical events that are reported through the hotline.
a) Members of the public may communicate with the hotline desk through phone calls, SMS, or social media messages.
b) The hotline desk officer filters notifications from callers to determine which alerts are valid.
c) A list of possible alerts should have been provided to the hotline desk operators or responders.
d) An alert log should also be provided in which responders are to record all valid alerts.

Step 3: Registration of EBS Alerts

a) All alerts that correspond with a predefined list of alerts (case definitions of chemical events, see section 5.7.2.1) should be registered in the alert logbook.

b) Each alert captured should include a minimum dataset for tracking the alert, such as:

i) Source/informant: name, contact phone number, time, and date of the call.

ii) Alert: What happened, when it happened, who was affected, and where it started and spread.

iii) Follow up the alert: Verification, risk assessment and response.

Step 4: Conducting Assessment of Alert Verification

a) The hotline desk operators should assess each alert and ensure it matches the priority chemical list of alerts (case definitions). If they do, the alert should immediately be sent to the ward focal person, LGA focal person and State focal person for verification.

Step 5: Conduct verification of alerts

a) Preliminary verification is undertaken by the ward focal person. This person verifies that the date, location and what happened are correct and true, assesses the scale and describes it to the investigating team.

b) A multi-disciplinary investigation team should be convened and deployed from either the LGA, State or national level, depending on the type of alert, to conduct a detailed investigation.

c) The investigating team then notifies relevant stakeholders of their findings.

d) All alerts should be verified within 48 hours and stakeholders notified within 24 hours of verification.

e) Once the alert is verified, an appropriate response should be instituted within seven days of notification.

5.7.4 National EBS

NCDC undertakes EBS at the national level via monitoring of media reports and social media (see further section 2). NCDC verifies the signal received via EBS with the community, and it is escalated through the Surveillance Outbreak Response Management and Analysis System (SORMAS) and WhatsApp. Following a preliminary risk assessment (the WHO guidelines are used), necessary action (such as activation of the Rapid Response Team and sampling) is undertaken, and relevant stakeholders are notified via the NCDC supervisor. The notification of other stakeholders may include agencies such as the NCS, poison centres, NIMR, NESREA, FMEnv and NEMA (for preparedness). Information is also reported to the NCDC supervisor for further escalation to the relevant Technical Working Groups (TWGs). SORMAS is used to store the data, which is currently used internally only.

5.7.5 Syndromic Surveillance

NCDC currently have a preliminary system in place to capture chemical events via syndromic surveillance. If a suspected chemical event is reported to an LGA (e.g. via community-based surveillance or a person(s) becoming ill) a Case Information Form for Chemical Events is completed (see Annex A) either in the community or at the hospital and captures key data in regards to patient details, occupation, potential environmental exposures (including food), symptoms reported and suspected chemical(s) exposed and any blood tests recommended. Once completed, this form is then forwarded to the MoH at the state level and the NCDC at the National level. This may prompt an appropriate response and, in significant incidents (such as multiple people unwell) may result in activation of the NCDC RRT for further investigation. It is important that appropriate training is implemented for NCDC staff manning the hotline to recognise toxidromes.

5.8 Establishing IBS for Chemical Events at the National Level

The chemical event under surveillance should be prioritised because many such events can occur in any given area. Prioritization should consider the frequency of occurrence of the

chemical event, the impact of the chemical events on humans, animals and environment when it occurs, the treaties signed by the country on control of some chemicals, the potential for spread including international spread, and any other priority that the country has set e.g. economic impact etc.

IBS involves the use of Standard Case Definitions to identify cases of people who are exposed to chemicals and are symptomatic. Where exposure occurs without symptoms, they should be reported as events and not as cases until biomonitoring reveals elevated levels of priority chemicals, then they are converted to cases. IBS will record both suspected and confirmed cases and will keep a log of all events leading to the cases.

Chemical event surveillance will leverage on established IBS.

a) IBS involves regular reporting of a predetermined list of conditions based on standard case definitions. These reports can be weekly, monthly, or quarterly, depending on the type of condition.
b) A list of reporting sites has to be determined, and focal persons from those sites identified and trained.
c) The standard case definitions of all conditions and diseases arising from chemicals should be developed and rightly circulated.
d) Health workers should be trained on how to identify and report conditions and illnesses arising from exposures to chemicals.
e) Laboratories that can detect these chemicals in biological samples should be equipped and provided with the necessary reagents to be able to confirm the presence of these priority chemicals.
f) Feedback from caregivers and laboratories should always be provided to the multidisciplinary team that investigates cases in the communities.

5.8.1 Role of Ministries, Departments and Agencies in IBS

IBS should be established in all MDAs that can provide data on chemical events regularly. All Organizations with established IBS are regarded as reporting sites.

When chemical exposures are suspected (e.g. due to environmental contamination) without suspected cases in humans or animals, reports are expected to be logged in the INEHSS and investigated. If cases are identified, it should trigger the chemical event surveillance system to be sure that the implicated chemicals are identified, and an appropriate response is instituted. In such Organizations, Focal Points need to be identified who will be responsible for managing the data of exposure to chemicals.

These Focal Points can be data managers in responsible agencies, laboratory scientist that work on samples suspected to have been exposed to chemicals, clinicians, nurses, first responders to disasters and emergencies, and workers in poison information centres, industrial chemical handlers, customs (border control), and law enforcement agents that investigate potential chemical incidents, researchers (academia).

The Focal Points should be trained on the standard case definitions of priority chemicals.

Table 6 below summarises section 2 information and lists the MDAs involved in the reporting of chemical events:

Table 6. Reporting MDAs

Sector	MDAs involved	Report to	Data to be reported
Drinking water (tap)	FMWR&S and water utility companies	NCDC	Annex C
Drinking water (Packaged)	NAFDAC (LIMS system)	NCDC	Annex C
Groundwater	NESREA (NESPAM database)	NCDC, FMEnv	Annex C
	Rural Water Supply and Sanitation Agency (RUWASSA)	NCDC, FMEnv	
Wastewater	NESREA (NESPAM database)	NCDC, FMEnv	Annex C
Air (industry)	Industrial facilities and NSEREA	NCDC, FMEnv	Annex C
Air (ambient)	FM Environment	NCDC	Annex C
Pharmacovigilance	NAFDAC	NCDC, Poisons Centres	Annex C (adapt)
Consumer products	NAFDAC (ad hoc or incidents) NESREA (toys)	NCDC, Poisons Centres	Annex C (adapt)
Emergency services / NGO's	Fire, Red Cross, MSF	NCDC, FMEnv, NESREA	Annex D
Chemical imports	NCS, SON, NAFDAC	NCDC, FMEnv, NESREA	Annex C
Biomonitoring	NIPRD, NIMR, Hospitals	NCDC, Poisons Centres	Annex C
National Events Based Surveillance	NCDC	Poisons centres, FMEnv, NESREA	Annex A, C, D
Community Events Based Surveillance	N/A	INHESS / NCDC	Annex A
Poisons Centres (Toxicovigilance)	All Operational Poisons Centres	NCDC	Annex A and D
Industry hazardous sites	NESREA, NAFDAC, FML&E	NCDC, FMEnv, NAFDAC	Annex C (adapt)
Occupational Health Data	FML&E	NCDC	Annex C, D
Chemical decontamination	NSCDC (NEMA, FFS, NAFDAC, NARICT, NESREA and NABDA support as necessary)	NCDC	

5.8.2 IBS Reporting Sites

The surveillance system for chemical events, which is domiciled in the NCDC, should maintain an updated list of reporting sites. This list should include:

i. Health Facilities
ii. Poison information centres
iii. Laboratories

Every reporting site should have at least one focal person who reports the incidence of chemical events either directly to the NCDC or via their organisation's designated focal points. Where all departments/units that can report chemical events in an organisation are located in one physical location, they should have one designated person who reports to NCDC and all other focal points report to that designated person. Where this is not possible, then each unit or department can report directly to the NCDC.

Designated focal persons are expected to report routinely based on an agreed frequency, using a reporting form (see Annex C for an example reporting form for biomonitoring/food data). If no chemical events are detected within the reporting period, they are able to submit a zero report to confirm this. Table 7 provides an example of a database of reporting sites:

Table 7. Example of Database of Reporting Sites

S/N	Name of facility/Unit/department	Address/location of facility or focal point of contact	Name of designated focal person for surveillance	Phone number of focal person	Email of focal person
1	Toxicology Information Centre	RMRDC			
2		National Hospital			
3	FMENV- Pollution Control & Environmental Health	Maitama Abuja			
4	FMENV- Environmental Assessment				
5	NAFDAC Lab- Toxicology lab	Lagos			
6	NAFDAC Lab – Toxicology lab	Calabar			
7	NESREA- Environmental reference laboratories	Kano and Portharcourt			

Note: Where there is more than one focal person per Organization, the name of the Organization should be appended to the name of the reporting unit for ease of consolidation of their data during analysis.

5.8.3 Role of Laboratories in Chemical Event Surveillance

Signs and symptoms of chemical events may be similar for several chemicals and may mimic the signs and symptoms of infectious diseases. For instance, lead or arsenic poisoning can present with vomiting, abdominal pain, and diarrhoea, which are common symptoms of many endemic infectious diseases in Nigeria. Therefore, it is important that laboratories have the capacity to confirm and distinguish the real cause of the symptoms a patient presents with via biomonitoring and any potential exposure from the environment (e.g. air, water food and soil) Laboratory confirmation of diagnoses chemical related conditions and events under surveillance is essential to: accurately confirm the diagnosis in an individual patient (human, animal, or environmental matrix (air, soil, water, food); and verify the cause (or etiology) of a suspected incident or events. All laboratories within the network of laboratories that can confirm chemicals in biological and environmental samples are expected to follow Standard Operating Procedures (SOPs) and have accreditations from reputable accrediting bodies for their results to be generally accepted.

5.8.3.1 Specimen/Sample Collection, Storage and Transportation

Collection, storage and transportation of biological specimens and environmental samples should be a collaborative effort between the laboratory conducting the analysis and the reporting sites (medical facilities, MDAs, point of entry, first responders, etc).

A) Biological specimen Collection, Storage and Transportation

The type of specimen collected, the transport medium and its packaging depend on the suspected chemicals and their routes of exposure, including the organs likely to be affected time lapse between exposure and specimen collection. For example, arsenic and its metabolites are quickly eliminated from blood; therefore, blood concentrations are less useful as a primary index of suspected acute exposure. Urine is most suitable.

a. Specimens should be collected in adequate quantity into appropriate containers at the healthcare facility level or, if necessary, in the field during an outbreak investigation.
b. All specimens must be triple packaged, labelled correctly and accompanied by the correct laboratory forms in order to arrive at the laboratory in good condition to obtain reliable results.
c. Samples should be transported to the laboratory as soon as possible at an appropriate temperature range to minimise delays and compromise between collection and processing in the laboratory.
d. The Health facilities should have relevant trained personnel, equipment, as well as adequate reagents and consumables to enable sample collection.
e. For outbreaks, specimen storage and transportation to the laboratory should follow standard guidelines for the collection, storage and transportation of specimens.
f. Trained personnel (LGA DSNO, Laboratory focal person, or logistics company) should transport samples from the field or health facility to the laboratories.

B) Environmental Sample Collection, Storage and Transportation

Procedures for the collection of environmental samples depend on the suspected chemicals and the environmental matrix from which the sample is taken.

a. All environmental samples must be taken by a trained Environmental Health Officer who is familiar with the procedures of environmental sample collection and the guidelines of the manufacturer of the sample collection kit being used.
b. In the case of a chemical event, environmental sample collection should be headed by a trained environmental health officer, who should be part of the Rapid Response Team (RRT).
c. If the environment is contaminated with chemicals but there are no human or animal cases of poisoning being reported, the level of contamination will determine the type of sample to be taken, and the extent of the coverage of the area from which samples should be taken.
d. Where there are both environmental and biological samples, guidelines that would ensure there is no cross contamination must be strictly applied and followed throughout the chain of custody of those samples.
e. When a sample has been collected, the laboratory must be kept informed of the date of collection and likely arrival at the laboratory, especially when the test being requested is not routinely done, is urgent, or has public health importance.
f. A register should be kept on the types of samples collected, date and time of collection, means of storage, means of transportation, types of chemicals to be analysed, and name of sender and Organization, name of laboratory performing the analysis, and the condition in which the sample arrived at the laboratory.

g. Feedback on laboratory turnaround time, number of days from date of sample collection to arrival in the laboratory, the condition in which the sample arrived in the laboratory, including the documentation for each sample, should be provided to all relevant stakeholders for corrective actions.

C) Conditions of Inadequate Samples

A sample arriving at a laboratory may be considered an inadequate sample if:

a. The wrong sample is collected.
b. The quantity of the sample is too small.
c. The temperature at which the sample arrives is inappropriate for the sample.
d. The wrong transport medium is used.
e. There is incomplete documentation, such as the name, where the sample was taken, the date the sample was taken, and the requested test to be conducted.
f. There is clear evidence of contamination or spillage of the sample (change in colour, the container is stained or not properly covered).
g. Inappropriate packaging (non-triple packaging, wrong packaging material for the requested analysis).

D) Collection, Storage and Transportation of Cosmetics and Other Non-Biological and Environmental Samples

Reporting sites such as Points of Entry (Customs, Quarantine Services), NAFDAC and other MDAs sending samples for chemical analysis that are neither biological nor environmental samples should follow SOPs for collection, storage and transportation provided by the laboratory to perform the required analysis.

5.8.3.2 Laboratory Analysis

The choice of equipment and procedure for laboratory analysis would depend on the physicochemical characteristics of the chemicals being tested. For surveillance and response to chemical contamination, poison and events, laboratories should be selected from the list of laboratories that have the capacity to analyse priority chemicals, as identified by the Federal Ministry of Health and Social Welfare. The choice of laboratory from the list should be based on the following criteria:

The laboratory should

a. Have the relevant accreditation/licence to practice.
b. Have an official agreement (MOU) with NCDC or other relevant Organizations stating terms and conditions for sample analysis.
c. have the best equipment to analyse the samples for the chemical of interest.
d. Confirm they have the required reagents to perform the analysis.
e. Have personnel disposed to perform analysis
f. be easily accessed.
g. be located preferably within or nearest the State where the incident occurred.

Results of laboratory analysis should be treated as confidential information and only shared with the reporting Site that provided the samples, and other government Organizations that may need to work with the data.

5.8.3.3 Establish a Laboratory Network

a) The FMoH&SW should maintain an updated list of laboratories that have the capacity to analyse chemicals.
b) This list should be circulated to all reporting sites as often as they are updated.
c) Reassessment of each laboratory's analytical capacity should be conducted every 5 years.
d) During reassessment of the exercise, attention should be paid to the inventory of supplies, reagents and equipment; laboratory procedures; and confirm laboratory quality control and assurance.
e) The network of laboratories and reporting sites should agree on methods of sample collection, preparation, storage and transportation for human and environmental samples, based on national policy.

5.9 Reporting of Chemical Events

Chemical events can be reported from the communities, health facilities, laboratories, Points of Entry, research centres, and companies that deal with chemicals. These reports can be of hazards, where the presence or use of chemicals and human activities around chemicals may cause loss of lives, injury or other health impacts to humans, animals or the environment. Additionally, the report of chemical events can be of exposures to humans, animals or the environment where there are cases of humans or animals presenting with symptoms for which no biological cause is identified. Reliable reports provide information for surveillance officers at the LGA and State Health Authorities, Points of Entry, and National Focal Points in respective MDAs responsible for regulating the use of these chemicals. These reports help to:

a. Identify emerging chemical events and plan appropriate responses.
b. Take timely action to limit morbidity and mortality associated with the chemical event.
c. Monitor trends of chemical events to inform policy and regulations around the registration, distribution, use and disposal of chemicals.
d. Evaluate the effectiveness of the response.

This section describes how to report events and conditions associated with priority chemicals in Nigeria within the One Health approach. This approach involves exposures to humans being reported through the IDSR to NCDC, exposures to animals being reported to NADIS, and exposures to the environment, as well as hazards associated with chemical handling and human activities related to chemicals, such as mining, being reported to INEHSS. Section 4 on risk assessment provides further information on risk assessment of surveillance data and the use of thresholds for reporting of chemical events.

The frequency of reporting will be as prescribed by the respective guidelines of the different sectors. For instance, some of the events that will be reported will fall into those for immediate reporting, in which case, a Case Investigation Form (see Annex A and D) will have to be filled out for every identified event and submitted to the appropriate authority immediately. Similarly, Annex C provides templates for reporting data for biomonitoring, water and soil, which can be adapted for other sectors as indicated. Other events may be reported weekly as aggregate data for monitoring the trends of the chemical events for detecting abnormalities and patterns associated with the chemicals. Similarly, some events may be reported monthly or quarterly, depending on the frequency of occurrence of such events.

5.9.1 Chemical Events for Immediate Reporting

All events in humans and animals where there are cases of ill-health associated with chemicals should be reported immediately, irrespective of how they occur. Information that is reported

immediately, such as single cases or clusters of reportable chemical events, should initiate case-based reporting of each of the identified cases. This means that specific information about each suspected case will be collected and reported to the next level. A list of reportable incidents that may occur includes:

i. Poisoning from contaminated drinking water or food with priority chemicals of public health concern
ii. Symptomatic exposures to chemicals from occupational work, such as battery manufacturing, paint production, hydrocarbon exploration, cosmetic production, paper bleaching, mining activities, agricultural application of pesticides, tanneries, electrical equipment like transformers, steel and aluminium manufacturing, etc.
iii. Symptomatic exposures to emissions from vehicles, industrial emissions, indoor use of fuel-burning equipment such as stoves, generators, etc, volcanic activities, combustion of fossil fuels, open burning of wastes.

If an immediate reportable condition is suspected, it must be reported to the health facility focal person within 24 hrs. Information obtained through a preliminary investigation of the suspected case should include:

1. Patient's geographical location
2. The health facility that managed or referred the patients
3. Patient's identification and demographic information
4. Information about signs and symptoms, including date of onset of first symptoms, history of exposure, and information about any relevant risk factors
5. Laboratory results if available
6. Occupational history

5.9.2 Notifying a Potential Public Health Emergency of International Concern under IHR

If the suspected case is as a result of chemicals of international interest or cross-border contamination through water sources or distribution of foods, the surveillance focal person of the LGA must notify the national IHR focal point immediately, using the fastest means of communication, while also notifying the State.

5.9.3 Reporting Events from Community Sources

A suspected event occurring in the community involving humans and animals should be reported immediately. The triggers for reporting should be clearly defined (see section 4 and Annex E), and the information immediately shared with the community key informant or the nearest health facility. The minimum information that should be collected while reporting a suspected case should include (Annex A and C):

a. The suspected condition or event/what happened.
b. When did the exposure happen (day, month, year)?
c. Where did the exposure happen, exact location/landmark (house/village/ward/LGA/State)?
d. The date of first symptoms and date of the reporting of the event.
e. Who is affected (age, gender, occupation, etc)?
f. How many people have been affected?
g. Has anyone died? If yes, how many?
h. Is the event ongoing?
i. Are there any animal deaths/exposure?
j. Any other information?
k. Any action taken?

l. Name and phone number of the person reporting

5.9.3.1 Chemical Events for Immediate Reporting

Any new or old exposure to chemicals without symptoms that have not been reported previously can be reported weekly to the appropriate authority. Examples of incidence for weekly reporting include the following:

a. Emergence of new chemical dumpsites within the community
b. Fish kill and deaths of animals
c. Contamination of water by chemicals or runoffs
d. New mining activities
e. Distribution of spoiled or contaminated foods within the community
f. Prolonged air pollution from the burning of chemicals, dumpsites, or industrial activity
g. Natural disasters such as flooding can lead to exposures of chemicals in the environment.

All these incidents will go through a verification process by the ward or LGA focal person, who will verify by answering the following questions:

a. Is the report accurate?
b. Has the information been reported by a reliable source or sources?
c. Does the report meet the criteria for one or more of the reportable chemical events?

5.9.3.2 Chemical Events for Monthly Reporting

Monthly reporting provides data for monitoring trends of chemical events or conditions. To avoid double-counting, events notified immediately should not be part of events reported monthly. The events reported monthly should be those that do not require immediate response or already have systems in place for managing the acute nature of their occurrences. All such events are expected to be summarised within the week and reported to the next appropriate level. For example,

a. Chronic exposures to chemicals that have not resulted in signs and symptoms that are of concern to the exposed person.
b. Chemical-related hazards identified within the community without established exposures to humans.

5.9.3.3 Keeping Records and Procedures for Managing Reporting

I) Reports from the communities are considered as notification of triggers or alerts that are unverified and should be logged in at the health facility or ward level by a designated focal person.
II) If the events are verified at that level, appropriate reporting forms are filled, which can be paper-based or electronic, and submitted to the appropriate next level.
III) For community members to report, they must be provided with community case definitions posters of the reportable chemical events and sensitised on the importance of reporting these events.
IV) The health facility or ward level focal persons to whom they report these events should be trained on the case definitions and the appropriate form to fill for each reported event (see Annex A, C and D). In addition, they should also be trained on how to supervise and support the community key informants, the reportable incidence and how to give feedback to the communities.
V) These focal persons should also have the capacity to participate in the local response to chemical events that occur in their communities.

VI) At the health facility and/or ward level, Alert Logs of all reported cases (unverified) should be maintained
VII) Individual cases reported in the health facility should be documented in a Case Investigation form appropriate for that condition.
VIII) Report of verified and true cases escalated to the next level should also be kept at this level.
IX) Evidence of supportive supervisory visits from higher levels should also be maintained.
X) Records of samples taken and their results should also be maintained.
XI) Evidence of some level of analysis, as simple as tables, summarising chemical events that occurred by week or month, should be kept at this level.
XII) At the LGA level, all reported cases from the health facilities and wards must be documented with evidence of the actions taken following the reports.
XIII) The LGA focal person should be trained on the case definition and how to support and supervise the lower levels.
XIV) The LGA must ensure that they investigate all reported cases of chemical events by completing the appropriate case investigation form, taking the appropriate samples where necessary, using the right sample collection kits, and ensuring that the samples get to the appropriate laboratory with the capacity for conducting the required tests for confirming the suspected condition.
XV) The LGA level should also compile all reported cases within the week and share with the State and the national level based on already established reporting guidelines.
XVI) The LGA can also be trained to conduct a simple risk assessment (see section 4) to determine which events they can respond to locally and which ones should be escalated to the State or national as appropriate.
XVII) Ensure that the surveillance unit at the LGA level has the means to transmit reports to the next level either by telephone calls, text messages, electronic mail, or other rapid communication means.
XVIII) Reports at the LGA, health facility and/or ward level should periodically be checked for data quality. Example of factors which may affect the quality that needs to be periodically checked include
a. Poorly completed forms (missing values)
b. Incomplete forms (presence of blanks)
c. Under-reporting or over-reporting of cases
d. Duplicate reporting
e. Untruthful reporting (e.g. reporting zero while there is an ongoing outbreak
f. Inconsistent reporting format
g. Late submission of reports
h. Inconsistent reporting periods
i. Calculation periods and aggregate reports.

5.9.4 Analysis and Interpretation of Data

5.9.4.1 Analysing

Records of all reported cases of chemical events or chemical hazards should be analysed at each level where it is collected. Organising and analysing data is an important function of surveillance that provides the information needed to take relevant, timely, and appropriate public health action. The analysis allows for:

a. Observing trends over time and alerting a community and stakeholders about emergent events or unusual patterns,
b. Identifying geographical areas at risk,
c. Characterising the vulnerable age or gender, or occupation most at risk,

d. Monitoring and evaluating the public health response to the reported events.

5.9.4.2 Interpreting Analysis to Generate Information

Present the findings of the analysed data in graphs, maps and tables to show comparisons or highlight the major findings. This can be done either weekly, monthly or quarterly, depending on the analysed data. It is important to maintain a particular routine. Ensure that analyses conducted do not contradict data from other one health sectors. When interpreting results, consider the quality of the data being used, especially when there are missing data values or inconsistencies in the data or instances with obvious arithmetic errors. Summarise and use the analysis to improve public health action. Prepare a summary report of all findings and share it with all stakeholders, including affected communities, who need this information. The report should visually represent the data being reported in either maps, graphs or tables, with a clear and short description, interpretation, comments and recommendations. Make statements that describe the conclusions you have drawn from the analysed data of all reported cases, and use them to take actions such as:

a. Conduct an investigation to find out why there is an increase or decrease in the number of reported chemical events.
b. Collaborate with other stakeholders to improve the timely detection of previously unreported chemical events.
c. Conduct advocacy to political and community leaders for more resources to respond to reported events and for a change in community practices to reduce the occurrence of avoidable chemical events.

5.10 Investigate Suspected Chemical Events

This section presents the steps that should be taken when investigating a chemical event. When a chemical event or condition is detected and notified, several steps need to be followed when conducting the investigation. Although the steps are usually listed in order, their implementation is often non-sequential. The investigation provides relevant information needed to take immediate action and prevent future occurrences. The purpose of the investigation is to:

a. Verify that the event is actually of chemical origin.
b. Identify and treat all cases, including those that were not previously reported or recognised.
c. Collect information and laboratory samples to confirm the chemical agent responsible.
d. Identify the source of the event (hazard) or risk associated with the event.
e. Describe the time, place and persons affected by the chemical event.
f. Describe the population at risk following the event.
g. Determine the appropriate response activities to mitigate the risk associated with the event.

Steps in investigating the event:

a. Establish the existence of a chemical event
    - Review data received and determine if a chemical event has occurred or is occurring
    - Collect additional data if necessary

b. Prepare for field work
    - Identify RRT members and prepare required logistics
    - Collect additional data if necessary

- Communicate to all reporting levels (including community leaders) the purpose of the investigation

c. Verify and confirm the event is of chemical origin
   - Review case notes or history of cases and preliminary laboratory results
   - Visit and speak to the sick persons if possible
   - Collect sample review laboratory results
   - Activate the incident management system and the Emergency Operations Centre (EOC), where applicable

d. Define a case and search for additional cases
   - Develop a case definition (if the existing case definition does not strictly apply)
   - Find and obtain additional cases and systematically record the information about each of them
   - Generate a line list of cases
   - Collect additional samples from new cases and old ones if applicable (human, animals, food, water, air, soil)

e. Analyse data and generate a hypothesis
   - Analyse data by using descriptive statistics to generate a hypothesis of a chemical event

f. Test and define the hypothesis with analytical studies
   - Based on descriptive epidemiology and the situation, select an appropriate study design
   - Obtain resources to conduct and analyse a study
   - Draw conclusions from studies, and as needed, define hypotheses
   - Conduct additional studies

g. Implement control measures

h. Write report and disseminate findings
   - Prepare a report
   - Communicate findings to stakeholders

i. Conduct a risk assessment to determine if the chemical event is a public health emergency of international concern
   - Evaluate the impact of the event and risk of spread or travel restrictions (use IHR decision instrument Maintain and intensify surveillance for new cases
   - National and state should maintain contact with LGA for daily updates (cases, deaths, number admitted, number discharged, areas affected, etc) until the event is under control.
   - Conduct an after-action review and amend tools, strategies based on lessons learned.

5.11 Response to Chemical Events

5.11.1 Preparing to Respond to Chemical Public Health Events

Rapid and effective response to public health events or emergencies of chemical origin is one of the core capacities required by the International Health Regulations in 2005. Just as in suspected outbreaks, being prepared to detect and respond to public health events of chemical origin is an essential role of the LGA, State and the National levels. Preparation for public health events includes:

a. Establishment or reactivation of the Public Health Emergency Management Committee
b. Development of a functional Public Health Emergency Operations Centre (PHEOC) that will act as a command-and-control centre for coordination of public health emergencies or events/incidents at the national level, with similar structures at the subnational levels.
c. Development of policies, plans and procedures for conducting operations, mapping available resources, estimating and procuring the required supplies, and conducting simulation exercises to test the system.
d. Identification and training of key members of the public health emergency management subcommittees and public health emergency rapid response teams.

In addition, having an All-Hazards Public Health Emergency Preparedness and Response Plan (PHEPRP), which includes chemical events, is crucial. The PHEPRP should include the layout of the coordination structure, the mapping of hazards and associated risks, and how to address and maintain the emergency response plan for relevant events, including the capacity to support operations at the primary response level during a public health emergency. The PHEPRP is the overarching plan and should be complemented by a PHEOC plan and an Event or Incident Specific Plan (ISP), for example, a Chemical Incident Plan. The PHEOC plan guides the operations of the Command- and –coordination Centre, outlining standard operating procedures on how each functional area operates and how they work together; and the chemical events ISP is the plan developed to address priority chemical events and emergencies based on risk analysis, and is always aligned to the PHEPR plan.

5.11.2 Responding to Public Health Events or Emergencies of Chemical Origin

The goal of integrated disease surveillance and response (IDSR) is to use data for public health response or action. This section describes the steps for declaring an established chemical event of public health importance and activating the response structures, conducting a public health response and providing general directions for immediate response actions targeting the leading causes of illness, death and disabilities.

When a chemical event is detected, an investigation should be conducted to determine the cause, and the implicated chemical should be confirmed by the laboratory. The results of the investigation should guide the response. Successful responses are carried out with community involvement and may include community education and behaviour change components.

Effective coordination of response activity is critical because of the many stakeholders that may be involved. It is important to identify these stakeholders in advance, including their areas of support, roles and responsibilities, to enable a smooth response to the chemical event or emergency. Irrespective of the type of event and the response strategy, and which administrative level is leading the response, it is important that the local government affected is involved in the response to the hazards or chemical events.

5.11.2.1 Activating the Response Structures

Once a chemical event is assessed to be of public health importance, the public health authority in the LGA must be notified, as well as the state and national authorities. Depending on the event, the appropriate MDA who should lead the response should be notified. If the event is a potential public health event of international concern, the IHR decision instrument should be used, and the event should be reported to the appropriate authorities. The mobilisation of the public health emergency rapid response teams, the convening of the public health emergency management committee and all other response activities should proceed as prescribed for all public health emergencies.

5.11.2.2 Provide a Regular Situation Report on the Chemical Event

Periodically, the Public Health Emergency Management Committee (PHEMC) should report on the progress of the response to the affected communities and all other stakeholders. The situation update should provide information such as:

a. Details of the response activities, including dates, places and individuals involved in each activity.
b. Any changes made since the last report.
c. Effectiveness of the response: number of new cases and deaths as a proportion of all reported cases, and containment of the chemical event.
d. Implementation of the response of the EPR Committee.
e. Operational challenges and gaps.
f. Recommended changes to overcome operational challenges and improve future response.

The situation report will be an important reference for evaluating the response and developing a final report.

5.12 Monitoring and Evaluation

Monitoring and evaluation are important for assessing the success of the surveillance system, to determine whether its objectives have been achieved, and evaluating areas that need strengthening. This information can help optimise and allocate limited resources to areas where they are most needed. The system can be evaluated using indicators such as timeliness of reporting from one level to another, the quality of data and the effectiveness of prevention and control activities. By evaluating information regularly, e.g. annually, helps, for example, to identify communities not reporting within the required frequency, what chemical hazards are being reported, which parts of the country/region people do report from, assess if the data analysis is understood, etc. The WHO guidance for After Action Review (AAR) describes the method of evaluation, which can also be used to capture learning from the management of chemical events to avoid failure and promote success for the future.

A more detailed guideline on the monitoring and evaluation of a surveillance system is described in the National Technical Guidelines for IDSR (2019)[22].

5.13 Risk Communication and Community Engagement

Risk communication and community engagement an essential elements of disaster and emergency preparedness and response, and are one of the Core Capacities in the IHR (2005). Risk communication and community engagement is a two-way exchange of information, perceptions and advice among risk assessors, risk managers, those affected by the threat or events and various groups of people in the society about the likelihood and consequences of harm from the event.

During chemical events, accurate information must be conveyed across all relevant agencies at the appropriate time. Feedback to the risk communicator must ensure that the right messages are passed and the purpose of the information is met.

5.13.1 Key Considerations for Risk Communication

Some key considerations for risk communication are summarised below; more detailed information can be found in the WHO guidelines on communicating risks in public health emergencies:

- Risk should not be explained in technical terms, creating scientific communication in an easy-to-understand manner to promote risk mitigation behaviours.
- A consistent, speedily disseminated message should come from different information sources and emerge early during the emergency. Ensuring coordination between different MDAs and the media, along with a uniform message.
- Messages should promote specific actions people can realistically take to protect their health, whilst acknowledging any uncertainty.
- Messages should be transparent and not conceal negative information, such as rates of casualties/deaths.
- Communication by authorities to the public should include explicit information about uncertainties associated with risks, events and interventions, and indicate what is known and not known at a given time.
- Identify people whom the community trusts and build relationships with them, and involve them in decision-making to ensure that interventions are collaborative and contextually appropriate, and that the community owns the process of communication.
- Tailor information and communication systems to users' needs and involve local stakeholders to guarantee the flow of information across sectors.
- Disseminate information through multiple platforms, including social media and traditional media as part of an integrated strategy.
- Social media may be used to engage the public, facilitate peer-to-peer communication, create situational awareness, monitor and respond to rumours, public reactions and concerns during an emergency, and to facilitate local-level responses.

5.13.2 Risk Communication

Nigeria has adopted the WHO-recommended integrated model for risk communication for developing, planning and implementing risk communication and community engagement (RCCE) and has developed comprehensive guidance. The guidance should be used when communicating in public health emergencies, but some key points are highlighted below:

- Risk communication TWGs should be established at national (EOC), state and local levels.
- Hazard-specific (including chemicals) communication strategies and plans should be developed, taking into account local context and vulnerabilities.
- NCDC hosts the National Risk Communication Technical Working group (NRCTWG), which is responsible for public health event (including chemical events) communication activities.
- For environmental events (including chemicals), the key stakeholders are defined as the FMEnv, NESREA and NOSDRA.

- NAFDAC is responsible for communications around pharmacovigilance, including issuing safety alerts and writing newsletters, publications and FAQs in relation to this.
- NCDC has a key role in response communication. They have a key role in coordinating messages, issuing press releases through the existing PHEOC framework and engaging with the media.
- There is a guide for Rapid Response Teams in conducting risk communication activities in a systematic manner in 6 key steps (see Appendix F for details):
    - Rapid risk communication needs assessment
    - Setting objectives
    - Stakeholder engagement
    - Audience segmentation and analysis
    - Message development and dissemination plan
    - Feedback management

In addition, more detailed risk communication and community engagement guidelines in the National Technical Guidelines for IDSR (2019) also describe how to conduct risk communication and community engagement before, during and after an outbreak in Nigeria. Some of the key aspects are summarised below:

- Ensure that the communication system has a link to the community leadership structure since they wield great influence with the local public.
- Produce a "Response Kit" which includes key frequently asked questions, media briefs, training manual, micro-planning tools, monitoring checklists/tools, communication plan templates and key messages/materials for rapid distribution.
- Identify mechanisms for communicating with hard-to-reach and vulnerable populations (the aged, persons with disabilities, children, the nomadic populations) and with isolated communities.
- Conduct community engagement activities and build trusted relationships between those in authority and communities through training, dialogue, consultations and capacity building.
- Develop plans for routine monitoring of misinformation and rumours and set up a media monitoring system to keep track of behaviours and practices related to the event.
- Consider developing fact sheets on the chemical of concern during an event for distribution to community groups, including key information on signs and symptoms, morbidity/mortality and steps to limit exposure.
- Meet regularly with the media, brief and educate them on priority hazards and response systems, and also provide them with appropriate information so as to cultivate a respectful and trusted relationship with them.
- Communicate regularly with health workers by providing correct information about the chemical event. It is important to communicate with health staff at the various levels about the data sent (including any gaps), analysis results for such data and the measures being taken to respond to the potential public health event which they have reported.

5.13.3 Summary

Risk communication between MDAs and with the community should begin in the affected community as soon as possible after a chemical event is identified. Its ultimate purpose is to ensure that everyone at risk can make informed decisions to mitigate the effects of the threat (hazard), such as a chemical event and take protective and preventive action. Currently MDAs communicate between the various partners and the public via a wide range of mechanisms, including press releases, radio messages, meetings, educational and communication materials (posters, fliers), community groups, social media (Facebook, Twitter, WhatsApp, etc.), SMS, telephone, site visits, and email updates. The investigators should engage the State and LGA risk communicators on time to ensure that the right messages are passed to the target audiences, such as healthcare providers and first responders, community pharmacies, surveillance officers, laboratory personnel, policymakers, traditional and religious leaders, media, points of entry (event dependant) in addition to the affected communities. Risk communication and community engagement use a mix of communication and engagement strategies and tactics, including but not limited to media communication, social media, mass awareness campaigns, and health promotion.

In general, in relation to chemical events, NCDC should lead in coordinating communications via the formation of communication technical working groups, including key MDAs involved in the event. Existing mechanisms utilised in other public health emergencies should be used, including the NRCTWG, PHEOC and RRT structures. However, for incidents involving food contamination, separate risk communication processes exist and reporting for issues with pharmacovigilance would be led by NAFDAC.

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Annex A: Case Information Form for Chemical Events

CHEMICAL EVENT CASE INVESTIGATION FORM

Surname: _____

Other Names: _____

Epid-Number: NIE -STA-LGA-YR-000 _____

Date of report (DD-MM-YYYY): _____

Section 1 - Reporting Health Facility		**Section 2 – Case Residential Address. Where does the case live?**			
1	**State:**	7	**State:**		
2	**LGA:**	8	**LGA:**		
3	**Ward:**	9	**Ward:**		
4	**Name of Health Facility:**	10	**Address: include address and any nearby landmarks (e.g. school, borehole, market)**		
5	**Suspected date of exposure (if known)** **Start (DD-MM-YYYY):** **End (DD-MM-YYYY):**				
6	**Date Seen at Health Facility (DD-MM-YYYY):**	11	**Settlement/village/town:**		
7	**Date of Onset of symptoms (DD-MM-YYYY):**		**GPS Code:**	**Longitude**	
				Latitude	

Section 3 - Patient Information					
12	**Outpatient** [ ] **Inpatient** [ ]		15	**Educational Level**	
13	**Sex:** Male [ ] Female [ ] If female pregnant? Yes [ ] No [ ]			[ ] No Formal Education	
14	**Date of Birth (DD-MM-YYYY):**			[ ] Primary	
	Years (Adult/children)			[ ] Secondary	
	Months (Infants)			[ ] Tertiary	
			19	**Occupation**	
17	**Phone Number**:			*(Farmer, Butcher, Hunter/trader of game meat, Miner, Religious leader, Housewife, Pupil/Student, Trader Artisan: Transporter; type of transport, Civil Servant; Health care worker; Traditional/spiritual healer, Unemployed, Specify Others)*	
18	**Owner of Phone Number**:				
20	**Present Condition**				
	Alive	[ ] At home [ ] On admission	**21. Name of Hospital:**		
	Dead	[ ] Died at Home [ ] Died on arrival at a hospital			
22	**Date of Death (DD-MM-YYYY):**				

Section 4 - Symptoms *(Please provide an answer for **all** symptoms)*									
24. Symptoms		**Yes**	**No**	**Unknown**	**24. Symptoms**		**Yes**	**No**	**Unknown**
A	Abdominal pain				N	Chest Pain			
B	Nausea				O	Oedema/swelling			
C	Vomiting				P	Confusion			
D	Diarrhoea/ GI bleed				Q	Agitation			
E	Oral/esophageal/gastric burns				R	Dizziness/Weakness			
F	Blurred vision/ Conjunctivitis				S	Lethargy			
G	Irritation/pain				T	Syncope			
H	Lacrimation				U	Seizures			
I	Blisters/burns				V	Hallucinations			
J	Redness/Rash				X	Tremor			
K	Tachycardia (palpitations)				Y	Drowsiness			
L	Bradycardia				Z	Coma			
M	Hypertension				AA	Paresthesia			
	Other Signs and Symptoms *(please describe)*				AB	Wheezing			
					AC	Coughing/choking			
					AD	Dyspnea			
					AE	Cyanosis			
					AF	Numbness			

Section 5: Source of exposure Please check the appropriate box for each question		Yes	No	Unknown
25. Is a chemical exposure suspected as the source of the illness? *If yes, specify suspected product, including product name and key chemical agents. Check product container or Material Safety Data Sheet (MSDS) if available.* Product name: Main chemical agents and % (if known): If unsure, list below the chemical agent(s) and sources that have been suspected as causing the illness. Put the most likely first: 1: 2: 3:				
1)	Did the patient participate in mass gathering (e.g. festival/ large sporting event) events**?			
2)	How many persons live in the same household as the patient?			
	Any household member presenting similar illness or symptoms?**			
	Anyone outside the household (e.g. at school or workplace) with similar illness or symptoms?**			
3)	Did you travel away from home in the 3 weeks before you became ill?			
	If yes, where and when did you travel (location and date) _____? Duration of Trip: From DD/MM/YYYY to DD/MM/YYYY			
4)	The following questions are about the source of water, food and beverage:			
	a) What is the source of water in the community?			
	b) Is the water clear, filtered or treated?			
	c) Have you attended an event (e.g. festival, wedding, etc.) where food or beverages were served and you know of others who are also sick?			
	d) Have you shared a meal with others who you know are also experiencing the same symptoms?			
	e) Does the patient suspect a specific food or the beverage to be the cause of the symptoms?			
	f) Were there any notable changes to the types of sources of food or drinks normally consumed prior to symptom onset?			
	g) If others, then please describe			
5)	Have there been any unusual environmental incidents occurring in the area recently? Consider: a: emissions from industry b: transport accidents c: chemical (e.g. petrol) spills, d: fires, e: mining activities, f: unusual odours? If yes, please describe under 6.			

6)	Any additional information to share?			
7)	For how long does the patient think chemical event has been going on in the community?			
8)	Does the patient know about any similar outbreak or event that happened previously?			

Section 6: Specimen Collection and Results

26. Specimen collection done? ☐ Yes ☐ No. If yes, what samples? ☐ Blood ☐ Urine ☐ Other: _____

Chemical specific testing	**Sample collection date** (dd/mm/yyyy)	**Result release date** (dd/mm/yyyy)	**Result**
			[ ] Positive [ ] Negative [ ] Rejected sample
Other investigations: e.g. Arterial blood gases, Urea and Electrolytes. Liver function, renal function			

If result is negative, what other differential test was conducted?

1. None [ ]
2. Others specify [ ] Positive [ ] Negative

Section 7: Outcome and Discharge details

Have environmental samples been collected? [ ] No [ ] Yes If yes: Water [ ] Food [ ] Soil [ ] Air [ ]

27. Did patient test positive for any infection? [ ] Yes [ ] No If Yes, specify_____

28. If positive, date commenced with treatment: DD/MM/YYYY

29. Discharge details (this is needed to know the duration of treatment when it started and ended)

Date of Discharge	_____**(dd/mm/yyyy)**
Outcome at discharge	Alive [ ] 1. Full recovery without sequelae at time of discharge [ ] 2. Full recovery with sequelae [ ] • Hearing loss [ ] • If pregnant, foetal loss [ ] • Please specify sequelae:
	Dead [ ]
	Abscond [ ]

Form completed by: _____Designation_____

Date of Completion_____(dd/mm/yyyy) Signature

Annex B: Priority Chemicals of Public Health Concern in Nigeria

PRIORITY CHEMICAL	JUSTIFICATION	SOURCE	SIGNS AND SYMTOMS AND HEALTH IMPLICATIONS
ARSENIC	Inadequate access to treated water, therefore, a high proportion of Nigeria population is at risk of arsenic due contaminated water and food. It is among WHO top priority chemicals of concern.	Contaminated water, soil, sediment, and food	Acute effect: vomiting, abdominal pain, diarrhoea, numbness, tickling of the extremities, muscles cramping, death in extreme cases. Chronic effect: pigmentation changes and hyperkeratosis, skin cancer etc.
CADMIUM	Inadequate access to treated water, therefore, a high proportion of the population is at risk to contaminated water and food. Indiscriminate discharge of industrial waste into rivers is still done in some part of Nigeria as well as dumping refuges into drainage during raining are practicing in most area in the Country. It is among WHO top priority chemical of concern.	Natural: weathering of rocks (air, soil & water), volcanoes & hydrothermal vent. Man-made: Fertilizer, rechargeable batteries, paints, plastics, metal solders and water draining from a landfill	Abdominal cramps, diarrhoea, salivation, severe nausea and vomiting. Chronic renal failure, kidney stones, liver damage (rare), lung cancer etc.
LEAD	Artisanal mining posing serious risk to the mining communities, water contamination. It is in the list of WHO top priority chemicals of concern.	Lead-based paint, contaminated soil, toys, jewellery, drinking water, cosmetics, imported candy etc.	Headaches, stomach cramps, constipation, muscle/joint pain, trouble sleeping, fatigue, irritability, and loss of sex drive. High blood pressure, brain, kidney and reproductive health issues in adults.
DIOXINS & DIOXIN-LIKE SUBSTANCES	Fire burning of materials are highly practice in Nigeria and dioxins have long range of movement (omnipresent) as open burning of wastes are still practice in the country and bioaccumulation in food chain in which human and animals ingest. It is among WHO top priority chemicals of concern.	Transformer oil, open burning of waste, Soils, sediments and food, especially dairy products, meat, fish and shellfish. Very low levels are found in plants, water and air.	Short-term: skin lesions, such as chloracne and patchy darkening of the skin, and altered liver function. Long-term: impairment of the immune system, the developing nervous system, the endocrine system and reproductive functions.
MERCURY	Industrial processes, artisanal and small-scale gold mining activities are undertaken in most part of Nigeria. Mercury is posing serious risk to the mining communities, high consumption of sea foods, still usage in dental amalgam and medical devices in Nigeria. It is also among WHO top priority chemicals of concern.	Contaminated water (fish, shellfish), coal combustion, waste incineration, industrial uses, mining, dental amalgams, mercury thermometers, fluorescent light bulbs. Volcanoes, geothermal springs, geologic deposits.	Shocks, headaches, difficulty sleeping, impaired sensations, muscle weakness and twitching, emotional changes (mood swings, irritability, and nervousness), kidney damage and breathing difficulties. Irritation to the eyes, skin, and stomach; cough, chest pain, or difficulty in breathing, insomnia, indecision, headache, weakness or exhaustion, weight loss and death.
HIGHLY HAZARDOUS PESTICIDES (e.g. DICHLORVOS)	Inappropriate handling and use of pesticides in agricultural activities such as pre and post farming activities. Intentional use for suicides in Nigeria. It is among WHO top priority chemicals of concern.	Organophosphate / pesticides, contaminated food, water and air.	Salivation, lacrimation, urination, defecation, gastric cramps, emesis (SLUDGE) symptoms occur acutely within minutes to hours. Sweating, vomiting, diarrhoea, drowsiness, fatigue, headache, and at high concentrations, convulsions, coma and death.

PRIORITY CHEMICAL	JUSTIFICATION	SOURCE	SIGNS AND SYMTOMS AND HEALTH IMPLICATIONS
CYANIDE	Tubers like cassava contain cyanide and Nigeria is the largest tuber production and the processing of these tubers like cassava production and its products are largely homemade as well as highly consumed.	Smoke inhalation, suicidal ingestion, and contaminated foods (tubers- like cassava).	Chest pain, chest tightness, confusion, dizziness, eye pain, eye tearing, excitement and difficult breathing. Cardiovascular and respiratory effects, an enlarged thyroid gland, and irritation to the eyes and skin and death.
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)	Polycyclic aromatic hydrocarbons (PAHs) are a large group of organic compounds containing two or more fused aromatic (benzene) rings. The main anthropogenic sources of emission are the incomplete combustion or pyrolysis of organic material (i.e. emissions from vehicles, domestic heating or cooking) and the burning of agricultural waste. Human exposure to PAHs may occur from inhalation, dermal exposure or the ingestion of food contaminated with PAHs.	Inhalation of contaminated air, ingestion of contaminated food etc	Eye irritation, nausea, vomiting, diarrhoea, and confusion. Long-term health effects of exposure to PAHs may include cancer, cataracts, kidney and liver damage, and jaundice.
AIR POLLUTANTS (e.g.CO, SOx, NOx, etc)	Poor ventilated housing in an unplanned area and use of generators are common in most communities in the Country. Vehicles or cars smoke often inhale during road traffic in the country. It is mentioned in the WHO top priority chemicals of concern.	Clothes dryers, water heaters or boilers fireplaces, both gas and wood burning, gas stoves and ovens, motor vehicles, grills, generators, power tools, lawn equipment, wood stoves etc.	Fatigue, headaches, confusion, and dizziness, neurological damage, illness, coma, or death due to inadequate oxygen delivery to the brain.
POLYCHLORINATED BIPHENYLS (PCBs)	One of the Persistent Organic Pollutants (POP), formally used in transformer oil and other electrical appliances.	These compounds were formally used as coolants and lubricants in transformers, capacitors, and other electrical equipment. They also find applications in fluorescent lighting fixtures, microscope oil, and hydraulic fluids.	Ingestion of PCB may lead to nausea, vomiting, respiratory irritation (sniffles, cough), and skin irritation (redness). Large exposure may also lead to acne and rashes on the skin. Exposure to PCB is associated with increased risk of certain cancers of the digestive tract, liver and skin. Reproductive deficiencies, such as reduced growth rates, retarded development, and certain neurological effects which may or may not persist beyond infancy. The immune system can also be compromised, chlor-acne and skin pigmentation.
NICKEL	Involved in cancer storm in Nigeria	Combustion of coal, diesel oil and fuel oil, and the incineration of waste and sewage	Nausea, vomiting, diarrhoea, headache, cough and shortness of breath, contact dermatitis, cardiovascular disease, asthma, lung fibrosis, and respiratory tract cancer.
ALUMINUM	Involved in neurodegenerative diseases in Nigeria	Drinking water, food, air, medicine, deodorants, cosmetics, packaging, many appliances and equipment, buildings, transportation industries, and aerospace engineering.	Proximal muscle weakness, bone pain, multiple nonhealing fractures, acute or sub-acute alteration in mental status, and premature osteoporosis. Oxidative stress in the brain, liver, and kidney.

PRIORITY CHEMICAL	JUSTIFICATION	SOURCE	SIGNS AND SYMTOMS AND HEALTH IMPLICATIONS
AMMONIA	Increased acid depositions and excessive levels of nutrients in soil, rivers or lakes, which can have negative impacts on aquatic ecosystems.	The decomposition or breakdown of organic waste matter, gas exchange with the atmosphere, forest fires, animal and human waste, and nitrogen fixation processes.	Burning sensation in the eyes, nose, and throat, accompanied by lacrimation, rhinorrhoea, and coughing. Toxic buildup in internal tissues and blood, and potentially death.
MONOSODIUM GLUTAMATE (MSG)	Commonly available and use in both commercial and non-commercial in most Nigeria local foods as an additives. These toxic effects include CNS disorder, obesity, disruptions in adipose tissue physiology, hepatic damage, CRS and reproductive malfunctions. These threats might have hitherto been underestimated. In the meantime, people keep using ever larger amounts of MSG unaware of the possible consequences.	Common sources are processed food with MSG and GSM as additives.	Headaches, serious allergic reactions, nausea, chest pains with heart attack–like symptoms, brain edema, weakness. MSG has been linked with obesity, metabolic disorders, Chinese Restaurant Syndrome, neurotoxic effects and detrimental effects on the reproductive organs. These toxic effects include CNS disorders, obesity, disruptions in adipose tissue physiology, hepatic damage, CRS and reproductive malfunctions.
VOLATILE ORGANIC COMPOUNDS (VOCs) e.g. Benzene, Toluene, Xylene etc.	Some volatile organic compounds such as benzene, Toluene, formaldehyde xylene, if present in high concentrations in ambient air, can have carcinogenic/carcinogenic effects on humans, lead to gene mutations, or be toxic for reproduction. Use of fossil products (soot, crude oil etc.) is abundant in Nigeria	Indoor and outdoor activities e.g Car paint shops, furniture spray activity and contact with some organic solvents in the laboratories. Natural sources (volcanoes sites) and manmade source are open fire/burning).	Breathing VOCs can irritate the eyes, nose and throat, can cause difficulty breathing and nausea, and can damage the central nervous system and other organs. Fatigue, headaches, confusion, and dizziness. Cancer, Gene mutation, respiratory diseases (Asthma), Cardiovascular disease, neurological damage, coma, or death due to inadequate oxygen delivery to the brain.
TOXIC ALCOHOLS (e.g. METHANOL AND ETHYLENE GLYCOL)	Alcohol intoxication or overdose known as drunkenness is a common behaviour among majority of people in Nigeria. Ingestion of toxic alcohols (methanol, ethylene glycol, or other glycols) is found in beverages and some pharmaceutical products consumed or used the country.	Beverages and some pharmaceutical products.	High blood pressure, heart disease, stroke, liver disease, and digestive problems. Cancer of the breast, mouth, throat, esophagus, voice box, liver, colon, and rectum. Weakening of the immune system, increasing the chances of getting sick.

Annex C: Surveillance Reporting Forms - Biomonitoring

Ref no	Date	Patient ID number	Reporting agency	Contact number / email	Reporting agency postcode	Laboratory used[1]	Reporter Name	Chemical	CAS no	Quantity	Units	Trigger[2]	Case exposure postcode[3]	Date sampled	Type of sample[4]	Date results	Age (years, months)	Gender [F/M]	Hospital[5] [Y/N]	Fatality [Y/N]
1	*31/10/24*	*345a*	*Abuja Hospital*	*0776543241*	*900001*	*NIMR*	*Dr Ebere*	*Lead*	*7440-38-2*	*50*	*Mg/l*	*20 mg/l*	*900002*	*21/10/25*	*Blood*	*28/10/25*	*5*	*F*	***yes***	***no***

Notes:

[1] Laboratory used - may be same as reporting agency in many cases

[2] Trigger – agreed level at which reporting is required

[3] Exposure postcode should be where exposure suspected to have occurred (e.g. work / home, event) if known

[4] Type of sample - biological sample type (e.g. Blood / Urine / Hair / Other)

[5] Hospital [Y/N] - whether patient was admitted to hospital as result of exposure (if known)

Annex C: Surveillance Reporting Forms – Environmental Medium (Water, Soil, Air)

Ref no	Date	Sample ID number	Reporting agency	Contact number / email	Reporting agency postcode	Laboratory used[1]	Reporter Name	Chemical	CAS no	Concentration	Units	Trigger[2]	Sampling location[3]	Date sampled	Type of sample[4]	Date results
1	*31/10/24*	*TP1*	*NESREA*	*07765432 41*	*900001*	*NIMR*	*Mr X*	*Lead*	*7440-38-2*	*1200*	*mg/kg*	*400mg/kg*	*Agropharm Ltd, Abuja, 900002*	*21/10/25*	*Soil*	*28/09/24*

Notes:

[1] Laboratory used - may be same as reporting agency

[2] Trigger – agreed level at which reporting is required

[3] Sampling location should be the site ID (such as site name and postcode)

[4] Type of sample - environmental sample type (e.g. Groundwater / Surface water / Drinking water / Soil / Air)

Annex C: Surveillance Reporting Forms – Food

Ref no	Date	Sample ID number	Reporting agency	Contact number / email	Reporting agency postcode	Laboratory used[1]	Reporter Name	Chemical	CAS no	Concentration	Units	Trigger[2]	Sampling location[3]	Date sampled	Type of food[4]	Date results
1	*31/10/24*	*658*	*NAFDAC*	*07765432 41*	*900001*	*NAFDAC*	*Mr X*	*Lead*	*7440-38-2*	*38*	*ppb*	*5 ppb*	*Russian market, Abuja, 900002*	*21/10/25*	*AnaWana rice cereal*	*28/09/24*

Notes:
[1] Laboratory used - may be same as reporting agency
[2] Trigger – agreed level at which reporting is required
[3] Sampling location should be the sampling site ID (such as site name and postcode)
[4] Type of food - type of food sampled (such as brand and type of food)

Annex D: Example Chemical Events Proforma

Incident reported by (name, title and organization): _____
Date Incident started: (MM/DD/YYYY) _____/_____/_____
Time Incident started (24hrs) _____:_____

Section 1. Incident Detail

Fire		**Contamination**		**Natural Events**	
Fire	☐	Consumer goods	☐	Flooding	☐
Explosion	☐	Drinking water	☐	Heatwave	☐
Bleve/fireball	☐	Soil	☐	Cold Spell	☐
Terrorism	☐	Property	☐	Severe Storm	☐
				Algal Toxin	☐
				Other natural event	☐

Release	☐	**Exercise**	☐	**Radiological Exposure**	☐
Airborne	☐	**Suspect Package**	☐	**Self Harm**	☐
Waterborne	☐	**Terrorism**	☐	**Other**	☐
Spill	☐	**Theft**	☐		

Section 2. Location

Incident Address_____
_____

Name of RRT involved _____

Section 3. Agent (Chemical name/identifier)

Name of agent _____

CAS number _____

Section 4. Exposure

Circumstance of exposure_____
_____

Potential Exposure Pathways

Dermal ☐ Inhalation ☐ Ingestion ☐ Ocular ☐ Sting ☐ Injection ☐ Bite ☐

Population Group

Family or Household ☐ Occupational ☐ Institutional academic ☐ Institutional Military ☐ Institution Correctional ☐

Type of exposure

_____

Date of initial exposure (MM/DD/YYYY) _____/_____/_____

Time since last exposure _____

Duration of exposure _____

Symptoms reported

_____

Gastrointestinal	Neurological	Respiratory
• Abdominal pain	• Agitation	• Wheezing
• Nausea	• Confusion	• Cough/choke
• Vomiting	• Headache	• Dyspnea
• Diarrhea	• Dizziness	• Cyanosis
• Oral/esophageal/gastric burns	• Lethargy	• Other *(specify)*

• GI bleed	• Syncope	
• Other *(specify)*	• Weakness	
	• Seizures	
	• Hallucinations	
Ocular	• Numbness	***Other Signs and Symptoms*** *(please describe)*
• Blurred vision	• Tremor	
• Irritation/pain	• Paresthesia	
• Lacrimation	• Other *(specify)*	
• Conjunctivitis		
• Other *(specify)*	***Cardiovascular***	
	• Chest Pain	
	• Palpitations	
Dermal	• Racing heart	
• Blisters	• Swelling of the legs, feet or ankles	
• Burns		
• Redness	• Other *(specify)*	
• Hives/welts		
• Rash *(please describe)*		
• Other *(specify)*		

Section 5. Action

Agencies involved	Reference number	Notified	At scene	NA
_____	_____	☐	☐	☐
_____	_____	☐	☐	☐
_____	_____	☐	☐	☐
_____	_____	☐	☐	☐
_____	_____	☐	☐	☐
_____	_____	☐	☐	☐
_____	_____	☐	☐	☐
_____	_____	☐	☐	☐
_____	_____	☐	☐	☐

Annex E: Priority Chemicals Factsheets

Arsenic (inorganic)

Potential sources:

- Contaminated water, soil, sediment, food, and air.
- Contaminated water used for drinking, food preparation and irrigation of food crops.
- Mining activities.
- Industrial processes: used as an alloying agent, as well as in the processing of glass, pigments, textiles, paper, metal adhesives, wood preservatives and ammunition. Also used in the hide tanning process and, to a limited extent, in pesticides, feed additives and pharmaceuticals.[10]
- Consumption of contaminated herbal medicines.[11]

Nigeria background levels in the environment:

- Can be naturally present at high levels in well/groundwater in certain regions within Nigeria[12]
- Can be elevated in soils/groundwaters / foods near landfills or waste dumping sites[13]
- Can be increased in areas near mining activities[14]

Clinical description (acute):

Mild toxicity:
Gastrointestinal symptoms of vomiting, abdominal pain, and diarrhoea, which can rapidly lead to dehydration.
Severe toxicity:
Summary: Shock related to fluid loss and progressive multi-organ toxicity. Death may occur.[15]
Cardiovascular: Hypotension and dysrhythmias including ST changes, ventricular tachycardia, myocardial depression, prolonged QT interval, torsades de pointes and ventricular fibrillation.
Central nervous system: Ataxia, paraesthesia, altered mental status, seizures, peripheral neuropathy and encephalopathy.
Other organ effects: Renal and hepatic injury, coagulopathy, haemolysis, alopecia, rhabdomyolysis, non-cardiogenic pulmonary oedema, pancytopenia and pancreatitis.

Health effects:

Chronic exposure:
A confirmed carcinogen. The first symptoms of long-term exposure to high levels of inorganic arsenic are usually observed in the skin and include pigmentation changes, mees lines, skin lesions and hard patches on the palms and soles of the feet (hyperkeratosis). Weight loss and persistent abdominal pain, and/or diarrhoea are also potential signs of chronic intake. Other adverse health effects that may be associated with long-term ingestion of inorganic arsenic include developmental effects, diabetes, pulmonary disease and cardiovascular disease.

Alert thresholds: If any of these thresholds are exceeded, report under surveillance

Biomonitoring:
Urine: Most effective and easy to implement – arsenic may be present if >50 µg/L for a spot test. Organic arsenic from seafood, fish or seaweed can inflate total arsenic values; hence, it is important to ensure patients abstain from ingestion of these foods for 5 days prior to sample collection[16]. An alternative is speciation analysis, which can differentiate the concentrations of organic and inorganic arsenic.
Blood: Most normal whole blood arsenic (inorganic plus its metabolites) concentration is less than 10 micrograms/L (1 µg/dL) (UK).[16]
Environmental: Detection of arsenic in environmental samples above typical background or relevant guideline levels, as determined by the relevant agencies.
Drinking water: 0.01 mg/L (Nigerian Drinking Water Standard)[17]
Groundwater/surface waters environmental standard: 0.05mg/l (Fisheries and Recreation Quality Criteria Standards and Effluent Discharges, Irrigation and Reuse Standards)[18]
Air: 6000 µg/m^3 (annual) (Nigeria Air Quality Standard)[19]
Soil: 20 mg/kg (Nigerian Soil Quality Standards - industrial sites)[20]
Food: 3.0 µg/kg/bw/day (FAO Codex Alimentarius)[21]

Case Classification

Suspected: A case in which a potentially exposed person is being evaluated by health-care workers or public health officials for exposure to / poisoning by a particular chemical agent, but no specific credible threat exists.

Probable: A clinically compatible case in which a high index of suspicion (credible threat or patient history regarding location and time) exists for arsenic exposure, such as **clinical manifestations** of arsenic poisoning, or an epidemiologic link between this case and a laboratory-confirmed case.
Confirmed: A clinically compatible case in which laboratory tests have confirmed exposure. The case can be confirmed if laboratory testing was not performed because either a predominant amount of clinical and nonspecific laboratory evidence of a particular chemical was present, or a 100% certainty of the aetiology of the agent is known.

Respond to the alert threshold:

If arsenic cases are suspected:

- **Report case-based information to NCDC via the Case Information Form (CIF).**
- Discuss with the Poisons Centre or clinical toxicologist for clinical management.
- As necessary, treat and manage the patient(s) with supportive care.
- Collect biological specimens and/or relevant environmental samples and send them to the laboratory to identify the aetiology of the illness.
- Consider sourcing DMPS or DMSA antidotes if indicated.

Respond to the action threshold:

If arsenic cases are confirmed:

- **Identify the population exposed to the chemical hazard.**
- Implement appropriate protection, prevention and control interventions.

Analyse and interpret data:

***Time*: Analysis of** suspected and confirmed cases by day/week. Graph cases and deaths daily/weekly.
***Place*:** Plot location of cases.
***Person*:** Analyse by age and gender.

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Lead

Potential sources:

- Contaminated water, soil, sediment, food, air.
- Contaminated water used for drinking, food preparation and irrigation of food crops.
- Mining activities.
- Industrial processes: storage batteries, cables, solders and steel products, ammunition, shielding systems from radiation and x-rays, circuit boards in computers and other electronic equipment and superconductor and optical technology. Also used as colour pigments, enamels and ceramics and in PVC.[1]
- Traditional herbal medicines and cosmetics.[1, 15]
- Petrol
- Contaminated toys [14]

Nigeria background levels

- Can be elevated in soils / groundwaters and urban areas 45mg/kg to >100,000 mg/kg[2]
- Can be increased in areas near mining activities [2]
- Maybe elevated due to use in petrol[3, 13]
- Can be found in lead paint[1]

Acute exposures to lead may cause gastrointestinal disturbances (anorexia, nausea, vomiting, abdominal pain), hepatic and renal damage, hypertension, and neurological effects (malaise, drowsiness, encephalopathy) that may lead to convulsions and death[15]

Health effects: Chronic

Mild toxicity:
Gastrointestinal symptoms of abdominal pain, constipation, nausea, vomiting and anorexia

Moderate to severe toxicity
Hematoxicity – anemia due to reduced hemoglobin production and a shortened life-span of erythrocytes[1]
Hepatoxicity – possible effects of lead on haem synthesis which may affect the functional capacity of hepatic cytochrome P450 enzymes to metabolize drugs[1].
Neurotoxicity: Reduced nerve conduction velocity, postural sway, tremor amyotrophic lateral sclerosis and intelligence and neurobehavioral effects in children and adults. Very high-level exposures can result in encephalopathy in both children and adults. Symptoms of lead induced encephalopathy include headache, confusion, drowsiness, convulsions, and coma.
Encephalopathy is more common in children and is more likely to occur at BLLs over 100 µg/dL[1]).
Cardiovascular toxicity: Associated changed with cardiac conduction and rhythm[1]. Increase QT and QRS interval and ventricular arrythmias. May be associated with increase in systolic blood pressure[1]
Renal toxicity: Nephrotoxicity characterized by glomerular sclerosis, interstitial fibrosis, and proximal tubular nephropathy[1]

Health effects:

Chronic exposure:
Inorganic lead compounds are classified as probably carcinogenic to humans (IARC group 2A)
Chronic or long-term exposure to lower levels of lead may cause anaemia, headaches, irritability, tiredness, muscle weakness, paralysis, kidney and liver damage, cardiovascular toxicity and gastrointestinal disturbances. Chronic exposure may also adversely affect both male and female reproductive functions. Long-term exposure to lead during pregnancy has been associated with miscarriage, stillbirths and premature birth.

Children are a particularly sensitive group to the effects of lead as chronic exposure may lead to a cognitive deficit such as decrease in IQ.

Alert thresholds: If any of these thresholds are exceeded, report under surveillance

Biomonitoring:
Blood: In children a concentration <2µg/dL (0.1µmol/L) is desirable[4] and 3.5µg/dL in adults [5]
WHO lead clinical management guidelines suggest treatment in children with blood lead level over 5 ug/dl [17]
Trigger level to be reported: concentration >2µg/dL in children and > 3.5µg/dL in adults

Environmental:
Detection of lead in environmental samples above typical background or relevant guideline levels, as determined by the relevant agencies.

Drinking water: 0.01 mg/L (Nigerian Drinking Water Standard)[6]
Groundwater/surface waters environmental standard: 15µg/l (Target value), 75µg/L (Intervention value) for groundwater [7], Fisheries and Recreation Quality Criteria Standards= 0.01 mg/l[8]and Effluent Discharges, Irrigation and Reuse Standards = 0.1mg/l[9]
Trigger level to be reported: concentration > 0.05 mg/L (drinking water); > 75µg/L (ground/surface water); >0.01mg/L (Fisheries and Recreation); > 0.1mg/L (Discharges, Irrigation and Reuse).

Air: 1.4µg/m3 24 hours (Nigeria Air Quality Standard)[10]
Trigger level to be reported: concentration > 1.4µg/m[3] 24 hours.

Soil: 35 mg/kg (Target Value), 210 mg/kg (intervention value) (Nigerian Soil Quality Standards - industrial sites)[11]
Trigger level to be reported: concentration ≥ 210 mg/kg.

Consumer products (Toys): 90µg/g[14]
Trigger level to be reported: concentration > 90µg/g

Food: TDI 0.025 mg/kg/bw/day (FAO Codex Alimentarius)[12]
Trigger level to be reported: concentration > 3 ppm (food supplement); 0.2 ppm (fish); 0.3mg/kg (leafy vegetables); 0.1mg/kg (fruits, tubers and bulb vegetables).

Case Classification

Suspected: A case in which a potentially exposed person is being evaluated by health-care workers or public health officials for exposure to / poisoning by a particular chemical agent, but no specific credible threat exists.
Probable: A clinically compatible case in which a high index of suspicion (credible threat or patient history regarding location and time) exists for arsenic exposure, such as clinical manifestations of arsenic poisoning, or an epidemiologic link between this case and a laboratory-confirmed case.
Confirmed: A clinically compatible case in which laboratory tests have confirmed exposure. The case can be confirmed if laboratory testing was not performed because either a predominant amount of clinical and nonspecific laboratory evidence of a particular chemical was present, or a 100% certainty of the aetiolgy of the agent is known.

Respond to the alert threshold:

If lead cases are suspected:

- Report case-based information to NCDC via Case Information Form (CIF).
- Discuss with Poisons Centre or clinical toxicologist for clinical management.
- As necessary treat and manage the patient(s) with supportive care.
- Collect biological specimens and/or relevant environmental samples and send them to the laboratory to identify the aetiology of the illness.
- Consider sourcing DMPS, DMSA or Sodium calcium adedate[16] antidotes if indicated.
-

Respond to the action threshold:

If lead cases are confirmed:

- Identify the population exposed to the chemical hazard.
- Implement appropriate protection, prevention and control interventions.

Analyse and interpret data:

Time: Analysis of suspected and confirmed cases by day/week. Graph cases and deaths daily/weekly.
Place: Plot location of cases.
Person: Analyse by age and gender.

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Mercury (elemental, organic and inorganic)

Potential sources[1]:

- Contaminated water, soil, sediment, food (especially certain fish), air
- Mining activities (especially artisanal and small-scale gold metal mining)
- Industrial processes, where mercury is used (such as cement production), coal-fired power stations, oil and gas exploration, residential heating systems, waste incineration
- Consumer products, such as some traditional, complementary and integrative medicine and skin lightening creams and soaps
- Use and improper disposal of mercury containing products and their wastes
- High consumption of contaminated sea foods,
- Dental amalgam and medical devices
- Smelting and roasting processes used in non-ferrous metal production

Nigeria background levels [1,2]:

- Natural releases do not account for the considerable concentrations in environmental mercury levels – mainly released from human activities
- Mercury levels have been noted at high levels in vegetables in Western Nigeria [3]
- Soil concentrations can be increased in areas near mining activities (e.g. Niger state[4]), waste disposal (e.g. Zamfara)[5] and industrial sites, soils and sediments contaminated with mercury

Health effects: Acute and Chronic

Elemental mercury*:* Accidental ingestion is unlikely to cause toxicity. Inhalation exposure is the most typical route of elemental mercury toxicity. Acute toxicity might result in fever, fatigue, and clinical signs of pneumonitis. Chronic exposure results in neurologic, dermatologic, and renal manifestations. Signs and symptoms might include neuropsychiatric disturbances (e.g., memory loss, irritability, or depression), tremor, paraesthesia, gingivostomatitis, flushing, discoloration and desquamation of the hands and feet, and hypertension.[6]

Inorganic mercury: Ingestion is the most typical route of exposure. Signs and symptoms might include profuse vomiting and diarrhoea that is often bloody, followed by hypovolemic shock, oliguric renal failure, and possibly death. Survivors of acute poisoning or persons chronically exposed to inorganic mercury might develop neurologic, dermatologic, and renal manifestations that might include neuropsychiatric disturbances (e.g., memory loss, irritability, or depression), tremor, paraesthesia, gingivostomatitis, flushing, discoloration and desquamation of the hands and feet, and hypertension.[2]

Organic mercury: Typically, via ingestion, however toxicity might also result from inhalation and dermal exposures, particularly with dimethylmercury. Symptoms of toxicity are typically delayed for >1 month after organic mercury exposure and usually involve the central nervous system. These symptoms might include paraesthesia, headaches, ataxia, dysarthria, visual field constriction, blindness, and hearing impairment.

Alert thresholds: If any of these thresholds are exceeded, report under surveillance

Biomonitoring:

Urine: Elemental and inorganic mercury creatinine-adjusted mercury spot collection; >5 µg/g creatinine (>25 nmol/g creatinine). Alternatively, 24-hour total urinary mercury collection; 20 µg/L (> 100 nmol/L)[2]. Organomercury compounds are fecally excreted; hence, urine concentrations will not be accurate.

Trigger levels to be reported: concentration > 20 µg/L

Blood: Elemental, organic, and inorganic mercury >10 µg/L (>50 nmol/L)[2]. May be less useful following chronic or delayed exposures, as redistribution to tissues occurs.

Trigger levels to be reported: concentration > 10 µg/L (whole blood)

No definitive correlation exists between either blood or urine mercury levels and mercury toxicity.[2]

Environmental:

Detection of mercury in environmental samples above typical background or relevant guideline levels, as determined by the relevant agencies.

Drinking water: 0.001 mg/L (Nigerian Drinking Water Standard)[7]

Groundwater/surface waters environmental standard: 0.3 mg/L (Fisheries and Recreation Quality Criteria Standards and Effluent Discharges, Irrigation and Reuse Standards)[8]

Trigger levels to be reported: concentration > 0.001 mg/L (drinking water); > **0.3mg/L** (ground/surface waters).

Air: 5 mg/Nm³ (maximum permissible limit as elemental Hg) (Nigeria Air Quality Standard)[ii]
Trigger levels to be reported: concentration > 5 mg/Nm³

Soil: 4 mg/kg (Nigerian Soil Quality Standards - industrial sites)[10]
Trigger levels to be reported: concentration > 4 mg/kg

Food: Inorganic mercury - 4 µg/kg bw applicable to dietary exposure to total mercury from foods other than fish and shellfish. Methylmercury - 0.0016 mg/kg bw (dietary exposure to Hg from fish and shellfish) (FAO Codex Alimentarius)[11]
Trigger levels to be reported: concentration > 0.004 mg/kg

Case Classification:

Suspected. A case in which a potentially exposed person is being evaluated by health-care workers or public health officials for exposure to / poisoning by mercury, but no specific credible threat exists.

Probable. A clinically compatible case in which a high index of suspicion (credible threat or patient history regarding location and time) exists for mercury exposure, or an epidemiologic link exists between this case and a laboratory-confirmed case.

Confirmed. A clinically compatible case in which laboratory tests have confirmed exposure.
The case can be confirmed if laboratory testing was not performed because either a predominant amount of clinical and nonspecific laboratory evidence of a particular chemical was present or a 100% certainty of the etiology of the agent is known.

Respond to the alert threshold:

If mercury cases are suspected:

- Report case-based information to NCDC via Case Information Form (CIF).
- Discuss with Poison Centre or clinical toxicologist for clinical management.
- As necessary treat and manage the patient(s) with supportive care.
- Collect biological specimens and/or relevant environmental samples and send them to the laboratory to identify the aetiology of the illness.
- Consider sourcing DMPS or DMSA antidotes if indicated

Respond to the action threshold:

If mercury cases are confirmed:

- Identify the population exposed to the chemical hazard.
- Implement appropriate protection, prevention and control interventions.

Analyse and interpret data:

Time: Analysis of suspected and confirmed cases by day/week. Graph cases and deaths daily/weekly.
Place: Plot location of cases.
Person: Analyse by age and gender.

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Cadmium
Potential Sources
• Cadmium is a toxic heavy metal which is widely distributed in the Earth's crust (soil and rocks), air and water. It is commonly associated with zinc, lead, and copper ores. • Natural activities, such as volcanic activity (both on land and in the deep sea), weathering and erosion, and river transport.[1] • Human activities, such as mining, tobacco smoking, smelting and refining of non-ferrous metals, fossil fuel combustion, incineration of municipal waste (especially cadmium-containing batteries and plastics), use of cadmium-containing phosphate fertilisers, and recycling of cadmium-plated steel scrap and electric and electronic waste [1]. • Remobilisation of historic sources, such as the contamination of watercourses by drainage water from metal mines or from waste sites [1]. • Cadmium can be present in drinking water[2] • Consumer products: Despite being banned in many countries, inexpensive jewellery, toys and plastics can be significant sources of exposure to cadmium, especially for children; [3,4]
Nigeria background levels:
• Residential soils in Lagos are up to 2.8 mg/kg [5]. Soils elsewhere in Nigeria are reported to have levels up to 210 mg/kg [6]. • 0 – 137 mg/L in water [6]. • 0 – 14 mg/kg in food crops [6]. • 0 – 21 mg/kg in foods (meat, chicken, fish and milk) [6]. • Exposure to cadmium in Nigeria is likely to vary significantly by region, location and employment. Reported blood concentrations varied from 13 µg/dl (Nigeria/Nnewi) and 60 µg/dl (Nigeria SW) [7,8].
Health effects: Acute
The most sensitive targets of cadmium toxicity are the kidney and bone following oral exposure and kidney and lung following inhalation exposure. Inhalation: • metallic taste in the mouth, • shortness of breath (dyspnoea), cough, chest pain • headache, muscular weakness, flu-like symptoms (metal fume fever). • Chemical pneumonitis and pulmonary oedema may develop within 1-4 days, and recovery may be complicated by interstitial lung disease. • In severe cases, exposure can lead to lung damage, extensive fluid loss, multiple organ failure and death. Symptoms may be delayed 12-36 hours. Ingestion: • Can cause irritation to the digestive tract, including nausea, vomiting, diarrhoea and abdominal pain. Ingestion of large amounts may result in corrosive injury to the GI tract, effects on metabolism, swelling of the face and a build-up of fluid in the lungs. • Severe poisoning can result in multi-organ failure with hypotension, circulatory failure, acute kidney injury, haemolytic anaemia, hepatotoxicity, and facial and pulmonary oedema. Skin contact: • Irritant, unlikely to be significantly absorbed via the skin Eye contact: • Irritant
Health effects: Chronic
• Children are likely to be most sensitive. • Anaemia, decreased lung function, emphysemia and kidney injury. • Decreases in bone mineralisation, leading to increased risk of bone fractures. Occupational studies have linked exposure to lung, prostate and other cancers.
Alert thresholds: If any of these thresholds are exceeded, report under surveillance
Biomonitoring: Blood**:** whole blood level of < 0.005 mg/L is considered normal[9,10]. Occupationally exposed persons may have higher blood levels than the general population. Note: Elevated blood cadmium levels confirm recent acute exposure, but do not correlate well with body burden[11]. Values > **0.01 mg/L should be reported.** Urine: Urine cadmium levels primarily reflect total body burden. The best screening and diagnostic test for chronic cadmium exposure is a 24-hour urinary cadmium level, normalized to creatinine excretion. Normal urinary cadmium is <3 µg/g creatinine [8], renal function disfunction is unlikely if urinary levels are less than

10 µg/g creatinine with most results in the range of 0.05 - 0.2 µg/dL, smokers are likely to have higher concentrations[12] .
Renal dysfunction is considered unlikely when urinary cadmium levels are less than 10 µg/g creatinine.
Values > **10 µg/g should be reported.**

Environmental monitoring
Air: Nigeria has set the maximum permissible limit for cadmium emissions to air as 10 mg/Nm^3 [13]. The WHO guideline for cadmium in air is 5 ng/m^3 (annual average). Values > 10 mg/Nm^3 should be reported.
Water
Drinking-water**:** Drinking water standard set at the WHO guideline level of 0.003 mg/L. [15,16,17]
Alerting threshold for Drinking water > **0.003 mg/L should be reported**.
Surface Water: Effluent Discharges/irrigation and reuse standards: 10 µg/L[18].
Trigger level ≥ 0.007mg/L should be reported.

Fisheries and recreation standard: 5 µg/L [18]
Trigger level ≥ **0.005mg/L should be reported.**
Groundwater Standard: Intervention value 6 µg/L[18].
Alert threshold > **0.006 mg/L should be reported**.

Soil: Soil quality within Nigerian manufacturing sites must not exceed 3 mg/kg dry weight.
UK-derived soil quality standards for cadmium [19] are within a range of 3mg to 220mg/kg, depending on the land.
Alert threshold > 3 mg/kg should be reported

Food: Cadmium contained in soil and water can be taken up by certain crops and aquatic organisms and accumulate in the food chain[20]. WHO provides guidance on the maximum permitted levels for a range of food substances [21]. The lowest emetic dose reported is 0.07mg kg^{-1} bw. The ingestion of cadmium exceeding 15mg kg^{-1} body weight (bw) may give rise to gastrointestinal symptoms such as vomiting, abdominal cramps and diarrhoea, whereas doses of 20 to 30mg kg^{-1} bw have caused human fatalities[22].
Alert threshold > 0.07 mg/kg should be reported

Case Classification:

Suspected. A case in which a potentially exposed person is being evaluated by health-care workers or public health officials for exposure to / poisoning by cadmium, but no specific credible threat exists.
Probable. A clinically compatible case in which a high index of suspicion (credible threat or patient history regarding location and time) exists for mercury exposure, or an epidemiologic link exists between this case and a laboratory-confirmed case.
Confirmed. A clinically compatible case in which laboratory tests have confirmed exposure.
The case can be confirmed if laboratory testing was not performed because either a predominant amount of clinical and nonspecific laboratory evidence of a particular chemical was present or a 100% certainty of the etiology of the agent is known

Respond to the alert threshold:

If Cadmium cases are suspected:
- Report case-based information to NCDC via the Case Information Form (CIF).
- Discuss with the Poison Centre or clinical toxicologist for clinical management.
- As necessary, treat and manage the patient(s) with supportive care.
- Collect biological specimens and/or relevant environmental samples and send them to the laboratory to identify the aetiology of the illness.
- Antidotal treatment with Sodium Calcium EDTA or DMSA may be indicated 23

Respond to the action threshold:

If [chemical] cases are confirmed:
- Identify the population exposed to the chemical hazard.
- Implement appropriate protection, prevention and control interventions.

Analyse and interpret data:

Time: Analysis of suspected and confirmed cases by day/week. Graph cases and deaths daily/weekly.
Place: Plot location of cases.
Person: Analyse by age and gender.

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Nickel

Potential sources:

Nickel (inorganic)

Food and cigarette smoke are the main sources of public exposure to nickel.[1]

- Drinking contaminated water[5]
- Contaminated water, soil, sediment, food (especially fish), air
- Contaminated water used for drinking, preparing food and watering food crops.
- Jewellery, stainless steel and coins
- Industrial processes: used to produce stainless steel and other alloys. Nickel alloys are also used to make coins. Nickel compounds are used in electroplating, pigments, ceramics and the production of nickel-cadmium batteries.
- Consumption of potentially contaminated herbal medicines.[6]

Nickel Carbonyl

- Inhalation of paint scrapings[2]
- Potential exposure from mining activities or other industries that produce nickel: (purification of nickel ore)[3,4]

Nigeria background levels:

- Can be present at high levels in groundwater in certain regions within Nigeria. Contamination from mining and agricultural industries as well as improper waste disposal. Contamination route via surface run off and subsequent infiltration processes from contaminated soils.[7]
- Can be higher levels in areas near mining activities.[8]
- One study in Nigerian metal workers identified nickel at urine concentrations between 14.3 and 25.8 ug/l[16]

Health effects: Acute

Ingestion:

Acute ingestion of nickel compounds can cause nausea, vomiting, diarrhoea and headache. Possibly associated with fatigue, dizziness and myalgia. Following substantial ingestions of nickel salts severe gastrointestinal irritation may occur and acute kidney injury is likely.

Inhalation:

Nickel carbonyl is the most toxic nickel compound following acute inhalational exposure.
Immediate effects: respiratory tract irritation and neurological effects.
Delayed effects: , secondary dermatitis include pulmonary oedema, pneumonitis and in severe cases death.

Dermal:

Most common symptom of exposure to nickel is allergic dermatitis.
Primary dermatitis typically localised to the area of skin contact, initially characterized by erythematous papules that may process to lichenification because of pruritus and scratching.

More widespread secondary dermatitis may occur as a result of other exposures, such as ingestion, transfusion, inhalation, implanted metal medical devices.[4]

Health effects: Chronic

Repeated dermal (skin) contact with nickel or nickel compounds can lead to sensitisation and the development of contact dermatitis.[9]
The most serious harmful health effects from exposure to nickel, such as chronic bronchitis, reduced lung function, and cancer of the lung and nasal sinus, have occurred in people who have breathed dust containing certain nickel compounds while working in nickel refineries or nickel processing plants)[10]

Exposure to high levels of nickel compounds that dissolve easily in water (soluble) may also result in cancer when nickel compounds that are hard to dissolve (less soluble) are present, or when other chemicals that can produce cancer are present.

Nickel carbonyl and soluble nickel salts are considered to be reproductive toxicants.[10]

Alert thresholds: If any of these thresholds are exceeded, report under surveillance

Biomonitoring:

Urine: Normal concentrations of nickel reported as 1 to 6 µg/L.[4] Absorbed nickel is primarily excreted in the urine. Urine collection should ideally use acid-washed, metal-free containers. Concentrations below 100 µg/L may imply mild toxicity. Concentrations of 100-500 µg/L are classified as moderate, and concentrations above 500 µg/L are categorized as severe exposures.[15]
Alert level (Trigger Value): 100 and above µg/L should be reported.

Blood: Normal concentrations of nickel < 1 µg/L (<17 nmol/L).[4]
Aler value to report: concentration >1 µg/L

Environmental: Detection of nickel in environmental samples above typical background or relevant guideline levels, as determined by the relevant agencies.

Drinking water: 0.02 mg/L (Nigerian Drinking Water Standard)[11]
Aler value to report: concentration > 0.02 mg/L

Groundwater/surface waters environmental standard: 0.01 mg/l (Fisheries and Recreation Quality Criteria Standards and 0.1 mg/l for Effluent Discharges, Irrigation and Reuse Standards)[12]
Trigger to report: concentration > 0.01 mg/l for Fisheries and Recreation Quality and >0.1 mg/l for effluent Discharges, Irrigation and Reuse Standards

Air: 20,000 µg/m^3 (annual) (Nigeria Air Quality Standard)[13]
Trigger to report: concentration > 20,000 µg/m^3

Soil: 70 mg/kg (Nigerian Soil Quality Standards - industrial sites)[14]
Acceptable level of 35mg/kg (Osmani, Bani and Hoxha (2015). However, WHO and National Institutes of Health (NIH) state the permissible level as 50mg/kg
Trigger to report: concentration > 50mg/kg

Case Classification

Suspected: A case in which a potentially exposed person is being evaluated by health-care workers or public health officials for exposure to / poisoning by a particular chemical agent, but no specific credible threat exists.

Probable: A clinically compatible case in which a high index of suspicion (credible threat or patient history regarding location and time) exists for nickel exposure, such as clinical manifestations of nickel poisoning, or an epidemiologic link between this case and a laboratory-confirmed case.

Confirmed: A clinically compatible case in which laboratory tests (e.g. urine) have confirmed exposure. The case can be confirmed if laboratory testing was not performed because either a predominant amount of clinical and nonspecific laboratory evidence of a particular chemical was present, or a 100% certainty of the aetiolgy of the agent is known.

Respond to the alert threshold:

If nickel cases are suspected:

- Report case-based information to NCDC via Case Information Form (CIF).
- Discuss with Poisons Centre or clinical toxicologist for clinical management.
- As necessary treat and manage the patient(s) with supportive care.
- Collect biological specimens and/or relevant environmental samples and send them to the laboratory to identify the aetiology of the illness.
- First step is to remove the source of exposure

Respond to the action threshold:

If nickel cases are confirmed:

- Identify the population exposed to the chemical hazard.
- Implement appropriate protection, prevention and control interventions.

Analyse and interpret data:
Time: Analysis of suspected and confirmed cases by day/week. Graph cases and deaths daily/weekly. ***Place***: Plot location of cases. ***Person***: Analyse by age and gender.

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Aluminium

- **Potential sources:** [1,2,3]

- Contaminated water, soil, sediment, food, air.
- Industrial use including mining
- Contaminated water used for drinking, food preparation and irrigation of food crops
- Aluminium compounds have many different uses, for example, as alums in water-treatment and alumina in abrasives and furnace linings.
- They are also found in consumer products such as antacids, astringents, buffered aspirin, food additives, cosmetics and antiperspirants
- There is the potential for aluminium and other metals to leach from artisanal mined cookwear

Nigeria background levels

- Increased aluminium concentrations noted in groundwaters[1] (0.06 to 14mg/l) and rivers[5] (0.04 to 64.9 mg/l close to aluminium industries
- Increased concentrations of Aluminium have been reported in sachet water in South Western Nigeria [6]
- Nigerian welders shown to have significantly higher blood concentrations compared to other people but within "normal" ranges[7]

Health effects: Acute: [8,9,10]

Ingestion

- Accidental ingestion of small amounts of dilute preparations of aluminium salts may cause mild gastrointestinal upset only. Ingestion of more substantial amounts may result in gastrointestinal (stomach) upsets, nausea or diarrhoea.
- Larger ingestions of certain aluminium salts like aluminium ammonium sulphate, aluminium potassium sulphate and aluminium chloride may result in ulceration of the lips and mouth, rarely haemorrhagic gastritis, circulatory collapse, reproductive toxicity and multi-organ failure.
- Patients with acute aluminium toxicity develop encephalopathy, myoclonus and seizures, disorientation, confusion and coma but usually from huge exposures in combination with renal insufficiency.
- Increased absorption and retention in bone has been reported following acute ingestion without apparent adverse sequelae.

Inhalation

- Inhalation of aluminium containing dust for a short period may cause irritation to throat and nose

Other

- Aluminium sulphate used in water purification is a potential source of aluminium toxicity in haemodialysis patients and may cause dialysis encephalopathy in patients with renal failure.

Health effects: Chronic [9,10]

- "Potroom asthma" has been documented in aluminium welders and smelters but uncertain whether aluminium was the primary cause
- Pulmonary fibrosis leading to fatalities has been reported when exposed to aluminium powder which can oxidise readily to aluminium oxide
- Cardiac conduction abnormalities have also been described following chronic inhalational exposure
- Neurocognitive dysfunction has been reported in chronic occupational exposure and can include deficits in learning, attention and short-term memory

Alert thresholds: If any of these thresholds are exceeded, report under surveillance

Biomonitoring:

Blood: Serum concentration less than 2ug/l (<0.074 umol/l)
Normal whole blood concentration less than 12 ug/L (<0.43 umol/l)[11]
Trigger level to be reported: concentration > 2µg/L for serum and > 12µg/L for normal whole blood.
Environmental: Detection of aluminium in environmental samples above typical background or relevant guideline levels, as determined by the relevant agencies.
Drinking water: 0.2 mg/L (Nigerian drinking water standard)
Groundwater/surface waters environmental standard: 0.2 mg/l [12]
Trigger level to be reported: concentration > 0.2 mg/L for drinking water and > 0.2 mg/L for ground water/surface waters.

Air: No applicable air quality standard
Occupational inhalation of dust (all 8 hours)[13]
Soluble aluminium salts - 2 mg/m^3

Inhalable dust (aluminium metal or aluminium oxide) - 10 mg/m^3
Respirable dust (aluminium metal or aluminium oxide) - (8 hours): 4 mg/m^3
Trigger level above given values to be reported.

Soil: N/A

Food: Provisional Tolerable Weekly Intake (PTWI) of 2 mg/kg/bw [14]
Trigger level to be reported: concentration > 2 mg/kg/bw

Case Classification

Suspected: A case in which a potentially exposed person is being evaluated by health-care workers or public health officials for exposure to / poisoning by a particular chemical agent, but no specific credible threat exists.
Probable: A clinically compatible case in which a high index of suspicion (credible threat or patient history regarding location and time) exists for arsenic exposure, such as **clinical manifestations** of arsenic poisoning, or an epidemiologic link between this case and a laboratory-confirmed case.
Confirmed: A clinically compatible case in which laboratory tests have confirmed exposure. The case can be confirmed if laboratory testing was not performed because either a predominant amount of clinical and nonspecific laboratory evidence of a particular chemical was present, or a 100% certainty of the aetiology of the agent is known.

Respond to the alert threshold:

If aluminium cases are suspected:

- Report case-based information to NCDC via Case Information Form (CIF).
- Discuss with Poisons Centre or clinical toxicologist for clinical management.
- As necessary treat and manage the patient(s) with supportive care.
- Collect biological specimens and/or relevant environmental samples and send them to the laboratory to identify the aetiology of the illness.
- Consider sourcing Desferroxamine antidote if indicated.

Respond to the action threshold:

If aluminium cases are confirmed:

- Identify the population exposed to the chemical hazard.
- Implement appropriate protection, prevention and control interventions.

Analyse and interpret data:

***Time*:** Analysis of suspected and confirmed cases by day/week. Graph cases and deaths daily/weekly.
***Place*:** Plot location of cases.
***Person*:** Analyse by age and gender.

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Benzene

Potential sources[1,2,3]:

- Primarily used as a chemical intermediate for creating benzene derivatives.
- As an organic solvent for waxes, fats, resins, oils, inks paints, plastics and rubber.
- Manufacturing of polymers, pesticides, detergents explosives and pharmaceuticals.
- Found as a gasoline additive and constituent of motor fuels (<2% in Nigeria).
- Volcano, forest fire, crude oil, gasoline and cigarette emissions.

Nigeria background levels in the environment:

- Benzene concentrations found in groundwater in the Niger delta were reported as being between 161 – 9280 µg/L, with concentrations between 0.155 - 48.2 µg/L in indoor air.[4]
- In a separate study, analysis of benzene concentrations in groundwater across 3 Nigerian regions varied considerably between 0.1 – 3500 µg/L Benzene was particularly high in well water close to an underground petroleum pipeline[5].

Health effects: Acute [16]

Inhalation of benzene vapour is the most common form of exposure, which may cause CNS depression, dizziness, drowsiness, headache and ataxia. Benzene can be irritant or corrosive depending on concentration, with mucous membrane irritation, sore throat, cough, hoarseness of voice and dyspnoea potentially extending to pulmonary oedema, airway inflammation and haemorrhage. Benzene is also haematoxic and associated with acute haemolysis.

Ingestion may cause a burning sensation in the mouth, throat and stomach, with nausea, vomiting and abdominal pain. Gastrointestinal ulceration and severe gastric inflammation have been reported

Benzene is also a skin irritant; prolonged or excessive exposure, even at low concentrations, may cause erythema or dermatitis. Chemical burns may occur. Benzene vapour may cause eye irritation at higher concentrations or a chemical injury if in direct contact with the liquid.

Health effects: Chronic

Benzene is a known mutagenic and genotoxic human carcinogen (IARC group 1), with a substantial number of case reports and epidemiological studies providing evidence of a causal relationship between chronic exposure and various types of leukaemia.[7] In one study, malignant lymphomas were seen to be increased in association with benzene exposures during pregnancy[8]. It is hypothesized to be mediated primarily by metabolites such as benzene oxide.[9]

Alert thresholds: If any of these thresholds are exceeded, report under surveillance

Biomonitoring:

Blood: Gas-liquid chromatography is used to determine benzene in serum; a concentration > 1 mg/L may be toxic.[10]

Urine: Benzene in urine potentially gives a better reflection of benzene exposure occupationally compared to blood measurements. Biological reference values measured for a general population (without occupational exposure) indicate 300 ng/L as a reference range for urinary benzene. As benzene is a volatile compound, it evaporates from biological samples rapidly and may be difficult to measure in urine.[11]

Breath: Breath benzene levels are typically well correlated with blood and urinary levels. Benzene is partially excreted in the breath regardless of the route of exposure; this method is particularly sensitive even after low level exposures to benzene. However, there are no formally established health-based guidance values for comparison.[9]

***Trigger levels to be reported: concentration* ≥ 1mg/L (blood); > 300 ng/L (urine).**

Environmental:

Drinking water: The WHO recommended drinking water value is 10 µg/L[12]. For additional context on increased cancer risks: 1 µg/L (excess lifetime cancer risk 10^{-6}), 10 µg/L (excess lifetime cancer risk 10^{-5}), 100 µg/L (excess lifetime cancer risk 10^{-4})[13,14]

Groundwater: 0.2 µg/L as a remedial target value, 30 µg/L as an intervention value (Nigeria National Environmental Regulations)[5]

***Trigger level to be reported: concentration* > 0.01mg/L (drinking water) and > 0.03 mg/L (ground water).**

Air: Odour air quality standard - 50 ppmV –(Nigeria National Environmental Air Quality Control Regulations 2021).[15]

Benzene is a genotoxic carcinogen in humans and no safe level of exposure can be recommended. The geometric mean of the excess lifetime risk of leukaemia at an air concentration of 1 µg/m^3 is 6*10^{-6}. The concentrations of airborne benzene associated with an excess lifetime risk of 1/10 000, 1/100 000 and 1/1000 000 are 17, 1.7 and 0.17 µg/m^3, respectively.[16]

The European ambient air quality directive for benzene is 5 µg/m^3.[17]
Trigger level to be reported: concentration >5µg/m^3

Soil: 5 mg/kg (Nigeria Soil Quality Standards Regulations 2007)[18]
***Trigger level to be reported: concentration* >5 mg/kg**

Case Classification:

Suspected. A case in which a potentially exposed person is being evaluated by health-care workers or public health officials for exposure to / poisoning by benzene, but no specific credible threat exists.

Probable. A clinically compatible case in which a high index of suspicion (credible threat or patient history regarding location and time) exists for benzene exposure, or an epidemiologic link exists between this case and a laboratory-confirmed case.

Confirmed. A clinically compatible case in which laboratory tests have confirmed exposure.
The case can be confirmed if laboratory testing was not performed because either a predominant amount of clinical and nonspecific laboratory evidence of a particular chemical was present or a 100% certainty of the etiology of the agent is known.

Respond to the alert threshold:

If benzene cases are suspected:

- Report case-based information to NCDC via Case Information Form (CIF).
- Discuss with Poison Centre or clinical toxicologist for clinical management.
- As necessary treat and manage the patient(s) with supportive care.
- Collect biological specimens and/or relevant environmental samples and send them to the laboratory to identify the aetiology of the illness.

Respond to the action threshold:

If benzene cases are confirmed:

- Identify the population exposed to the chemical hazard.
- Implement appropriate protection, prevention and control interventions.

Analyse and interpret data:

Time: Analysis of suspected and confirmed cases by day/week. Graph cases and deaths daily/weekly.
Place: Plot location of cases.
Person: Analyse by age and gender.

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Polychlorinated biphenyls (PCBs)

Potential sources:

- Main routes of public exposure are primarily from contaminated water and food including meat, dairy products, fish and cooking fuels[5] and breathing contaminated air[1,4]
- PCBs are not manufactured in Nigeria but have been imported into the country as components of electrical equipment such as old fluorescent lighting fixtures, electrical devices or consumer products / appliances containing PCB capacitors, old microscope oil, and old hydraulic oil.[3]
- PCBs were widely used as coolants and lubricants in transformers, capacitors and other electrical equipment
- PCBs are a restricted chemical that can only be used with a permit[4]
- PCBs enter the environment as mixtures containing a variety of individual chlorinated biphenyl components, known as congeners, as well as impurities.[1]
- Environmental PCB pollution may occur during incineration of municipal waste, via industrial sewage release, leaks or fires in transformers, capacitors or other electrical products
- Soils and sediments and landfills can release low levels back into the atmosphere.
- Consumer products potentially containing PCBs include old fluorescent lighting fixtures, electrical devices or appliances containing PCB capacitors, old microscope oil, and old hydraulic oil.
- Workplace exposure may occur during repair and maintenance of PCD transformers.

Nigeria background levels:

- PCBs can be present at high levels in rivers, soils and sediments in certain regions and near certain land uses such as waste disposal sites within Nigeria[3,6,8] Background concentrations ranging between <0.001-570 µg/l have been reported in surface waters and <0.001- 560 µg/l in groundwaters.[6]
- Concentrations between 4.6-116ng/g for soils, 1.80-23ng for indoor dust and 2.73-57ng/g for outdoor dust in Port Harcourt have been reported.[3]
- Concentrations between 976-6340ng/g have been reported for river sediments in the Niger Delta.[9]
- A study measured concentrations of PCBs in canned fish (ranging between 0.33-9.48ng/g), which is imported and collected from retail shops in Delta State[10]

Health effects (acute):

PCBs are a group of synthetic organic chemicals that can cause a number of different harmful effects.

They have no known smell or taste.[1] The health effects of environmental mixtures of PCBs are difficult to evaluate, this relates to PCB mixtures that were commercially produced.

No reports of effects in humans following acute (short-term) exposure to PCBs are available.[1] Animal studies have shown PCB's to have moderate acute toxicity and reported acute effects on the liver, kidney, and central nervous system (CNS) from oral exposure to PCBs.[1, 11]. Workplace exposure may cause irritation of the nose and lungs, skin conditions such as acne and rashes, gastrointestinal discomfort, changes in the blood and liver, depression and fatigue.[1]

Health effects (chronic):

Most long-term toxicity studies on PCBs have been performed using commercial mixtures of PCBs, the exact composition of which are unknown. Impurities in these mixtures may contribute to toxicological effects.[4]

The human health effects from exposure to PCBs will depend on the many different congeners, contaminants present in PCB formulations and the combustion by-products of PCBs.

PCB exposure is associated with[4]:

- Potential increased risk of cancers of the digestive system (notably of the liver) and of malignant melanoma. U.S. EPA classified PCBs as probable carcinogens[15]
- Reproductive deficiencies, such as reduced growth rates, retarded development, and neurological effects (although some neurological deficiencies at early ages may disappear later during childhood).
- Immunological changes, manifested as increased infection rates and changes in circulating lymphocyte populations; and dermatological changes, including chloracne and pigmentation

disturbances of skin, nails, and gingivaes, as well as nail deformation after exposure to highly chlorinated congeners.

Alert thresholds: If any of these thresholds are exceeded, report under surveillance

Biomonitoring: No reporting thresholds identified but following background concentrations have been reported:
In 2001-2004, the median level of PCBs in blood serum among American (U.S) women ages 16 to 49 years (the sum of PCBs 118, 138, 153 and 180) was 30 ng/g lipid.[12]

Environmental:
No established Nigerian or WHO guideline values for air, drinking water, surface water, soil or sediment**.**

Air

Indoor air, >0.1 µg/m^3 should be reported to protect human health[16]. While for outdoor environments, PCB concentrations are typically much lower, >0.0001 µg/m^3 [16](Report Trigger value).

Water

U.S. Environmental Protection Agency (EPA) Drinking water standards and health advisories: Enforceable Max Contaminant Level (MCL) in drinking water is 0.0005 mg/L[12] and values greater than it should be reported.

For aquatic life protection, NOAA recommends a chronic concentration (CCC) of 14 ng/L and a maximum concentration (CMC) of 2,000 ng/L for PCBs in water. >0.002 mg/L[18] should also be reported.

Food: U.S. Food and Drugs Administration (FDA): tolerances of 0.2-3.0 mg/kg PCBs for all foods, with a tolerance level in fish of 2 mg/kg.[14] The FAO and the WHO allow a daily PCB intake of 0.006 mg/kg per day.[12] Values greater than 0.668mg/kg for canned fish should be reported[17]

Case Classification

Suspected: A case in which a potentially exposed person is being evaluated by health-care workers or public health officials for exposure to / poisoning by a particular chemical agent, but no specific credible threat exists.

Probable: A clinically compatible case in which a high index of suspicion (credible threat or patient history regarding location and time) exists for PCB exposure, such as clinical manifestations of PCB poisoning, or an epidemiologic link between this case and a laboratory-confirmed case.

Confirmed: A clinically compatible case in which laboratory tests have confirmed exposure. The case can be confirmed if laboratory testing was not performed because either a predominant amount of clinical and nonspecific laboratory evidence of a particular chemical was present, or a 100% certainty of the aetiology of the agent is known.

Respond to the alert threshold:

If PCB cases are suspected:

- Report case-based information to NCDC via Case Information Form (CIF).
- Discuss with Poisons Centre or clinical toxicologist for clinical management.
- As necessary treat and manage the patient(s) with supportive care.
- Collect biological specimens and/or relevant environmental samples and send them to the laboratory to identify the aetiology of the illness.

Respond to the action threshold:

If PCB cases are confirmed:

- **Identify the** population exposed to the chemical hazard.
- Implement appropriate protection, prevention and control interventions**.**

Analyse and interpret data:

Time**:** Analysis of suspected and confirmed cases by day/week. Graph cases and deaths daily/weekly.
Place**:** Plot location of cases.
Person**:** Analyse by age and gender**.**

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Benzo[a]pyrene or PAHs (Polycyclic Aromatic Hydrocarbons)

Potential sources:

- Burning of coal, wood, agricultural waste and other solid fuels[1]
- May be present in vehicle emissions and cigarette smoke
- Indoor sources include domestic heating and cooking especially from charcoal, open fires
- Natural sources include forest fires and volcanoes[2]
- Contaminated soil, sediments[4], fish[5], water[6] or drinking water
- Occupational exposure including coal industries, aluminium production and working with asphalt[1,2]

Nigeria background levels:

- Can be present at high levels in rivers, soils and sediments in certain regions (e.g. Delta region, Benin) within Nigeria[5,6]
- Can be elevated in soils and air near landfill, waste dumping sites[7]
- Potential risk from the consumption of bread[8], fish[9] and meat[10] (including street foods)[11]

Clinical description: Acute

There are several hundred polycyclic aromatic hydrocarbons (PAHs), that usually occur as complex mixtures rather than individual compounds. However, PAHs generally have a low degree of acute toxicity to humans. Health effects are more likely following chronic exposure (see below).[1, 2]

Health effects: Chronic

Chronic exposure to mixtures of PAHs in air have resulted or been associated with a range of respiratory effects (e.g. asthma, reduced lung function), ischemic heart disease, chronic dermatitis, depressed immune system.[1, 2]

BaP amongst other PAHs is able to form DNA adducts which are likely key to their mutagenic potential. Hence, complex mixtures of PAHs which include BaP are considered to be carcinogenic to humans and have been associated with breast cancer, childhood cancers and lung cancer.[1,2]

Limited epidemiological evidence of adverse effects on cognitive or behavioural function in children[1]

Alert thresholds: If any of these thresholds are exceeded, report under surveillance

Biomonitoring: PAH's and their metabolites can be measured in urine, blood, or body tissues to confirm exposure. However, these are difficult to interpret to guide clinical management or determine exposure source (e.g. combustion) so environmental thresholds (see below) are of more use initially for surveillance purposes.[12]

Environmental: Detection of PAHs in environmental samples above typical background or relevant guideline levels, as determined by the relevant agencies**.**

Drinking water: 0.007 mg/L (Nigerian Drinking Water Standard)[14]
Triger level to be reported: concentration > 0.007 mg/L

Groundwater/surface waters environmental standard:
Intervention value 0.070 mg/L (70 µg/L) (For total of 10 PAHs)[15]
Concentration of 0.2µg/L in groundwater (United State Environmental protection Agency,2023); Concentration of 10 µg/L (WHO, Guidelines for drinking water quality, 2011).
Trigger level to be reported: concentration > 0.01 mg/L.

Air: 8.7 x10^{-5} per ng/m^3 of B[a]P unit risk for lung cancer for PAH mixtures.[15, 16] - Indoor
Air value 0.1ng/m^3 Benzo(a)pyrene (WHO) – Lifetime exposure
Trigger to report: concentration above 8.7 x10^{-5} per ng/m^3 - Indoor

Soil: 1 mg/kg (Soil quality guidelines Switzerland)[18].
Range of 5.0 mg/kg to 21 mg/kg (UK, dependent on land use)[19]
Trigger value to be reported: concentration > 5 mg/kg

Food: 12Mean 4.0 ng/kg/bw/day; high 10 ng/kg bw/day (FAO Codex Alimentarius)[20]
2.0- 12 µg/kg and 30 µg/kg PAH_4 [21,22]
For Baby food and infant formula: 1 µg/kg for B(a)P and PAH_4.
Trigger level to be reported: concentration >12 µg/kg for food generally and >1 µg/kg B(a)P and PAH_4 for baby food and infant formula.

Case Classification

Suspected: A case in which a potentially exposed person is being evaluated by health-care workers or public health officials for exposure to / poisoning by a particular chemical agent, but no specific credible threat exists.

Probable: A clinically compatible case in which a high index of suspicion (credible threat or patient history regarding location and time) exists for PAH exposure, such as clinical manifestations of PAH poisoning, or an epidemiologic link between this case and a laboratory-confirmed case.

Confirmed: A clinically compatible case in which laboratory tests have confirmed exposure. The case can be confirmed if laboratory testing was not performed because either a predominant amount of clinical and nonspecific laboratory evidence of a particular chemical was present, or a 100% certainty of the aetiolgy of the agent is known.

Respond to the alert threshold:

If PAH cases are suspected:

- Report case-based information to NCDC via Case Information Form (CIF).
- Discuss with Poisons Centre or clinical toxicologist for clinical management.
- As necessary treat and manage the patient(s) with supportive care, there are no antidotes to treat PAH poisoning
- Collect biological specimens and/or relevant environmental samples and send them to the laboratory to identify the aetiology of the illness.

Respond to the action threshold:

If PAH cases are confirmed:

- Identify the population exposed to the chemical hazard.
- Implement appropriate protection, prevention and control interventions.

Analyse and interpret data:

***Time*:** Analysis of suspected and confirmed cases by day/week. Graph cases and deaths daily/weekly.
***Place*:** Plot location of cases.
***Person*:** Analyse by age and gender.

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2,3,7,8-Tetrachlorodibenzo-p-dioxin - TCDD (Dioxin)

Potential sources[1-4]:

- Not synthesised intentionally for commercial purposes
- Formed during incomplete combustion (natural e.g. forest fires and industrial, domestic and municipal waste incineration).
- Very small amounts may be formed during the production of some solvents.
- Small amounts released during metal smelting, processing, and refining and during the use of chlorine for bleaching of pulp in paper mills and chlorination by waste and drinking water treatment plants.
- Low levels in cigarette smoke and motor vehicle emissions.
- Persistent environmental pollutant (POP) – soils and sediments can release low levels back into the atmosphere.
- Accumulate in the food chain, mainly in fatty tissue of animals and can therefore be present in very small amounts in some food products including meat, dairy products, and fish.
- There is the potential for dioxins to be used in deliberate poisoning events
- The main route of human exposure is through ingestion of contaminated foodstuffs, especially animal products. However, absorption of TCDD may follow inhalation or dermal exposure to aerosols.

Nigeria background levels:

- No specific background levels were identified for Nigeria.
- Annual releases of polychlorinated dibenzo-p-dioxins and furans (PCDD/Fs) in different matrixes were estimated using the UNEP toolkit method in Nigeria recorded the following (g/TEQ[1]/year): Air ~2784; Water ~0.034; Land ~2521; Products ~0; Residue ~34; and Total ~5340.[5]
- The results of a study examining the presence of dioxins in domestic and burnt tyre waste residues at a dumpsite in Abuja indicate that the population and activities within the area of study are under threat of health hazards potentially arising from the high concentration of dioxins recorded in the study.[6]
- Dioxins are not on the list of contaminants routinely checked in imported food by the Nigerian regulatory authority. A study measured concentrations of PCDD/Fs, including TCDD, in canned fish, which is almost exclusively imported, collected from retail shops in Delta State. The study showed that nearly half of the samples exceeded acceptable safe limits.[7]

Health effects: Acute [1, 3]:

- Dioxins are the general name for a group of 210 compounds of similar structures but greatly varying toxicity. The most toxic is 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD).
- At the levels which generally occur in food and the environment, dioxins have no immediate effect on health if exposed for a short period of time.[1] Very high concentrations associated with deliberate poisoning, industrial accidents and occupational exposure to chemicals contaminated with dioxins can cause skin disorders such as chloracne (acne-like spots), rashes, redness, skin discoloration, excess body hair, irritating to skin and eyes; Gastrointestinal symptoms of vomiting, diarrhea, abdominal pain; neurological effects including headaches, weakness, muscular pains, peripheral neuropathy, loss of appetite, sexual dysfunction and transient weight loss, and other organ effects such as lung infections and damage to liver and immune systems.[1,3]

Health effects: Chronic

A confirmed carcinogen.[1,2]
The adverse effects of chronic exposure to dioxins are similar to those following acute exposure and may also cause liver disease, increased risk of diabetes, alterations in thyroid function, impaired immune function, cardiovascular disease, mild neuropathies, developmental effects and reproductive toxin.[1]

Alert thresholds: If any of these thresholds are exceeded, report under surveillance

Biomonitoring:

No reporting thresholds identified but following studies on background concentrations.

A study in Japan on 490 males and 248 adults in Japan determined a median concentration between 8.8 and 9.9 pg TEQ/g fat (12)

A study in Germany in 9 to 11year old children identified concentrations between 8.3 and 11.5 pg I-TEQ/g fat in a mixture of industrial and urban areas (13)

Blood:

Values greater than 1pg should be reported.

Environmental:
No established Nigerian or WHO guideline values for air, drinking water, surface water, soil or sediment**.**

Water

U.S. Environmental Protection Agency (EPA) Drinking water standards and health advisories: Max drinking water level: $3x10^{-8}$ mg/L (public health goal: 0mg/L)[8]

U.S. EPA Health advisories for food and water: 1-day health advisory (10-kg child) $1x10^{-6}$ mg/L; 10-Day health advisory (10-kg child) $1x10^{-7}$ mg/L; 10^{-4} Cancer risk: $2x10^{-8}$ mg/L[8]. **Values > $3x10^{-8}$mg/L should be reported.**

Air

U.S. Department of Energy Protective Action Criteria (DOE) Emergency Criteria PACs-air: PAC-1 0.00013 mg/m^3, PAC-2 0.0014 mg/m^3 PAC-3 0.0085 mg/m^3 [10]. **Values for PAC-2 ≥ 0.0014 mg/m^3 should be reported.**

Food:

The Joint Food and Agriculture Organization of the United Nations (FAO)/WHO Expert Committee on Food Additives (JECFA): a provisional tolerable intake of 70 pg/kg body weight per month for PCDDs, PCDFs and coplanar PCBs expressed as Toxic Equivalency Factors (TEFs)[11]

Case Classification

Suspected: A case in which a potentially exposed person is being evaluated by health-care workers or public health officials for exposure to / poisoning by a particular chemical agent, but no specific credible threat exists**.**

Probable: A clinically compatible case in which a high index of suspicion (credible threat or patient history regarding location and time) exists for TCDD exposure, such as clinical manifestations of TCDD poisoning, or an epidemiologic link between this case and a laboratory-confirmed case.

Confirmed: A clinically compatible case in which laboratory tests have confirmed exposure. The case can be confirmed if laboratory testing was not performed because either a predominant amount of clinical and nonspecific laboratory evidence of a particular chemical was present, or a 100% certainty of the aetiolgy of the agent is known**.**

Respond to the alert threshold:

If TCDD cases are suspected:

- Report case-based information to NCDC via Case Information Form (CIF).
- Discuss with Poisons Centre or clinical toxicologist for clinical management.
- As necessary treat and manage the patient(s) with supportive care.
- Collect biological specimens and/or relevant environmental samples and send them to the laboratory to identify the aetiology of the illness**.**

Respond to the action threshold:

If TCDD cases are confirmed:

- Identify the population exposed to the chemical hazard.
- Implement appropriate protection, prevention and control interventions.

Analyse and interpret data:

Time**:** Analysis of suspected and confirmed cases by day/week. Graph cases and deaths daily/weekly.
Place**:** Plot location of cases**.**
Person**:** Analyse by age and gender**.**

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DICHLORVOS (DDVP)

Potential Sources of Exposure:

- Oral exposure ingestion of pesticide deliberately (e.g. self-harm) or accidentally (e.g. in infants)
- Food items contaminated with dichlorvos[5]
- Individuals involved in the manufacture, formulation, and application of dichlorvos in agricultural, household, and public health uses are most likely to be exposed to this insecticide [1,2].
- Individuals may be exposed to dichlorvos from indoor air in buildings where it is used in pest strips or sprays for insect control [2,3].
- Residues of dichlorvos have been detected in food [2,4].
- People living near hazardous waste sites containing dichlorvos may also be exposed [5].
- Oral exposure by ingesting food items contaminated with dichlorvos or direct ingestion [5].

Nigeria background levels:

- It is not a naturally-occurring compound but can be present at different levels in groundwater, soil, crops, and other non-target species in Nigeria.
- Dichlorvos pesticide have been reported at concentrations between 0.10–0.31 µg/L in river samples [6].
- Detecting dichlorvos (DDVP) directly in human blood or urine is challenging due to its rapid metabolism by liver and blood esterases. As a result, intact dichlorvos is rarely found in biological samples.

Health effects: Acute

Systemic Effects:[23]

Acute cholinergic syndrome including: Cramp-like abdominal pain, vomiting, diarrhoea, sweating, salivation, tightness in the chest, and miosis. As poison progresses, muscular twitching (fasciculation) and generalized muscle weakness (particularly the respiratory muscles) occur, bronchial hypersecretion with bronchoconstriction, respiratory depression, ataxia, convulsion, and coma. Cardiac effects could include sinus tachycardia.

Ingestion [7,8,9,14]:

Excessive salivation, nausea, vomiting, and diarrhoea, burning of mouth, with retrosternal and abdominal pain, larynx may also be affected, causing oedema, airway obstruction, and difficulty in clearing bronchial secretions. Systemic effects may follow hours or days later (see systemic features above).[9,10,11]

Inhalation: Mucous membrane and upper airway irritation, tightness of chest at early stages may occur due to local anticholinesterase effects on the bronchi. Systemic effects may follow (see above).

Dermal Exposure: Signs of irritation such as redness, local neuromuscular effects such as sweating, or muscle fasciculation may occur Redness. Extensive dermal contact may progress to systemic symptoms.

Ocular Exposure: Lacrimation, redness, pain, local anticholinesterase effects may pupillary constriction, blurred vision. Systemic features are unlikely but also consider the possibility of simultaneous inhalation/dermal exposure.

Chronic Effects:

Non-Cancer Effects: Acetylcholinesterase inhibition may also occur in humans from chronic exposure to dichlorvos. [10,11]

Carcinogenic Effects [12,13]**:** Potential evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential.

Health effects: Chronic

Non-Cancer Effects: Acetylcholinesterase inhibition may also occur in humans from chronic exposure to dichlorvos which can lead to similar (bit often milder) effects to acute exposure. [10,11]

Carcinogenic Effects[12,13]**:** Potential evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential.

Alert thresholds: If any of these thresholds are exceeded, report under surveillance

Biomonitoring:

Blood:

Dichlorvos diagnosis is based on its tendency to inhibit cholinesterase. Patients with depressed cholinesterase activity (in serum or erythrocyte) should be reported.

Urine[17]**:** Specific test required to determine Dichlorvos poisoning is by testing urine for its transformation products which include dichloroacetaldehyde, dichlorethanol, and dichloracetic acid.

Environmental:
Drinking water[6, 22, 24]*:* 0.02mg/L (Health-based value*), 3mg/L (Acute Health-based value*),
Groundwater/surface waters environmental standard [18]*:* 6.0E-5µg/l AA-EQS (6.E-8mg/l) (Annual Average Environmental Quality Standard). Concentration level > 0.01mg/l for drinking water and > 0.05 mg/L for ground/surface water should be reported.

Air[17]**:** The U.S. OSHA has set a permissible exposure limit (PEL) of 1 mg/m^3 (0.11 ppm) of dichlorvos for workplace air over a 10-hour workday. Concentration > 1 mg/m^3 should be reported.

Soil[17]*:* Consider reporting any discharge of dichlorvos to the environment that exceeds 4.5Kg (10 pounds). Concentration level > 0.03mg/kg in soil used for food production.

Food[17]: WHO/FAO set Acceptable Daily Intake (ADI) of 0 - 0.004 mg/kg bw and Acute Reference Dose (ARfD) of 0.1mg/kg bw. Concentration level > 0.1mg/kg bw should be reported.

Case Classification

Suspected: A case in which a potentially exposed person is being evaluated by health-care workers or public health officials for exposure to / poisoning by a particular chemical agent, but no specific credible threat exists.
Probable: A clinically compatible case in which a high index of suspicion (credible threat or patient history regarding location and time) exists for Dichlorvos exposure, such as clinical manifestations of Dichlorvos poisoning, or an epidemiologic link between this case and a laboratory-confirmed case. Dichlorvos and other organophosphates have a toxidrome specific to their exposure, which helps to identify them as the source of exposure.
Confirmed[19]***:*** A clinically compatible case in which acetylcholinesterase in blood is tested and found to be depressed, or specifically, dimethyl phosphate is found in urine. confirmed exposure. The case can be confirmed if laboratory testing was not performed because either a predominant amount of clinical and nonspecific laboratory evidence of a particular chemical was present, or a 100% certainty of the aetiology of the agent is known.

Respond to the alert threshold:

If Dichlorvos cases are suspected:

- Report case-based information to NCDC via Case Information Form (CIF), and PIC.
- Discuss with Poisons Centre or clinical toxicologist for clinical management.
- As necessary treat and manage the patient(s) with supportive care.
- Collect biological specimens and/or relevant environmental samples and send them to the laboratory to identify the aetiology of the illness.
- Consider having a reasonable stock of atropine.

Respond to the action threshold:

If Dichlorvos cases are confirmed:

- Identify the population exposed to the chemical hazard.
- Implement appropriate protection, prevention and control interventions.

Analyse and interpret data:

***Time*:** Analysis of suspected and confirmed cases by day/week. Graph cases and deaths daily/weekly.
***Place*:** Plot location of cases.
***Person*:** Analyse by age and gender.

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Toxic Alcohols

Potential sources[1]:

Methanol:

- Contaminated alcohol, particularly from illicit production or domestic distillation.
- Consumer products such as antifreezes, windscreen washers and alcohol hand gels.
- As a solvent in chemical manufacturing processes (e.g. formaldehyde).
- As a fuel additive in numerous applications, including model engines.
- As the minor ingredient in methylated spirits (the major ingredient is ethanol).

Ethylene glycol:

- Automobile products such as antifreezes, coolants and brake fluids.
- As a contaminant in cough syrups, in some cases may be imported[1].
- Thermal circulation systems including radiator fluids and geothermal heat pump fluids.
- Can be found in some inks.
- As a solvent in chemical manufacturing processes.

Isopropyl alcohol:

- Consumer products such as alcohol hand gels, cleaning products (Dettol) and cosmetics.
- Used in fuels, inks and pesticides.
- As a solvent in chemical manufacturing processes, for creating coatings.
- Can be used by laboratories to preserve biological samples and in DNA extraction.

Nigeria background levels / previous incidents

- Toxic alcohols are not persistent in the environment and are broken down after a few weeks.[1,1]
- The normal methanol level acceptable in Nigerian petrol is 2-3%[5].
- No data is available for background methanol or ethylene glycol concentrations in air/soil/water for Nigeria.
- 39 cases of methanol toxicity were seen in Ondo State following consumption of locally produced gin; 29 deaths were recorded giving a case fatality rate of 74.4%[6].
- 13 cases of unexplained acute renal failure in children within Lagos State developed into 57 cases of diethylene glycol poisoning across Nigeria; the cause was found to be as a misformulation of acetaminophen-based teething medications[7]
- Methanol occurs naturally in food, notably in fresh fruit/vegetables and their juices. The WHO estimated the methanol content of fruit juices between 1-640 mg/L, with an average of 140 mg/L[8].
- Dietary methanol can also be found following conversion of the dietary sweetener aspartame[5].
- Methanol concentrations of 6-27 mg/L have been reported in beer, 96-321 mg/L in wine, and 10-220 mg/L in (correctly produced) distilled spirits[7].
- Methylated spirits typically contain between 0-10% methanol, averaging 5%.

Health effects: Acute and chronic: [1]

Ingestion is the most typical route of exposure for toxic alcohols. However, methanol can cause toxicity by dermal absorption or incidental vapour inhalation.

Initial symptoms are consistent across the group and can be considered features of “intoxication”. This includes headache, nausea, vomiting, dizziness, ataxia, drowsiness and tachycardia.

Methanol:

Intoxication as described above is the typical early feature of methanol toxicity, with metabolic toxicity potentially taking 12-24 hours to fully develop. The osmolar or anion gap may be raised. Visual disturbances and blindness, severe metabolic acidosis, convulsions, coma, renal failure and cardiac failure may occur.

Ethylene glycol:

Apparent intoxication with no ethanol smell on the breath. The osmolar or anion gap may be raised. Convulsions, nystagmus, congestive cardiac failure, myoclonic jerks and tetanic contractions may occur. High anion gap metabolic acidosis, flank pain, acute tubular necrosis, anuria, hypocalcaemia, hypokalaemia and hypomagnesaemia may occur as ethylene glycol is metabolised to oxalic acid. Severe metabolic acidosis, convulsions and coma carry a poor prognosis.

Isopropyl alcohol:

Manifests as intoxication which worsens into central nervous system depression and marked gastrointestinal and cardiovascular toxicity. Gastritis, bradycardia, hypotension, melaena, haematemesis, cardiovascular collapse, coma and cardiac arrest may occur. Hepatic or renal injury, pancreatitis and respiratory depression can occur.

Clinical indicators:

Any features consisting of: intoxication, metabolic acidosis, raised osmolar gap, raised anion gap, renal impairment/failure or visual disturbances may indicate toxic alcohol poisoning.

Methanol alert thresholds: If any of these thresholds are exceeded, report under surveillance

Biomonitoring:

Blood: Methanol concentrations are the most effective mechanism of confirming exposure[1]. The normal blood concentration of methanol from endogenous production is 0.5 mg/L[5]. A blood methanol concentration above 15 mg/L[9] may indicate exposure, whereas above 200 mg/L is potentially clinically significant[1]. Concentrations ≥ 500 mg/L may indicate severe toxicity[10,13] and should be reported.

In the absence of assays, a raised osmolar gap indicates an osmotically active substance is present in the blood (e.g. an alcohol or a glycol) - but is not specific. A normal osmolar gap [a] is between -9 and +19 mOsm/kg H_2O, with a result under 10 mOsm/kg H_2O considered definitely normal.

Urine: Urinary formic acid concentrations have been used to estimate methanol exposure; the normal range is approximately 2-30 mg/L.

Environmental:

Air: >200ppm(260mg/m^3) as an 8hr time-weighted average (TWA) and >250ppm (325mg/m^3 as a short-term exposure limit (STEL)[16] should be reported.

Water: >4mg/l in water should be reported.[17]

Food: In beverages (fruit spirits) ≥13.5g/L of 100% Volume of Alcohol should be reported[14,15].

Case Classification:

Suspected. A case in which a potentially exposed person is being evaluated by health-care workers or public health officials for exposure to / poisoning by a toxic alcohol, but no specific credible threat exists.

Probable. A clinically compatible case in which a high index of suspicion (credible threat or patient history regarding location and time) exists for toxic alcohol exposure (such as consumption of illicit or homemade alcohol) or an epidemiologic link exists between this case and a laboratory-confirmed case.

Confirmed. A clinically compatible case in which laboratory tests (e.g. serum methanol concentration) have confirmed exposure. The case can be confirmed if laboratory testing was not performed because of either a predominant amount of clinical and nonspecific laboratory evidence (e.g. raised anion/osmolal gap and visual disturbances), or a 100% certainty of the aetiology of the agent is known[1].

Respond to the alert threshold:

If toxic alcohol cases are suspected:

- Report case-based information to NCDC via Case Information Form (CIF).
- Discuss with Poison Centre or clinical toxicologist for clinical management.
- As necessary treat and manage the patient(s) with supportive care.
- Collect biological specimens and/or relevant environmental samples and send them to the laboratory to identify the aetiology of the illness.
- Consider sourcing fomepizole or ethanol as an antidote for methanol and ethylene glycol poisoning, where available and if required – discuss with a poison centre for best application.

Respond to the action threshold:

If toxic alcohol cases are confirmed:

- Identify the population exposed to the chemical hazard.
- Implement appropriate protection, prevention and control interventions.

Analyse and interpret data:

Time: Analysis of suspected and confirmed cases by day/week. Graph cases and deaths daily/weekly.
Place: Plot location of cases.
Person: Analyse by age and gender.

[a] Osmolar gap calculation = ([Measured osmolality] – [glucose + urea + {1.86 x Na}] / 0.93)

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Monosodium Glutamate (MSG)

Potential sources[1,2]:

- Monosodium glutamate (MSG) is the sodium salt of the common amino acid glutamic acid. Glutamic acid is naturally present in the people and in many foods and food additives.
- MSG is widely used in Asian cooking and in processed foods in Western countries.
- Typically, MSG is added to savory prepared and processed foods such as frozen foods, spice mixes, canned and dry soups, salad dressings and meat or fish-based products and as a table top seasoning.

Nigeria background levels

- The consumption of MSG in Nigeria is predicted to increase as Asian food become more widespread[3]

Health effects [4,5,6]

- The Joint FAO/WHO Expert Committee on Food Additives (JECFA), the Food and Drug Administration (FDA), and the European Food Safety Authority (EFSA), generally consider MSG to be safe
- Some research has indicated that MSG may suppress appetite, while others suggest that its flavour-enhancing effects may lead to overeating.
- MSG consumption and tumorigenesis, increased oxidative stress and apoptosis (cell death) in thymocytes, as well as genotoxic effects in lymphocytes and metabolic disorders have been reported. However, these were in animal studies in doses that are not relevant to human exposure levels.
- MSG use in food has been linked to hypersensitivity reactions. Symptoms reported include burning sensations along the back of the neck, chest tightness, nausea and sweating and cancer. However, these have not been replicated in evidence from clinical trials.
- Analysis revealed that although monosodium glutamate (MSG) is generally considered safe at low doses, high doses and repeated exposure to MSG were associated with embryotoxicity and teratogenicity, obesity, cardiotoxicity, hepatotoxicity, kidney toxicity, neurotoxicity, endothelial dysfunction, reproductive toxicities, and alterations in lipid and glucose metabolism[7].

Alert thresholds: If any of these thresholds are exceeded, report under surveillance

***Food*:** The acceptable daily intake (ADI) for MSG is set at 30 mg/kg of body weight per day, which is significantly higher than would be typically found in food products.[4]
Trigger level to be reported: concentration > 30 mg/kg

Case Classification

Note that based on current evidence, it is highly unlikely that cases of MSG poisoning will occur in Nigeria that require reporting under surveillance.

Suspected: A case in which a potentially exposed person is being evaluated by health-care workers or public health officials for exposure to / poisoning by a particular chemical agent, but no specific credible threat exists.
Probable: A clinically compatible case in which a high index of suspicion (credible threat or patient history regarding location and time) exists for MSG exposure, such as clinical manifestations of MSG poisoning, or an epidemiologic link between this case and a laboratory-confirmed case.
Confirmed: A clinically compatible case in which laboratory tests have confirmed exposure. The case can be confirmed if laboratory testing was not performed because either a predominant amount of clinical and nonspecific laboratory evidence of a particular chemical was present, or a 100% certainty of the aetiolgy of the agent is known.

Respond to the alert threshold:

If MSG cases are suspected:

- Report case-based information to NCDC via Case Information Form (CIF).

- Discuss with Poisons Centre or clinical toxicologist for clinical management.
- As necessary treat and manage the patient(s) with supportive care.
- Collect relevant food samples and send them to the laboratory to identify the aetiology of the illness.

Respond to the action threshold:

If MSG cases are confirmed:

- Identify the population exposed to the chemical hazard.
- Implement appropriate protection, prevention and control interventions.

Analyse and interpret data:

***Time*:** Analysis of suspected and confirmed cases by day/week. Graph cases and deaths daily/weekly.
***Place*:** Plot location of cases.
***Person*:** Analyse by age and gender.

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Carbon Monoxide

Potential sources[1, 2, 3]:

- Indoor environments
  - oil, gas or kerosene heaters and appliances
  - electricity generators[4,5,6]
  - solid fuel burners (such as charcoal and firewood)
  - smoking fumes
- Outdoor environments
  - industry (e.g. industrial fuel burning, refineries, oil wells, gas flaring, petrochemical and gas plants[7])
  - bush and refuse burning[7]
  - vehicle fumes (e.g. motor parks[5])
  - volcanoes, fires, reactions with light

Nigeria background levels in the environment:

- Background levels of CO in the environment are unknown, though likely to be higher in areas where the noted indoor and outdoor sources are present[3,4,5,6,7].

Clinical description (acute)[1]:

- The most common symptoms following acute exposure are headache, nausea, vomiting, vertigo, alteration in consciousness and subjective weakness.
- Symptoms of severe poisoning include confusion, myocardial infarction, respiratory failure, loss of consciousness and death.
- The cardiovascular system and the central nervous system (CNS) are the most sensitive target organs for carbon monoxide toxicity. Following an acute exposure, neuropsychiatric features may develop in some individuals; these have been observed up to 40 days after initial exposure.
- Long-term neurological effects may occur following an acute exposure, including cognitive and behavioural changes.

Health effects[1,2,8]:

Chronic exposure:

Chronic exposure to low concentrations of carbon monoxide may lead to lethargy, headaches, nausea, flu-like symptoms and neuropsychological and cardiovascular issues. As these symptoms are non-specific this may lead to misdiagnosis.

Adverse outcomes, including fetal and neonatal death, congenital malformations and neurological effects, have been reported following acute exposure to high levels of carbon monoxide during pregnancy.

Alert thresholds: If any of these thresholds are exceeded, report under surveillance

Biomonitoring[8]:

Blood: carboxyhaemoglobin levels are not a reliable indicator of poisoning severity or clinical outcome. No significant adverse health effects have been reliably demonstrated in the literature where carbon monoxide exposure resulted in carboxyhaemoglobin levels of below 6% in healthy individuals. In non-smokers, the baseline carboxyhaemoglobin is around 1 to 2% while in smokers it is around 5 to 10% (1)

A carboxyhaemoglobin level of 30% indicates severe exposure; however, significant poisoning effects cannot be excluded at lower concentrations.

Alert threshold > 6% should be reported since no significant adverse health effects have been reliably demonstrated in literature where known carbon monoxide exposure resulted in carboxyhaemoglobin levels of below 6% in healthy individuals

Breath: high concentrations of exhaled carbon monoxide suggest excess CO exposure. Smokers will have elevated concentrations (breath concentrations up to 70 ppm, equivalent to ca.12% COHb have occasionally been recorded immediately after smoking a cigarette).

Environmental:

Air[9]:

Indoor air quality for offices and public spaces: <1.7 ppbv10 (excellent), <8.7 ppbv (good).

Maximum concentrations in indoor air in the home: 9 ppm (8 hours)

Ambient air quality standards: 4.4 ppm (8 hours); 8.7 ppm (1 hour)

Trigger: Concentration levels > 35 mg/m^3 for 1 hour for the elderly and children; > 10 mg/m^3 for 8 hours for healthy adult should be reported.

Case Classification
Suspected: A case in which a potentially exposed person is being evaluated by health-care workers or public health officials for exposure to / poisoning by a particular chemical agent, but no specific credible threat exists. ***Probable:*** A clinically compatible case in which a high index of suspicion (credible threat or patient history regarding location and time) exists for carbon monoxide exposure, such as **clinical manifestations** of carbon monoxide poisoning, or an epidemiologic link between this case and a laboratory-confirmed case. ***Confirmed:*** A clinically compatible case in which laboratory tests (e.g. carboxyhaemoglobin) have confirmed exposure. The case can be confirmed if laboratory testing was not performed because either a predominant amount of clinical and nonspecific laboratory evidence of a particular chemical was present, or a 100% certainty of the aetiolgy of the agent is known.
Respond to the alert threshold:
If carbon monoxide poisoning is suspected: • Report case-based information to NCDC via Case Information Form (CIF). • Discuss with Poisons Centre or clinical toxicologist for clinical management. • As necessary treat and manage the patient(s) with supportive care. • Collect biological specimens and/or relevant environmental samples and send them to the laboratory to identify the aetiology of the illness. • Treatment with high-flow oxygen
Respond to the action threshold:
If carbon monoxide poisoning cases are confirmed: • Patients should be advised on measures to avoid further exposure by excluding potential sources of CO[9]. • Ensure that the source of CO in the home, school or workplace -has been identified and dealt with by appropriate engineers/specialists. This will help prevent further exposures to the patient(s) and others[9,10].
1Analyse and interpret data:
***Time*:** Analysis of suspected and confirmed cases by day/week. Graph cases and deaths daily/weekly. ***Place*:** Plot location of cases. ***Person*:** Analyse by age and gender.

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Cyanide

Potential sources[1,2]:

- Contaminated water, soil, sediment and food.
- As a product of combustion from thermoplastics and similar materials.
- Cyanogenic glucosides can be found in plants including Cassava (compound: linamarin); these glucosides are metabolised to hydrogen cyanide.
- Metal ore extraction processes.
- Previously used as a fumigant and as a pesticide.
- Cigarette smoke produces hydrogen cyanide.
- Cyanogen (two cyanide groups bonded together) is used as a fuel for cutting and welding.
- As a solvent in chemical, pharmaceutical and dye manufacturing.
- Cyanide salts are used in the production of stainless steel and cement.
- Used in silver plating and photography.
- Used in the chemical industry, including ammonia extraction and analytical techniques.
- Sodium nitroprusside, an antihypertensive medication, is metabolised to thiocyanate.

Nigeria background levels:

- Cyanide levels between 1.58–7.89 mg/L have been detected in natural water sources near large-scale cassava processing facilities in Nigeria[3,4].
- A study analysing well water samples across 10 locations in southwestern Nigeria (Akure & Ife-Ife) close to Cassava processing plants detected concentrations ranging between 2.3-15.2 mg/L[5].
- Hydrogen cyanide has been detected in air at concentrations of 20–46 mg/m^3 near large-scale cassava processing facilities in Nigeria[1].
- Can be found in principal food sources such as Gari flour, where cyanide was detected in Nigerian samples at concentrations between 10.6-22.1 mg/kg[7].
- Hydrogen cyanide has been detected in Cassava flour at a concentration of 2.37 mg/kg, equating to estimated daily intake of 0.03 mg/kg bw/day[8].

Health effects [1]: Acute

Inhalation is the most typical route of hydrogen cyanide exposure and ingestion is most typical of cyanide salts and plant material. Irrespective of the route and source of exposure, systemic acute cyanide toxicity is consistent across sources.

Initial/mild features include headache, nausea, dizziness, drowsiness, tachycardia and tachypnoea. Moderate symptoms of toxicity include loss of consciousness, convulsions and hypotension.

In severe poisoning, coma and cardiovascular collapse with fixed, unreactive and dilated pupils may occur. Myocardial ischaemia, cardiac arrhythmias and pulmonary oedema may also occur.

Clinical indicators:

Severe lactic acidosis with a high anion gap is a relatively consistent feature of cyanide toxicity.

Cherry-red skin may occur as a result of increased venous oxygen saturation. Whilst not strictly specific to cyanide, it may be indicative and can be measured by a decreased arteriovenous oxygenation gap on blood gas analysis.

Cyanide compounds are thought to smell of almonds; an almond smell on the breath or in the environment may be present.

Alert thresholds: If any of these thresholds are exceeded, report under surveillance

Biomonitoring:

Blood: Cyanide assays are not readily available but where the expertise exists, whole-blood cyanide concentrations can be used; the whole-blood concentration is approximately twice the serum concentration. The background whole-blood concentration can range between 0.02 and 0.5 mg/L[9].

Mild toxicity may occur at whole blood concentrations under 1 mg/L, moderate toxicity at 1-3 mg/L and severe toxicity at > 3 mg/L[1]. For the purpose of reporting, **> 1 mg/L of cyanide in blood should reported**.

Environmental:

Detection of cyanide in environmental samples above typical background or relevant guideline levels, as determined by the relevant agencies.

Drinking water: ≥ 0.07 mg/L[10,13] should be reported as trigger levels.

Air: 0.01 mg/m³ (chronic/long-term)[10]; 11 mg/m³ (8-hour workday)[11]; 5 mg/m³ (15 minutes)[6]. **≥ 5 ppm should be reported.**

Soil: **≥ 0.4 mg/kg[12] should be reported**.

Food: Hydrocyanate: 10 mg/kg for cassava flour, 2 mg/kg for gari. Others include 50 mg/kg in nougat/marzipan, 35 mg/mg in alcoholic beverages and 5 mg/kg in canned stoned fruits (Codex Alimentarius Commission). **≥ 10.6 mg/kg in cassava floor should be reported** (WHO Codex)

Case Classification:

Suspected. A case in which a potentially exposed person is being evaluated by health-care workers or public health officials for exposure to / poisoning by cyanide, but no specific credible threat exists.

Probable. A clinically compatible case in which a high index of suspicion (credible threat or patient history regarding location and time) exists for cyanide exposure (such as proximity to a house fire or occupational use), or an epidemiologic link exists between this case and a laboratory-confirmed case.

Confirmed. A clinically compatible case in which laboratory tests have confirmed exposure.
The case can be confirmed if laboratory testing was not performed because either a predominant amount of clinical and nonspecific laboratory evidence of a particular chemical was present or a 100% certainty of the aetiology of the agent is known.

Respond to the alert threshold:

If cyanide cases are suspected:

- Report case-based information to NCDC via Case Information Form (CIF).
- Discuss with Poison Centre or clinical toxicologist for clinical management.
- As necessary treat and manage the patient(s) with supportive care.
- Collect biological specimens and/or relevant environmental samples and send them to the laboratory to identify the aetiology of the illness.
- Consider sourcing sodium thiosulphate, dicobalt edetate or hydroxocobalamin where available and if required – discuss with a poison centre for best application.

Respond to the action threshold:

If cyanide cases are confirmed:

- Identify the population exposed to the chemical hazard.
- Implement appropriate protection, prevention and control interventions.

Analyse and interpret data:

Time: Analysis of suspected and confirmed cases by day/week. Graph cases and deaths daily/weekly.
Place: Plot location of cases.
Person: Analyse by age and gender.

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Ammonia

Potential sources: [1,2]

- Natural and Anthropogenic sources
- Naturally at low levels throughout the environment, released from the breakdown of organic waste.
- Local concentrations may be elevated where there is a lot of animal waste
- Non-agricultural sources include sewage sludge and industry.
- Petrol vehicles fitted with catalytic converters.
- Uses for ammonia include the production of fertilisers, plastics, synthetic fibres, dyes, explosives, and pharmaceuticals.
- In the home, ammonia is used in certain cleaning products and garden fertilisers.
- Ammonia is also used as a refrigerant gas.

Nigeria background levels in the environment:

- Estimates of the average global ammonia concentration are approximately 0.6–3 ppb
- Ammonia air concentrations near Major Roads in Residential, Commercial and Industrial Areas in Ibadan City, Nigeria are in the region of 463±180 µg/m3 [3]
- Ammonia air levels associated with waste and agricultural uses in Ondo State varied between 3.87 ± 1.60 in the wet season and 5.87 ± 1.60 ppm in the dry season [4]
- Ammonia concentrations in air can show large spatial variability. For example in the UK levels vary from 10 µg m-3 in areas of intensive livestock production, especially dairy and beef production, to 0.1 µg m-3 in remote areas with no agriculture or industry. [5]

Health effects: Acute [1,1]

Inhalation
Can cause rapid onset of health effects including irritation to the nose, throat (coughing) and respiratory tract.
May cause increased respiratory rate and in substantial exposures can cause burns in the oral cavity, nasopharynx, larynx, trachea, airway obstruction and bronchiolar and alveolar oedema.
In severe cases pulmonary oedema, breathlessness, wheezing, hypoxia, and cyanosis may take 36 hours to develop after the initial inhalation exposure. Exposure to very large concentrations of ammonia gas may be fatal within minutes.
Ingestion[8,9]
Ingestion of ammonia solutions (e.g. ammonium hydroxide) causes rapid onset of signs and symptoms including irritation in the mouth, throat and chest, excessive salivation and extensive alkali burns to the aerodigestive tract. Perforation of the stomach or oesophagus may occur soon after ingestion in more severe cases.
Ocular exposure
Irritant Effects include: lacrimation, conjunctivitis leading to palpebral oedema, photophobia and blepharospasm.
More serious cases may include, corneal ulceration, corneal opacification, Iritis, Anterior and posterior synechia formation, Retinal atrophy, Glaucoma, Cataract formation and blindness.
Dermal exposure
Irritation and, depending on the concentration, alkali burns. Pressurised ammonia (as a liquefied gas) may also cause cryogenic burns following skin or eye contact.

Alert thresholds: If any of these thresholds are exceeded, report under surveillance

Biomonitoring: N/A: Ammonia endogenous so may not relate to exposure

Environmental
Air:

- Nigeria emission standards point source 0.28 ppm (30 minute period)[10]
- Nigeria 5ppm air quality odour threshold
- Airborne concentrations of ammonia greater than AEGL-1 (30ppm). [11]

Trigger: a concentration > 35ppm within a short term of 15mins, 25ppm within 8hour exposure limit (Agency for Toxic Substances and Disease Registry) or 50 ppm for 5mins of exposure for indoor air quality (NIOSH)

Water:

- 0.5mg/l [12] (UK drinking water standard but used in numerous countries)

Trigger to report: concentration above 0.5mg/l

Food: Maximum allowable levels in processed foods are as follows: 0.04–3.2% ammonium bicarbonate in baked goods, grain, snack, foods and reconstituted vegetables; 2.0% ammonium carbonate in baked goods, gelatins and pudding[13]
Permissible limit: 0.01-3.2% in processed foods
Trigger to report: concentration above 3.2%

Case Classification:

Suspected. A case in which a potentially exposed person is being evaluated by health-care workers or public health officials for exposure to / poisoning by ammonia, but no specific credible threat exists.

Probable. A clinically compatible case in which a high index of suspicion (credible threat or patient history regarding location and time) exists for ammonia exposure, or an epidemiologic link exists between this case and a laboratory-confirmed case.

Confirmed. A clinically compatible case in which diagnostic tests have confirmed exposure.
The case can be confirmed if laboratory testing was not performed because either a predominant amount of clinical and nonspecific laboratory evidence of a particular chemical was present or a 100% certainty of the etiology of the agent is known.

Respond to the alert threshold:

If ammonia cases are suspected:

- Report case-based information to NCDC via Case Information Form (CIF).
- Discuss with Poison Centre or clinical toxicologist for clinical management.
- As necessary treat and manage the patient(s) with supportive care.

Respond to the action threshold:

If [chemical] cases are confirmed:

- Identify the population exposed to the chemical hazard.
- Implement appropriate protection, prevention and control interventions.

Analyse and interpret data:

Time: Analysis of suspected and confirmed cases by day/week. Graph cases and deaths daily/weekly.
Place: Plot location of cases.
Person: Analyse by age and gender.

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