Foreword
The contents of this manual have been developed by an international working group of experienced poisons centre staff. The aim of the manual is to provide source material for those needing to train poisons information staff, either when setting up a new poisons centre or when establishing a training programme in an existing centre. The materials are written from a general perspective and may need to be adapted to local circumstances.

This volume is written for the trainee. It contains the same content as that for the trainer, though without the answers to the test questions.

Each of the chapters stands alone, however they have been compiled into a single volume for convenience.

A Word version of the chapters in the manual can be obtained by contacting ipcsintox@who.int.

Acknowledgments
The following people have assisted in the development of this training manual and their contributions are gratefully acknowledged:
Professor Rahmat Awang, National Poison Centre, Penang, Malaysia; Dr Kinda Bakjaji, Syrian Poisons Information Centre, Damascus, Syrian Arab Republic; Dr Edith Clarke, Poisons Centre, Accra, Ghana; Mr Mark Colbridge, Guy's & St Thomas' Poisons Unit, London, UK; Dr Wim Daelman, Belgian Poisons Centre, Brussels, Belgium; Ms Alison Dines, Guy's & St Thomas’ Poisons Unit, London, UK; Mr Diego Gotelli, Centro de Información Química para Emergencias, Buenos Aires, Argentina; Dr Maren Hermanns-Clausen, Poisons Information Centre, Freiburg, Germany; Dr Tomas Jovaisa, Poisons Centre, Vilnius, Lithuania; Dr Jules de Kom, Paramaribo, Suriname; Dr Michael Kunde, Federal Institute for Risk Assessment, Berlin, Germany; Dr Amalia Laborde, Centro de Información y Asesoramiento Toxicológico, Montevideo, Uruguay; Dr Irma Makalinao, National Poison Control & Information Service, Manila, Philippines; Dr Wael Malas, Syrian Poisons Information Centre, Damascus, Syrian Arab Republic; Ms Robin McKeown (retired), Canberra, Australia; Dr Martine Mostin, Belgian Poisons Centre, Brussels, Belgium ; Dr Lynn Panganiban, National Poison Control & Information Service, Manila, Philippines ; Dr Daniela Pelcová, Poisons Information Centre, Prague, Czech Republic; Dr Hans Persson, Swedish Poisons Information Centre, Stockholm, Sweden; Dr Lexley Pinto Pereira, University of the West Indies, Port of Spain, Trinidad & Tobago; Dr Uwe Stedtler, Poisons Information Centre, Freiburg, Germany; Dr Wayne Temple, National Poisons Centre, Dunedin, New Zealand; and Dr Rebecca Tominack, Missouri Regional Poison Center, St Louis, USA.

Secretariat: Joanna Tempowski, International Programme on Chemical Safety, Department of Public Health and Environment, WHO.
Table of Contents

2. Skills and Operations
2.1 Telephone communication skills
2.2 Handling a poisons call: taking a clinical history
2.3 Documenting enquiries
2.4 Units, calculations and conversions
2.5 Use of the Poisoning Severity Score

3. Subject knowledge
3.1 General management of the poisoned patient
3.2 Globally Harmonized System of Classification and Labelling of Chemicals (GHS)
3.3 Management of chemical incidents and the role of the poisons centre
CHAPTER 2.1

TELEPHONE COMMUNICATION SKILLS
- Trainee's version

Objectives

On completing this chapter, you will be able to:

- Understand the unique characteristics of telephone communication for advising on the diagnosis and treatment of poisoning cases

- Identify the factors that impede and those that enhance good telephone communication in the context of providing poisons information.

- Identify the efforts required by the telephone information service professional to ensure that the necessary information is conveyed clearly.

- Become familiar with the different steps needed to compensate for the disadvantages of telephone communication.

Subject content

Introduction
This chapter discusses the relevant skills that you must develop to ensure good telephone communication and to maximize the information obtained from the caller and their understanding of the response that you give. The chapter also provides guidance on dealing with situations of crisis in which you and the caller may be involved.

Telephone communication for the purposes of diagnosis, treatment or prevention of poisoning is a unique situation in the health care delivery system. Good telephone communication is a particular skill that poison information specialists have to learn,
particularly the factors that can impede and promote the exchange of poisons information.

Often, poisoning cases or toxic exposures at home or in the emergency room may represent a crisis situation for the caller. You may, therefore, be confronted with a distressed caller, and your voice and manner will be your key tools for taking a proper history and giving an adequate reply.

A combination of a good subject knowledge and effective communication skills makes the ideal poison information specialist.

**Factors that add to the stress of a poisons call**

Very often, a poisons call carries an element of stress or crisis. There are a number of factors that may make this more likely, including:

- When there is a real or potential poisoning case the caller may be anxious, impatient or demanding and will almost always be in a hurry to get an answer.

- If the caller is personally involved e.g. they are the patient or parent, they may be in a panic or aggressive or hostile.

- Often the caller calls the centre with poor or incomplete information about the incident or the patient and may feel disadvantaged when asked for information that they do not have.

- Telephone calls from emergency rooms or ambulances are often surrounded by background noise or distracting activities.

- A poor telephone line can cause difficulties in hearing or understanding the other person.

- There may be other calls waiting for your attention.

- You may realize that:
  - there is no available toxicological information about the agent;
  - the centre has not developed specific management protocols for that poisoning;
  - the specific management requires many diagnostic and treatment steps that are difficult to explain in a single, brief conversation

**Skills required for telephone communication in a poisons centre**

Communication is a multi-layered process involving not only the exchange of information but also feelings and attitudes as well and it is important to be aware of this. The large part of communication between people occurs at a non-verbal level.
and the scope for non-verbal communication is much less over the telephone. Moreover, as described above, there may be particular stresses involved in a poisons call. Thus additional skills are required for good telephone communication. In particular it is important that you show respect for the caller, ask appropriate questions, listen carefully and present the necessary information in a clear and comprehensible way.

If you have some prior experience in a work environment similar to that of the caller’s e.g. in a hospital emergency department, then you may understand the problems at the other end of the telephone, and this may help you to communicate better. Previous experience in communication-related fields or teaching may also be useful.

You need the following qualities and skills to manage this particular type of communication.

1. **In taking the history**
   - Self-control: capacity to stay calm enough to listen and direct the conversation to a better communication.
   - Ability to empathise with the caller and the ongoing situation without being over sympathetic.
   - A respectful manner, avoiding behaviour that can provoke resentment in the caller e.g. behaving in a superior way or being deliberately obstructive.

2. **In giving the appropriate reply**
   - Personal initiative in finding the information where there may be a number of sources, such as a large range of documents, other professionals or others who may have the required knowledge.
   - Capacity to synthesize or integrate information from several sources quickly.
   - Good judgment in order to adapt and interpret the data in accordance with the specific case you are dealing with.
   - Capacity to communicate the risk evaluation in understandable terms.

**The telephone call: a disadvantageous situation**
You should keep in mind the disadvantages of telephone communication, which include:
   - Loss of visual information leading to a risk of misinterpretation of facts or feelings:
     - colour is highly subjective (white, yellowish? pale? cyanosis?)
     - shape and pattern can be difficult to convey reliably
some medical terminology is ambiguous: a ‘flat’ patient can be semi-conscious or psychiatrically depressed.

- Your mental image of what the caller is describing might be different from the reality.

- Because you have no visual information you may find your attention wandering.

- Incorrect assumptions may be made by the caller about how the poison centre works. The caller may think that you have all the necessary information available with one computer "click", whereas in fact you may have to search in several places for this information.

- Assumptions and stereotyping about what you think the caller ought to know, e.g. because they are a doctor or because they are a member of the public, can hinder proper listening and can lead to a patronizing, disrespectful or unhelpful response which, in turn, may antagonise the caller.

- There may be other calls waiting so you may feel that you must finish the conversation quickly at the expense of taking a proper history or giving an adequate reply.

- When spelling a name over the telephone some letters may sound the same, e.g. in English ‘f’ and ‘s’ sound the same.

**Some steps to compensate for the disadvantages of telephone communication**

You can minimize the above-mentioned problems by understanding how they can arise and by compensating with particular communication techniques and more explicit information

1. The first is to establish empathy with the caller so that they have confidence in your competence and in the information that you give them:
   - greet the caller, identify yourself and your position
   - let the caller know that they have reached the correct service
   - use respectful language with a friendly, polite and helpful tone

2. The next step is to use appropriate questioning and listening techniques to establish the information that the caller requires.

2.1. It is often useful to start with open-ended questions using ‘who’, ‘what’, ‘how’ or ‘when’, particularly when the situation is unclear and it is necessary to get an idea of what the caller needs. Open questions tend to give the caller more control over the conversation and can be time consuming.
2.2. To focus the enquiry you should use closed questions, such as “Have you given activated charcoal?” These require a yes/no answer or a simple statement of fact, have a narrow focus, discourage expansive answers and are most useful for establishing facts. Using closed questions gives you more control over the conversation.

2.3. Questions can also be probing: “what do you mean by...”, or “can you describe it more fully..."

2.4. It may be necessary to ask the caller to spell out certain words, (or to do the same yourself), using a phonetic alphabet (e.g. A-alpha, B-bravo, C-Capri etc).

2.5. It is best to avoid combining several questions in one sentence, e.g. “When was she found, and did she vomit?” because the reply may be ambiguous or incomplete.

2.6. You should avoid leading questions, i.e. where you seem to be suggesting the answer or making an apparent statement of fact, for example “So she’s depressed, is she?”

3. Listen to the caller with active listening techniques: the caller needs to know that you are giving them your full attention. There are various ways of indicating this e.g. by using vocal indicators, such as “hm...hm” or “yes...”. Using confirmatory phrases such as "yes, I see your problem..." also helps to show the caller that you have some understanding of their situation and needs.

4. To minimize misinterpretation of facts you should confirm the data with a summary of the information obtained, highlighting the most important toxicological data, for example:

“So, you have a 5 year old child who has taken a mouthful of an unidentified solvent 15 minutes ago and at the moment he is asymptomatic” or

“May I just recap: it was a maximum of 10 tablets, and it was taken more than 6 hours ago. Is that correct?”

5. Once you have established what the caller wants to know, and found the information then you must formulate an appropriate response to convey this information. There are several stages to the process of replying to a request for information.

5.1. If it is necessary to leave the telephone to look up information or to calculate toxic dose etc it is a good idea to tell the caller what is happening, so that they understand that the telephone has gone quiet for a good reason (rather than because you have forgotten them).
5.2. If the patient has had a life-threatening exposure you should make this clear straight away so that the caller can take any immediate action necessary (such as phone an ambulance, get a colleague to start decontamination).

5.3. You must decide what information should be given to the caller, what are the key points and how much detail is required. It will help if you have established what the caller already knows and the caller’s level of understanding. You should adjust your language to the caller’s level of understanding.

5.4. The decision about how much information to give can be a difficult one, particularly if there is a lot of information available. It is possible to overwhelm the caller with information that they do not immediately need, so you should give some thought to this. It will help to establish what the caller actually wants to know, however, sometimes this is different from what you judge that the caller needs to know (for example, the caller may have phoned just to ask about the dose of methionine to give a patient who has taken paracetamol, without realizing that this is an inappropriate antidote because the patient has already been given activated charcoal).

5.5. The information that you give to the caller should be correct, clear and concise, and presented in a logical and comprehensible manner. Ideally you should keep key points to a minimum, since people have a tendency to remember the first and the last things said and to forget what was in the middle. For this reason it is a good idea to emphasize the important information by saying, for example, “this is very important…” or: “there are three important points, first…”.

5.6. The caller will need time to assimilate the information they are being given and to write it down, so you should not give the information too quickly and allowing a few judicious pauses will help.

5.7. It may be a good idea, in a tactful way, to check that the caller has understood everything they have been told by asking them, for example, “was everything I said clear enough?”. In the case of certain types of caller, e.g. someone who seems panicky or who has poor communication skills, it may be advisable to ask the caller to repeat back the information they have been given. This should be done with care, because it may be perceived as rude or offensive.

6. You should invite the caller to call again if they need any further information to manage the case. In some poisons centres it is normal practice to call back to members of the public after a period of time to check that all is well.

Dealing with distressed callers
The distressed or angry caller can be very difficult to deal with since their emotion may evoke a similar reaction in you. It is therefore important to try and take a step
back and to understand that you are not the cause of the caller's distress or anger, rather, it is the caller's situation. It is vital not to respond in kind, i.e. with rudeness or anger, but to remain polite and calm. Generally it is better to let the caller have their say without interruption, at least initially. You can use vocal indicators to reassure the caller that they are being listened to. It often helps to acknowledge the caller's feelings by reflecting back e.g. “you are clearly upset/angry”. It is important that you establish the facts of the situation and indicate a willingness to try and help. At the same time you should be careful about offering help that is beyond your remit or competence and if necessary you should refer the caller to someone else.

In the case of offensive callers (callers who are making personal remarks or using bad language) you should know what the policy of the poisons centre is. In some centres, for example, the policy is to tell that caller that they are being offensive and that they will be disconnected if they continue to talk in the same manner.

**Practice**
The best way to learn good skills is to practise telephone communication in a reflective way and to be given constructive feedback. One approach is for you to listen to tape recorded calls that you have taken and to identify good and bad communication, both the caller's and your own.

The analysis of short telephone call scripts and role play are other techniques that could be used initially.

**Summary**
Good telephone communication is a skill that requires an awareness of the factors that can impede and promote it. It is important to respect the caller, to ask appropriate questions, to listen carefully and to present the necessary information in a clear and comprehensible way. Most of us will have to learn to be good telephone communicators and reflective practice is required. We should never forget that the beneficiary of our skills is the patient waiting to receive the appropriate treatment.

**Materials and Resources**

**Author(s)**
Dr Amalia Laborde, Centro de Información y Asesoramiento Toxicológico, Hospital de Clínicas, Montevideo, Uruguay
Dr Lexley Pinto Pereira, Pharmacology Unit, Faculty of Medical Sciences, University of the West Indies, Trinidad & Tobago


Written for the INTOX Programme of the International Programme on Chemical Safety, World Health Organization, Geneva, Switzerland.

### Objectives

On completing this chapter, you will be able to:

- Explain the importance of effective data collection in a poisoning case
- Identify the important information necessary for assessing and managing a poisoned patient
- Describe the most common poisoning settings and how to gather information given a particular situation.

### Subject content

#### Introduction

In order to be able to advise on the management of poisoning cases you need to take an accurate and complete history of the poisoning incident. This will enable you to perform a proper clinical risk assessment and arrive at the appropriate management decisions. The information that you document during a poisons call is important for a number of other reasons e.g. for medico-legal cases, for characterizing particular poisons and improving treatment guidelines. These are described further in Chapter 2.3 Documenting Enquiries.

You may receive calls from health personnel attending to patients in the emergency room or other health facility, as well as in the workplace, school, or other institutions. You may also receive calls from the general public, mostly ringing from home. In this case, the caller may be the patient, a relative or a friend.

It is important to note the source of information (i.e. whether it is from the patient themselves or someone else e.g. a health professional) and the location of the
patient (is the patient with the caller) since the quality of information received and the type and extent of information to be provided will vary from setting to setting.

In general, data gathered from a hospital setting are more organized and accurate than those from the home, especially with regard to the patient’s clinical status. When a call is from a lay person, it may not be so easy to collect data efficiently: the caller may be anxious or panicky and you may need to perform crisis intervention (see Chapter 2.1 Telephone Communication Skills).

The type of advice that you provide will vary depending on the location and the caller. Information on clinical management can be provided to a health professional at a treatment facility, whereas to a lay person at home you may only be able to provide first aid advice. Furthermore, poisons centres may observe different policies and guidelines in dealing with poisoned patients. For instance, some poisons centres suggest hospital(s) where patients can be brought for treatment. They may even go to the extent of contacting these hospital(s) and informing the emergency room physician regarding the possible admission. Other poisons centres call for the ambulance to pick up the patient from the home. In other cases, poisons centres simply give advice that the patient should go or be taken to a hospital. Thus you should be familiar with the protocol in your poisons centre for calls from different settings. More information on settings is given towards the end of the chapter.

**Basic information**
The first information to collect is about the caller: who they are (i.e. whether they are a health care professional, and what type/grade, or member of the public) their name, where they are ringing from and their contact telephone number in case the caller is cut off and/or it is necessary to call them back.

Regardless of who the caller is you should then collect the following data:

**Step 1:** Assess the patient’s condition by asking whether the patient is showing any signs or symptoms. If the patient is symptomatic then it is important to establish the severity and whether there are life-threatening signs such as:

- Depressed sensorium/unconsciousness
- Laboured breathing
- Bleeding
- Shock
- Behavioural changes

**Intervention:** If any of the above signs is present, and the caller is a health professional, you should check that emergency stabilization is being performed and, if necessary, instruct the caller to go and attend to this first. They can call back to provide more information about the patient’s exposure once the patient is stabilized. If the caller is a member of the public then tell them to get the patient to hospital, e.g. by calling an ambulance, right away. If appropriate, give first aid advice.
Step 2: After emergency stabilization is established gather the following information:

**WHO? - Patient information:**
This is important because **patient factors** can influence the severity of poisoning.
- Age (preferably date of birth)
- Sex
- Weight/Height  (useful in some settings for indication of nutritional status, also toxic dose and doses of antidotes may be based on body weight)
- Past medical history such as allergies, psychiatric conditions, hypertension, heart disease, seizure disorder, etc.
- Current medications
- Pregnancy or lactating
- (Other information that can be taken later if relevant and appropriate: occupation, details of family doctor etc.)

**WHAT? - Agent information:**
This is important to guide you as to the appropriate advice to be given, especially therapeutic interventions.
- Name: brand name and/or generic name, common name, genus and species etc. Try to get the name as precisely as possible, e.g. there may be several variants of a brand of household cleaner with slightly different names but very different formulations.
- Information on product packaging e.g. hazard warnings, ingredients
- Type/use:
  - Medication: prescribed or over-the-counter, whether it is the patient’s own medication
  - Chemical: pesticide, solvent, caustic, etc.
  - Household/industrial product
  - Plant (which part - berry, leaf, root etc)
  - Mushroom (where was it growing)
  - Animal bite or sting: snake, spider, etc
  - Something eaten as a food e.g. marine bivalve, etc.
- Form e.g.: solid/gel/liquid/gas/aerosol etc
- Amount: exact or estimate
  - If plant: number of berries, leaves etc
  - If tablets/capsules: number and strength
  - If powder: amount in mg, teaspoonfuls or tablespoonfuls
  - If liquid: concentration, amount in mLs, number of mouthfuls.
As an approximate guide\(^4,3\)
- Adult male: 1 mouthful = 25 mL
- Adult female: 1 mouthful = 20 mL
- Child: 1 mouthful = 10 mL

- Intake of other substances (co-ingestants): interactions can occur between the toxicant and co-ingestants which can be synergistic or potentiating. Alcohol is a common co-ingestant with deliberate overdoses.

- Last meal intake: presence of food can reduce or delay absorption of toxicant.

- NB: Ask the caller to bring to the telephone containers, packaging e.g. empty blister packs, samples etc for confirmation of identity and quantity.

In cases when the identity of the toxicant(s) is unknown ask the caller to provide as much information as possible e.g.:  
- Parents' occupations and availability of products from their workplace (in the case of children)
- Presence of environmental sources of poison e.g. sources of combustion (carbon monoxide), recent pesticide use
- Presentation of the product e.g. liquid, capsule, tablet, powder, gel?
- Description and size of container
- Colour of packaging and/or product.
- Information on the packaging or container e.g. hazard warnings
- If tablets or capsules:  
  - Film coated or uncoated  
  - Dimensions  
  - Shape e.g. round, oblong, square etc. both on face-view and on side-view  
  - Presence of markings  
  - Scored, not scored
- Whose medication: a relative's, a co-habitant's
- Conventional pharmaceutical or traditional/herbal medicine

In the case of prescribed medicines of unknown identity, when possible, contact the physician who prescribed the drug.

For chemical products obtain the name, address and telephone number of the manufacturer/distributor.

In cases of poisoning secondary to plants/fungi or animal bites/stings, samples should be brought to the hospital, when appropriate, for proper identification by an expert.
HOW? - Route of exposure:
The degree and rapidity of absorption of a poison is dependent on the route of exposure. Absorption is faster through the inhalational route or by injection compared with the oral route.
- Route: oral / inhalational / dermal/ parenteral/ bite/sting/ mucosal

WHEN? - Time of exposure
This is important for the following reasons: (1) to determine the kinetic phase of the poison, e.g. is it still being absorbed or is absorption likely to be complete; (2) to interpret plasma concentrations of toxic agents; (3) to correlate signs and symptoms to the risk to poisoning; and (4) to decide on appropriate management, e.g. decisions about gastrointestinal decontamination.

Also the frequency and duration of exposure may be important, e.g. a staggered drug overdose, or the patient was exposed to a gas for five minutes three hours ago.

WHERE?
This is important for the evaluation of the extent of poisoning. For instance, if it occurred in the workplace, other workers may also be poisoned, or the agent involved in poisoning may be the industrial grade which is more concentrated; an exposure to a gas in a confined space may be more severe than the same exposure in an open space.

Place of poisoning incident:
Home, workplace, enclosed public places, open spaces, hospital/clinic, etc.

Place where poison was obtained / bought:
- Home, drugstore/pharmacy, market etc.
- In case of plants and fungi: forest, along the road, swamp, etc.

WHY?
This is important in the overall risk assessment and may also influence medical disposition. For instance, a patient who has intentionally self-poisoned is likely to have taken a larger amount than someone who accidentally ingested a substance. Someone who has deliberately overdosed may also need a psychiatric evaluation. A young child who accidentally swallows something will usually ingest much less than a child who has been fed something by another person.

Circumstances of poisoning:
- Non-accidental/intentional (self-harm, criminal)
- Accidental
- Work-related
- Substance abuse
• Iatrogenic
• Others

**WHAT? – Measures undertaken prior to admission**
Some interventions carried out at home may complicate the patient’s condition, for example:
• Use of salt water as an emetic
• Use of milk of magnesia or tannic acid in cases of caustic poisoning
• Induction of vomiting in cases of caustic poisoning

**Step 3:** Establish the *toxidrome* by asking for signs and symptoms pertaining to the exposure. Do not volunteer or feed the signs and symptoms - let the caller provide you with the information. You may need to prompt the caller e.g. "what is the pulse rate?" rather than "Does the patient have a tachycardia?".

Ask about the time of onset of the clinical manifestations. This information can help identify suspected toxicants. For example, in cases of mushroom poisoning, patients poisoned with *Psilocybe* manifest with earlier signs of toxicity by comparison with those poisoned with *Gyromitra*.

**Specific situations**

If the caller is a health professional from a hospital or another health facility, follow the above steps discussed under basic information.

If the caller is a qualified and responsible person from the home or facility other than a medical institution, get the caller’s name, address, telephone number and patient’s name. Enquire if they are near a medical facility and if they have access to an ambulance transport. If not, ask if there is somebody to drive patient to the hospital with another person taking care of the patient while in transit.

If the caller is panicky and hysterical, get the caller’s name, address, telephone number and patient’s name. Ask if there is somebody else to whom you can talk, otherwise, you should perform a quick crisis intervention (see Chapter 2.1 *Telephone Communication Skills*).

If the patient is the caller, awake but incomprehensible, try to get the name, address and telephone number right away and ask if there is someone else in the household to whom you can talk.

If the patient is alone, get the name, address and telephone number right away. Depending on the local situation or guidelines and whenever possible, either call an ambulance and tell the patient that the ambulance will take him/her to the nearest hospital, or, if, by assessment, the patient can manage to travel, advise them to go to the nearest hospital or health facility.
Practice
You will get practice in taking a history by first observing an experienced member of staff, then by taking calls yourself under their supervision and guidance.

Summary
This chapter discusses the salient and relevant patient data that should be collected that are necessary in the assessment and management of a poisoned patient. Emphasis is also placed on the manner of gathering this information.

Student Test
CASE STUDIES:
Given the following settings, indicate the salient information needed and how you will gather such information:

1. Telephone call from a 40 year old, drowsy male who claimed that he intentionally took tablets of a medication for allergies.

2. 5 year old girl rushed to the emergency room because of accidental ingestion of a jewellery cleaning agent.

3. A 15 year old male has consulted a medical clinic because of nausea and vomiting after eating a mushroom burger.

Materials and Resources
1. Internal protocols and guidance on dealing with telephone enquiries and handling ill, suicidal or distressed callers.

2. Lawless HT et al, Gender, age, vessel size, cup vs. straw sipping, and sequence effects on sip volume. Dysphagia (2003), 18(3):196-202


Author(s)
Dr Lynn Panganiban, Director, National Poison Control and Information Service, Philippines General Hospital, Manila, The Philippines.

Peer reviewed by members of the IPCS INTOX Poisons Centre Training Manual Working Group (R Awang, K Bakjaji, A Laborde, E Clarke, M Colbridge, W Daelman, A Dines, D Gotelli, M Hermanns-Clausen, T Jovaisa, J de Kom, M Kunde, I Makalinao, W Malas, R McKeown, M Mostin, D Pelclová, H Persson, L Pinto Pereira, U Stedtler, W Temple)
Objectives

On completing this chapter, you will be able to:

- List at least three reasons why documentation of enquiries is important
- Be able to complete a call record form to the standard set by the poisons centre

Subject content

Introduction
A poisons centre provides information on all aspects of poisoning including the management of cases, general information about toxicity, information about the incidence of poisoning and its prevention and identification of plants, animals or medicines. In addition, some poisons centres may provide access to an analytical service or may supply antidotes. All of these activities involve some form of communication between the poisons centre and its clients, be it by telephone, fax, email, letter, or face-to-face enquiry.

Adequate documentation of enquiries is essential to the work of the poisons centre and its staff. Documentation of telephone enquiries is usually contemporaneous with the enquiry. It may involve completion of a paper record or direct entry into a computerized database through an electronic record. In some poisons centres, information from a paper record is subsequently entered into a computer database. Some centres make an audio recording of each call so as to have a complete record of enquiries.
This chapter will focus on the documentation of telephone enquiries onto a call or communication record, but the basic principles apply to documentation of all types of enquiry. Information from these enquiries can be used for a number of different purposes, which will be described below. In addition, information concerning patients may have clinical and medico-legal importance. It is therefore important that enquiries are documented accurately and to a sufficient level of detail.

It is important to remember much of the information that you take during an enquiry is confidential. This is particularly true about patient information, but it usually also applies to product and, possibly, other information.

Reasons for documenting enquiries
The information documented from enquiries can be used for a number of purposes. The main ones are as follows:

- Administrative
- Clinical
- Medico-legal
- Toxicovigilance / Research

In order for the information to be useful it must be recorded and stored in such a way that it can be readily retrieved and analysed. It goes without saying that paper records should be completed legibly.

1. Administrative purposes
Information from enquiries can be analysed in a variety of ways to provide, for example, evidence of the workload of the centre, a guide to staffing and equipment needs, a guide to whether the centre is reaching the appropriate user population and for other purposes.

Reports generated from enquiry data may include:

- number of enquiries handled
- variations in the numbers of enquiries according to time of day, month or season
- types of enquirer e.g. members of the public, categories of medical staff etc
- types of enquiry e.g. about cases, requests for analytical services, written as well as telephone enquiries etc
- types of exposure

Much of this information will be published in the form of an annual report, which is usually an official document of the poisons centre. The annual report is often required by funding bodies as evidence of work performed. This information can also be used to justify requests for additional budget, for example to hire more staff or to buy equipment. In addition, the annual report may be circulated to other interested parties.
in order to inform and to raise the profile of the poisons centre. Note that the annual report will usually also include epidemiological data aggregated from enquiries.

2. Clinical record
For enquiries concerning patients, the call record is a form of clinical record. It should be sufficiently detailed that someone else looking at the record can tell who made the enquiry, how to contact them, what the nature of the exposure was, the clinical condition of the patient, the severity of poisoning, the treatment already given and the management advice that you provided. If there are subsequent calls about the same case then the information collected each time will provide a description of the evolution of the poisoning and the continuity of care.

This information can also be used to guide the need for follow-up of the case, either by telephone to check the status of the patient and the need for further advice, or by post to find out more about the case and its outcome for research purposes. Naturally, any information that you have provided during follow-up calls should also be documented.

The analysis of the clinical records will provide information about the quality of treatment provided by various health care facilities and identify the treatment gaps such as availability of decontamination facilities, or access to antidotes, etc. These data will be important in formulating more effective treatment strategies and requests for necessary medicines and devices to improve delivery of care to poisoned patients.

3. Medico-legal record
As a clinical record the call record has medico-legal significance. A poisons centre might be required to reveal the call record if a case about which it was consulted had an unexpectedly poor outcome and there was a subsequent investigation. The person who dealt with the enquiry would not necessarily be at fault but without an adequate record they would find it difficult to defend themselves. It is therefore important that you make an adequate record of each of the enquiry, since it is impossible to predict which case might subsequently be scrutinized. It also follows that you should be careful about writing unnecessary comments on the call record that might later prove embarrassing.

Poisoning cases may occasionally also be homicidal in nature. Therefore, it is important that enquiries of this nature should be documented as accurately as possible.

4. Toxicovigilance & Research
Toxicovigilance is the active process of identifying and evaluating the toxic risks in a community and evaluating the measures taken to reduce or eliminate them. Analysis of enquiries received by the poisons centre can reveal particular sub-populations, agents and circumstances that are most likely to be associated with poisoning. Such analysis may also identify a newly emerging toxicological problem. This information can then be used to alert the appropriate health and other authorities so that preventive and/or regulatory measures can be taken.
Information from call records can be aggregated to characterize the epidemiology of poisoning and to identify changing trends in poisoning - perhaps as a result of some preventive action. In addition the information documented about exposure to specific substances may contribute to a body of information about the toxicity of those substances. For certain kinds of research, you may be asked to document additional specific kinds of information not normally collected e.g. about type of packaging.

**Practice**
You will get practice in completing call records at the same time as you practise dealing with enquiries and you will be given feedback about how well you have done this. Always ask your trainer if you are uncertain about any information elements.

**Summary**
This chapter discusses the reasons why documentation of enquiries is important and the uses that can be made of information from enquiries. The local policy on documentation is also explained.

**Student Test**
**Identify the types of information that it is important to document for the following purposes:**

1. Administrative information for the annual report
2. Clinical record
3. Medico-legal record
4. Toxicovigilance
5. Toxicological research

**Materials and Resources**
1. Poisons centre internal guidance on the completion of the call record
2. IPCS INTOX PC Training Manual, Chapter 2.2 : Handling a poisons call: taking a clinical history
   - Toxicovigilance and Prevention of Poisoning, pp 44-49
   - Model Formats for Collecting, Storing and Reporting Data, pp 64-65
Author(s)
Ms Joanna Tempowski, International Programme on Chemical Safety, World Health Organization, Geneva, Switzerland

Peer reviewed by members of the IPCS INTOX Poisons Centre Training Manual Working Group (R Awang, K Bakjaji, A Laborde, E Clarke, M Colbridge, W Daelman, A Dines, D Gotelli, M Hermans-Clausen, T Jovaisa, J de Kom, M Kunde, I Makalinao, W Malas, R McKeown, M Mostin, D Pelclová, H Persson, L Pinto Pereira, U Stedtler, W Temple)

Written for the INTOX Programme of the International Programme on Chemical Safety World Health Organization, Geneva, Switzerland.

Objectives

On completing this chapter, you will be:

- Familiar with the systems of units that they are likely to encounter in their day-to-day work
- Able to make conversions from one system of units to another
- Able accurately to convert a stated quantity and concentration of an agent into a toxic or exposure dose

Subject content

Introduction

In the course of your daily work you will regularly have to make calculations and conversions. The most common type involves calculating the quantity of toxin involved in an exposure. Other calculations include converting units for mass or volume, or plasma concentrations of toxins, and calculating anion gap and osmolar gap.

These calculations are generally simple to perform once you are familiar with the procedures and the formulae. Accuracy is of course important. The following basic principles should be taken into account:

1. Identify clearly the various parameters involved.
2. Choose the most direct way to solve the problem.
3. Remember that the various steps of the calculation cannot proceed simultaneously but, rather, sequentially.
4. Check the data (volume, concentration, weight, etc) and make sure that the units are clear.
5. Make the necessary conversions e.g. imperial to metric, mass to molar etc
6. Apply the appropriate equation either on paper, by calculator or with computer assistance.
7. Document the calculations in a clear manner, on the call record if possible.
8. Double check the results.

1. International unit system
The international unit system i.e. the Système International d’Unités (SI units), is an extension of the conventional metric system. Its objective is to standardize the units of measurement in order to simplify the conversions, to reduce the risks of errors and to favour its universal acceptance by all countries. Base SI units include the metre (m), kilogram (kg) mole (mol), and the second (s). They are modified by prefixes to indicate a multiple of fraction of the base unit, as follows:

<table>
<thead>
<tr>
<th>Factor</th>
<th>Prefix</th>
<th>Symbol</th>
<th>Factor</th>
<th>Prefix</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^{-18}$</td>
<td>atto</td>
<td>a</td>
<td>$10$</td>
<td>deca</td>
<td>da</td>
</tr>
<tr>
<td>$10^{-15}$</td>
<td>femto</td>
<td>f</td>
<td>$10^3$</td>
<td>hecto</td>
<td>h</td>
</tr>
<tr>
<td>$10^{-12}$</td>
<td>pico</td>
<td>p</td>
<td>$10^3$</td>
<td>kilo</td>
<td>k</td>
</tr>
<tr>
<td>$10^{-9}$</td>
<td>nano</td>
<td>n</td>
<td>$10^6$</td>
<td>mega</td>
<td>M</td>
</tr>
<tr>
<td>$10^{-6}$</td>
<td>micro</td>
<td>μ</td>
<td>$10^9$</td>
<td>giga</td>
<td>G</td>
</tr>
<tr>
<td>$10^{-3}$</td>
<td>milli</td>
<td>m</td>
<td>$10^{12}$</td>
<td>tera</td>
<td>T</td>
</tr>
<tr>
<td>$10^{-2}$</td>
<td>centi</td>
<td>c</td>
<td>$10^{15}$</td>
<td>peta</td>
<td>P</td>
</tr>
<tr>
<td>$10^{-1}$</td>
<td>deci</td>
<td>d</td>
<td>$10^{18}$</td>
<td>exa</td>
<td>E</td>
</tr>
</tbody>
</table>

2. Units of mass and volume

2.1. Mass

1.1.1 SI units
Kilogram (kg)
Conversions
1 kilogram (kg) = 1000 grams (g)
1 gram (g) = 1000 milligrams (mg)
1 milligram (mg) = 1000 micrograms (mcg or μg)
1 microgram (mcg or μg) = 1000 nanograms (ng)
water 1 g = 1 mL
2.1.2 SI equivalents of imperial weight measures

<table>
<thead>
<tr>
<th>Imperial</th>
<th>SI equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ton</td>
<td>= 1016 kg = 1.016 tonne (t)</td>
</tr>
<tr>
<td>1 stone (st)</td>
<td>= 6.35 kg</td>
</tr>
<tr>
<td>1 pound (lb)</td>
<td>= 0.45 kg</td>
</tr>
<tr>
<td>1 ounce (oz)</td>
<td>= 28.35 g</td>
</tr>
</tbody>
</table>

2.2. Volume

2.2.1 SI units

Cubic metre (m³)

<table>
<thead>
<tr>
<th>Conversions</th>
<th>SI equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 litre</td>
<td>= 0.001 m³</td>
</tr>
<tr>
<td>1 litre (L)</td>
<td>= 1000 mL = 1 dm³</td>
</tr>
<tr>
<td>1 decilitre (dL)</td>
<td>= 100 mL = 0.1 dm³</td>
</tr>
<tr>
<td>1 centilitre (cL)</td>
<td>= 10 mL = 0.01 dm³</td>
</tr>
<tr>
<td>1 millilitre (mL)</td>
<td>= 1 mL = 0.001 dm³ = 1 cm³</td>
</tr>
</tbody>
</table>

2.2.2 English and American units of volume

Key:

Font regular: English units

Font italic: American units

<table>
<thead>
<tr>
<th>Volume</th>
<th>SI equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 minim (min)</td>
<td>1/76800 gal = 5.92 x 0.01 cm³ = 0.059 mL</td>
</tr>
<tr>
<td>1 fluid ounce (fl oz)</td>
<td>1/160 gal = 2.84 x 0.01 dm³ = 28.41 mL</td>
</tr>
<tr>
<td>1 fluid ounce (fl oz)</td>
<td>1/128 gal = 2.96 x 0.01 dm³ = 29.57 mL</td>
</tr>
<tr>
<td>1 pint</td>
<td>1/8 gal = 5.68 x 0.1 dm³ = 568.26 mL</td>
</tr>
<tr>
<td>1 liquid pint (liq pt)</td>
<td>1/8 gal = 4.73 x 0.1 dm³ = 473.175 mL</td>
</tr>
<tr>
<td>1 quart</td>
<td>1/4 gal = 1.14 x 1 dm³ = 1136.52 mL</td>
</tr>
<tr>
<td>1 liquid quart (liq qt)</td>
<td>1/4 gal = 9.46 x 0.1 dm³ = 946.353 mL</td>
</tr>
<tr>
<td>1 gallon (gal)</td>
<td>1 gal = 4.55 x 1 dm³ = 4546.09 mL</td>
</tr>
<tr>
<td>1 cubic inch (in³)</td>
<td>0.0036 gal = 1.63871 x 0.01 dm³ = 16.3871 mL</td>
</tr>
<tr>
<td>1 cubic foot (ft³)</td>
<td>6.229 gal = 2.83168 x 1 dm³ = 28316.8 mL</td>
</tr>
<tr>
<td>1 cubic yard (yd³)</td>
<td>168.2 gal = 7.64555 x 100 dm³ = 764555 mL</td>
</tr>
</tbody>
</table>
2.2.3 Examples of volumes with no precise units:

1 teaspoon = 5 mL approx
1 tablespoon = 15 mL approx
Mouthful\(^ {3,2} \):
  - Adult male approx 25 mL
  - Adult female approx 20 mL
  - Child approx 10 mL

3. Concentrations
The concentration of a solution of a drug or chemical can be expressed in different ways depending on the states in which the solute and solvent occur. It may be expressed either in terms of the quantity of solute in a definite volume of solution or as a quantity of solute in a definite mass of solvent or solution. The various expressions are summarized in the table below.

<table>
<thead>
<tr>
<th>Expression</th>
<th>Abrev.</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight by volume</td>
<td>w/v</td>
<td>g/L, mg/L, ( \mu )g/mL, etc.</td>
</tr>
<tr>
<td>Per cent weight in volume</td>
<td>% w/v</td>
<td>g/100 mL</td>
</tr>
<tr>
<td>Per cent by weight</td>
<td>% w/w</td>
<td>g/100 g (solid or liquid)</td>
</tr>
<tr>
<td>Per cent by volume</td>
<td>% v/v</td>
<td>mL/100 mL</td>
</tr>
<tr>
<td>Milligrams per cent</td>
<td>1 mg%</td>
<td>1 mg/100 mL = 10 mg/L</td>
</tr>
<tr>
<td>Ratios</td>
<td>1:10</td>
<td>1 mL liquid or 1 g solid in a quantity of solvent to obtain 10 mL of final solution</td>
</tr>
<tr>
<td>Part per million</td>
<td>ppm</td>
<td>1 mg/L (liquid), mg/m³ (gas)</td>
</tr>
<tr>
<td>Molar solutions</td>
<td>M</td>
<td>1 mole or gram molecular weight of solute in 1 litre of solution (= 1 mmol/mL)</td>
</tr>
</tbody>
</table>

3.1. Weight by volume
Examples of the concentration expressed as weight by volume are:

\[
\begin{align*}
1 \text{ g/L} & = 1 \text{ mg/mL} \\
1 \text{ mg/L} & = 1 \text{ \( \mu \)g/mL} \\
1 \text{ mg/dL} & = 1 \text{ mg/100mL} = 10 \text{ mg/L} \\
1 \text{ \( \mu \)g/L} & = 1 \text{ ng/mL} \\
1 \text{ \( \mu \)g/dL} & = 1 \text{ \( \mu \)g/100mL} = 10 \text{ \( \mu \)g/L}
\end{align*}
\]
Sometimes the concentrations may also be expressed in terms of amount per 5mL, per 10mL, per 20mL measure etc. This particularly applies to medicinal products e.g. Calpol Infant® is paracetamol 120mg/5mL.

3.2. Percentage concentrations
Concentrations of drugs and chemicals are frequently expressed in percentages. A good understanding of the rules of conversion is essential in order to calculate the amount of active ingredient involved. The percentage concentration can be expressed in three different ways.

3.2.1 Weight/volume percentage (w/v)
This is the expression of the number of grams of an ingredient for 100 mL of solution and is used whether the solvent is water or another substance.

It is the most frequently used way to express percentages in liquid solutions. This mode of calculation is based on the assumption that 1 mL of solvent weighs 1 g. Therefore, the density of the solvent or the solution is not required to do the calculations.

Example
alcohol 80% = alcohol 80% w/v \[\rightarrow\] 80 g of alcohol in 100 mL of solution

3.2.2 Weight/weight percentage (w/w)
This is the expression of the number of grams of the ingredient in 100 g of the solution. In a weight/weight solution, the ingredients and solvents need to be weighed. If they are measured in volume, their density needs to be taken into account in order to obtain their weight.

Example
How many grams of chemical A is to be found in 200 g of a 10% w/w solution?

10% w/w means that we have 10 g of the chemical A in 100 g of the total solution. If 100 g of the total solution contains 10 g of the chemical A, there are 90 g of the solvent. Then, we will have 2 x 90 g of solvent or 180 g of solvent and 20 g of chemical A in 200 g of the total solution. The way to calculate it would be:

\[
\begin{align*}
10 \text{ g of chemical A in 100 g of solution} \\
? \text{ g of chemical A in 200 g of solution} \\
&= 10 \times 200 / 100 \\
&= 20 \text{ g chemical A}
\end{align*}
\]

To calculate the w/w concentration of a solution when only the volume is known, we need to know the density of the solvent expressed in g/mL.
Example
240 mL of a 2% w/w of miconazole in alcohol

The approach to solve the problem:

- density of alcohol = 0.816 g/mL
- convert the 240 mL of alcohol in weight
- density = weight/volume  \[ \Rightarrow \] weight = volume x density
- 240 mL of alcohol x 0.816 g/mL = 195.8 g (196 g)

- 2% w/w means 2 g miconazole in 100 g of the solution
  In this case, 240 mL only represents the solvent. The solvent then equals 98% of the weight of the final solution, and we will have:
  2 g of miconazole in 98 g of alcohol
  ? g of miconazole in 196 g of alcohol = 2 g x 196 g/98 g = 4 g

- The total solution then contains 4 g of miconazole in 240 mL of alcohol.

The concentration expressed in % w/w is frequently used in solid (powders) or semi-solid mixtures (creams, ointments, etc.).

Example
How many grams of hydrocortisone is contained in 30 g of a 1% hydrocortisone ointment?

This being a solid preparation, the % means weight/weight:
hydrocortisone = 30 g x 1 g/100 g = 0.3 g or 300 mg

3.2.3 Volume/volume percentage (v/v)
This is the expression of the number of mL in 100 mL of solution. In volume/volume mixture, the percentages of ingredients is directly proportional to the volume.

Example
How many mL of phenol in 60 mL, of a 20% solution in water?

As it is a liquid in a liquid solution, % means volume/volume.
- 20% = 20 mL of phenol in 100 mL solution
  20 mL x (60 mL/100 mL) = 12 mL phenol

When a concentration is expressed only as a percentage, it means:

- mixture of solids % w/w
- solution or suspension of solids in a liquid % w/v
- mixture of liquids % v/v
- mixture of gases in liquid % w/v
3.3. Ratios
Ratio is another way to express a concentration. Concentrations may be expressed as, for example, 1 in 10 or 1:10. This means that 1 mL of a liquid or 1 g of a solid has been dissolved in a quantity of solvent sufficient to obtain 10 mL of the final solution.

The ratio may be converted in percentages:

*Example*

1:10  
1 g : 10 mL  
? g : 100 mL  
?=(100 mL/10 mL) x 1 g = 10 g  
10 g in 100 mL solution or 10%

The expression parts per thousands always means the number of parts in weight by volume when we refer to solids in liquids.

*Example*

A solution of 1:5000 means 1 g of a substance in enough solvent to obtain 5000 mL of solution.

3.4. Parts per million
The expression parts per million is just another way to indicate a concentration especially for highly diluted solutions of liquids or gases.

1% solution = 1 part per cent solution  
0.1% solution = 1 part per thousand solution

3.4.1 Liquids
For liquids 1 ppm = 1 mg/L or 1 part of solute to 1,000,000 parts of solution.

*Example*

How many mg of sodium fluoride is contained in 90 mL of a 3 ppm solution?

3 ppm = 3 mg : 1000 mL  
? mg : 90 mL  
? = (3 mg x 90 mL/1000 mL) = 270/1000 = 0.27 mg

3.4.2 Gases
For gases 1 ppm = 1 mg/m³ or 1 part of solute to 1,000,000 parts of solution. In identical conditions of temperature and pressure, equal volumes of gases contain the same number of molecules. At a temperature of 25°C and a pressure of 760 mm Hg (i.e. one atmosphere) the volume occupied by 1 gram molecule is 24.45 litres.
To convert mg/m³ to ppm

\[
\frac{24.45 \times \text{mg/m}^3}{\text{mol wt}}
\]

To convert ppm to mg/m³

\[
\frac{\text{ppm} \times \text{mol wt}}{24.45}
\]

For details of conversions at other temperatures and pressures see [http://www.ccohs.ca/oshanswers/chemicals/convert.html](http://www.ccohs.ca/oshanswers/chemicals/convert.html)

### 3.5. Molar solutions

The definition for a mole is: 1 mole is the amount of substance that contains as many elementary particles as there are atoms in 0.012 kg C¹².

A mole is the mass numerically equal to the molecular weight, i.e. the sum of the atomic weights of all the atoms in a molecule. It is most frequently expressed as the gram molecular weight, i.e. as the weight of one mole expressed in grams.

To calculate how many moles there are in a given mass of substance divide the mass by the molecular weight.

**Example**

- mol wt paracetamol = 151.2
- 1 mole paracetamol = 151.2g
- 1 g paracetamol = \(\frac{1}{151.2} = 6.6 \times 10^{-3}\) mol = 0.0066 mol
- 1 mg paracetamol = 0.0066 mmol
- 1 mg/L paracetamol = 0.0066 mmol/L

To convert molar units to mass units use a conversion factor which is the molecular weight.

A 1 M (molar) solution contains 1 mole or gram molecular weight of the solute in 1 litre of solution: 1 mol/L (= 1 mmol/mL).

**Example**

Molecular weight of NaCl is 58.44

2 M solution of NaCl (2 moles NaCl) = \(2 \times 58.44 (116.88)\) grams of NaCl in enough water to produce a final volume of 1 litre.

The concentration of a solution bears no relation to the amount of solution. If the concentration of a solution is designated as 2 M, then every drop, every mL, every litre or, even, every barrel of that solution has the same concentration, 2 M.
Plasma concentrations of drugs or other metabolically active substances may be quoted using either mass or molar units i.e. in terms of the number of moles of active substance per litre of blood or the number of mg of substance per litre of blood.

3.6. Others
3.6.1 Proof of alcohol
This concentration value is strictly used for excise and tax purposes. In the USA, proof is defined as twice the percent ethanol by volume, i.e. a drink that is 100° proof contains 50% ethanol by volume, or 42.49% by weight of ethanol.

In the UK the term proof corresponds to 4/7 of the amount of ethanol by volume. Thus a drink that is 100° proof contains 57% ethanol by volume.

4. Calculations and conversions
4.1. Basic methodology
As mentioned in the introduction the poisons information specialist may be required to make some calculations and conversions of figures in the course of dealing with a poisoned patient or enquiry. Besides the basic principles that were listed, one should also take a basic methodology into account.

- Always convert data into the metric system.
  
  *Example*
  
  2 fluid ounces (US) = 60 mL
  1 tablespoon ≡ 15 mL

- If the metric units are different for the various data, change to a common and practically manageable unit. As far as possible, bring each value to its largest measure unit in order to simplify the results and reduce the number of figures or, if preferable, to reduce the number of decimals.
  
  *Example*
  
  2000 mg = 2 g
  0.001 mg = 1 µg

- Be extremely vigilant about the decimal point. This is a common source of error in calculations and it could be catastrophic for the patient. To prevent these errors make the calculations using the same number of decimals for each parameter.
  
  *Example*
  
  \[2.15 \text{ g} + 7 \text{ g} \rightarrow 2.15 \text{ g} + 7.00 \text{ g} = 9.15 \text{ g}\]
4.2 Conversions
4.2.1 Metric conversions
In the metric system, conversions are easily made by a displacement of the decimal point.

- Displacing the decimal point to the right increases the size of the number but reduces proportionally the value of the unit.
  
  Example
  
  \[1.000 \text{ g} = 1000 \text{ mg}\]
  \[0.0066 \text{ mmol} = 6.6 \text{ µmol}\]

- Displacing the decimal point to the left reduces the size of the number but increases the unit value.
  
  Example
  
  \[1 \text{ g} = 0.001 \text{ kg}\]
  \[1000 \text{ mL} = 1.000 \text{ L}\]
  \[1320 \text{ µmol} = 1.32 \text{ mmol}\]

- For practical purposes, we assume that 1 g = 1 mL = 1 cc. This assumption simplifies greatly the conversion of solids and liquids in the metric system.

Different laboratories may use different systems of units when reporting analytical results. Be careful about units for blood concentrations of, for example, ethanol, salicylate, paracetamol, iron and digoxin.

4.3. Calculation of osmolal gap
The degree to which any chemical substance contributes to the osmolality of a solution is simply based on the number of molecules present. One millimole of substance will contribute 1 mOsm to the measured osmolality.

Serum osmolality can be measured (Osm\(_{\text{M}}\)) in the laboratory with the freezing point depression osmometer. The serum osmolality can also be calculated (Osm\(_{\text{C}}\)) from the results of the sodium, glucose and urea tests. Note that there are a number of variations on this formula. One version is as follows\(^3\):

\[
\text{Osm}_{\text{C}} = 2[\text{Na}^+] + \text{glucose} + \text{urea} \\
0.93
\]

Where Na\(^+\), glucose and urea are in mmol/L.

The osmolal gap (OG) is the difference between the measured serum osmolality and the calculated osmolality, i.e.

\[
\text{OG} = \text{Osm}_{\text{M}} - \text{Osm}_{\text{C}}.
\]

The osmolal gap can be increased in the presence of low-molecular-weight substances such as ethanol, other alcohols, glycols, acetone, and ether which can contribute to the
measured but not the calculated osmolality. Based on the osmolal gap the serum alcohol and glycol levels in mg/dL can be estimated by multiplying the osmolal gap figure by a conversion factor.

False elevations of the osmolal gap may be caused by laboratory errors and certain diseases.

4.4. Calculation of anion gap (AG)
The anion gap is calculated by subtracting measured serum anions from serum cations. Not all of the anions and cations normally present are routinely measured. Anions that are routinely measured are chloride and bicarbonate, and these account for 85% of measured extracellular anions. Unmeasured serum anions include phosphate, sulphate and anionic proteins. Cations that are routinely measured are sodium and potassium, and these account for 95% of measured extracellular cations. Unmeasured serum cations include calcium and magnesium. Since we measure more cations than anions we expect a positive number, which is the anion gap. In order to calculate the anion gap the following values are required:

- serum electrolytes: $\text{K}^+$, $\text{Na}^+$, $\text{Cl}^-$
- blood concentration of bicarbonate calculated from arterial blood gases ($\text{CO}_2$ and pH).

The equation is:

$$AG = ([\text{Na}^+ + \text{K}^+]) - ([\text{HCO}_3^-] + [\text{Cl}^-])$$

NB potassium is often deleted from the calculation because potassium is a largely intracellular cation that rarely alters the anion gap.

A normal anion gap is 7-12 ± 4 mmol/L. Metabolic acidosis is usually associated with an elevated anion gap greater than 20 mmol/L. An elevated anion-gap acidosis can be caused by unmeasured acid anions such as formate, (e.g. methanol poisoning) or oxalate (e.g. ethylene glycol poisoning), lactic acidosis (iron, isoniazid, salicylates, seizures, shock or hypoxia), or alcoholic ketoacidosis or diabetic ketoacidosis.

False elevations of the anion gap may be caused by laboratory errors and certain diseases.

Other useful formulae:
Practice
You should take every opportunity to practise these skills, for example while you are listening in to calls taken by others you can do the necessary calculations to work out toxic dose etc and have this checked by a colleague.

Student Test
1 A local anaesthetic preparation contains lidocaine in a concentration of 0.9% w/v.
   a How much lidocaine is contained in a 6mL bottle?
   b How much of the preparation would be toxic to a 10kg child, assuming that the toxic dose was 10mg/kg body weight?

2 If an aftershave contains 80% ethanol v/v and the toxic dose of ethanol is 0.4mL/kg body weight, how much aftershave would be toxic for a 10kg child?

3 Express the following in terms of mg/L:
   - Salicylate 25.2mg%
   - Ethanol 85mg/dL
   - Paracetamol 3.96mmol/L
   - Theophylline 150μmol/L

4 Express the following in terms of mmol/L or other molar units as indicated:
   - Salicylate 25.2mg%
   - Iron 150μg/dL (as μmol/L)
   - Paracetamol 240mg/L
   - Digoxin 9μg/L (as nmol/L)

5 An analgesic elixir contains paracetamol in the concentration 120mg/5mL.
   a How much paracetamol is there in a 70mL bottle of the elixir?
   b If the toxic dose of paracetamol is 150mg/kg body weight, how much of the elixir would be toxic for a 12kg child?
6 An analgesic elixir for older children contains paracetamol in the concentration 250mg/5mL.
   a How much paracetamol is there in 60mL?
   b If the toxic dose of paracetamol is 150mg/kg body weight, how much elixir would be toxic for a 14kg child?

7 The severely toxic dose of elemental iron is 60mg/kg body weight. An iron preparation contains 100mg of elemental iron. If a 15kg child swallows 11 tablets is this a dangerous dose?

8 If the iron salt taken was ferrous gluconate 300mg, how many tablets would be toxic for a 12kg child (check formulary for iron salts)?

9 A product contains sodium sulphate 50ppm. How much sodium sulphate is there in 45mL?

10 A child weighing 22lb has swallowed 2 fl oz of mouthwash containing 12% v/v ethanol. If the toxic dose of ethanol is 0.4mL/kg has this child taken a toxic dose?

11 A female adult weighing 9.5 stone has taken half a pint of Polish Pure Spirit, with an alcohol content of 80% v/v. If the potentially fatal dose is 6-10mL/kg is this patient in any danger?

12 An antifreeze contains 50% methanol w/v.
   a How many g of methanol are contained in 40mL of antifreeze?
   b How many mLs of methanol are contained in 40mL of antifreeze?

13 A screenwash contains 75% ethylene glycol v/v.
   a How many mL of ethylene glycol are contained in 60mL of screenwash?
   b How many g of ethylene glycol are contained in 60mL of screenwash?
14 What is the conversion factor for diazepam (i.e. to convert a mass concentration to a molar one or vice versa)?

15 What is the conversion factor for ibuprofen (i.e. to convert a mass concentration to a molar one or vice versa)?

16 If a patient has a sodium of 135mmol/L, a chloride of 100mmol/L and a bicarbonate of 4mmol/L what is their anion gap?

17 If the same patient has a urea of 7.5mmol/L, a glucose of 8.8mmol/L and a measured osmolality of 378 mOsm/kg what is their osmolal gap?

Materials and Resources

1. Lawless HT et al, Gender, age, vessel size, cup vs. straw sipping, and sequence effects on sip volume. Dysphagia (2003), 18(3):196-202


The following books provide tables of units and conversion factors:

CRC Handbook of Chemistry and Physics, CRC press, Boca Raton, USA


Author(s)

Jules de Kom, Pharmacy Department, Academic Hospital Paramaribo, Suriname

Peer reviewed by members of the IPCS INTOX Poisons Centre Training Manual Working Group (R Awang, K Bakjaji, A Laborde, E Clarke, M Colbridge, W Daelman, A Dines, D

Written for the INTOX Programme of the International Programme on Chemical Safety, World Health Organization, Geneva, Switzerland.

Finalized August 2006.
CHAPTER 2.5

USE OF THE POISONING SEVERITY SCORE (PSS)
- Trainee's version

Objectives

On completing this chapter you will:

- Understand what the PSS is intended for and to be aware of its benefits and limitations.
- Be familiar with all of the instructions given on the front page of the PSS schema.
- Be able to use the PSS is a consistent and reliable way

Subject content

Introduction
The Poisoning Severity Score (PSS) has been developed to provide a standardized scheme for grading the severity of poisoning. While it was primarily developed for the retrospective grading of poisoning cases collected in poisons information centres, it has also been applied and found useful in the clinical setting.

The use of a generally applicable grading scale facilitates the qualitative evaluation of morbidity caused by poisoning and the identification of risks, and it also, importantly, increases the comparability of data.

A possible weakness of the PSS is related to the simplicity of the scheme, which makes the judgement of ‘borderline’ cases less clear-cut. This is, however, balanced by the ease of application of the system, which allows its widespread use for the grading of different types of poisoning. For special studies of certain kinds of poisoning, however, adaptations of the scheme may be made. The PSS has been studied and compared to grading scales designed for specific poisonings and found to be useful, with some modifications.

Further information on the process of developing and validating the PSS is provided in the paper by Persson et al, listed under 'Materials and Resources'.
Principles behind the PSS
This chapter presents the principles of the PSS and instructions for its use. The PSS schema is attached. It is in two sections: introductory text with instructions for use, and a two page chart listing the clinical and biochemical criteria against each severity score. You should read these carefully.

The PSS is a classification scheme for cases of poisoning in adults and children. It is aimed at classifying the severity of acute poisonings regardless of the type and number of agents involved. In reality, however, the PSS is mostly used for poisoning cases where just one agent is involved. The PSS is intended to be a simple but relatively reliable system for describing a poisoning in qualitative terms and defining its ultimate severity.

An advantage of the PSS is that it can be used in poisons information centres, both during a telephone consultation and retrospectively, as well as in the clinical setting.

The PSS grades observational data on poisoning cases. To reflect the true severity of a poisoning you should take account of the overall clinical course and apply the score according to the most severe symptomatology (including both subjective symptoms and objective signs). This usually requires a follow-up or the continuous recording of clinical data and the severity grading is often a retrospective process. However, grading can also be useful at any other time (e.g. on admission / during an initial telephone contact). In this situation, you should clarify the actual time point when data on severity are presented.

Severity grading takes into account only the observed clinical symptoms and signs and should not estimate risks or hazards on the basis of information on amounts ingested or toxic serum/plasma concentrations. The toxicity of a substance indicates a certain risk, but this alone does not necessarily indicate the severity of poisoning, since other variables are also important, such as the degree of exposure. Similarly, toxic serum/plasma concentrations will reflect the degree of exposure and thereby also the risk but will not always result in severe poisoning, as the risk may be modified or even eliminated through specific treatment (e.g. use of antidotes in paracetamol or methanol poisoning). That is why, in severity grading, you should only take account of the observed clinical symptoms and signs. The PSS works according to this principle.

Using the PSS
Symptoms and signs addressed by the PSS are given in the following categories: gastrointestinal tract, respiratory system, nervous system, cardiovascular system, metabolic balance, liver, kidney, blood, muscular system, local effects on skin, local effects on eye and local effects from bites and stings.
The Severity Grades are:

- **0 None:** No symptoms or signs related to poisoning
- **1 Minor:** Mild, transient and spontaneously resolving symptoms
- **2 Moderate:** Pronounced or prolonged symptoms
- **3 Severe:** Severe or life-threatening symptoms
- **4 Fatal:** Death

The signs and symptoms given in the scheme for each grade serve as examples to assist in grading severity. You should check the occurrence of a particular clinical feature against the chart and assign the severity grading according to the most severe symptom(s) and sign(s) observed in any of the categories.

Treatment measures employed are not graded themselves, but the type of symptomatic and supportive treatment applied (e.g. assisted ventilation, inotropic support, haemodialysis for renal failure) may indicate the extent of organ failure and indirectly help you in evaluating severity.

The use of antidotes or procedures for enhanced poison elimination may prevent evolution of toxic effects. Their use should not, however, influence your severity grading in any respect. Rather, you should mentioned these when you present your data. In this way the PSS may be used to assess treatment efficacy.

A different aspect is that severity grading also might indicate an appropriate level of treatment. Thus, patients assigned Severity Grade 3 would often need intensive care and some special management, and an early, rapid progression of liver damage to Grade 2 may predict fulminant liver failure. One study showed that fatal cases of drug overdose were given Severity Grade 2 or 3 on admission, confirming the usefulness of PSS in the initial assessment of complicated cases (Casey et al 1998).

Although the scheme, in principle, is intended for grading the acute stage of poisoning, if disabling sequelae and disfigurement occur, this would justify your assigning a high severity grade and you should comment on this when presenting the data. If a patient’s medical history is considered to influence the severity of poisoning, you should also comment on this.

Cases resulting in death are graded in a separate category to allow a more accurate presentation of data, although it is understood that death is not a grade of severity but an outcome.

**Practical considerations**

You need to be flexible when using the PSS since in some cases one single feature may determine the severity grading, whereas in other cases, in particular in borderline cases, an overall evaluation will be necessary for defining the seriousness of the case. The principle is, however, the following: If only one single Grade 3 symptom is observed in any of the categories, then you should grade the poisoning as Severe (Grade 3). On the other hand, if there are many symptoms graded as 2,
then you should grade the poisoning as Moderate (2). Having said this, in a simple system like the PSS it is not always possible to insist on strict criteria and your evaluation will therefore largely depend on your judgment and experience. This is, as mentioned, particularly true for borderline cases.

Depending on the circumstances one may wish to classify poisonings in quite different ways, e.g. the risk of poisoning, the prognosis in a certain case, or the actual severity of the poisoning. The PSS is constructed for the latter purpose.

Grading and classification systems usually undergo several revisions during their existence. The PSS is a relatively new grading system. With time and a more extensive use it is anticipated that the PSS will be subject to some amendments.

**Practice**
You should study the PSS schema and read the paper by Persson et al. When familiar with the PSS principles you will be given a series of real cases for grading that have been documented according to the routines in the poisons centre.

Four test examples are given below which you should grade and discuss with the trainer. You may also be given some other cases that the trainer will also grade. The results can then be compared and methodology considerations, discrepancies, misunderstandings etc analysed and discussed.

**Summary**
The Poisoning Severity Score (PSS) has been developed to provide a standardized scheme for grading the severity of poisoning. It is primarily intended for retrospective grading of poisoning cases collected in poisons information centres. It can also be used during a telephone consultation and has been found useful in the clinical setting.

Grading is determined by the actual manifestations of toxicity rather than by the risk of poisoning.

The PSS facilitates the collection of comparable data on poisoning. It may be modified for certain kinds of poisoning.

While it shows some weaknesses when grading ‘borderline’ cases, it is nevertheless easy to use, which encourages its widespread application.

**Student Test**
Please grade the severity of poisoning in the following cases.

1. A 20-year-old male was brought to the emergency department 4 hours after ingesting forty 500 mg paracetamol tablets in a suicide attempt. He was given
50 g of oral activated charcoal. Antidote therapy with NAC was initiated with an IV bolus. The patient had prolonged and pronounced vomiting. 8 hours after ingestion the serum paracetamol level was 650 μmol/L (100 mg/L) i.e. above the treatment line and antidote therapy was continued. Laboratory analysis revealed a rise in ALT and AST with peak concentrations 4 times above normal. No clinical signs of hepatic injury were noted. There were no abnormal changes in laboratory analyses on the day of discharge.

Answer:

2. A 38-year-old female was found unconscious in her country house. On admission to the emergency department she presented with coma (Glasgow Coma Scale 7), but with no specific neurological symptoms or abnormalities on the initial CT scan. Carbon monoxide poisoning was suspected. The COHb level in blood was 28%, metabolic acidosis was present with pH 7.2, base excess -13.2. The patient was treated with hyperbaric oxygen, followed by oxygenation via facial mask, and supportive and symptomatic care. She became conscious within the next 8 hours, but short term memory loss was persistent for 6 months after poisoning. MRI scans performed 2 days and 3 weeks after admission showed bilateral subcortical lesions.

Answer:

3. A 55-year-old male arrived in the emergency department three hours after accidental ingestion of approximately 30-40 ml of gasoline. He had persistent coughing. On initial clinical evaluation no abnormalities were noted, blood gases and whole blood count were normal. Two days later the patient developed moderate dyspnoea, bilateral basal infiltrates were found on chest X-ray and he had a leucocytosis. Treatment was given with oxygen, antibiotics and supportive care. Clinical symptoms resolved within 5 days and pulmonary X-ray abnormalities within two weeks. There were no sequelae.

Answer:

4. A 4-year-old boy was admitted to hospital because of accidental ingestion of five 50 mg atenolol tablets. The exposure occurred approximately 20-30 minutes before admission. The child was given activated charcoal. He was admitted to a paediatric unit. Mild hypotension was observed but was easily reversed by IV fluids. No further therapy was needed. He was discharged the next day.

Answer:
Materials and Resources
1. Poisoning Severity Score schema (Appendix 1)
3. Pach J et al. Comparison between the poisoning severity score and specific grading scales used at the Department of Clinical Toxicology in Krakow. Przeglad lekarski. 1999;56(6):401-8

Author(s)
Dr Tomas Jovaisa, Poisons Centre Vilnius, Lithuania
Dr Hans Persson, Swedish Poisons Information Centre

Peer reviewed by members of the IPCS INTOX Poisons Centre Training Manual Working Group (R Awang, K Bakjaji, A Laborde, E Clarke, M Colbridge, W Daelman, ADines, D Gotelli, M Hermanns-Clausen, J de Kom, M Kunde, IMakalinao, W Malas, RMcKeown, M Mostin, DPelclová, LPanganiban, LPinto Pereira, UStedtler, WTemple)

Written for the INTOX Programme of the International Programme on Chemical Safety, World Health Organization, Geneva, Switzerland.

Finalized November 2005.
Appendix 1

POISONING SEVERITY SCORE (PSS)
IPCS/EAPCCT

A standardized scale for grading the severity of poisoning allows qualitative evaluation of morbidity caused by poisoning, better identification of real risks and comparability of data.

INSTRUCTIONS

The Poisoning Severity Score (PSS) is a classification scheme for cases of poisoning in adults and children. This scheme should be used for the classification of acute poisonings regardless of the type and number of agents involved. However, modified schemes may eventually be required for certain poisonings and this scheme may then serve as a model.

The PSS should take into account the overall clinical course and be applied according to the most severe symptomatology (including both subjective symptoms and objective signs). Therefore it is normally a retrospective process, requiring follow-up of cases. If the grading is undertaken at any other time (e.g. on admission) this must be clearly stated when the data are presented.

The use of the score is simple. The occurrence of a particular symptom is checked against the chart and the severity grading assigned to a case is determined by the most severe symptom(s) or sign(s) observed.

Severity grading should take into account only the observed clinical symptoms and signs and it should not estimate risks or hazards on the basis of parameters such as amounts ingested or serum/plasma concentrations.

The signs and symptoms given in the scheme for each grade serve as examples to assist in grading severity.

Treatment measures employed are not graded themselves, but the type of symptomatic and/or supportive treatment applied (e.g. assisted ventilation, inotropic support, haemodialysis for renal failure) may indirectly help in the evaluation of severity. However, preventive use of antidotes should not influence the grading, but should instead be mentioned when the data are presented.

Although the scheme is in principle intended for grading of acute stages of poisoning, if disabling sequelae and disfigurement occur, they would justify a high severity grade and should be commented on when the data are presented. If a patient's past medical history is considered to influence the severity of poisoning this should also be commented on.
Severe cases resulting in death are graded separately in the score to allow a more accurate presentation of data (although it is understood that death is not a grade of severity but an outcome).

SEVERITY GRADES

NONE (0): No symptoms or signs related to poisoning
MINOR (1): Mild, transient and spontaneously resolving symptoms
MODERATE (2): Pronounced or prolonged symptoms
SEVERE (3): Severe or life-threatening symptoms
FATAL (4): Death
<table>
<thead>
<tr>
<th>ORGAN</th>
<th>NONE</th>
<th>MINOR</th>
<th>MODERATE</th>
<th>SEVERE</th>
<th>FATAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>No symptoms or signs</td>
<td>Pronounced or prolonged symptoms or signs</td>
<td>Severe or life-threatening symptoms or signs</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Mild, transient and spontaneously resolving symptoms or signs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GI-tract</td>
<td></td>
<td>Vomiting, diarrhoea, pain</td>
<td>Pronounced or prolonged vomiting, diarrhoea, pain, ileus</td>
<td>Massive haemorrhage, perforation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Irritation, 1st degree burns, minimal ulcerations in the mouth</td>
<td>1st degree burns of critical localization or 2nd and 3rd degree burns in restricted areas</td>
<td>More widespread 2nd and 3rd degree burns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Endoscopy: Erythema, oedema</td>
<td>Dysphagia</td>
<td>Severe dysphagia</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Endoscopy: Ulcerative transmucosal lesions</td>
<td>Endoscopy: Ulcerative transmural lesions, circumferential lesions, perforation</td>
<td></td>
</tr>
<tr>
<td>Respiratory system</td>
<td></td>
<td>Irritation, coughing, breathlessness, mild dyspnoea, mild bronchospasm</td>
<td>Prolonged coughing, bronchospasm, dyspnoea, stridor, hypoxemia requiring extra oxygen</td>
<td>Manifest respiratory insufficiency (due to e.g. severe bronchospasm, airway obstruction,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>glottal oedema, pulmonary oedema, ARDS, pneumonia, pneumonia, pneumothorax)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chest X-ray: Abnormal with moderate symptoms</td>
<td>Chest X-ray: Abnormal with severe symptoms</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nervous system</td>
<td></td>
<td>Drowsiness, vertigo, tinnitus, ataxia</td>
<td>Unconsciousness with appropriate response to pain</td>
<td>Deep coma with inappropriate response to pain or unresponsive to pain</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Brief apnoea, bradypnoea</td>
<td>Respiratory depression with insufficiency</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Confusion, agitation, hallucinations, delirium</td>
<td>Extreme agitation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Infrequent, generalized or local seizures</td>
<td>Frequent, generalized seizures, status epilepticus, opisthotonus</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pronounced extrapyramidal symptoms</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pronounced cholinergic/anticholinergic symptoms</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Localized paralysis not affecting vital functions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Visual and auditory disturbances</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ORGAN</td>
<td>NONE</td>
<td>MINOR</td>
<td>MODERATE</td>
<td>SEVERE</td>
<td>FATAL</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------</td>
<td>---------------------------------</td>
<td>----------------------------------------------</td>
<td>---------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No symptoms or signs</td>
<td>Mild, transient and spontaneously resolving symptoms or signs</td>
<td>Pronounced or prolonged symptoms or signs</td>
<td>Severe or life-threatening symptoms or signs</td>
<td>Death</td>
</tr>
<tr>
<td>Cardio-Vascular system</td>
<td>Cardiac arrest (HR &lt;30, &gt;180)</td>
<td>&amp; Sinus bradycardia (HR ~40-50 in adults, 60-80 in infants and children, 80-90 in neonates)</td>
<td>&amp; Sinus tachycardia (HR ~140-180 in adults, 160-190 in infants and children, 160-200 in neonates)</td>
<td>&amp; Severe sinus bradycardia (HR ~40 in adults, &lt;60 in infants and children, &lt;80 in neonates)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&amp; Isolated extrasystoles</td>
<td>&amp; Frequent extrasystoles, atrial fibrillation/flutter, AV-block I-II, prolonged QRS and QTc-time, repolarization abnormalities</td>
<td>&amp; Life-threatening ventricular dysrhythmias, AV block III, asystole</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&amp; Mild and transient hypo/hypertension</td>
<td>&amp; Myocardial ischaemia</td>
<td>&amp; Myocardial infarction</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&amp; More pronounced hypo/hypertension</td>
<td>&amp; Shock, hypertensive crisis</td>
<td></td>
</tr>
<tr>
<td>Metabolic balance</td>
<td></td>
<td></td>
<td>&amp; More pronounced acid-base disturbances (HCO₃⁻ <del>15-20 or 30-40 mmol/l, pH</del>7.25-7.32 or 7.50-7.59)</td>
<td>&amp; Severe acid-base disturbances (HCO₃⁻ &lt;10 mmol/l, pH ~&lt;7.15 or &gt;7.7)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&amp; More pronounced electrolyte and fluid disturbances (K⁺ 3.0-3.4 or 5.2-5.9 mmol/l)</td>
<td>&amp; Severe electrolyte and fluid disturbances (K⁺ &lt;2.5 or &gt;7.0 mmol/l)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&amp; Mild hypoglycaemia (~50-70 mg/dl or 2.8-3.9 mmol/l in adults)</td>
<td>&amp; Severe hypoglycaemia (~&lt;30 mg/dl or 1.7 mmol/l in adults)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&amp; Hyperthermia of short duration</td>
<td>&amp; Dangerous hypo- or hyperthermia</td>
<td></td>
</tr>
<tr>
<td>Liver</td>
<td></td>
<td></td>
<td>&amp; Minimal rise in serum enzymes (ASAT, ALAT ~2-5 x normal)</td>
<td>&amp; Rise in serum enzymes (ASAT, ALAT ~5-50 x normal) but no diagnostic biochemical (e.g. ammonia, clotting factors) or clinical evidence of liver dysfunction</td>
<td></td>
</tr>
<tr>
<td>Kidney</td>
<td></td>
<td></td>
<td>&amp; Minimal proteinuria/haematuria</td>
<td>&amp; Massive proteinuria/haematuria</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&amp; Renal dysfunction (e.g. oliguria, polyuria, serum creatinine of ~200-500 μmol/l)</td>
<td>&amp; Renal failure (e.g. anuria, serum creatinine of &gt;500 μmol/l)</td>
<td></td>
</tr>
</tbody>
</table>

*Use of the poisoning severity score (PSS) - Trainee's version*
## Use of the poisoning severity score (PSS) - Trainee’s version

### ORGAN

<table>
<thead>
<tr>
<th>NONE</th>
<th>MINOR</th>
<th>MODERATE</th>
<th>SEVERE</th>
<th>FATAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Mild, transient and spontaneously resolving symptoms or signs</td>
<td>Pronounced or prolonged symptoms or signs</td>
<td>Severe or life-threatening symptoms or signs</td>
<td>Death</td>
</tr>
</tbody>
</table>

#### Blood
- Mild haemolysis
- Mild methaemoglobinemia (metHb ~10-30%)
- Haemolysis
- More pronounced methaemoglobinemia (metHb ~30-50%)
- Coagulation disturbances without bleeding
- Anaemia, leucopenia, thrombocytopenia
- Massive haemolysis
- Severe methaemoglobinemia (metHb >50%)
- Coagulation disturbances with bleeding
- Severe anaemia, leucopenia, thrombocytopenia

#### Muscular system
- Mild pain, tenderness
- CPK ~250-1,500 iu/l
- Pain, rigidity, cramping and fasciculations
- Rhabdomyolysis, CPK ~1,500-10,000 iu/l
- Intense pain, extreme rigidity, extensive cramping and fasciculations
- Rhabdomyolysis with complications, CPK ~>10,000 iu/l
- Compartment syndrome

#### Local effects on skin
- Irritation, 1<sup>st</sup> degree burns (reddening) or 2<sup>nd</sup> degree burns in <10% of body surface area
- 2<sup>nd</sup> degree burns in 10-50% of body surface (children: 10-30%) or 3<sup>rd</sup> degree burns in <2% of body surface area
- 2<sup>nd</sup> degree burns in >50% of body surface (children: >30%) or 3<sup>rd</sup> degree burns in >2% of body surface area
- 2<sup>nd</sup> degree burns involving the whole extremity, local necrosis
- Swelling involving the whole extremity and significant parts of adjacent area, more extensive necrosis
- Critical localization of swelling threatening the airways
- Extreme pain

#### Local effects on eye
- Irritation, redness, lacrimation, mild palpebral oedema
- Intense irritation, corneal abrasion
- Minor (punctate) corneal ulcers
- Corneal ulcers (other than punctate), perforation
- Permanent damage

#### Local effects from bites and stings
- Local swelling, itching
- Swelling involving the whole extremity, local necrosis
- Critical localization of swelling threatening the airways
- Extreme pain

#### Local effects from exposure
- Mild pain
- Moderate pain

---

*IPCS INTOX Poisons Centre Training Manual*
CHAPTER 3.1

GENERAL MANAGEMENT OF THE POISONED PATIENT
- Trainee's version

Objectives

On completing this chapter, you will be able to:

- Explain the different steps in the emergency stabilization of a poisoned patient
- Describe how to perform external decontamination of a patient
- Describe the 3 most important procedures that may be used to prevent gastro-intestinal absorption of poisons
- Describe 3 approaches to enhancing elimination of poisons
- Explain the limitations and complications of the above techniques
- Select the appropriate procedures to be used in a sample of cases

Subject content

Introduction
Since you will be advising on the initial management of poisoned patients on a daily basis it is important that you understand the general principles involved and can discuss these knowledgably with callers on a case-by-case basis. The text below provides a brief overview and you are recommended to supplement this with additional reading. A suggested list of references for background reading is provided below.

1. General Management
In the majority of poisoning cases, management is mainly symptomatic and supportive with the primary goals of maintaining the patient in a stable condition,
limiting absorption of the poison if still possible, and enhancing elimination of the poison if methods are available. In this regard, medical interventions have been developed and adopted to effectively manage a poisoned patient.

Prior to instituting decontamination techniques, the initial management of a frank or suspected poisoning case should be directed towards any emergency, life-threatening problems involving airway, breathing or circulation, and convulsions, drug-induced central nervous system depression and metabolic abnormalities.

2. Emergency Management of a Poisoned Patient
The steps involved in the emergency management of a poisoned patient are the same as in any other emergency condition; the early recognition and treatment of life threatening problems contribute greatly to a favourable patient outcome.

2.1 Maintain adequate airway
The clinician must assess the patency of the airway so as to decide on the appropriate intervention. A decreasing level of consciousness may compromise the airway. Pooling of secretions, vomitus and the presence of a foreign body in the buccal cavity can obstruct and further compromise respiratory functions.

In the event of an obstructed airway, the patient should be placed on a supine position and chin-lift and jaw thrust manoeuvres be performed to position the tongue away from the airway. Any foreign body should be removed. In cases of respiratory insufficiency, depressed level of consciousness, and impaired or absent gag reflex, endotracheal intubation should be instituted to keep the airway open.

2.2 Provide adequate oxygenation
In patients presenting with central nervous system and respiratory depression, oxygen delivery to vital organs is compromised. In the event of clinical signs of poor oxygenation (e.g. shallow, slow or irregular respirations, reduced level of consciousness, arrhythmias, cyanosis), the patient should be connected to a pulse oximeter and given oxygen.

Arterial blood gases should be analysed to assess ventilation accurately. Depending on the clinical manifestations and the pO2 levels of the patient, oxygen administration should be adjusted through the use of either a nasal cannula, face mask or a mechanical ventilator.

The poisoned patient may present with shock or hypotension which requires intravenous infusion of appropriate fluids for resuscitation. Adequate circulation should be maintained. It important to ensure that patient has adequate urine output. Since fluid overload is a complication of volume expansion, it is important to monitor fluid input and output.
Cases of severe poisoning may require inotropic/vasopressor therapy if volume expansion is ineffective. Commonly used vasopressors are dopamine, dobutamine, epinephrine (adrenaline) and norepinephrine (noradrenaline).

Cardiac arrhythmias and cardiogenic shock are common life-threatening manifestations in a poisoned patient and therefore should be attended to promptly.

2.3 Treat convulsions
Treatment of convulsions should take account of the likely etiology: convulsions may be due to a direct toxic effect of the substance concerned or may be secondary to metabolic abnormality or trauma. Thus head injury should be excluded and hypoxia, electrolyte imbalance and hypoglycaemia should be checked for and corrected. Management includes administration of a benzodiazepine such as diazepam or lorazepam, followed by a barbiturate if necessary. In the case of isoniazid overdose pyridoxine (Vitamin B₆) is also used. Core temperature should be monitored and cooling measures instigated if necessary.

2.4 Treat the coma
The following agents can be utilized in the poisoned patient with altered level of consciousness:

- **100% oxygen** in suspected cases of poisoning with carbon monoxide, hydrogen sulphide, cyanide and asphyxiants
- **Thiamine** in an alcohol intoxicated patient to prevent Wernicke’s encephalopathy in case the patient may be a chronic alcoholic.
- **Glucose** to reverse the effects of drug-induced hypoglycaemia.
- **Naloxone** in cases of possible opioid toxicity.
- **Flumazenil** in cases of coma known to be caused by benzodiazepines ALONE (because of the risk of provoking convulsions or arrhythmias, flumazenil should not be given when the patient is suspected of having taken other drugs as well). If the patient is dependent on benzodiazepines, or is on benzodiazepine therapy for epilepsy, there is a risk of provoking convulsions by giving flumazenil. It should only be used if really necessary, and used with caution, starting with a low dose.

It is important to consider other causes of central nervous system depression, including ruling out structural lesions such as a subdural haematoma.
2.5 Correct metabolic abnormalities
The following metabolic abnormalities should be corrected:
- Hypo- or hyperkalaemia
- Hypoglycaemia
- Acid-base abnormalities, particularly metabolic acidosis
- Hypomagnesaemia
- Hypocalcaemia
- Hypo- or hyperthermia

3. Techniques Used to Prevent Absorption of Poisons
Preventing absorption of the poison may be achieved through the following interventions:

3.1 External Decontamination
NB: Before attempting decontamination, the health care provider should use adequate personal protective equipment such as impermeable gloves and gowns to prevent their own contamination.

Dermal Decontamination
When there is dermal contamination, particularly if it is with a substance that is absorbed through the skin, early decontamination should be started by removing the patient’s contaminated clothing and flushing or rinsing the exposed areas with tepid water (e.g. in a shower) using soap if the substance was oily. Contaminated clothes should be put into an impermeable, preferably see-through, bag e.g. a strong plastic bag for later cleansing or disposal.

Eye Decontamination
Eye contamination should be performed as quickly as possible, by copious irrigation of the eyes with free flowing water or saline for 15-30 minutes. Contact lenses should be removed prior to decontamination if possible. In case of acid or alkaline contamination, the pH of the eyes should be checked and irrigation should again be performed if pH has not returned to normal. Make sure that the pH remains normal (~pH 7.5) for at least 2 hours. Neutralizing agents should not be used as these may cause further injury. This is especially the case with acids or alkalis, which can produce exothermic reactions and liberate carbon dioxide.

The eyes should be stained with fluorescein to check for abrasions. Referral to an ophthalmologist should be made immediately in cases of significant exposures. Topical anaesthetics may facilitate irrigation by reducing blepharospasm.

3.2 Gut Decontamination
Clinical studies have not shown convincing evidence that induction of emesis and gastric lavage have effectively decreased absorption of poisons. Furthermore, there are a number of potential complications to their use. The evidence for the use of
gastric decontamination techniques has been evaluated by the American Academy of Clinical Toxicology (AACT) and the European Association of Poisons Centres and Clinical Toxicologists (EAPCCT) in a series of position papers published in 1997 and subsequently revised in 2004-5. References are given below.

3.2.1 Single-dose activated charcoal
Activated charcoal is effective in decreasing absorption of a number of drugs and chemicals by binding or adsorbing these substances in the gastrointestinal tract. Its effectiveness is time-dependent with greatest benefit observed when administered within one hour of ingestion. Its administration is more favoured than the use of syrup of ipecac and gastric lavage.

It has been recommended by AACT/EAPCCT (2005) that administration of activated charcoal may be considered if a patient has taken a potentially toxic amount of a poison up to one hour following ingestion. It may be considered more than one hour after ingestion, however, there are insufficient data to either support or exclude its use.

Different references quote slightly different dosing regimens. That suggested in the AACT/EAPCCT position statement is:

**Dosage:**

**Children:**
- up to 1 year: 0.5-1 g/kg
- 1-12 years old: 25-50 g

**Adolescents and adults:** 25-100 g

Activated charcoal should be mixed in water and prepared as a slurry. It may be administered through an orogastric or nasogastric tube if the patient is not able to tolerate the charcoal orally or is unable to swallow. The airway should be properly protected while administering activated charcoal.

**Contraindications** to activated charcoal include:
- Gastrointestinal tract not anatomically intact, because of the possibility of aspiration and peritonitis
- Unprotected airway, because of the possibility of aspiration
- Ingestion of corrosive substances, because of the danger of perforation

**Complications** of the administration of activated charcoal include:
- Vomiting, which is influenced by rate and volume of administration
- Pulmonary aspiration

Activated charcoal is not usually recommended for the following substances, either because of poor adsorption or because giving charcoal increases the risk of complications:
- Alcohol
3.2.2 Gastric lavage

Gastric lavage is a method of evacuating stomach contents by means of the passage of an orogastric or nasogastric tube and the subsequent administration then aspiration of small volumes of liquid, bringing with it the ingested poison.

It has been recommended by the AACT/EAPCCT (2004)\(^2\) that gastric lavage should not be considered unless the patient has ingested a potentially life-threatening amount of poison and the procedure can be performed within 1 hour of ingestion. Some studies have indicated that lavage can be of benefit up to 4 hours post ingestion especially in patients with ingestion of substances that form concretions in the stomach, or substances that markedly decrease gastric motility.

Clinical studies have not demonstrated any benefit of gastric lavage undertaken ALONE even when carried out within 1 hour of ingestion. In fact, there is evidence that the procedure can enhance gastric emptying of contents into the small intestine.

**Procedure:**

1. Ensure adequate protection of the airway, especially in a comatose patient with a poor or absent gag reflex.
2. Place the patient in the left, lateral, head down position.
3. Insert an appropriately sized and properly lubricated orogastric or nasogastric tube. An orogastric tube is preferred over a nasogastric tube as particulate matter may not pass through its relatively smaller bore. Furthermore, there is a potential risk of causing damage to the nasal mucosa leading to epistaxis. However, in areas where an orogastric tube is not available, a nasogastric tube can be used.

<table>
<thead>
<tr>
<th>Tube Size</th>
<th>Adult</th>
<th>Paediatric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orogastric tube</td>
<td>French 32-40</td>
<td>French 16-26</td>
</tr>
<tr>
<td>Nasogastric tube</td>
<td>French 16</td>
<td>Appropriate size for age</td>
</tr>
</tbody>
</table>

4. Check the proper positioning of tube in the stomach by air insufflation and/or aspiration with pH testing of aspirate.
5. Instil and lavage with lukewarm or tepid water or normal saline. Repeat until the return flow is clear.
   Volume of fluid:  
   Adult 100-300 mL
   Child: 10 mL/kg

Contraindications to gastric lavage include:
- Depressed sensorium with unprotected airway, because of the possibility of aspiration
- Ingestion of corrosive substances, because of the danger of perforation
- Ingestion of hydrocarbons (unless a more toxic substance is combined with the hydrocarbon such as a pesticide), because of the possibility of aspiration
- Presence of frank convulsions, because of the possibility of aspiration
- Patients at risk of haemorrhage or gastrointestinal perforation
- Uncooperative patient, because the tube can injure the gastrointestinal tract

Complications of gastric lavage include:
- Aspiration pneumonia
- Laryngospasm
- Hypoxia and hypercapnia
- Mechanical injury to the throat, oesophagus and stomach
- Fluid and electrolyte imbalance

3.2.3 Induction of emesis
Induction of emesis is usually performed by the administration of syrup of ipecac. However, according to the AACT/EAPCCT Position Statement (2004)\(^3\) ipecac should no longer routinely be recommended in the management of poisoned patients for the following reasons:

- There is no evidence from clinical studies that syrup of ipecac improved patient outcomes
- Because it can cause prolonged vomiting, this may delay by 1-2 hours the administration of activated charcoal, oral antidotes and whole bowel irrigation

Contraindications to induction of emesis include:
- Depressed sensorium or impending loss of consciousness, because of possible aspiration
- Impaired gag reflex, because of possible aspiration
- Late pregnancy, because it may induce labour
- Presence of cardiac disease and aneurysm, because of possibility of development of arrhythmias
- Ingestion of corrosive substances, hydrocarbons, convulsants, emetic and arrhythmogenic agents, because the ipecac can aggravate the patient’s condition
• Debilitated, elderly patients or medical conditions that may be further compromised by the induction of emesis

Complications of the use of ipecac include:
• Diarrhoea
• Lethargy / drowsiness
• Prolonged (greater than 1 hour) vomiting
• Pulmonary aspiration

3.2.4 Cathartics
Cathartics, also known as laxatives or purgatives, have been used in the belief that they decrease absorption of poisons by accelerating their expulsion from the gastrointestinal tract. However, published clinical studies have not shown the efficacy of cathartics, with or without activated charcoal, in reducing bioavailability of drugs or improving patient outcome.

The review carried out by the AACT/EAPCCT (2004) concluded that there were no definite indications for the use of cathartics, but if they were used only a single dose should be given, in order to minimize the risk of adverse effects. Furthermore, the routine use of cathartics in combination with single-dose activated charcoal was not endorsed.

Most of the cathartics used in the management of poisoned patients are osmotic cathartics. The saccharides, such as sorbitol, produce their effects by hygroscopically attracting water into the gastrointestinal lumen from the splanchnic circulation. On the other hand, saline cathartics, such as sodium sulphate and magnesium citrate, act by altering physico-chemical factors within the intestinal lumen. They have also been found to increase gastrointestinal motility by stimulating gastrointestinal hormones or acting on the myenteric plexus and other gastrointestinal nerves.

Contraindications to the use of cathartics include:
• Absent bowel sounds/paralytic ileus
• Recent abdominal trauma
• Recent bowel surgery
• Intestinal obstruction or intestinal perforation
• Ingestion of corrosive substances
• Severe fluid and electrolyte imbalances
• Extremes of age

In addition:
• Sodium-containing cathartics are contraindicated in patients with congestive heart failure, severe hypertension and renal failure

• Magnesium-containing cathartics are contraindicated in patients with renal impairment and central nervous system depression
Complications of using cathartics include:
- Abdominal cramps, nausea, vomiting
- Transient hypotension
- Dehydration
- Hypernatraemia
- Hypomagnesaemia

3.2.5 Whole bowel irrigation
Whole bowel irrigation utilizes electrolyte-balanced, inert solutions such as polyethylene glycol-electrolyte solution to induce a liquid stool. It is used to expel poisons that are poorly adsorbed by activated charcoal and also sustained-release and enteric-coated drugs. It is also useful as an enhanced elimination technique if tablets have passed beyond the pylorus. The AACT/EAPCCT review (2004) has concluded that whole bowel irrigation could have potential value in a limited number of toxic ingestions, for example sustained-release or enteric-coated drugs, iron preparations and packets of illicit drugs.

There are no established indications for the use of whole bowel irrigation, nor is there conclusive evidence showing that this procedure improves patient outcome. Thus, whole bowel irrigation should not be used routinely.

Procedure:
The polyethylene glycol-electrolyte solution is continuously administered, either orally or through a nasogastric tube until the rectal effluent is clear. This procedure usually takes 2-6 hours.

Children
- 9 months – 6 years: 500 mL/hour
- 6 –12 years: 1,000 mL/hour
Adolescents and adults: 1,500 – 2,000 mL/hour

Contraindications include:
- Bowel obstruction
- Bowel perforation
- Paralytic ileus
- Compromised, unprotected airways
- Haemodynamic instability

Complications include:
- Abdominal cramps, nausea, vomiting
- Bloating/abdominal distension
- Electrolyte imbalance when incorrectly formulated mixture has been used
4. Techniques Used to Enhance Elimination of Poisons

4.1 Multiple dose activated charcoal

Multiple dose activated charcoal (MDAC) is useful for the following purposes:
- pre-absorptive enhancement of elimination
- post-absorptive enhancement of elimination or gut dialysis, and
- interruption of enterohepatic recirculation.

The recommendations presented here are based upon the AACT/EAPCCT position statement (1999)^6^.

Preabsorptive enhancement of elimination

Drugs that decrease gastrointestinal motility (e.g. anticholinergics), sustained-release agents and medicines that are poorly or erratically absorbed when taken in overdose (e.g. phenytoin) will theoretically benefit from administration of multiple doses of activated charcoal.

Gut dialysis

A number of drugs (e.g. barbiturates, theophylline, aspirin, phenytoin, atenolol) have the capability of diffusing across the mucous membranes of the gastrointestinal tract back into the gut lumen, adsorbing to the charcoal and eventually being excreted in the stools. Most of these drugs are lipophilic and have small volumes of distribution (< 1 L/kg), low protein binding (< 70-80%), and long half-lives.

Interruption of enterohepatic recirculation

Enterohepatic recirculation is the phenomenon by which drugs emptied through the bile into the small intestine can be reabsorbed from the intestinal lumen into the systemic circulation. When reaching the distal ileum, bacterial flora convert the parent drug and its active metabolites back into lipophilic states when they are reabsorbed along with the bile acids. Multiple dose activated charcoal will bind the drug when it reaches the gut and prevent reabsorption.

Multiple dose activated charcoal has been shown to be effective in poisoning secondary to:
- carbamazepine
- dapsone
- phenobarbital
- quinine
- theophylline

Possible benefits are observed in the following drugs:
- amitriptyline
- dextropropoxyphene
- digitoxin and digoxin
- disopyramide
- nadolol
- phenylbutazone
• phenytoin
• piroxicam
• sotalol

**Dosage:**
The effective dose has not yet been established by prospective studies but a typical regimen is 50-100g initially, followed by hourly, 2 hourly or 4 hourly doses equating to a rate of 12.5g per hour. Lower doses (10-25g) of activated charcoal should be given to children under 5 years.

**Complications** include:
- Insipidation of charcoal in the gut
- Gut obstruction/perforation
- Bowel infarction
- Pulmonary aspiration

**NOTE:** The need for a cathartic remains unproven, but if it is considered necessary only one dose should be given. If constipation sets in after activated charcoal is discontinued, cathartic administration may be required.

**4.2 Urinary alkalization therapy**
The 2004 AACT/EAPCCT Position Statement² still supports urinary alkalization as a method for increasing elimination of selected toxins.

Increasing the pH of fluids in the renal tubules by the administration of sodium bicarbonate increases the degree of ionization of weak acids and reduces their passive reabsorption. This is known as ion-trapping. Since ionized substances remain in the renal tubules their elimination is enhanced. Examples of these weakly acidic substances are chlorpropamide, 2,4-dichlorophenoxyacetic acid (2,4-D), diflunisal, fluoride, mecoprop, methotrexate, phenobarbital, and salicylates.

**Dosage:**
8.4% Sodium bicarbonate: 225 mmol (225 mL) in adults or 25-50 mmol (25 mL) in children given intravenously over one hour. Subsequent doses are given to titrate urine pH within 7.5-8.5. Monitor arterial blood gases, electrolytes and central venous pressure.

**Complications** of urinary alkalization include:
- Hypernatraemia
- Hypokalaemia
- Metabolic alkalosis

**4.3 Urinary acidification therapy**
This is not recommended because it can produce metabolic acidosis, rhabdomyolysis and renal failure.
4.4 Extracorporeal elimination
Haemodialysis and haemoperfusion can be used to enhance elimination of poisons such as ethylene glycol and methanol. These are invasive procedures and the decision to use them involves an analysis of risks and benefits. Considerations for their use would include the following:

- Severe poisoning with depression of midbrain function
- Impairment of normal excretory function in the presence of hepatic, cardiac and/or renal insufficiency
- Poisoning with agents producing metabolic acidosis and/or delayed effects
- Poisoning with agents that can be removed at a rate exceeding that of endogenous elimination by the liver or the kidneys
- Acute renal failure

4.4.1 Haemodialysis
Haemodialysis is effective for drugs that are not water soluble, with a small volume of distribution, low protein binding, and low molecular weight (<500 daltons).

Complications include: hypotension, bleeding, nosocomial infection and air embolism.

4.4.2 Haemoperfusion
This technique involves passing blood through a filter in the form of a column or cartridge containing activated charcoal or a synthetic resin. For its efficiency, haemoperfusion is dependent on the physical process of drug adsorption and not on water solubility. This technique is more efficient than haemodialysis in removing poisons. However, the charcoal filters are not readily available and there is a greater risk of the development of complications compared to the other methods.

Complications include: hypotension, bleeding, nosocomial infection, air embolism, leucopenia, thrombocytopenia and hypocalcaemia.

4.4.3 Haemodiafiltration
This procedure combines continuous haemodialysis and haemoperfusion. Its advantage over other methods is that it does not produce a rebound phenomenon with the drug being eliminated.

5. Supportive Management
Supportive care is important in the management of a poisoned patient, especially when intensive care admission is required. The following measures should be instituted:

- Monitor vital signs (blood pressure, heart rate, respiratory rate, temperature)
- Monitor fluid input and output
- Monitor level of consciousness, pattern of breathing and regularity of the heart rate
- Monitor oxygen saturation using a pulse oximeter
• Administer intravenous fluids for maintenance and fluid loss replacement
• Carry out intensive nursing care to avoid aspiration or the development of bed sores
• Treat metabolic disturbances such as electrolyte abnormalities, hypoglycaemia and metabolic acidosis
• Manage underlying illnesses that may be aggravated by existing problem of poisoning
• Use specific antidotes if indicated

Practice
When reading treatment protocols during training take time to familiarise yourself with the indications and contraindications for different methods of gut decontamination and other forms of decontamination for each substance. Whether to use gut decontamination is a question that you will frequently be asked during poisons calls.

Summary
This chapter discusses the different techniques employed in the management of a poisoned patient with the goal of preventing absorption of a poison and enhancing its elimination. The emergency stabilization of a poisoned patient is included as an essential component of management. The chapter also emphasizes the contraindications and complications of the techniques used in the management of poisoning cases.

Student Test

CASE STUDY 1:
A 30-year old female was brought to the emergency room with diarrhoea and dizziness. History revealed that 50 minutes previously she took approximately 50 mL of organophosphate (OP) pesticide. Physical examination revealed an awake patient with vital signs of BP=100/70, HR=50/minute, RR=20/minute, T=37.5°C. Other pertinent findings included: pinpoint pupils, clear breath sounds, hyperactive bowel sounds.

QUESTIONS:
1. What would be the initial considerations when advising on managing this patient?
2. List the emergency problem(s) of the patient and what advice would you give on management?
3. What would be the best technique to prevent absorption of the poison?
4. Would the patient benefit from emesis? From gastric lavage?
5. Would you recommend enhancing elimination of the chemical?
CASE STUDY 2:
A 5-year old male was rushed to the emergency room with coma. History revealed that 2 hours prior to admission, the boy was found lying on the bedroom floor with an empty bottle of Phenobarbital lying by his side. Vital signs showed a BP=60/40, HR=100/minute, shallow respiration, temperature=36 ºC. Patient was comatose with pupils measuring 3 mm.

QUESTIONS:
1. What would be the initial considerations when advising on managing this patient?
2. List the emergency problem(s) of the patient and how would you advise on management?
3. What would be the best technique to prevent absorption of the poison?
4. Would you recommend enhancing elimination of the drug?
5. Is there an antidote?

CASE STUDY 3:
A 20-year old, 70 kg man, was brought to the emergency room because of intentional ingestion of 100 x 500mg tablets of paracetamol (acetaminophen). History revealed that 4 hours prior to admission, he had an argument with his wife. Thirty minutes prior to admission, after visiting his child who is confined in the hospital, he took the paracetamol tablets. He immediately went to the emergency room when he felt nauseated.

While in the emergency room, he experienced abdominal pain and one episode of vomiting. Vital signs were essentially stable. Except for a slight epigastric tenderness, the rest of the physical findings were normal.

QUESTIONS:
1. What would be the initial considerations when advising on managing this patient?
2. List the emergency problem(s) of the patient and how would you advise on management?
3. What would be the best technique to prevent absorption of the poison?
4. Would you recommend enhancing elimination of the drug?
5. Is there an antidote?
References and additional reading

American Academy of Clinical Toxicology (AACT), European Association of Poisons Centres and Clinical Toxicologists (EAPCCT) Position Statements:

2. Position Paper: Gastric Lavage. *Journal of Toxicology Clinical Toxicology*, 2004; 42(7):933-944

Other background reading:


**Author(s)**
Dr Lynn Panganiban, Director, National Poison Control & Information Service, Philippines General Hospital.

Peer reviewed by members of the IPCS INTOX Poisons Centre Training Manual Working Group (R Awang, K Bakjaji, A Laborde, E Clarke, M Colbridge, W Daelman, A Dines, D Gotelli, M Hermanns-Clausen, T Jovaisa, J de Kom, M Kunde, I Makalinao, W Malas, R McKeown, M Mostin, D Pelclová, H Persson, L Pinto Pereira, U Stedtler, W Temple)

Written for the INTOX Programme of the International Programme on Chemical Safety, World Health Organization, Geneva, Switzerland.

Objectives

On completing this chapter, you should be able to:

- Explain the purpose and scope of the GHS
- Discuss the basic principles of classification under the GHS
- Identify the UN diamond shaped warning labels of the GHS
- Explain why the GHS is relevant to poisons centres
- Recognize the categories of information that can be found on a product label
- Become familiar with the contents of safety data sheets

Overview of the chapter

This chapter describes the purpose of the Globally Harmonized System of Classification and Labelling of Chemicals and the background to its development. It also highlights why the GHS is relevant to poisons centres. An outline of the principles for classifying the hazards of chemicals and products is provided, together with a worked example. The chapter also explains the communication elements used to convey information to the user about the hazards and the protective measures that should be taken to ensure that the chemical/product is used safely. Finally information is provided about sources
of internationally agreed GHS classifications of chemicals.

Subject content

Introduction
The Globally Harmonized System of Classification and Labelling of Chemicals (GHS) is an international system for the hazard classification of chemicals and products and for the provision of information to the users of chemicals and products about those hazards and about measures for safe use. It provides a logical and comprehensive approach to:

- defining the health, physical and environmental hazards of chemicals;
- creating classification processes that use available data on chemicals for comparison with defined hazard criteria; and
- communicating hazard information, as well as protective measures, on labels and Safety Data Sheets (SDS).

The GHS also provides a basis for the harmonization of rules and regulations on chemicals at national, regional and worldwide level, which is an important factor for facilitating trade.

The GHS provides countries with the regulatory building blocks to develop or modify existing national programs that address the classification of hazards, and transmittal of information about those hazards and associated protective measures. This helps to ensure the safe use of chemicals as they move through the product lifecycle from "cradle to grave" (Fig 1).

The GHS covers all hazardous chemical substances and mixtures with the exception of formulated pharmaceuticals, food additives, cosmetics and pesticide residues in food.

The target user groups for the GHS are people who work
with chemicals and chemical products, consumers, transport workers, emergency responders and the sections of the health sector that provide emergency care or who advise on chemical exposures, such as poisons centres.

**Historical background of the GHS**

The work on the elaboration of the GHS began with the premise that existing systems should be harmonized in order to develop a single, global system to address the classification of chemicals, and provision of information on labels and safety data sheets. This was not a totally novel concept since harmonization of classification and labelling was already largely in place for physical hazards and acute toxicity in the transport sector, based on the work of the United Nations Economic and Social Council's Committee of Experts on the Transport of Dangerous Goods (UNSCETDG).

Harmonization had not, however, been achieved in the workplace or consumer sectors, and transport requirements in many countries were not harmonized with those of other sectors.

Chapter 19 of Agenda 21, adopted at the UN Conference on Environment and Development (UNCED, 1992), provided the international mandate to complete the task of harmonization. The work was coordinated and managed under the auspices of the Inter-Organization Programme for the Sound Management of Chemicals (IOMC) Coordinating Group for the Harmonization of Chemical Classification Systems (CG/HCCS). The technical focal points for completing the work were divided between IOMC members as follows:

- hazard communication - the International Labour Organization (ILO);
- classification of health and environmental hazards - the Organisation for Economic Cooperation and Development (OECD);
- physical hazards - UNSCETDG and the ILO.

The UN Sub-Committee of Experts on the GHS (GHS Sub-Committee) is responsible for monitoring the use of the GHS and its periodic revisions.

In its Plan of Implementation adopted in Johannesburg on 4 September 2002, the World Summit on Sustainable Development (WSSD) encouraged countries to implement the GHS as soon as possible with a view to having the system fully operational by 2008. Information on the current status of implementation is available at [http://www.unece.org/trans/danger/publi/ghs/implementation_e.html](http://www.unece.org/trans/danger/publi/ghs/implementation_e.html)
GHS Classification
Classification is the starting point for hazard communication. It involves the
identification of the hazard(s) of a chemical or mixture by assigning a category of
hazard/danger using defined criteria. The GHS includes classification criteria and
standardized hazard communication elements for physical hazards, health hazards, and
environmental hazards. The specific types of hazards classified are listed below.

Physical Hazard Classes
1. Explosives
2. Flammability – gases, aerosols, liquids, solids
3. Oxidizers – liquids, solids, gases
4. Self-Reactive
5. Pyrophoric – liquids, solids
6. Self-Heating
7. Organic Peroxides
8. Corrosive to Metals
9. Gases Under Pressure
10. Water activated flammable gases

Health Hazard Classes
1. Acute Toxicity
2. Skin Corrosion/Irritation
3. Serious Eye Damage/Eye Irritation
4. Respiratory or Skin Sensitization
5. Germ Cell Mutagenicity
6. Carcinogenicity
7. Reproductive Toxicity
8. Target Organ Systemic Toxicity – single and repeated exposure
9. Aspiration Hazard

Environmental Hazard Classes
1. Hazardous to the Aquatic Environment – short-term (acute) and long-term
   (chronic)
2. Hazardous to the Ozone Layer

Each class is assigned a category of hazard that represents its severity. For example, for
acute toxicity, substances are assigned to one of the five toxicity categories on the basis
of LD$_{50}$ (oral, dermal) or LC$_{50}$ (inhalation). This is illustrated in Table 1, below.
Table 1: Acute toxicity hazard categories showing numeric cut-off criteria for each category\(^1\)

<table>
<thead>
<tr>
<th>Exposure route</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
<th>Category 4</th>
<th>Category 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral (mg/kg body wt)</td>
<td>5</td>
<td>50</td>
<td>300</td>
<td>2000</td>
<td>5000</td>
</tr>
<tr>
<td>Dermal (mg/kg body wt)</td>
<td>50</td>
<td>200</td>
<td>1000</td>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>Gases (ppmV)</td>
<td>100</td>
<td>500</td>
<td>2500</td>
<td>20000</td>
<td>See detailed notes in GHS manual</td>
</tr>
<tr>
<td>Vapours (mg/L)</td>
<td>0.5</td>
<td>2.0</td>
<td>10</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Dusts &amp; mists (mg/L)</td>
<td>0.05</td>
<td>0.5</td>
<td>1.0</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

It is the intrinsic nature of the chemical that determines its GHS classification. The source data for GHS classification is mainly animal test data - in many cases this can be found in published sources such as Screening Information Data Sets (SIDS). Access to the SIDS and to a wide range of other data on the properties and toxicity of chemicals can be found through the eChemPortal (http://www.echemportal.org/echemportal/index?pageID=0&request_locale=en).

A worked example for the classification of methanol is given below, based primarily on data in the SIDS initial assessment profile (http://webnet.oecd.org/Hpv/UI/handler.axd?id=840a5b21-432b-488a-842c-283939c16175). NB this is not a definitive classification but is provided as an illustration. Normally when classifying a chemical you would check multiple sources of data.

*Methanol has the following \(LD_{50}\) or \(LC_{50}\) values:*
- Oral = 790 to 13,000 mg/kg bw in the rat;
- Inhalation of vapour = 83.2 to 128.8 mg/L in the rat
- Dermal = 15,800 to 20,000 mg/kg bw in the rabbit.

*Taking the lowest values this corresponds to:*
- Acute oral toxicity - Category 4
- Acute inhalation toxicity – unclassified
- Acute dermal toxicity - unclassified

*Methanol was found on testing to cause moderate skin irritation and slight eye irritation with some reversibility of effects. Skin sensitization tests were negative. Mutagenicity and carcinogenicity tests were negative. Rodent data suggest that*

---

\(^1\) (adapted from Table 3.1.1 in GHS Manual Rev 5, p 111)
methanol causes developmental toxicity. This corresponds to:

- Skin corrosion/irritation Category 3 or unclassified
- Eye damage/irritation Category 2B
- Toxic to reproduction Category 1B

Acute exposure to methanol can cause CNS depression, retinal damage, acid-base disruption, irritation of the respiratory and gastrointestinal tracts. Repeated exposure can cause nerve damage, including to the optic nerve, liver fibrosis and fatty degeneration, and kidney damage. This corresponds to:

- Specific target organ toxicity on single exposure Category 1
- Specific target organ toxicity on repeated exposure Category 1

The flash point of methanol is 15.6, which corresponds to a classification of flammable liquid category 2.

Detailed guidance on how to classify chemicals and mixtures is provided in the GHS Manual, which can be downloaded from [http://www.unece.org/trans/danger/publi/ghs/ghs_rev05/05files_e.html](http://www.unece.org/trans/danger/publi/ghs/ghs_rev05/05files_e.html)

**GHS Hazard communication**

Once a chemical or product has been classified as having one or more hazards, the hazard(s) must be communicated to the target audiences. Labels and Safety Data Sheets are the main tools for chemical hazard communication. They convey information on the health, physical and/or environmental hazards that the chemical or product may pose during normal handling or use.

These communication elements are also harmonized, and include specified wording and easily understandable symbols. This facilitates the translation of the communication elements into multiple languages. The communication elements that should be shown on labels and safety data sheets are as follows:

- Symbols/pictograms;
- Signal word
- Hazard statements
- Product identifier
- Supplier identifiers
- Precautionary statements

In addition, supplemental information can be provided to give more detail or cover
additional hazards, provided this does not undermine the core GHS information.

**Symbols/pictograms**
The pictograms for physical hazards are modelled on those already in use under the UN Model Regulations for the Transportation of Hazardous Goods. The pictograms and the corresponding hazard classes are shown in Annex 1 of this document, while those for the UN Model Regulations for the Transportation of Hazardous Goods are shown in Annex 2. The latter continue to be used for goods in transport and the outer packaging of these goods will show a transportation pictogram rather than a GHS pictogram.

**Signal Words**
The signal word indicates the relative degree of severity of a hazard. The signal words used in the GHS are:

"Danger" for the more severe hazards, and
"Warning" for the less severe hazards.

Signal words are standardized and assigned to the hazard categories within endpoints. Some lower level hazard categories do not use signal words. Only one signal word corresponding to the class of the most severe hazard should be used.

**Hazard Statements**
Hazard statements are standardized and assigned phrases that describe the hazard(s) as determined by the hazard classification. An appropriate statement for each GHS hazard should be included on the label and safety data sheets for chemicals and products. The assigned label elements are provided in each hazard chapter of the GHS manual. The table below illustrates the assignment of standardized GHS label elements for the acute oral toxicity categories.

**Table 2: GHS hazard labelling elements for Acute Oral Toxicity**

<table>
<thead>
<tr>
<th>ACUTE ORAL TOXICITY</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
<th>Category 4</th>
<th>Category 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>LD&lt;sub&gt;50&lt;/sub&gt; (mg/kg body weight)</td>
<td>&lt;5</td>
<td>&gt;5 ≤50</td>
<td>&gt;50 ≤300</td>
<td>&gt;300 ≤2000</td>
<td>&gt;2000 ≤5000</td>
</tr>
<tr>
<td>Signal word</td>
<td>Danger</td>
<td>Danger</td>
<td>Danger</td>
<td>Warning</td>
<td>Warning</td>
</tr>
<tr>
<td>Hazard statement</td>
<td>Fatal if swallowed</td>
<td>Fatal if swallowed</td>
<td>Toxic if swallowed</td>
<td>Harmful if swallowed</td>
<td>May be harmful if swallowed</td>
</tr>
</tbody>
</table>
Although GHS classification and labelling is based on the intrinsic properties of the product, special provision is made for labelling consumer products. For acute health hazards the classification must be based on the intrinsic hazard, however, competent authorities may classify chronic hazards through an assessment of the risk of harmful effects from exposure. Further information can be found in Annex 5 of the GHS Manual.

**Precautionary statements**
A precautionary statement means a phrase (and/or pictogram) that describes the recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure to a hazardous product, or from the improper storage or handling of a hazardous product. This includes aspects of prevention, response in cases of accidental spillage or exposure, safe storage, and disposal. The GHS-compliant label should include appropriate precautionary information, the choice of which is with the labeller or the competent authority. The aim of precautionary statements is to protect users from adverse effects.

The use of precautionary response statements such as “Immediately call a POISON CENTRE or doctor/physician” following a toxic exposure assumes that a poison centre will have the information on the product necessary to give an adequate response. It is therefore important for poison centres to have access to product information, particularly on the ingredients and relevant health data.

Precautionary statements include first-aid advice; this should be applicable to an untrained responder without sophisticated equipment. Poison centres may be contacted by manufacturers of hazardous substances to give advice on appropriate first-aid procedures.

**GHS Label Elements**
An illustration of the various elements that can appear on a GHS-compliant label is given in Annex 3. A mock-up of a label for methanol is given in Fig 2, showing the signal word, hazard statements, hazard pictograms, and precautionary information.
### Fig 2 Mock-up of a GHS label for a methanol container

<table>
<thead>
<tr>
<th>Methanol</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DANGER</strong></td>
</tr>
<tr>
<td>Highly flammable liquid and vapour</td>
</tr>
<tr>
<td>Harmful if swallowed</td>
</tr>
<tr>
<td>Causes mild skin irritation</td>
</tr>
<tr>
<td>Causes eye irritation</td>
</tr>
<tr>
<td>May damage fertility or the unborn child</td>
</tr>
<tr>
<td>May cause respiratory irritation</td>
</tr>
<tr>
<td>May cause drowsiness or dizziness</td>
</tr>
<tr>
<td>Causes damage to the optic nerves and systemic toxicity by ingestion</td>
</tr>
<tr>
<td>Causes damage to the liver and kidneys through prolonged or repeated exposure</td>
</tr>
<tr>
<td>Keep away from heat/sparks/open flame – No smoking</td>
</tr>
<tr>
<td>Use only non-sparking tools</td>
</tr>
<tr>
<td>Keep container tightly closed. Use only in well ventilated areas</td>
</tr>
<tr>
<td>Ground/Bond container and receiving equipment</td>
</tr>
<tr>
<td>Use explosion-proof electrical/ventilating/lighting equipment</td>
</tr>
<tr>
<td>Take precautionary measures against static discharge</td>
</tr>
<tr>
<td>IF ON SKIN (or hair): Remove immediately all contaminated clothing</td>
</tr>
<tr>
<td>Obtain special instructions before use.</td>
</tr>
<tr>
<td>Do not handle until all safety precautions have been read and understood.</td>
</tr>
<tr>
<td>Use personal protective equipment as required.</td>
</tr>
<tr>
<td>Do not breathe mist/vapours/spray.</td>
</tr>
<tr>
<td>Do not eat, drink or smoke when using this product</td>
</tr>
<tr>
<td>Wash hands thoroughly after handling</td>
</tr>
<tr>
<td>IF exposed or concerned: Get medical attention/advice</td>
</tr>
<tr>
<td>IF SWALLOWED: Immediately call a POISON CENTER. Rinse mouth.</td>
</tr>
<tr>
<td>If skin irritation occurs, get medical advice</td>
</tr>
<tr>
<td>IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.</td>
</tr>
<tr>
<td>If eye irritation persists, get medical advice/attention.</td>
</tr>
</tbody>
</table>

Company name, address, telephone number

---

### Safety Data Sheet (SDS)

The (Material) Safety Data Sheet (SDS) provides comprehensive information for use in workplace chemical management. Employers and workers use the SDS as a source of information about hazards and to obtain advice on safety precautions. The SDS is product-related and, usually, is not able to provide information that is specific for any given workplace where the product may be used. However, the SDS information enables the employer to develop a programme of worker protection measures, including training, which is specific to the individual workplace, and to consider any measures that may be necessary to protect the environment. Information in a SDS also provides a source of information for other target audiences such as those involved with the GHS - Trainee’s version
transport of dangerous goods, emergency responders, poison centres and health-care workers treating exposed patients. Most consumer products are not supplied with SDS and consumers, therefore, rely upon the information on the label.

The SDS contains 16 headings, which are listed below. The SDS should provide a clear description of the data used to identify the hazards.

**Minimum information for a SDS**

1. **Identification of the substance or mixture and of the supplier**
   - GHS product identifier
   - Other means of identification
   - Recommended use of the chemical and restrictions on use
   - Supplier’s details (including name, address, phone number, etc.)
   - Emergency phone number

2. **Hazard identification**
   - GHS classification of the substance/mixture and any national or regional information
   - GHS label elements: signal word(s), hazard statement(s) and precautionary statements. Pictograms may be provided as images or as the name of the symbol, e.g. “flame”, “skull and crossbones”.
   - Other hazards that do not result in classification (e.g. dust explosion hazard) or are not covered by the GHS

3. **Composition/information on ingredients**
   **Substance:**
   - Chemical identity.
   - Common name, synonyms, etc.
   - CAS number, EC number, etc.
   - Impurities and stabilizing additives that are themselves classified and which contribute to the classification of the substance.
   **Mixture:**
   - The chemical identity and concentration or concentration ranges of all ingredients that are hazardous within the meaning of the GHS and are present above their cut-off levels.

**NOTE:** For information on ingredients, the competent authority rules for confidential business information take priority over the rules for product identification.
4. First-aid measures
   • Description of necessary measures, subdivided according to the different
     routes of exposure, i.e. inhalation, skin and eye contact, and ingestion.
   • Most important symptoms/effects, acute and delayed.
   • Indication of the need for immediate medical attention and special
     treatment, if applicable.

5. Fire-fighting measures
   • Suitable (and unsuitable) extinguishing media.
   • Specific hazards arising from the chemical such as hazardous combustion
     products.
   • Special protective equipment and precautions for fire-fighters.

6. Accidental release measures
   • Personal precautions, protective equipment and emergency procedures.
   • Environmental precautions.
   • Methods and materials for containment and cleaning up.

7. Handling and storage
   • Precautions for safe handling.
   • Conditions for safe storage, including any incompatibilities.

8. Exposure controls/personal protection
   • Control parameters, e.g. occupational exposure limit values or biological limit
     values.
   • Appropriate engineering controls.
   • Individual protection measures, such as personal protective equipment.

9. Physical and chemical properties
   • Appearance (physical state, colour, etc.)
   • Odour
   • Odour threshold
   • pH
   • Melting point/freezing point
   • Initial boiling point and boiling range
   • Flash point
   • Evaporation rate
   • Flammability (solid, gas)
   • Upper/lower flammability or explosive limits
   • Vapour pressure
   • Vapour density
• Relative density
• Solubility(ies)
• Partition coefficient: n-octanol/water
• Autoignition temperature
• Decomposition temperature

10. Stability and reactivity
• Chemical stability
• Possibility of hazardous reactions
• Conditions to avoid (e.g., static discharge, shock or vibration)
• Incompatible materials
• Hazardous decomposition products

11. Toxicological information
Concise but complete and comprehensible description of the various toxicological (health) effects and the available data used to identify those effects, including:
• Information on the likely routes of exposure (inhalation, ingestion, skin and eye contact)
• Symptoms related to the physical, chemical and toxicological characteristics
• Immediate and delayed effects, and also chronic effects from short- and long-term exposure
• Numerical measures of toxicity (such as acute toxicity estimates)

12. Ecological information
• Ecotoxicity (aquatic and terrestrial, where available)
• Persistence and degradability
• Bioaccumulative potential
• Mobility in soil
• Other adverse effects

13. Disposal considerations
• Description of waste residues and information on their safe handling and methods of disposal, including the disposal of any contaminated packaging.

14. Transport information
• UN Number
• UN Proper shipping name
• Transport Hazard class(es)
• Packing group, if applicable
• Marine pollutant (Yes/No)
• Special precautions that a user needs to be aware of or needs to comply with
in connection with transport or conveyance either within or outside their premises.

15. Regulatory information
   • Safety, health and environmental regulations specific for the product in question.

16. Other information including information on date of preparation and revision of the SDS

International sources of information on GHS classifications

*International Chemical safety Cards (ICSCs)*
ICSCs provide essential health and safety information on chemicals to promote their safe use. They are developed in a joint activity by the World Health Organization and the International Labour Organization. The ICSCs are similar in content to a safety data sheet, but provide information in a more summarized form. They undergo international peer review by specialists in toxicology and occupational health and are therefore authoritative documents. Since 2006 the ICSCs have included GHS classifications.

A full list of ICSCs can be found at [http://www.inchem.org/pages/icsc.html](http://www.inchem.org/pages/icsc.html) and on the ILO website at [http://www.ilo.org/dyn/icsc/showcard.home](http://www.ilo.org/dyn/icsc/showcard.home). Many ICSCs have been translated into other languages and links to these translations can be found on the ILO website.

*European Union*
Within the European Union, GHS classifications can be found in the *Regulation on classification, labelling and packaging of substances and mixtures* (the CLP regulation)\(^2\), part 3 of Annex VI. There is a procedure for the revision of these classifications, managed by the European Chemicals Agency (ECHA).

Relevance of the GHS to poison centres
The GHS is relevant to the work of the poison centre in a number of ways. The information that must be included on product labels and in SDS about health hazards and precautionary measures provides a guide about the nature of the product and the types of management advice that should be given to the caller if more detailed information on composition is unavailable. Moreover, the standardised way in which this information is presented makes it more accessible even if it is in a foreign language.

Since the supplier’s identity and contact details must also be provided there is the possibility of obtaining more precise information about the product.

The label and SDS may include advice to contact a poison centre following exposure. Ideally, of course, the manufacturer should couple this advice with the provision of the necessary information to the poisons centre. Some poisons centres are able to charge a fee to manufacturers to register their products. If, as sometimes happens, the poisons centre identifies that the toxicity or first-aid information on a product label or SDS is incorrect the poisons centre should notify the manufacturer. Checking this information on SDS may provide the poisons centre with an opportunity for income generation.

**Practice**

You could examine the labels and SDS of a range of products and identify whether the elements of information provided (warning words, hazard statements, pictograms etc) are GHS compliant.

**Summary**

The GHS is an internationally harmonized system for the hazard classification of chemicals and products and for the provision of information to the users of chemicals and products. Information is provided on labels and on safety data sheets, and this information is conveyed using a set of standard words, phrases and pictograms. The purpose of the information is to guide the user about the hazards and safe use of the chemical or product concerned.

The GHS does not cover formulated pharmaceuticals, food additives, cosmetics and pesticide residues in food.

**Student Test**

1. **What is the GHS?**

2. **What hazards of a chemical are used for the GHS classification criteria?**

3. **What hazards do these GHS pictograms represent?**
4. What is a precautionary statement?

5. What signal word is featured in the following GHS label.

<table>
<thead>
<tr>
<th>2 – Methyl Flammable</th>
<th>DANGER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highly flammable liquid and vapour</td>
</tr>
<tr>
<td></td>
<td>Harmful if swallowed</td>
</tr>
<tr>
<td></td>
<td>May cause cancer</td>
</tr>
<tr>
<td></td>
<td>Keep away from heat, sparks and flame – No smoking</td>
</tr>
<tr>
<td></td>
<td>Keep container closed. Use only in well ventilated areas.</td>
</tr>
<tr>
<td></td>
<td>Wash hands thoroughly after handling. Avoid contact.</td>
</tr>
</tbody>
</table>

ABC Chemical Co. 302 David Road, Dunedin 0800 – 450879

6. To what sections of a Safety Data Sheet could poison centres readily contribute, in assisting companies wishing to compile a SDS.

Materials and Resources

Comprehensive information on the GHS can be found on the website of the United Nations Economic Commission for Europe (UNECE) [http://www.unece.org/trans/danger/publi/ghs/ghs_welcome_e.html](http://www.unece.org/trans/danger/publi/ghs/ghs_welcome_e.html)

Additional materials on hazard communication and the GHS in a range of languages can be found on the UNITAR website [http://www2.unitar.org/cwm/publications/cbl/ghs/index.htm](http://www2.unitar.org/cwm/publications/cbl/ghs/index.htm).
Author(s)

Dr Wayne Temple, National Poisons Centre, Dunedin, New Zealand


Updated in October 2013 to reflect Revision 5 of the GHS

Reviewers:
Dr Aruna Dewan, Centre for Education, Awareness and Research on Chemicals and Health, Ahmedabad, India
Ms Alison Dines, Guy's & St Thomas' Poisons Unit, London, UK
Ms Haslina Hashim, National Poison Centre, Penang, Malaysia
Dr Jonas Höjer, Swedish Poisons Information Centre, Stockholm, Sweden
Ms Carine Marks, Tygerberg Poison Information Centre, Cape Town, South Africa
Dr Robert Nyrango, Drug & Poisons Information Centre, Nairobi, Kenya
Dr Lynn Panganiban, National Poison Management & Control Center, Manila Philippines
Dr Mark Personne, Swedish Poisons Information Centre, Stockholm, Sweden
Dr Hans Persson, Swedish Poisons Information Centre, Stockholm, Sweden
Dr V V Pillay, Poison Control Centre, Cochin, India
Dr Juan Carlos Rios Bustamante, Centro de Información Toxicológica Universidad Católica de Chile, Santiago, Chile
Dr Rachida Soulaymani Bencheikh, Centre Anti-Poisons du Maroc et de Pharmacovigilance, Rabat, Morocco
Ms Joanna Tempowski, World Health Organization, Geneva, Switzerland

Written for the INTOX Programme of the International Programme on Chemical Safety, World Health Organization, Geneva, Switzerland. The financial support of the Swedish Chemicals Agency (KemI) for the production of this chapter is gratefully acknowledged.
### Annex 1

#### GHS Pictograms and Hazard Classes

<table>
<thead>
<tr>
<th>Oxidizers</th>
<th>Flammables</th>
<th>Explosives</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Self Reactives - fire</td>
<td>- Pyrophorics</td>
<td>- Self Reactives - explosive</td>
</tr>
<tr>
<td>- Self-Heating</td>
<td>- Emits Flammable Gas</td>
<td>- Organic Peroxides - explosive</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acute toxicity – categories 1-3</th>
<th>Corrosives</th>
<th>Gases Under Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Skin corrosion</td>
<td>- Eye damage/serious irritation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Carcinogen</th>
<th>Sensitizer – respiratory</th>
<th>Aquatic hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Reproductive Toxicity</td>
<td>- Target Organ Toxicity</td>
<td>- Irritation skin/eye/respiratory tract</td>
</tr>
<tr>
<td>- Germ Cell Mutagen</td>
<td>- Aspiration Toxicity</td>
<td>- Sensitizer - skin</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acute Toxicity (harmful)</th>
<th>Narcotic Effects</th>
<th>Reproductive Toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Respiratory Tract</td>
<td>- Hazardous to the ozone layer</td>
<td></td>
</tr>
</tbody>
</table>
Annex 2

**Pictograms used in the UN Model Regulations for the Transportation of Hazardous Goods**

<table>
<thead>
<tr>
<th>Pictogram</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Flammable Liquid" /></td>
<td>Flammable Liquid</td>
</tr>
<tr>
<td><img src="image2" alt="Flammable Gas" /></td>
<td>Flammable Gas</td>
</tr>
<tr>
<td><img src="image3" alt="Flammable Aerosol" /></td>
<td>Flammable Aerosol</td>
</tr>
<tr>
<td><img src="image4" alt="Flammable Solid" /></td>
<td>Flammable Solid</td>
</tr>
<tr>
<td><img src="image5" alt="Self-Reactive Substances" /></td>
<td>Self-Reactive Substances</td>
</tr>
<tr>
<td><img src="image6" alt="Pyrophorics" /></td>
<td>Pyrophorics (Spontaneously Combustible)</td>
</tr>
<tr>
<td><img src="image7" alt="Substances, which in contact with water, emit flammable gases" /></td>
<td>Substances, which in contact with water, emit flammable gases (Dangerous When Wet)</td>
</tr>
<tr>
<td><img src="image8" alt="Oxidizing Gases" /></td>
<td>Oxidizing Gases</td>
</tr>
<tr>
<td><img src="image9" alt="Oxidizing Liquids" /></td>
<td>Oxidizing Liquids</td>
</tr>
<tr>
<td><img src="image10" alt="Oxidizing Solids" /></td>
<td>Oxidizing Solids</td>
</tr>
<tr>
<td><img src="image11" alt="Explosive Divisions 1.1, 1.2, 1.3" /></td>
<td>Explosive Divisions 1.1, 1.2, 1.3</td>
</tr>
<tr>
<td><img src="image12" alt="Explosive Division 1.4" /></td>
<td>Explosive Division 1.4</td>
</tr>
<tr>
<td><img src="image13" alt="Explosive Division 1.5" /></td>
<td>Explosive Division 1.5</td>
</tr>
<tr>
<td><img src="image14" alt="Explosive Division 1.6" /></td>
<td>Explosive Division 1.6</td>
</tr>
<tr>
<td><img src="image15" alt="Compressed Gases" /></td>
<td>Compressed Gases</td>
</tr>
<tr>
<td><img src="image16" alt="Acute Toxicity (Poison): Oral, Dermal, Inhalation" /></td>
<td>Acute Toxicity (Poison): Oral, Dermal, Inhalation</td>
</tr>
<tr>
<td><img src="image17" alt="Corrosive" /></td>
<td>Corrosive</td>
</tr>
<tr>
<td><img src="image18" alt="Marine Pollutant" /></td>
<td>Marine Pollutant</td>
</tr>
<tr>
<td><img src="image19" alt="Organic Peroxides" /></td>
<td>Organic Peroxides</td>
</tr>
</tbody>
</table>
Annex 3

GHS Label Elements

Product Name or Identifier
(Identify Hazardous Ingredients, where appropriate)

Hazard pictogram(s)

Signal Word

Physical, Health, Environmental
Hazard Statements

Supplemental Information

Precautionary Measures & Pictograms

First Aid Statements

Name and Address of Company

Telephone Number
CHAPTER

3.3

MANAGEMENT OF CHEMICAL INCIDENTS AND THE ROLE OF THE POISONS CENTRE – Trainee’s version

Objectives

On completing this chapter, you should be able to:

- Describe what is meant by a chemical incident and the circumstances under which chemical incidents can arise
- Describe the chemical incident management cycle and the role of the poisons centre in this cycle
- Describe the basic principles of chemical incident management
- Describe the local arrangements at the poisons centre for dealing with chemical incidents
- Summarize the kinds of preparedness plans and resources needed at the poisons centre to fulfil this task adequately

Overview of the chapter

This chapter describes what is meant by a chemical incident and indicates the types of circumstances that give rise to such incidents. It also outlines the basic principles of chemical incident management, including the roles of different categories of personnel, recognizing that the detailed management procedures may vary from country to country. Information is also provided about the role of poisons centres in chemical incident management.
Subject content

Introduction

A chemical incident can be defined as: “...the uncontrolled release of a toxic substance, resulting in (potential) harm to public health and the environment " (1). This definition encompasses many different kinds of incidents, including: an explosion at a factory that stores or uses chemicals; the contamination of a product or the food or water supply; an oil spill; a leak from a storage vessel during transportation; or an outbreak of disease associated with an unknown chemical exposure. In addition, a chemical incident can arise from a natural source such as a volcano emitting toxic gases. A natural disaster may also result in a chemical incident, for example, an earthquake can damage a chemical installation resulting in a leak. Some real-life examples of different kinds of incident are given below and in Annex 1.

A chemical release may be evident, e.g. a large leak, or silent, e.g. an outbreak of illness of (initially) unknown cause. Even if the fact of a release is known, the identity of the chemical may not be. Chemical incidents range from small releases, for example a chemical drum being washed ashore, to full-scale major emergencies. The different circumstances of chemical release, the different physical states of chemicals, and the range of possible chemicals can all have an impact on the planning and management of incidents. While small chemical incidents are relatively frequent, large scale incidents, and in particular major disasters involving toxic chemicals, are less common.

For any chemical incident, medical care providers such as ambulance and emergency department staff will need urgent access to information and expert advice about the chemicals involved. This information will include different aspects of the medical management depending on the situation, for instance the need for personal protection equipment, the need for patient decontamination, expected signs and symptoms, and the need for specific treatment including antidotes. For some events the identity of the chemical may be unknown and information may be needed about possible causative agents based on the signs and symptoms shown by victims. The poisons centre can assist with all of the information needs described above, and it is therefore desirable that the poisons centre has an established role in plans for the management of chemical incidents.

The chemical incident management cycle

The chemical incident management cycle describes the continuous process by which authorities, industries, first-responders, communities etc plan for and reduce the impact of incidents by acting at different stages of the cycle (1). There are five stages (Fig 1), which are briefly described below.

Prevention is the first line of defence against the adverse consequences of chemical incidents. This involves technical and organizational activities aimed at reducing the
likelihood of an incident occurring and reducing the severity and impact of any incident that might occur. Examples include planning regulations governing the proximity of chemical factories to residential areas, and establishment of a hazardous sites database.

**Preparedness** involves activities directed at ensuring that when an incident does occur an effective response is mounted with the minimum delay. It includes ensuring that the various stakeholders know their roles and responsibilities, that their actions are coordinated, that the chain of command and communication is agreed and understood, that the necessary links have been made between first-responders and technical advisers, and that the necessary equipment, e.g. for decontamination or personal protection is available and maintained. Above all it means having a response plan that all stakeholders understand and support and that is regularly tested and practised. The stakeholders concerned would normally include the following: fire and ambulance services, police service, hospital services, public health authorities, industries, local government authorities and the poisons centre.

Incident **detection and alert** is a continuous activity undertaken to pick up signals that a chemical incident has occurred, and to ensure rapid alert for an appropriate and timely response. The poisons centre has a particular role here since it may pick up the first enquiries that signal a chemical release.

**Response** involves activities to terminate the incident and mitigate the consequences. This requires an evaluation of the incident, including a health risk assessment, followed by decisions about appropriate actions, for example how to contain the release, whether the public should shelter in place or evacuate, how to triage and manage victims. An understanding of health hazards and the routes and pathways of exposure for the chemical(s) concerned is key to decisions about response and is an area where the poisons centre can advise. Effective communication with the general public about the event is also an important response activity, and again is an area where the poisons centre can contribute.

After the incident has been terminated the **recovery** may take years of clean-up, health
monitoring, evaluation and other activities that are aimed at restoring the situation to the way it was before the incident and contributing to prevention of recurrence.

**Underlying causes of chemical incidents**

Probably the most common causes of major chemical incidents are accidents at a chemical installation or during transportation of chemicals by road or railway. During recent years concerns about the risk of terrorist action have increased and this should also be considered. Chemical incidents can also arise from the illegal or unsafe dumping of toxic waste. Schools are a relatively common site of accidental and unintentional chemical releases, e.g. in chemistry laboratories and in workshops (2). Other common causes of chemical incidents are the inappropriate mixing of cleaning products, e.g. hypochlorite bleach and an acidic descaler, and the incorrect use of swimming pool disinfectants. In both cases chlorine gas is typically produced. In some parts of the world the risk of natural emissions of chemicals, e.g. from volcanoes, is substantial (3).

Once released chemicals can enter different environmental media, such as the air, water or soil, which provide the exposure pathway to humans and animals. Of particular importance is contamination of water systems that feed into drinking water supplies and contamination of one or more parts of the food chain. Another form of chemical incident, however, is the silent release of a chemical into environmental media, the water or food supply, or a product, which is only detected when consumers start reporting an unusual smell or taste, or once people start to become ill.

**Examples of types of chemical incidents**

Examples of different kinds of chemical incident are described below, additional examples can be found in Annex 1.

1. *Leak from a chemical plant*

In 1984 in Bhopal, India a large quantity of methyl isocyanate was released from a pesticide manufacturing plant during the night, resulting in over 3800 fatalities (4). Most of the affected people lived in densely populated, poor communities around the plant. Many survivors have suffered long-term health effects from the chemical exposure.

2. *Transportation accident*

In 2005 in Graniteville, South Carolina, USA in the early hours of the morning, a train collision resulted in the release of over 50 tonnes of chlorine. Nine people died, nearly 600 attended hospital and several thousand people were evacuated from the surrounding area. It took several days to control the chlorine leak (5).

3. *Deliberate release*

In 1995, in Tokyo Japan, the nerve gas sarin was deliberately released inside the subway
transportation system of the city in a terrorist attack. The attack left 12 people dead, 54 critically injured and affected thousands of others. Rescue workers and hospital staff did not have protective equipment and many became ill themselves (6).

4. Food contamination
In 2007, in the suburbs of Luanda, Angola, more than 450 people, most of them children, were affected by a mysterious neurological illness. Investigations eventually revealed that the illness was bromide poisoning, caused by the inadvertent use of sodium bromide, an industrial chemical used in oil drilling, as table salt (1).

5. Environmental contamination
In a number of small villages in North West Nigeria in 2010 a mass poisoning with lead was discovered when dozens of children became ill and died. This was caused by environmental contamination with lead as a result of artisanal gold extraction. The ore from which gold was being extracted also contained a high concentration of lead, which became dispersed in the environment when the rock was pulverised (7). Children became exposed through normal hand-to-mouth activity.

6. Contaminated medicine
In Panama in 2006 there was an outbreak of renal failure and neurological illness of unexplained etiology. An infectious cause was ruled out and an extensive investigation into a possible toxicological cause was initiated. This eventually found that the outbreak was caused by consumption of a cough syrup that had been formulated with sub-standard glycerin that had been adulterated with diethylene glycol (8).

Types of chemicals commonly involved
There are over 60,000 chemical substances in regular use and about 1,000 that are produced in quantities of more than one tonne per year, so-called high production volume (HPV) chemicals. Thus the range of chemicals that could be involved in a chemical incident is very wide, and this is illustrated by the list in Annex 1.

Fires, e.g. at chemical installations, at oil processing or storage depots, or at tyre dumps, are a common cause of chemical release (9). Products of combustion are typically a mixture of irritant and toxic gases together with particulate matter, with the exact mixture depending on the materials that are burning. For example, burning tyres typically produce a complex mixture including particulate matter, sulphur dioxide, metals, carbon monoxide, polycyclic aromatic hydrocarbons, phenols, dioxins and furans (10).

Some basic principles of chemical emergency response
As mentioned above, the chemical emergency plan should describe the roles and
responsibilities of each category of personnel involved in the response, and also the chains of command and communication. The four main groups of response personnel who must collaborate together are the rescue or fire service, the police, the medical care providers and the public health authorities. In the case of an incident at a chemical plant, usually specialist staff at the plant will also be involved in the response.

Typically, the job of the first-responders is to take control of the site of chemical release, contain the release, and rescue people who have been exposed. First-responders should be equipped with adequate personal protection equipment (PPE) and may also bring decontamination equipment e.g. mobile showers. Medical first-responders, who may include personnel sent out from the nearest hospital and/or ambulance service personnel, are concerned with triage, first aid and medical stabilisation. This may include the administration of antidotes if appropriate. These responders should have access to specialist toxicological advice e.g. from the poisons centre.

The public health authorities must make a rapid assessment of the immediate and longer term risks to health consequent on the chemical release and weigh up different response options. They will need to take account of the toxicity of the chemical(s), likely pathways and routes of exposure and how these can be controlled, and the need for exposure and health monitoring. These authorities are also responsible for risk communication with the affected communities.

Victims may be taken, or may self-present, to hospitals and other health-care facilities for assessment and treatment. People presenting to health care facilities may also include the ‘worried well’ who are not sure if they have been exposed and want reassurance that they are okay, and information about what symptoms to look out for. The poisons centre can provide information to assist health-care staff in assessing the degree and severity of exposure to the chemicals concerned, as well as advising on treatment. In addition, victims and the “worried well” may contact the poisons centre directly for advice on what to do.

**Organization at the site of the chemical incident**

In the case of a chemical release from a point source it is common practice to designate a series of zones around the site of the release indicating decreasing level of risk. An internationally accepted zone division is shown in Fig 2.

Typically there will be a **hot or exclusion zone** around the centre of the release where the level of contamination is highest and there is severe risk to life and health for unprotected personnel. Normally, only personnel from the rescue or fire service, equipped with appropriate PPE, work in this zone.
The next zone is known as the warm or contamination-reduction zone. Here the level of contamination is lower but there is still a certain degree of risk for life and health for unprotected personnel. The rescue or fire service personnel as well as the police and medical care providers may be working in this zone and PPE is normally needed. Decontamination of victims and responders will normally take place on the boundary between this zone and the cold zone.

The defined area outside the warm zone where there is considered to be no risk for unprotected personnel is called the cold or support zone. PPE is not needed. Rescue personnel and victims must have been adequately decontaminated before entering the cold zone. This is where victims receive initial treatment before being transferred to hospital if necessary. This is also where the incident command post is usually situated.

Movement from the hot through to the cold zone must be controlled to prevent the transfer of contamination.

**Personal Protection Equipment (PPE)**

There are different kinds of PPE suited for different purposes and offering different levels of resistance to chemicals, extreme temperatures etc. Thus PPE can range from gloves, apron and goggles or face shield, to a fully protective suit covering the whole body. In addition there may be a breathing mask with a filter or with a clean air supply through a connection to a portable air container.
Brief information about the kinds of PPE needed for specific chemicals can be found on the International Chemical Safety Cards (www.inchem.org and http://www.ilo.org/dyn/icsc/showcard.home). More detailed information can be found on the following sites:

- WebWISER (http://webwiser.nlm.nih.gov/knownSubstanceSearch.do)

**Decontamination**

Victims who have been exposed to a toxic chemical may need to be decontaminated. This usually involves undressing and rinsing with water or washing with soap and water. For some chemicals dry decontamination with a specialized powder, such as fuller’s earth, is sometimes used. The decontamination procedure is essential to stop further exposure of the victims and to prevent secondary exposure of other persons.

Decontamination can be performed by the rescue service immediately at the site of the accident (between the hot and warm zones), known as “life-saving decontamination”. It can also be performed by medical care providers between the warm and cold zones or at a specified decontamination station outside the hospital, called “complete decontamination”.

It is important that victims who have been highly exposed to a chemical, for instance ammonia, are completely decontaminated before they are taken into an ambulance or an emergency department. If not, health care facilities may become temporarily unavailable for use because of secondary contamination.

Contaminated clothing and personal effects should be isolated e.g. by placing in a sealable plastic bag which is itself placed in another sealable plastic bag (known as double-bagging). Transparent bags are helpful because they allow the contents to be seen. Bags should be labelled with information about the contents and the owner.

**The role of the poisons centre**

Referring back to the chemical incident management cycle (Fig 1), the poisons centre has particular roles in prevention, preparedness, detection, alert and response (11).

**Prevention and preparedness**

The poisons centre should actively participate in the development of prevention and preparedness strategies for chemical accidents. This involves cooperation with a number of institutions in the community, including the emergency services, the
chemical industry, government officials, transport officials, as well as other organizations involved in chemical safety in the country, and the mass media. There are a number of ways in which the poisons centre can contribute to preparedness, e.g. by maintaining lists of antidote stocks in the country (see below for more on this), and a list of toxicology laboratories.

The poisons centre should itself be prepared with an internal plan and checklist of actions to be taken should a major chemical incident occur. This could include, for example, procedures for strengthening the centre’s capacity by calling in additional staff and installing additional telephone lines. The centre should also have a telephone list covering important local authorities and other agencies who should be alerted if the poisons centre becomes aware of a chemical incident, or a possible incident, at an early stage. Staff should be trained in the application of this “chemical incident action list” with refresher training on a regular basis.

**Detection and alert**
Poisons centres have an important role in detecting and alerting about a chemical release. Poisons centres commonly work on a 24-hour basis and are therefore always contactable. If a poisons centre receives several enquiries from a defined area concerning persons with similar symptoms, this could be the first sign of a chemical incident and the appropriate authorities should be alerted.

**Response**
Using their databases and specialist knowledge poisons centres can assist public health authorities and medical personnel in assessing the short and long-term health risks associated with a chemical release and in deciding on appropriate mitigation measures, investigations and treatment. The poisons centre can also advise on the need to collect blood and/or urine specimens from patients to confirm exposure to chemicals.

The routine work of a poisons centre is to advise callers on the risks of chemical exposures and the need for specific treatment, and this is no different when a chemical incident occurs. An extension of this task is in working with public health authorities to develop appropriate risk communication for the public.

**Resource needs**
To be able to fulfil its roles in preparedness and response for chemical incidents the poisons centre needs largely the same resources that it needs to fulfil its normal day-to-day functions, namely trained personnel, databases on chemicals and products, reference books, treatment protocols, and access to the Internet and to relevant external databases. If available, a local risk inventory, i.e. information about which specific chemicals exist in large amounts or are being transported through the area, can be used to prioritize the chemicals for which detailed information should be compiled. The poisons centre should also maintain contacts with scientific institutions, local
authorities, representatives of the chemical industry and healthcare providers as well as chemical experts and poisons centre colleagues in other countries to provide additional support.

**Organization of antidote stocks**
A chemical disaster can create a situation with many victims and an acute need for a larger amount of a specific antidote than is immediately available. The poisons centre can play an important role by maintaining lists of antidote stocks available in the country (including those held by certain industries), ensuring the good organization of these stocks and by giving evidence-based recommendations concerning the content of the stocks and the specific indications for antidotes. Poisons centres can also provide training for clinical personnel on the selection and use of antidotes.

**Practice**
You should familiarise yourself with any internal procedures for dealing with chemical incidents, as well as where to find contact details of relevant external agencies. You could also review some past incidents that the centre was involved with and think, in particular, about the roles of different agencies including the centre itself, the steps you would take to deal with the incident, including how you would find the necessary information on the chemicals involved, how you would determine the need for decontamination and PPE and who you would contact about the event.

**Summary**
Chemical incidents vary in scale from localised to widespread. They are commonly associated with the manufacture or transport of chemicals, however, less obvious chemical incidents can involve the contamination of products food or water. Response to a chemical incident is usually multisectoral and includes the poisons centre. The poisons centre also plays a part in preparedness for, and detection of, chemical incidents. The poisons centre should therefore ensure that it is included in chemical incident preparedness planning.

Victims rescued from a chemical incident need to be moved from the highly contaminated zone to the clean zone and need to be decontaminated during this transfer process. The poisons centre can assist in identifying the chemicals concerned, if this is initially unknown, and can advise on the health hazards, the risks to responders and the need for PPE, as well as recommending special decontamination and treatment measures for victims if necessary. The poisons centre needs resources such as trained personnel, chemical databases, lists of antidote stocks and a network of experts to enable it to fulfil its roles in chemical incident response. Poisons centre staff
should be familiar with the procedure for dealing with chemical incidents.

**Student Test**

1. List four common causes of chemical incidents.

2. Name three categories of personnel who should routinely collaborate in the management of a major chemical incident.

3. What are the terms for the 3 response zones at the site of a major chemical incident?

4. a) What is PPE? b) Give two examples.

5. In which of the three zones mentioned in question 3, is PPE normally not required?

6. The complete personal decontamination of victims who have been exposed to a chemical is normally performed by the medical care providers. Where, in principle, are the locations for these procedures?

7. The poisons centre should establish its own “chemical incident action list”. Give three important issues that should be included in this list.

8. Someone calls the poisons centre and says that she has just walked past a parked lorry where she noticed a strong smell. She is now coughing and her eyes are watering. What possible actions should you take?

9. Over the course of a few hours, the poisons centre starts to receive calls about children who have fallen ill after being given paracetamol syrup to treat fever. The children all have neurological signs such as drowsiness and slurred speech, and some have been vomiting. What might have happened and what possible actions should you take?
Materials and Resources

Cited references


No


Sources of information on chemicals


WebWISER: WISER is a system designed to assist first-responders in hazardous material incidents. WISER provides a wide range of information on hazardous substances, including substance identification support, physical characteristics, human health information, and containment and suppression advice (http://webwiser.nlm.nih.gov/knownSubstanceSearch.do)

TOXNET: a portal to a set of databases on toxicology, hazardous chemicals, environmental health, and toxic releases (http://toxnet.nlm.nih.gov/). These include the Hazardous Substances Data Bank, which provides Comprehensive, peer-reviewed toxicology data for around 5,000 chemicals.

eChemPortal: a portal to a set of international databases providing information on the properties and uses of chemicals http://www.echemportal.org/echemportal/index?pageID=0&request_locale=en

Emergency Response Guidebook: developed jointly by the US Department of Transportation, Transport Canada, and the Secretariat of Communications and Transportation of Mexico (SCT) for use by fire-fighters, police, and other emergency first-responders. It is primarily a guide to (1) quickly identifying the specific or generic classification of the material(s) involved in the incident, and (2) protective measures for responders and the general public. The guide is updated every three to four years to accommodate new products and technology. It is available in English and Spanish at http://phmsa.dot.gov/portal/site/PHMSA/menuitem.ebd7a8a7e39f2e55cf2031050248a0c/?vgnextoid=ebfeca57e196d110VgnVCM1000009ed07898RCRD&vgnextchannel=16ad08ae2db83110VgnVCM1000009ed07898RCRD&vgnextfmt=print
Author(s)

Dr Jonas Höjer, Swedish Poisons Information Centre, Stockholm
Ms Joanna Tempowski, International Programme on Chemical Safety, WHO, Geneva


Updated in July 2013 to reflect new WHO guidance and additional peer review comments provided by email.

Reviewers:

Dr Aruna Dewan, Centre for Education, Awareness and Research on Chemicals and Health, Ahmedabad, India
Ms Alison Dines, Guy’s & St Thomas’ Poisons Unit, London UK
Dr Kersten Gutschmidt, World Health Organization, Geneva, Switzerland
Ms Carine Marks, Tygerberg Poison Information Centre, Cape Town, South Africa
Dr Robert Nyrango, Drug & Poisons Information Centre, Nairobi, Kenya
Dr Lynn Panganiban, National Poison Management & Control Center, Manila, Philippines
Dr Mark Personne, Swedish Poisons Information Centre, Stockholm, Sweden
Dr Hans Persson, Swedish Poisons Information Centre, Stockholm, Sweden
Dr V V Pillay, Poison Control Centre, Cochin, India
Dr Rachida Soulaymani Bencheikh, Centre Anti-Poisons du Maroc et de Pharmacovigilance, Rabat, Morocco
Dr Dexter Tagwireyi, Drug and Toxicology Information Service, Harare, Zimbabwe
Dr Wayne Temple, National Poisons Information Centre, Dunedin, New Zealand

Written for the INTOX Programme of the International Programme on Chemical Safety, World Health Organization, Geneva, Switzerland. The financial support of the Swedish Chemicals Agency (Kemi) for the production of this chapter is gratefully acknowledged.
Annex 1

Examples of major chemical incidents worldwide

Adapted from Table 1, WHO Manual for the Public Health Management of Chemical Incidents (1)

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Description of incident</th>
<th>Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976</td>
<td>Seveso, Italy</td>
<td>Airborne release of dioxin from an industrial plant</td>
<td>No immediate human deaths 3300 animal deaths 80 000 animals slaughtered</td>
</tr>
<tr>
<td>1984</td>
<td>Bhopal, India</td>
<td>Methyl isocyanate leak from a tank</td>
<td>3800 immediate deaths 15 000 t- 20 000 premature deaths 500 000 exposed to the gas</td>
</tr>
<tr>
<td>1984</td>
<td>Mexico City, Mexico</td>
<td>Explosion at liquefied petroleum gas terminal</td>
<td>500 deaths 6400 injuries</td>
</tr>
<tr>
<td>1995</td>
<td>Tokyo, Japan</td>
<td>Deliberate release of a warfare agent</td>
<td>12 deaths 54 critical casualties Thousands of people affected</td>
</tr>
<tr>
<td>2000</td>
<td>Enschede, The Netherlands</td>
<td>Explosion of a fireworks factory</td>
<td>20 deaths, 562 casualties Hundreds of houses destroyed 2000 people evacuated</td>
</tr>
<tr>
<td>2001</td>
<td>Toulouse, France</td>
<td>Explosion of 300–400 tonnes of ammonium nitrate in a fertilizer facility</td>
<td>30 deaths 2500 casualties 500 homes uninhabitable</td>
</tr>
<tr>
<td>2002</td>
<td>Galicia, Spain</td>
<td>Shipwreck of the Prestige, causing the release of 77 000 tonnes of fuel</td>
<td>Estimated clean-up costs of US$ 2.8 billion</td>
</tr>
<tr>
<td>2002</td>
<td>Jabalpur, India</td>
<td>Mass poisoning due to the use of pesticide containers as kitchen vessels</td>
<td>Three deaths At least 10 hospitalizations</td>
</tr>
<tr>
<td>2003</td>
<td>Baton Rouge, USA</td>
<td>Release of chlorine gas from a facility</td>
<td>No human deaths</td>
</tr>
<tr>
<td>2004</td>
<td>Neyshabur, Iran</td>
<td>Train explosion due to mixing of incompatible chemicals</td>
<td>Hundreds of deaths and casualties among emergency responders and onlookers</td>
</tr>
<tr>
<td>2005</td>
<td>Songhua River, China</td>
<td>Plant explosion releasing 100 tonnes of pollutants in the Songhua River</td>
<td>Five casualties Millions of people without water for several days</td>
</tr>
<tr>
<td>2005</td>
<td>Bohol, The Philippines</td>
<td>Inadvertent use of an insecticide in the preparation of sweets</td>
<td>29 deaths 104 hospitalizations</td>
</tr>
<tr>
<td>2005</td>
<td>Hemel Hempstead, UK</td>
<td>Three explosions in an oil storage facility (Buncefield depot)</td>
<td>43 reported injuries 2000 persons evacuated</td>
</tr>
<tr>
<td>Year</td>
<td>Location</td>
<td>Description of incident</td>
<td>Consequences</td>
</tr>
<tr>
<td>------</td>
<td>---------------------------</td>
<td>----------------------------------------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>2006</td>
<td>Abidjan, Côte d’Ivoire</td>
<td>Dumping of toxic waste in Abidjan landfills</td>
<td>10 deaths, thousands made ill</td>
</tr>
<tr>
<td>2006</td>
<td>Panama</td>
<td>Diethylene glycol in a cough syrup</td>
<td>Over 100 people ill, at least 70 deaths,</td>
</tr>
<tr>
<td>2007</td>
<td>Angola</td>
<td>Sodium bromide confused with table salt</td>
<td>Over 450 people ill, most of them children</td>
</tr>
<tr>
<td>2008</td>
<td>Senegal</td>
<td>Lead from informal battery recycling.</td>
<td>Over 900 people exposed with many children showing symptoms of lead intoxication and 18 deaths.</td>
</tr>
</tbody>
</table>