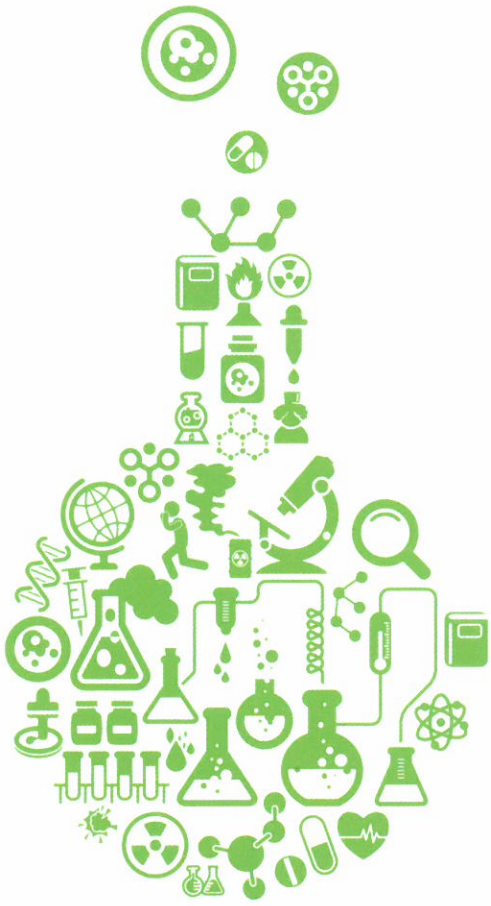
Standard Textbook for Safety in Laboratory

Safety Before and After the Experiment Ⅱ



KIRD | Korea Institute of Human Resources Development in Science and Technology

All research and development start
from performing safe experiment.

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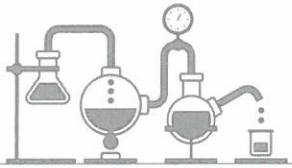


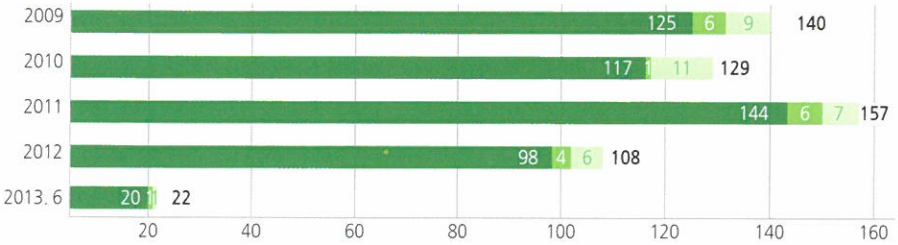
Part Ⅱ Safety After the Experiment

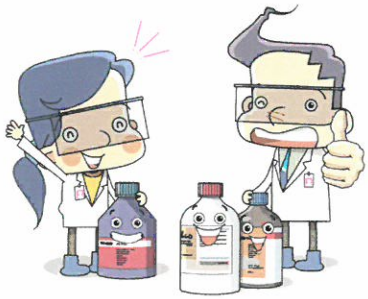
Introduction

With the recent disclosure that chemical substances are the key cause of a diverse range of accidents at industrial sites and laboratories, the "Chemical Substance Management Act" and the "Chemical Substance Registration and Assessment Act" were enacted and came into effect on January 1, 2015 as part of the fundamental countermeasures. In addition, the government is pursuing the establishment of the safety control tower and cooperation system at a national level in order to lay down the fundamental safety measures for disasters and accidents. At the same time, the government is focusing on setting a diverse range of policies that can supplement them at each of the government departments.

As the result of these efforts, "Law on Establishment of Safe Environment for Laboratories (hereinafter referred to as the Research Safety Law)" was enacted in March 2005 and effectuated in April 2006 after after a year of grace period/after one year of grace period. The Research Safety Law, as indicated in its Article 1, is aimed at "securing the safety of laboratories in the areas of science and technology" and "appropriate compensation of the casualties and material losses arising from accidents in the laboratories" at the same time. Moreover, the government has been implementing an extensive range of projects over the last eight years with the research environment safety team playing the central role in order to accomplish such goals. The key contents of the Research Safety Law include enactment of safety management regulations, operation of safety management committee, appropriation of budget for safety management, execution of safety inspection (annually) and precision safety

2009 ~ 2013
Current status of occurrence of laboratory accidents

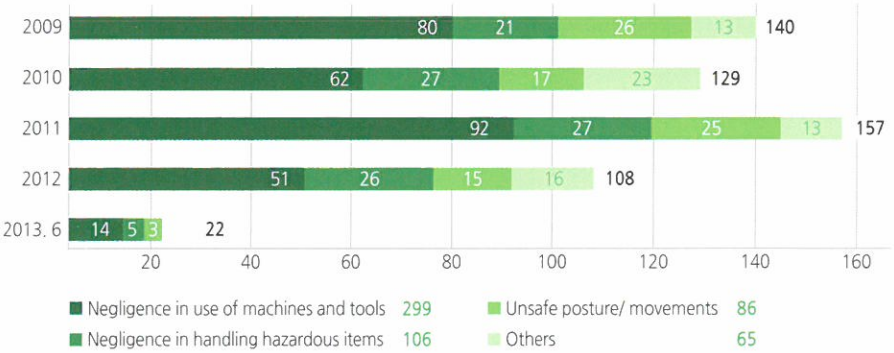




diagnosis (once in two years), subscription to insurance policy (minimum of 100 million Won for death and maximum of 10 million Won for injuries), execution of health check-up, and execution of education and training (regularly scheduled: 1 hour per month, every year; new: 8 hours, research modification: 2 hours), and etc.

However, according to the parliamentary inspection of the Ministry of Science, ICT and Future Planning in 2013, a total of 556 laboratory accidents occurred from 2009 to the first half of 2013, with 94% of the accidents occurring in university research institutes. In addition, without any decrease in the accidents at university laboratories, a total of 177 laboratory accidents occurred in 2014. The major causes of these accidents included negligence of the researchers such as negligence in using machines and devices, handling

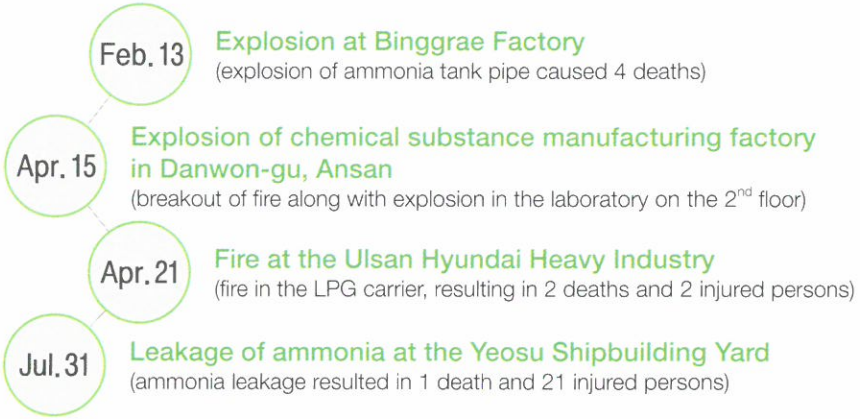
2009 ~ 2013
Causes of laboratory accidents



hazardous items and unsafe posture. In particular, 88% of the safety accidents in the laboratories due to carelessness. Moreover, although it is regulated that personnel involved in research activities must complete 12 hours of regularly scheduled education stipulated by law only 49.3% completed such education in universities and 43.9% in research institutions. This clearly indicated that the awareness of the need for education and training for safety in the laboratory is yet to be settled in the field of science and technology.

Along with the need for firm settlement of education and training, the issue on diversity of the educational contents in accordance with the academic level and areas of major engaged in research activities has been brought up continuously. Therefore, there is a need to confirm the necessity of standardized safety text book at this time considering the efforts that had been put in to establish safe environment thus far.

2014
Example of laboratory accident



This lesson plan aims to build up the foundation of safe research environment by describing the methods of selecting and using appropriate protective devices to secure the safety of individuals those engaged in research activities, and the MSDS utilization methods and chemical substance storage methods as well as safe and appropriate methods of handling waste matters generated from experiments that need to be familiarized prior to the experiment. In addition, the lesson will enable the relevant personnel to familiarize with themselves and prevent a diverse range of safety accidents that can occur prior to experiments and quickly and accurately respond to actual emergencies by. Through these, it is hoped that awareness of the safety issues will be propagated and the improved laboratory safety is guaranteed by advancing the level of the existing laboratory safety lesson plan a step further. Not only that, it is desired that standardized safety text book will ensure appropriate measures under hazardous circumstances.

Basic Safety Rules in Laboratories

Protection of those engaged in research activities

- All students must wear shoes that cover the toes during practicum. Shoes made of leather straps, shoes that reveal the toes and sandals are not appropriate as protective shoes.
- Long hair must be tied at the back of the head to prevent injuries.
- Clean lab coat must be worn at all times throughout the experiment and be taken off when leaving the laboratory. (Take precaution since the contaminated lab coat can be a potential cause of infection.)
- It is required to wear eye protection equipment in all laboratories and designated locations, protective eye glasses must be worn at all times during the experiment.

Prevention of safety accidents in laboratory

- All students must comply with the terms and conditions required for the safe handling of the substances and microbiological specimen being handled. All microbiological specimens must be deemed to be contagious.
- The source of generation of radiation (laser, UV ray radiation substance or arc lamp, etc.) must be used under the instruction and supervision of teaching assistant or supervisor.

General rules at the time of experiment and practicum

- Students are not allowed to enter any pre-treatment laboratory without permission of professor or teaching assistant in charge of the laboratory.
- Experiments not approved for the laboratory is strictly prohibited. Undergraduate students wishing to use the laboratory outside the scheduled hours must acquire written approval by their respective professor or teaching assistant.
- Sitting on the laboratory benches is prohibited and you must not run in corridors of the laboratory.
- You must not drink food & beverages (including bottled beverages) in the laboratory.
- For the correct and safe use of the burner, follow the instruction of teaching assistant.
- Pipetting by using mouth is prohibited.

Basic Safety Rules in Laboratories

General rules after the experiment and practicum

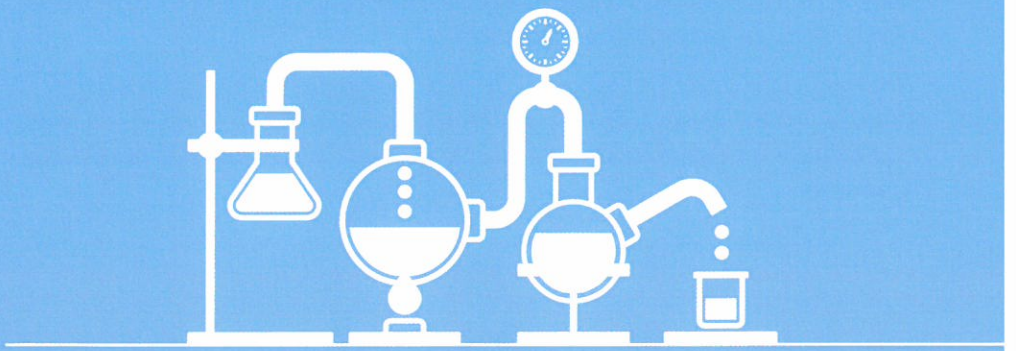
- Notify the teaching assistant about broken equipment or glass devices.
- Keep the areas for experiment and practicum clean. Discard broken glasses, sharp objects and laboratory wastes into the designated waste bin in the laboratory. Do not leave wastes in the sink or unattended. In addition, do not discard wastes into the sink without permission of teaching assistant.
- All leaked substances must be wiped off immediately. Reagents, liquids or experimental devices must not be taken out of the laboratory without the approval of teaching assistant.
- Gloves that came in contact with bio specimen must be thrown out into the specially marked waste bin for bio wastes.
- Make sure to wash your hands all the time before leaving the laboratory.

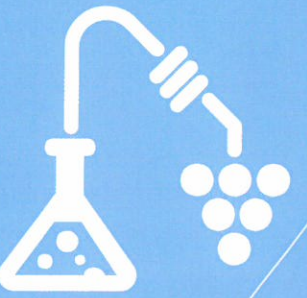
Measures to be taken in emergency situations

- You must become familiarized with procedures to be followed case of emergencies and escape procedures.
- Familiarize with location of all the emergency exits of all the work zones in the floors of the building with laboratory for experiment and practicum.
- You must familiarize with all the safety facilities of the laboratory (locations of safety shower, eye washing equipment, fire extinguisher, and etc.).
- Do not place any obstructions (containers and sacs) to ensure that they do not interfere with the pedestrian path or fire exit.
- Report and record all accidents and even minor mistakes in a form for reporting of injuries, diseases and incidents in the laboratory.
- When executing training for emergencies and emergency escape, move to external stairs or nearest emergency exit quickly and carefully. Move to the designated location (as instructed by teaching assistant) and wait until re-entry into the building is permitted.

Standard Textbook for Safety in Laboratory

Safety After the Experiment





CHAPTER

1

Disposal of experimental wastes

1. Experimental wastes
2. Disposal of experimental wastes
3. Use of sticker for laboratory wastes
4. Examples of accidents related to experimental wastes and its prevention

CHAPTER 1 Safety After the Experiment

Disposal of experimental wastes

1. Experimental wastes

Management of wastes generated in the laboratories can be divided into prior to and after the generation. Method of managing wastes through source reduction and internal recycling is most desirable. However, since it is not possible to perfectly resolve the generation in advance, we have to rely on processing technology after the generation.

Wastes that are generated in the experimental laboratory and disposed of are highly diversified, ranging from experiment devices and equipment to product and chemical substances. The experimental laboratory wastes, although the quantity is small, can impart significant harm and hazard not only to the researchers but also to those who are retrieving and processing as well as to the facilities involved due to their diversity and unclear composition.

(1) Classification of experimental wastes

Experimental wastes can be divided largely into ordinary wastes, chemical wastes, biological wastes, medical wastes, radioactive wastes and exhaust gas, etc. Processing of toxic, pyrophoric, corrosive or reactive chemical products of the chemical wastes including organic liquid waste, inorganic liquid waste, acidic liquid waste, alkaline liquid waste, mercury liquid waste and waste oil, etc., as well as bio wastes or radiation contaminated wastes, etc. generated in the research activities are becoming increasingly more difficult issue in almost all research centers and university laboratories. Accordingly, particular interests of the researchers and close cooperation with those retrieving and processing experimental wastes are required.

① Types of the designated wastes (Article 3 of the Waste Control Act, 2013.5.28.)

a. Wastes generated in particular facility

- **Waste synthetic polymer compound**: Waste synthetic resin, waste synthetic rubber
- **Contaminated soil**: Contaminated soil from processing of waste water, contaminated soil from processing
- Waste agricultural chemicals

b. Corrosive wastes

- **Waste acid**: Liquid state with pH < 2
- **Waste alkaline**: Liquid state with pH > 12.5

c. Wastes containing harmful substances

- Slag
- Dust
- Waste molding sand and waste sandblast sand
- Waste refractories and fragments of ceramics with glaze applied prior to re-firing
- Incineration ash
- Processed substances of stabilization or solidification
- Waste catalyst
- Waste adsorbent and waste absorbent

d. Waste organic solvents

- Halogens
- Other waste organic solvent

e. Waste paint and waste lacquer

f. Waste oil: Contains more than 5% oil ingredient

g. Waste asbestos

h. Waste that contains polychlorinated-biphenyl

i. Waste toxic substances

j. Medical wastes

k. Other harmful substances that can contaminate the surrounding environment as determined and announced by the Minister of Environment

② Types of medical wastes (Article 4 of the Waste Control Act, 2013.5.28.)

a. Isolated medical wastes

All wastes generated from the medical treatments on the people isolated for the protection of others from being infected in accordance with the Clause 1 of the Article 2 of the [Law on prevention and management of infectious diseases]

b. Harmful medical wastes

- **Waste bodily organ tissues**: Portion of tissues and organs from human or animals, carcass, blood, pus and blood byproduct (serum, plasma and blood preparations)
- **Pathological wastes**: Culture solution, culture container, strain stored, and waste test tube, slide, cover glass, waste culture medium, waste glove used in test and examination, and etc.
- **Damaging wastes**: Intravenous injection needle, suture needle, surgical blade, acupuncture needle, dental needle, broken glass experimental device
- **Biological and chemical wastes**: Used vaccine, waste anticancer drug, waste chemotherapeutic drug
- **Blood contaminated wastes**: Used blood pouch, wastes used during blood dialysis, and other wastes that require special handling due to the quantity of blood

③ Ordinary medical wastes

Cotton ball, bandage, gauze, disposable diaper, sanitary pad, disposable hypodermic needle and intravenous injection set contaminated by blood, body fluid, secretion or excretion.

(2) Information on experimental wastes

Prior to the processing of the wastes generated in the laboratory, the properties and characteristics of the wastes including corrosiveness, oxidizing and pyrophoric properties (air or water reactivity), toxicity, and etc must be. must be familiarized through GHS/MSDS and processed in accordance with precautions to be exercised at the time of disposal under the GHS/MSDS. If the characteristics of wastes are not recognized clearly, safety accidents and environment contamination by the wastes can occur. Therefore, they must be processed in accordance with proper processing procedures.

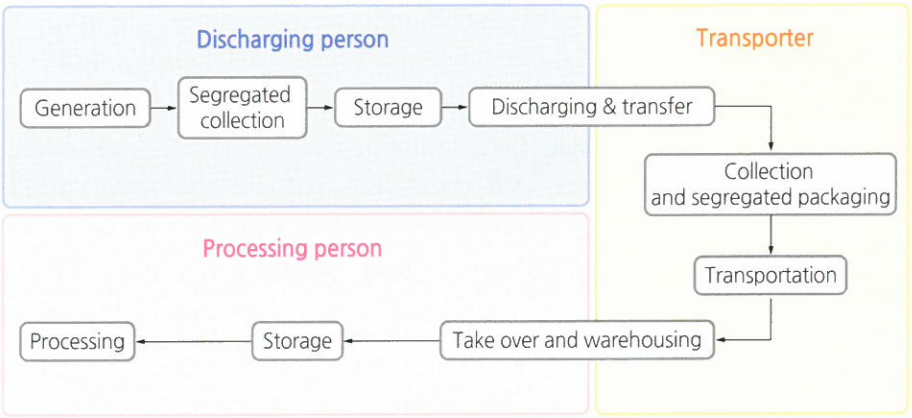


Fig. 1-1 Process of treating experimental wastes

2. Disposal of experimental wastes

(1) Issues to be familiarized in advance at the time of processing of the laboratory wastes

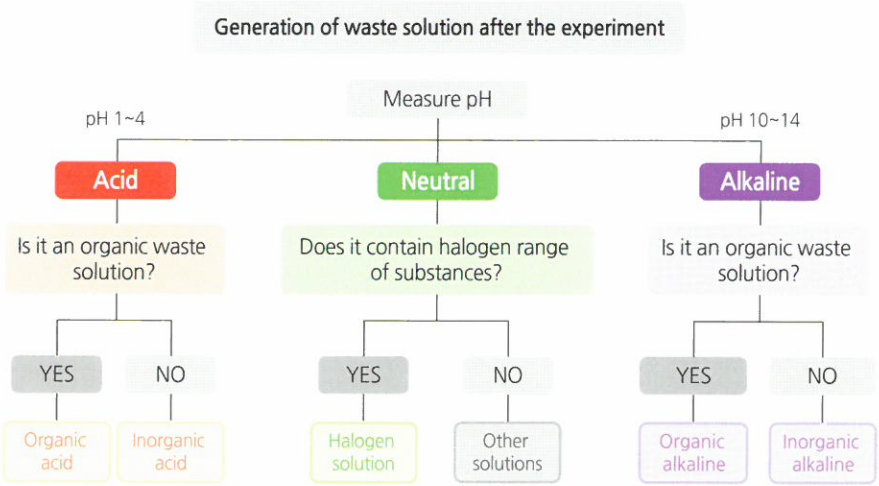


Fig. 1-2 Method of distinction and processing of experimental wastes

① Evaluate and familiarize with harmfulness and hazardousness of the wastes to be processed in advance.

② Do not mix substances for which occurrence of chemical reactions is anticipated.

③ The chemical substances to be disposed must be stabilized with the reactions completed.

④ Separate and dispose chemical substances by assessing their properties and states.

⑤ If gas is generated, dispose only after the reactions have been completed.

⑥ Appropriate wastes containers must be used.

⑦ Attach appropriate waste sticker to the collection container and record and maintain the information on the waste.

⑧ Tightly close the cover to ensure that wastes are not leaked out and install kit for prevention of leakage.

⑨ Prohibit long term storage of wastes.

⑩ To be prepared for unexpected emergencies, personal protection equipment, emergency safety equipment such as emergency shower, eye washer fire extinguisher, and etc. must be installed.

(2) Means of minimizing the wastes

Researchers have primary responsibility in the processing of wastes and must put efforts to minimize the generation of wastes.

Methods of storing and minimizing wastes include the following.

① If chemical substance is needed, purchase only the minimum quantity by considering the packaging units.

② Use the minimum quantity of chemical substances as much as possible by establishing exhaustive experimental plan prior to the experiment, and also minimize the repetition and confirmation experiments.

③ Record all the chemical substances used and disclose the record for reference for others.

④ In order to prevent any contamination, carefully manage the chemical substances for which the seal has been opened.

⑤ When temporarily storing synthesized chemical substances, record the details of the administrator for storage and precautions when handling.

(3) Processing of chemical wastes

Chemical wastes are the chemical substances such as liquid, solid and sludge that are generated after the experiment and of which expiration period has lapsed that are no longer necessary for experimental activities. Precautions must be exercised for such chemical wastes that continue to maintain its characteristics such as corrosiveness, oxidizing properties, reactivity with air or water and hazardousness, or even greater harmfulness and hazard than the chemical substances prior to the experiment through synthesis of new chemical substances during the experiment.

① Waste organic solvent

All organic compounds in liquid state including solvents, etc.

a. Halogen range organic solvents

They include carcinogenic substances such as dichloromethane, trichloromethane, tetrachloromethane, dichlorodifluoromethane, trichlorofluoromethane, dichloroethane, trichloroethane, trichlorotrifluoroethane, trichloroethylene, tetrachloroethylene, chlorobenzene, dichlorobenzene, monochlorophenol, dichlorophenol, trichlorophenol ethylene dibromide, organicfluorides, methyl iodide that contains Cl, F, Br and I, etc., thereby requiring precautions in processing them through one of the following methods:

- After having processed the waste through separation, evaporation, extraction and/or enrichment, incinerate the residues at high temperature.
- Process by means of neutralization, oxidation, reduction, polymerization and condensation, etc.

b. Non-halogen range organic solvents

- They include acetone, various alcohols, benzene and hexane that are to be processed in any one of the following methods:
- After having processed the waste through separation, evaporation, extraction and enrichment, incinerate the residues at high temperature.
- Process through methods including neutralization, oxidation, reduction, polymerization and condensation, etc.

② Wastes containing harmful substance

Solid wastes, waste catalyst, waste absorbent, waste adsorbent and silica, etc. with potential hazard are processed in any one of the following methods.

- Bury in managed type landfill facility for burying of the designated wastes.
- Incinerate at high temperature.

③ Corrosive substance

It is a substance that destroys skin tissues (cells) when contacted with the skin of an animal or human body. Wastes in liquid state such as strong acid with pH of less than 2 or alkaline with pH of more than 12.5

a. Corrosive acids

Nitric acid, hydrochloric acid and sulfuric acid with concentration of more than 20% and phosphoric acid, hydroflouric acid and acetic acid with concentration of more than 60%.

b. Corrosive bases

Sodium hydroxide solution, calcium hydroxide solution and ammonia, etc. with concentration of more than 40% need to be processed through one of the following methods:

- Separately store acidic and alkaline wasted to prevent them being mixed with other wastes.
- Neutralize acidic and basic wastes if possible. At the time of neutralization, mix base with acid and acid with base at appropriate proportion to make the resulting pH to be as close to 7 as possible.
- After having performed oxidation or reduction reactions, process the waste through the methods of condensation, sedimentation, filtration or dehydration.
- Process by means of evaporation or enrichment.
- Purify by using methods such as separation, evaporation, extraction or filtration.

④ Pyrophoric substance (substances that are reactive with air or water)

It refers to the substance with ease of self-ignition in the atmosphere that generates combustible gas through ignition when it comes into contact with water. Hazardous substances that belong to the category of pyrophoric substance include the lump or powder of the metal elements that belong to the rows 1~3 of the periodic table. These are substances including metal potassium, metal sodium, calcium carbide, magnesium powder, alkyllithium, alkyaluminum, etc. that induces exothermic reaction or generates combustion through reaction with water, thereby causing combustion or explosion. Phosphorous sulfide, red phosphorous, sulfur, iron, metal powder flammable solid, and etc. are the combustible substances that can ignite well at relatively low temperature. They should be disposed of in solid state by fully reacting or oxidizing them, or by turning them into solution.

⑤ Oxidizing substance

Substances with powerful oxidation that react due to violent deposition, heating, impact and contact with other chemical substances. Take precautions in handling to ensure there is no heating, impact or friction exerted on such substances, and strictly separate from combustible substances that can accelerate their decomposition in storing them. In addition, store in a cool location with good ventilation. In particular, special precautions must be exercised when disposing perchloric acid since they can induce explosion if mixed with sulfuric acid or organic compound.

⑥ Disposal of toxic substances

Process with care to ensure that toxic substance is not discharged outside through processes such as cooling, separation, absorption and/or incineration. Detection and alarm devices must be installed to sense the leakage of toxic substance.

⑦ Other wastes

There are various substance resulting after having fully used the chemical substances and including solid wastes such as empty reagent/drug bottle, broken glasses, glove contaminated with chemical substances, devices and materials for experiment, and contaminated packaging paper and waste paper, etc.

Fig. 1-3

Container to be used exclusively for each of the types of wastes (20 L HDPE)

Fig. 1-4

Wastes basket made from SUS material

Fig. 1-5

Bio wastes container

Fig. 1-6

Safety waste container for flammable liquid (prevention of explosion through automated venting of gas)

(4) Chemical wastes that require precaution at the time of disposal

① Explosive substance

Explosive substance can explode by inducing violent reactions due to heating, friction, impact or contact with other compounds without the supply of oxygen or oxidizing agent, and includes ester range of acetic acid, nitro compounds, azo compounds, nitrogen dioxide compounds and organic peroxide that are combustible substances that contain nitrogen and oxygen, etc. Particular precautions must be exercised at the time of handing for the following compounds since they are explosive:

- Potassium chlorate: Explodes when heated at high temperature or subjected to sudden impact.
- Compounds of acetylene and heavy metal: Substance obtained through addition of acetylene to the silver nitrate or copper sulfate can explode easily when dried.
- Silver nitrate and ammonia solution: Leaving mixture of silver nitrate and ammonia solution will generate explosive substance.

- **Hydrogen peroxide**: Mixture of concentrated hydrogen peroxide (30~50%) with metal, oxides of metal or carbon powder can explode easily.
- There is a risk of explosion when nitric acid + organic substances or sulfuric acid + potassium permanganate are mixed.

② Peroxide forming substance

Particular precautions are necessary in storage and disposal of waste of peroxides since it can explode upon contact with impact, friction and/or heat. Peroxide forming substance is an unsaturated compound that forms peroxide compound or react with oxygen at low or room temperature. In particular, if enriched peroxide crystalline is formed on the bottom of cover of glass container, it can induce serious explosion at the time of removal or opening of the cover. Therefore, particular precautions must be taken at the time of disposal by making reference to the list of substance in accordance with the classification of peroxide forming substances in the tables below.

Removal of peroxide compound

- Method that uses reactive alumina: When solvent that includes peroxide is passed through the tube filled with reactive alumina, it is possible to remove the peroxide compound.
- Peroxide compound can be removed by putting reductants solution or peroxide compound into reactant solutions such as $FeSO_4$ or Na_2SO_4 and shaking the mixture. Or it can be collected in the waste canister by diluting it before disposal.

a. Class I

These are unsaturated chemical substances with low molecular weight, and are capable of inducing hazardousness through violent polymerization reaction or formation of peroxide. It must be disposed of by confirming the presence of formation of peroxide at every 6-month interval.

Table 1-1 Peroxide Forming Chemicals, Class I

Acrylic Acid	Styrene
Acrylonitrile	Tetrafluoroethylene
1,3-Butadiene	Vinyl Acetate
2-Chloro-1,3-Butadiene(Chloroprene)	Vinyl Acetylene
Chlorotrifluoroethylene	Vinyl Chloride
1,1-Dichloroethene	Vinyl Pyridine
Methyl Methacrylate	Vinylidene Chloride

b. Class II

These are substances that form hazardous peroxides if evaporated or enriched in the process of evaporation. It must be disposed of by confirming the presence of formation of peroxide at every 6-month interval.

Table 1-2 (Peroxide Forming Chemicals), Class II

Acetal	Ethylene Glycol Dimethyl Ether (Glyme)
Cyclohexene	Furan
Cyclooctene	Isopropyl Benzene
Cyclopentene	Methylacetylene
Diacetylene	Methylcyclopentane
Dicyclopentadiene	Methylisobutyl Ketone
Diethylene Glycol Dimethyl Ether (Diglyme)	Tetrahydrofuran
Diethyl Ether	Tetrahydronaphthalene
Dioxane(P-Dioxane)	Vinyl Ethers

c. Class III

These are substances with the possibility of explosion if turned into peroxide. It must be disposed of by confirming the presence of formation of peroxide 3 months after the opening of the container.

Table 1-3 Peroxide Forming Chemicals, Class III

Divinyl Ether	Potassium Metal
Divinyl Acetylene	Potassium Amide
Diisopropyl Ehter	Sodium Amide
1,1-Dichloroethene	

③ Pyrophoric substance (substance that react with air or water)

Hazardous substances that belong to the category of pyrophoric substance such as metal potassium, metal lithium, metal sodium, calcium carbide and magnesium powder are the lumps or powders of metal elements that belong to the rows 1~3 of the periodic table, and combust or explode by generating combustible gas or induce exothermic reaction by reacting with water. Therefore, alkaline metals must be disposed of by turning them into solid or into solution through complete reduction or oxidation.

④ Infectious wastes

Infectious wastes include blood secretion, materials extracted from human organs, cotton balls and cadaver of experimental animals that needs health, hygienic and environmental management. Culture solutions, containers, slide, hypodermic needle and cover glasses as well as disposable goods such as gloves used or discharged in relations to bio experiment, and wastes mixed or came in contact with infectious wastes are classified as infectious wastes.

Infectious bio substance, unlike the chemical substances, has reproduction capabilities with the potential for major proliferation. In addition, although the chemical substances within the "safe" range are allowed to be discharged into the environment, there is no "safe" range for discharging of pathogenic organic bodies.

a. Management of bio wastes

- **Solid**: Plastic board, paper and glove
  - Attach container bio hazardous substances sticker on the outside of the container and put clear garbage bag inside the container that can be compression sterilized for collection of the wastes.
  - When the bag is almost full, move it to the compression sterilizer and execute compression sterilization while the bag is opened by including the compression sterilization tag.
  - Manual must be familiarized with for the use of the equipment since the methods of application differ depending on the types of the compression sterilizer.
  - Upon completion of the operation of the compression sterilizer, cool the wastes.
  - At the time of cooling the waste, close the bag and fixate the tag, and put the compression sterilized wastes into the waste container.
  - Complete the recording of the compression sterilized wastes.
- **Liquid**: Culture solution, supernatant and medium
  - After having compression sterilized and cooled the waste, either discharge through the sewage or use chemical sterilizer such as chlorine or iodine compound.
  - Add corresponding enrichment solution.
  - Enrichment differs depending on the disinfectant and quantity of the liquid wastes. In the case of bleach, the final enrichment must be 10% of the contents (example: add 1 unit of Clorox bleach to 9 units of liquid wastes).
  - Wait 20 minutes before discharging it down the sewer.

b. Sharp objects

Needle, hypodermic needle, razor blade, glass slide, plastic pipette, glass (including broken glass) and pasteurization pipette tip

- Sharp objects that have been bio-contaminated must be collected in a steri-cycle puncture resistant container with bio hazardous substances sticker attached.
- Once the front line of the container is filled, completely close the cover and fixate the container before attaching a label that indicates the container is full.
- Once the container becomes full, draft the format of collection and dispose the container in accordance with the prescribed procedure.
- Sharp radioactive object must be put into an appropriate container provided by the personnel in charge of the radiation safety in accordance with the half-life of the radioactive isotope.

c. Special experimental wastes

- Animals and animal floor matt
  - All animal cadavers must be returned to the refrigerated equipment for storage first prior to processing.
  - Prior to placing the cadaver into the refrigerated equipment, it must be put into the vinyl bag and closed tightly.
  - Process the floor matt for animals in accordance with the given procedures.
- Human blood, body fluid and tissues
  - Human tissues and organs must be incinerated.
  - Solid wastes that came into contact with human blood, body fluid or tissues must be processed through compression sterilization or incineration.

– Contaminated liquid wastes must be processed by means of compression sterilization or contaminants removed chemically by using 10% bleach. Let it stand for 20 minutes before discharging through the sewer.

d. Bio harmfulness mixture

– Inactivate the bio waste through sterilization processing that will not proliferate the chemically hazardous element associated with the waste.

– Once the bio substance becomes inactive, it can be managed only as a harmful chemical waste.

※ Compression sterilization is not recommended. Some of the chemical substances can explode or evaporate when heat or pressure is exerted.

e. Bio radioactive mixture

– For the radioactive wastes, inactivate bio substances through sterilization processing that does not make them volatile.

– Sterilizer used must be appropriate for the regulations on the storage and packaging of the radioactive wastes (pH, etc.).

– Once the bio substance becomes inactive, this waste can now be managed simply as a radioactive waste.

– Subjecting radioactive wastes to compression sterilization differs depending on the situation. If there is discharging of radiation, compression sterilization is not recommended.

– Inquire with the personnel in charge of radiation safety for more detail.

⑤ List of substances that need consultation in advance at the time of disposal

The following table is a list of the chemical substances for which their wastes are prohibited from being taken out under the UCSF in the USA. Sufficient consultation with company in charge of waste processing is necessary in order to dispose of them.

Table 1-4 List of substances that need consultation in advance at the time of disposal

Acrolein, inhibited	Hydrogen cyanide, anhydrous
Arsine	Hydrogen selenide, anhydrous
Benzoyl peroxide	Methyl chloroformate
Boron trichloride	Methyl isocyanate
Chlorine pentafluoride	Methylchloromethyl ether
Cyanogen chloride, inhibited	Methylhydrazine
Diborane	Nickel carbonyl
Dinitroglycerine	Nitric oxide
Dinitromethane	Nitrourea, dry
Ethyleneimine, inhibited	Phosgene
Ethyl Perchlorate	Phosphine
Fluorine, compressed	Phosphorus pentafluoride
Hydrazine azide	Picric acid, dry
Hydrazine chlorate	Trinitrophenol

3. Use of sticker for laboratory wastes

Waste sticker must be attached for the laboratory wastes from the time of collection. Wastes sticker must be manufactured so that the types of the wastes can be distinguished by means of the color of the sticker.

(1) Information to be recorded at the time of handling of wastes

① Date of the initial collection: Record the date of the initial collection in detail.
② Collector information: Record the name, laboratory and contact number of the collector in detail.
③ Wastes information:

a. Contents

Describe approximate contents in terms of "kg" or "L". Fill up only 70% of full capacity to ensure there is spilling during transportation.

b. State

Put efforts to collect only a single chemical type as much as possible and record the following issues.

- Aqueous solutions: In case of aqueous solution, record approximate pH by using pH paper.
- Mixture substance: Accurately indicate the names and concentrations of all the chemical substances included in the mixed substance.
- Organic solvents: Clearly indicate the name of the chemical substances.

c. Name of the chemical substances

Record all the chemical types included and indicated approximate concentration in terms of %.

d. Level of potential hazard

Explosiveness and virulent toxin are important information to the company specializing in transportation or processing. In the event of handling substances with potential hazard, record all the corresponding issues to enable those involved to take precautions in handling.

e. Date of transfer to the waste storage location

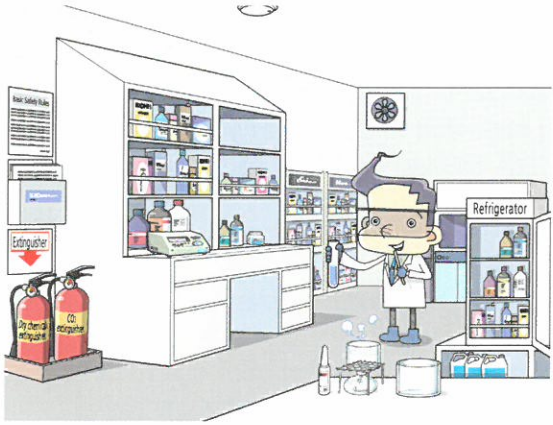
Record the date on which the wastes were moved to the storage location within the institution.

Fig. 1-7 Example of the use of sticker for wastes

4. Examples of accidents related to experimental wastes and its prevention

(1) Examples of accidents

Examples of explosion of the compressed container due to the discharging of gas as the result of violent reaction at the time of collection and transportation or prolonged period of storage of liquid wastes that have been mixed without segregation are given below.



① Explosion due to mixed waste I

- Overview of the Accident: Explosion accident due to the reaction of substance with high reactivity among the ingredients of the mixed waste solution
- Cause of the Accident: Causes included explosion of the compressed liquid waste container due to the thermal energy and gas generated through the violent reaction of highly reactive substances such as dichlorodimethylsilane and benzoyl chloride, and etc. in the waste solution

② Explosion due to mixed waste Ⅱ

- Overview of the Accident: Explosion accident due to the chemical reaction of the waste solution in the waste solution canister
- Cause of the Accident: Mixing of the chemical substances that can react with each other in disposal

③ Explosion due to rupture of waste

- Overview of the Accident: Accident due to the rupturing of the liquid waste canister stored in the hood
- Cause of the Accident: Causes included rupturing of the compressed liquid waste container due to the thermal energy and gas generated due to adding nitric acid to the container with residual organic liquid waste mixture such as ethyl alcohol, and failure to wear personal protective equipment.

④ Ignition due to residual waste

- Overview of the Accident: Accident due to disposing of residual zinc powder after the experiment into PVC waste basket
- Cause of the Accident: Ignition due to the prolonged period of reaction of the zinc powder thrown out with the water vapor in the air.

⑤ Fire due to uncategorized waste

- Overview of the Accident: Fire accident at the time of disposal of sodium
- Cause of the Accident: Causes included generation of hydrogen due to the explosive reaction between incompletely oxidized sodium and water, failure to recognize the hazard of the ensuing scattering of the strong alkaline aqueous solutions, ignorance of the personnel on the fire hazard

as the result of the hydrogen generated and failure to wear personal protective equipment.

Fig. 1-8

Explosion accident involving nitric acid liquid waste canister

Fig. 1-9

Explosion accident involving metal powder

(2) Preventive and coping methods

- Take care not to mix and store the substances that should not be kept together in the same container by checking the GHS/MSDS, and reinforce safety education in advance at the time of collection of waste reagent.
- Do not store solid wastes, residual reagent and liquid waste in the laboratory for prolonged period of time, but rather frequently consign the collection and processing by the professional company.
- Attach the request invoice for liquid waste and label for each of the type of waste reagent canister in order to confirm the waste placed in the waste canister.
- Transportation cart with impact and leakage prevention functions must be used at the time of transportation of waste canister.
- Store the waste canister in a location with good ventilation but no direct sunlight.
- It should be transported by a team of more than two with everyone wearing personal protective equipment.

- Install emergency safety equipment (emergency shower, eye washer and fire extinguisher, etc.) at the location for collection of wastes and regularly check their normal operation.
- Do not dispose of the flammable liquid with the risk of causing major fire and explosion accident through the sink in the experimental laboratory.
- Dispose of hyper-reactive substances after the experiment in accordance with the prescribed liquid waste procedures only when the researcher conducted stabilization processing.
- For powder with large surface reactivity or metal powders with large surface areas with small size of powder particles, turn them into solid by fully reducing or oxidizing or turn them solution.
- Establish safety management system for wastes.

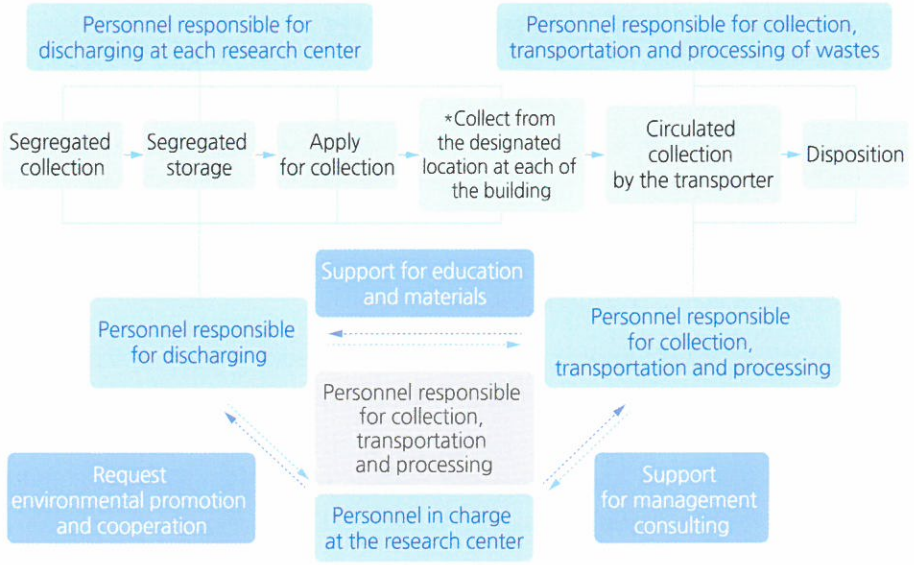


Fig. 1-10 Illustrative diagram for establishment of safety management system at laboratory

Perfect means of storing and managing waste solution

- Use chemical container with UN mark (jerry can) for the waste solution
- Make sure to wear protective devices when transferring the waste solution into a different container.
- Make sure to avoid direct sunlight when storing the waste solution.
- Store in a cool location with good ventilation
- Restrict access by unauthorized person and lock up the storage location.
- Attach signboard that indicates the presence of waste substances.
- Furnish neutralizing agents (acid,alkaline, and etc) for the storage of acid and base in preparation for the occurrence of unforeseen safety accident.
- Do not store waste solution for prolonged period of time but, rather, discard them on a regular basis. However, allocate reasonable period for storage within the range that complies with the law on safe management of waste matters before disposal in order to lower the cost of processing the waste.

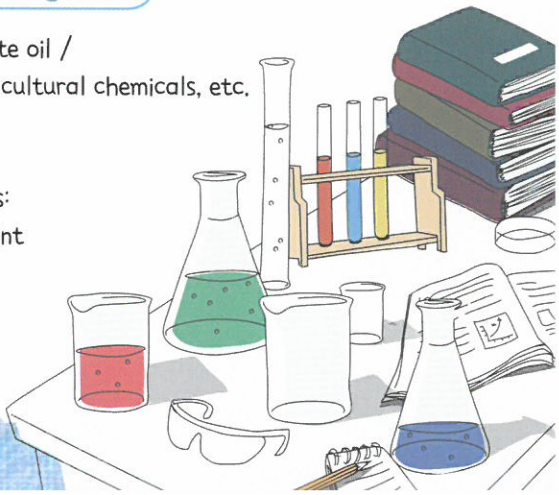
Criteria for period of storage

* Waste acid / waste alkaline / waste oil / waste organic solvent / waste agricultural chemicals, etc.

==> 45 days

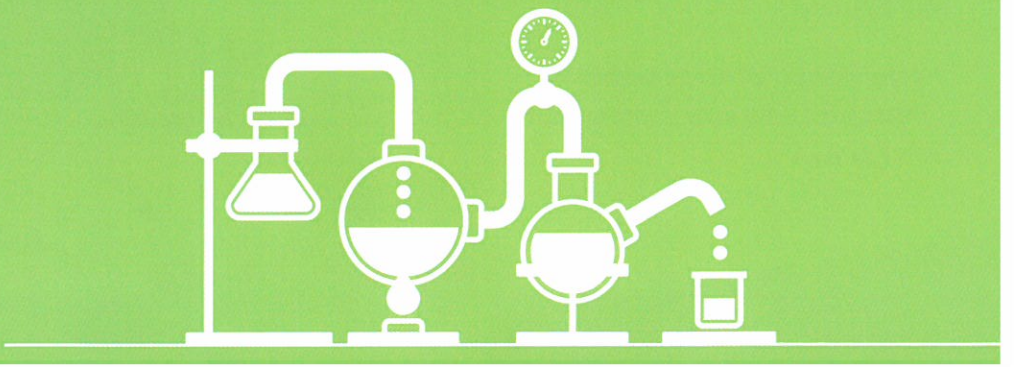
* Other designated waste substances: Waste toxic substances / waste paint

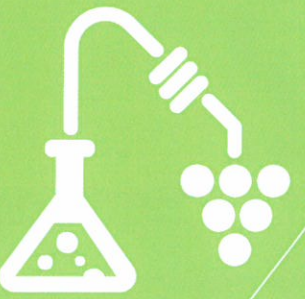
==> 60 days



Standard Textbook for Safety in Laboratory

Safety After the Experiment





CHAPTER

2

Emergency treatments

1. Emergency treatments
2. Cardiopulmonary resuscitation
3. Treatment of wounds
4. Treatment of burns
5. Emergency treatments in accordance with the types of injuries
6. Emergency treatments in accordance with the types of chemical substances

CHAPTER 2 Safety After the Experiment

Emergency treatments

1. Emergency treatments

Emergency treatments refer to the simple treatment executed on the trauma and diseases that occurred at unexpected location and time urgently at the site of such occurrence, and are temporary yet appropriate treatment to be given until formal treatment by medical doctor can be provided. The purposes of the emergency treatments include lifesaving, pain reduction, prevention of aggravation of wound or disease, and psychological stability. Therefore, proper emergency treatments can increase the survival rate of a patients, minimize the future disabilities, reduce the progress of diseases and damages, and is important in reducing the pain suffered by the patients.

Law on emergency medical treatment defines patients with possibility of occurrence of material hazard or life cannot be preserved unless immediate necessary emergency treatments are not. Prompt and accurate emergency treatments are necessary to prevent life threatening hazard or significant aggravation of the symptoms. In particular, those engaged in research activities at

research centers and experimental laboratories of universities are exposed to the hazards of various safety accidents since they frequently use highly pressurized gases and harmful chemical substances, and must familiarize with the techniques of emergency treatments. This Chapter will examine a diverse range of emergency situations and provide detailed explanations and pictorial illustrations of basic emergency treatments.

(1) Precautions to be taken at the time of emergency treatments

It must be remembered that the most important issue among those that need to be abided by at the time of provision of emergency treatments are as follows. The foremost important issue to be remembered is to maintain the safety of those providing emergency treatments. Therefore, it is important for the provider of emergency treatment to achieve psychological stability and cope with the situation composedly.

① Regardless of the urgency of the situation, it is of foremost importance to secure the safety of the person providing emergency treatment and the safety of on-site situation.

② Non-medical professionals should refrain from making determination of whether the patients or injured persons are live or not.

③ In principle, do not use medical drug unless instructed to do so.

④ Do not give food (including water) to unconscious patients.

⑤ Treat the patients who urgently need treatment.

⑥ In the event of requesting assistance, status of the patient and contents of the emergency treatments provided must be notified.

⑦ Following completion of emergency treatments, the patient or injured person must be turned over to professional medical personnel for specialized treatment.

(2) Basic principles of emergency treatments

Ordinarily, when emergency patient is discovered, determine what needs to be done and what must not be done after having composedly and promptly observing the surrounding situation and the condition of the patient, and execute emergency treatment in accordance with the decision made in such manner. The common principles of the emergency treatment to be given under emergency situation include hemostasis and prevention of shock, maintenance of respiratory tract, confirmation of the state of consciousness, prevention of complication of wound and reduction of the anxiety of the patient.

① Prevention of shock and hemostasis

Loss of more than 15% of the circulating blood (70ml per kg of the body weight) over a short period of time will induce shock and loss of more than 25% can result in death. Therefore, hemostasis has to be performed promptly in order to prevent shock. Since it is not the case that there is no bleeding simply because there is no outwardly observable bleeding wound, internal bleeding should be suspected if the appearance of the body changes or there are areas that suddenly swells up by carefully examining all parts of the body.

② Maintenance of the respiratory tract

If supply of oxygen to the brain cells is cut for more than 5 minutes, the patient may receive serious damages. Frequently, the outwardly observable bleeding wound causes the person providing emergency treatment to become confused, anxious and ignore injuries in thorax of respiratory tract, thereby needing attention to the breathing of the injured.

③ Observation of the state of consciousness and parts of the body

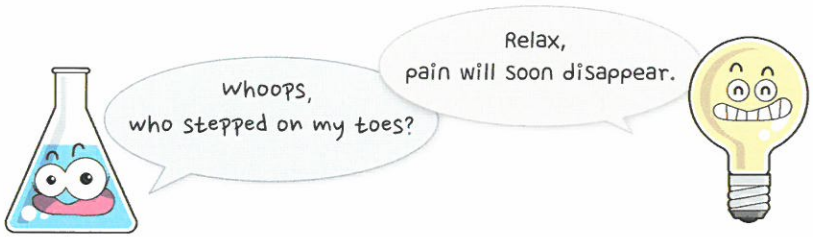
Check the state of consciousness of the patient by asking or inducing him/her to move slightly. If you have flashlight, observe whether the pupil is enlarged or fixated. Pupil has the property of quickly responding to light and if the reaction is very slow or if the pupil is fixated, then, the patient is in a very serious condition.

④ Protection of the wound

Take sterilization measures that are possible in order to prevent infection of the wound. Do not apply just any drug on the wound but, rather, lightly cover it with clean gauze to prevent infection.

⑤ Reduction of pain and anxiety

If there is pain, anxiety and the pain increases. One of the duties of the person performing emergency treatment is to reduce the anxiety and pain of the injured persons. Remember that the anxiety of the provider makes the injured person even more confused and anxious, thus try to settle down the mental state of the injured as much as possible.



(3) Emergency treatment products to be furnished basically in the laboratory

Table 2-1 List of emergency treatment products to be furnished in the laboratory

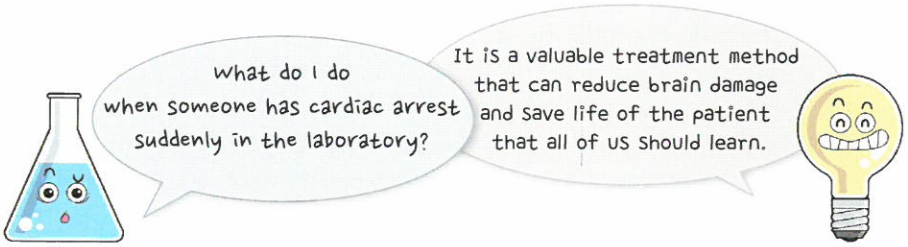
Categories	Emergency treatment drugs
Medical items	• Bandage: cotton bandage (3-inch width) • Cotton gauze (diverse sizes), disinfected cotton balls • Triangle bandage, elastic bandage • Scissor and knife • Tweezers • Adhesive plaster • Disposable glove • Disposable adhesive plaster • Wooden plate to be used as splint
Externally applied drugs	• Disinfectant: Hydrogen peroxide, Betadine • Skin ointment for external wounds containing antibiotics • Skin ointment containing steroid • Ointment for massaging of the muscles • Vaseline gauze for burns • Ointment or medicated patch for insect bites • Physiological saline solution • Liquid eye drops, eye ointment
Internally applied drugs	• Pyretic drug: Tylenol, syrup, suppository • Digestive medicine: Medical drugs and liquid preparations to aid with digestion • Antacid
Emergency supplies	• Thermometer • Flashlight • Tourniquet • Not pack • Ice pack • Soda water • Salt • Emetic • Match • Needle • Soap • Vinegar • Handkerchief

2. Cardiopulmonary resuscitation

(1) Importance of cardiopulmonary resuscitation

Heart is the pump in our body that pumps out the blood to all parts of the body. Cardiac arrest refers to the condition in which the pumping function of the heart has stopped. When cardiac arrest occurs, the blood circulation stops and, unless measures are taken to resuscitate the circulation, death or serious brain damage can occur. Brain may become permanently damaged if blood supply is stopped just for 4~5 minutes.

Cardiopulmonary resuscitation (CPR) is an emergency treatment method of artificially circulating the blood in the event of cardiac arrest and provides decisive assistant in delaying damages to the brain by circulating blood even when the heart has stopped and restoring the heart from the state of arrest. If person who observed cardiac arrest executes cardiopulmonary resuscitation immediately, the probability of saving cardiac arrest patient increases in comparison to the case of not having executed cardiopulmonary resuscitation. In particular, if cardiopulmonary resuscitation is executed effectively, it also increases the survival rate of the cardiac arrest patients in comparison to the situations in which CPR was not executed effectively. Therefore, cardiopulmonary resuscitation plays decisive role in reducing the brain damage of cardiac arrest patients, and, ultimately, it is a valuable treatment method to save the life of cardiac arrest patient. As illustrated in the [Fig. 2-1], prompt execution of cardiopulmonary resuscitation by the first person who detected cardiac arrest is very important.



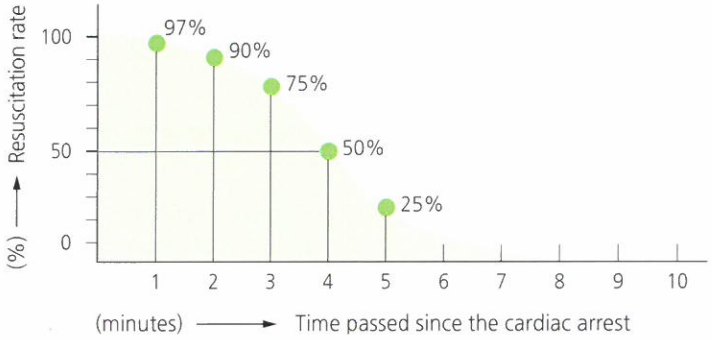


Fig. 2-1 Resuscitation rate through cardiopulmonary resuscitation in accordance with the time passed

(2) Basic principles of cardiopulmonary resuscitation

① In the order of performing cardiopulmonary resuscitation, it is recommended that chest compression be performed first prior to artificial respiration Therefore, the guideline made amendment of the order of cardiopulmonary resuscitation to chest compression (Compression) – maintenance of respiratory tract (Airway) - artificial respiration (Breathing), that is, in the order of C-A-B.

② For ordinary persons who have not received education on cardiopulmonary resuscitation or not familiar with cardiopulmonary resuscitation, it is recommended that 'chest compression resuscitation (hands-only CPR)' in which only chest compression is performed without the performance of artificial respiration is recommended.

③ For high quality cardiopulmonary resuscitation, it is recommended that the chest be compressed with minimum compression depth of 5cm at the rate of 100 times per minute with minimization of stoppage in chest compression during the execution.

④ Although it is recommended to check the heartbeat within 10 seconds even for the experts giving emergency medical treatment, chest compression must not be delayed for the purpose of checking the heartbeat.

⑤ In the event of having discovered patients with no reaction or breathing, chest compression must be performed immediately in principle.

(3) Procedures and methods of cardiopulmonary resuscitation

① Check the reactions of the patient

The rescuer should check the site situation to ensure the safety prior to approaching the patient. Once it is determined that the situation is safe, the rescuer should approach and lightly tap on the shoulder of the patient and ask whether the patient is alright. At this time, if the patient displays reactions but is in the state of needing treatment, call 119 and follow the instruction of the consultant for emergency medical treatment while frequently checking the conditions of the patient.

② Call 119

If it is confirmed that the patient is in the state of cardiac arrest, call 119 immediately. When calling 119, the rescuer must make preparations to give answers to the emergency medical treatment consultant regarding the location, situation of the site, number, conditions of the patients and the assistance necessary. If the rescuer has not received education on cardiopulmonary resuscitation or not confident on performing cardiopulmonary resuscitation, then, make preparations to follow the instructions of the emergency medical treatment consultant. The rescuer should continue to perform cardiopulmonary resuscitation by following the instruction of the emergency medical treatment consultant over the phone until the consultant advises that it is fine to hang up the phone.

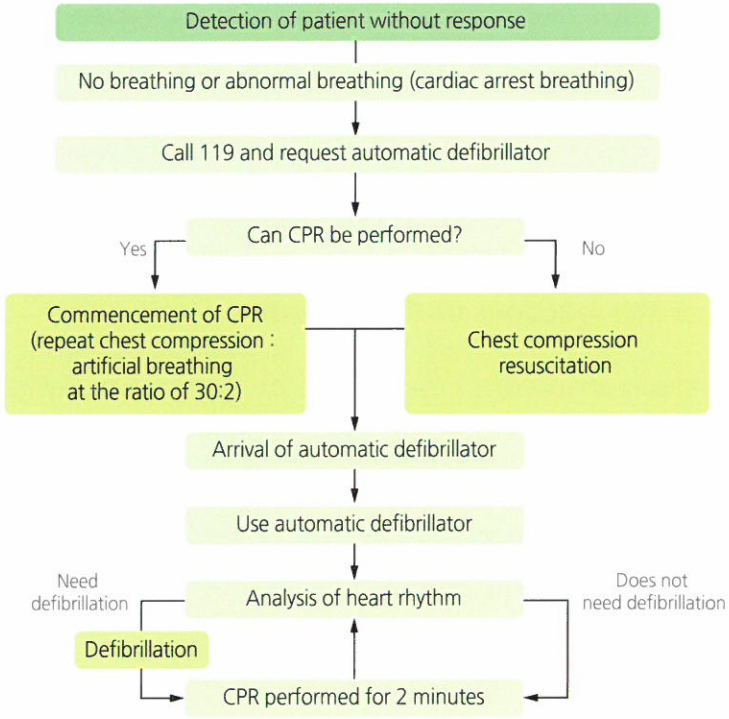


Fig. 2-2 Flow chart for the basic resuscitation provided by ordinary rescuer

③ Check breathing and heartbeat

a. Check breathing

One of the biggest changes in the guideline in 2011 was the simplification and specification of the process of checking breathing. The method of checking breathing by the method of 'seeing, listening and feeling' after having opened the respiratory tract within 10 seconds presented in the guideline in 2006 was excluded, and it is now necessary to determine the presence and abnormality of breathing at the stage of checking reactions.

b. Check heartbeat

If patient without reaction does not show normal breathing, it is recommended that ordinary people will perform chest compression immediately without having to check the heartbeat. Medical personnel must ensure that the time taken to check heartbeat does not exceed 10 seconds.

④ Chest compression

Effective chest compression is an essential element in delivering sufficient blood flow to the heart and brain during cardiopulmonary resuscitation. In order to effectively circulate blood by means of chest compression, lower half of the sternum must be compressed forcefully, regularly and quickly. In the case of cardiac arrest in adult, the rate of chest compression must be maintained at more than 100 times per minute but not exceed 120 times per minute with the depth of compression maintained at 5~6cm at the minimum. When performing chest compression, the hands must be placed at the 'center of the chest'. In order for the chest compression to be performed maximally, the period and frequency of stoppage of chest compression must be minimized. The ratio of chest compression and artificial respiration is recommended at 30:2 and substituting the person performing chest compression at every 2 minute will reduce the fatigue of the rescuer and provide high quality of cardiopulmonary resuscitation.

⑤ Use automatic AED

Automatic external defibrillator (AED) is emergency treatment equipment used when the cardiac function or breathing has stopped. It can be used easily by those who have not received education on cardiopulmonary resuscitation and must be used assertively when there is a cardiac arrest patient in the surrounding.

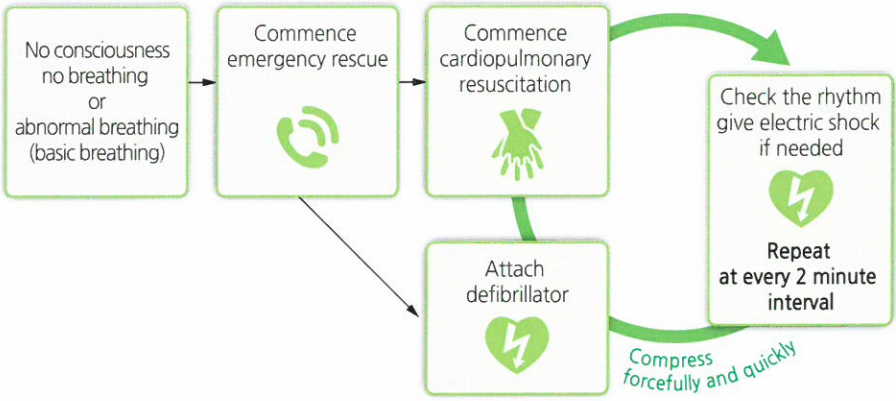
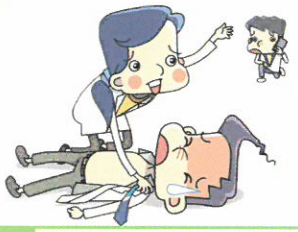


Fig. 2-3 Simplified flow chart for basic cardiopulmonary resuscitation for adult

(4) Pictorial illustration of the order of execution of cardiopulmonary resuscitation

Order of execution of cardiopulmonary resuscitation	Implementation method
 1 Confirm cardiac arrest	• First, tap the both shoulders of the patient lightly and shout with loud voice, "Hello, are you alright? Can you open your eyes?" • Check the reaction of the patient by means of bodily movement, flicking of the eyelids and answers (cardiac arrest -no reaction), and observe whether the patient is breathing or has abnormal breathing (cardiac arrest -no breathing or abnormal breathing). • It is not a cardiac arrest if there is movement or breathing even if there is no reaction.



2 Assistance and calling 119

- If there is no reaction of the patients, ask for assistance of those in the surrounding immediately if there is no reaction in the patient.
- If there is no one in the surrounding, call 119 immediately.
- If AED is available in the vicinity, request AED at the same time.

3 Execute chest compression 30 times

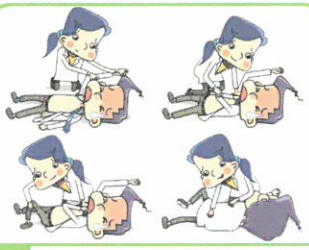
- Place the palm of the 2 hands overlapped with fingers interlocked on top of the center of the chest of the patient first.
- Take precaution to ensure that the fingers do not touch the chest and compress the chest by putting weight on the hand with the both arms extended straight full such that the arms are vertical with the body of the patient.
- Perform chest compression forcefully and quickly at the speed of 100~120 times per minute and depth of 5-6 cm for adult. In addition, count up to 30 while compressing and allow the compressed chest to be fully relaxed.

4 Execute artificial respiration 2 times

- In order to perform artificial respiration, tilt the head of the patient back and raise the chin to open the respiratory tract of the patient.
- With the thumb and index finger of the hand used to tilt the head back, hold and block the nose of the patients and open the mouth widely to cover the mouth of the patients completely. Breathe into the mouth of the patient for 1 second until the chest of the patient rises.
- When breathing into the mouth, visually check whether the chest of the patients is rising or not, and after having breathed into the mouth, take the mouth off from the patient and release the nose to allow the air to be discharged from the lung of the patient.
- If you do not know the method of or reluctant to perform artificial respiration, continue to perform artificial respiration chest compression with the exclusion of artificial respiration (hand only CPR).

5 Repeat chest compression and artificial respiration

- Then, perform 30 times of chest compressions and 2 times of artificial respirations repeatedly until the 119 Rescue Team arrives at the site.
- If there is another rescuer on the site, one of the rescuers should be in charge of chest compression while the other of artificial respiration. After having performed cardiopulmonary resuscitation 5 times (chest compression and artificial respiration at the ratio of 30:2 five times), exchange the respective roles.

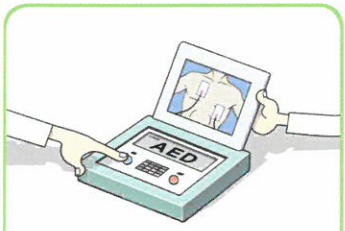


6 Recovery posture

- If the patient makes sound or moves while repeatedly performing chest compression and artificial respiration, check if the breathing has returned.
- If breathing has returned, turn the patient to the side in supine position to prevent the blocking of airway.
- Continue to observe if the patient continues to move and breathe thereafter.
- If the reaction and normal breathing of the patient disappears, it is a sign that cardiac arrest has recurred. Recommence chest compression and artificial respiration immediately.

(5) Pictorial illustration of AED application method

Order of AED application	Method of application



1 Turn on the power

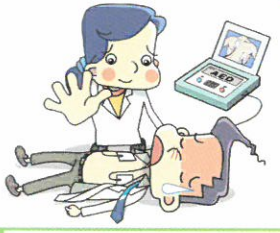
- AED must be used for the cardiac arrest patients with no reaction and normal breathing, and when AED arrives in the middle of execution of cardiopulmonary resuscitation, it must be applied without delay.
- After having placed the AED at a location that does not interfere with cardiopulmonary resuscitation, first , turn the power button on.

2 Attach 2 pads

- Pad 1: Immediately below the right ribs
- Pad 2: At the armpit next to the left nipple
- Remove any foreign matters at the area of attachment of the pad, and if the pad and the body of the defibrillator are disconnected, connect the pad.

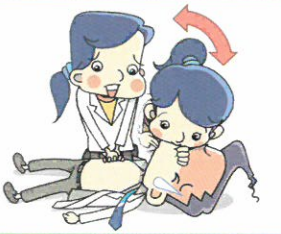
3 Analysis of heart rhythm

- When voice message that "analysis is being made…" is heard, stop execution of cardiopulmonary resuscitation and take hands off the patients
- If defibrillation is needed, AED will automatically commence recharging with the set energy level along with the voice message, "Defibrillation is needed" on its own. Since charging of AED takes more than several seconds, execute chest compression as long as possible.
- If defibrillation is not needed, voice message to "check the condition of the patient and continue cardiopulmonary resuscitation" will be given. In such case, recommence cardiopulmonary resuscitation immediately



4 Execute defibrillation

- Defibrillation button will start to flicker only when defibrillation is necessary. Execute defibrillation by pressing the flickering defibrillation button.
- Before pressing the defibrillation button, make sure to confirm that other people are distanced from the patient.



5 Execute cardiopulmonary resuscitation again immediately

- After having performed defibrillation, immediately repeat CPR with the ratio of chest compression: artificial respiration at 30:2.
- AED should be executed at every 2 minute interval by analyzing the heart rhythm and the use of AED and cardiopulmonary resuscitation must be continued until the 119 Rescue Team arrives at the site.

(6) Summary of the cardiopulmonary resuscitation method (for adult and children)

Table 2-2 Summary of cardiopulmonary resuscitation method (execute for those over the age of 8 years old in accordance with the method applied to the adult)

<table>
<tr><th></th><th>Adult</th><th>Child</th><th>Infant</th></tr>
<tr><td rowspan="3">Check cardiac arrest</td><td colspan="3">No response</td></tr>
<tr><td colspan="3">No breathing or cardiac arrest breathing</td></tr>
<tr><td colspan="3">No heartbeat checked within 10 seconds
(only for professional medical staff)</td></tr>
<tr><td>Order of CPR</td><td colspan="3">Chest compression - Maintenance of airway - Artificial breathing</td></tr>
<tr><td>Speed of chest compression</td><td colspan="3">More than 100 times per minute (less than 120 times per minute)</td></tr>
<tr><td>Depth of chest compression</td><td>Minimum of 5cm
(maximum of 6cm)</td><td>1/3 of the depth of the chest (5cm)</td><td>1/3 of the depth of the chest (4cm)</td></tr>
<tr><td>Relaxation of the chest</td><td colspan="3">Complete relaxation of the chest between each of the chest compression</td></tr>
<tr><td>Stoppage in chest compression</td><td colspan="3">Minimize stoppage of the chest compression
(stop for less than 10 seconds if it is unavoidable)</td></tr>
<tr><td>Maintenance of airway</td><td colspan="3">Tilt the head back and lift the chin</td></tr>
<tr><td rowspan="5">Ratio of chest compression to artificial breathing</td><td colspan="3">Prior to securing specialized airway</td></tr>
<tr><td rowspan="2">30:2</td><td colspan="2">30:2 (1 rescuer)</td></tr>
<tr><td colspan="2">15:2 (2 rescuers)</td></tr>
<tr><td colspan="3">After having secured specialized airway</td></tr>
<tr><td colspan="3">Artificial respiration at every 6~8 seconds
regardless of chest compression (8~10 times per minute)</td></tr>
<tr><td>Ordinary rescuer who had not received education or cannot perform CPR</td><td colspan="3">Execute 'Hands only CPR'</td></tr>
</table>

3. Treatment of wounds

Skin in our body is the organ that includes fingernail, toenail, hair, body hair subcutaneous fat, and etc. with the biggest surface area and exposure to external environment. Skin is made largely of three layers, namely, epidermal layer, dermal layer and subcutaneous fat layer. Wounds in the skin are divided largely into concussion, abrasion, knife wound, laceration, piercing wound, and etc. These wounds cause loss of protection function of the skin by inducing damaged area of the skin.

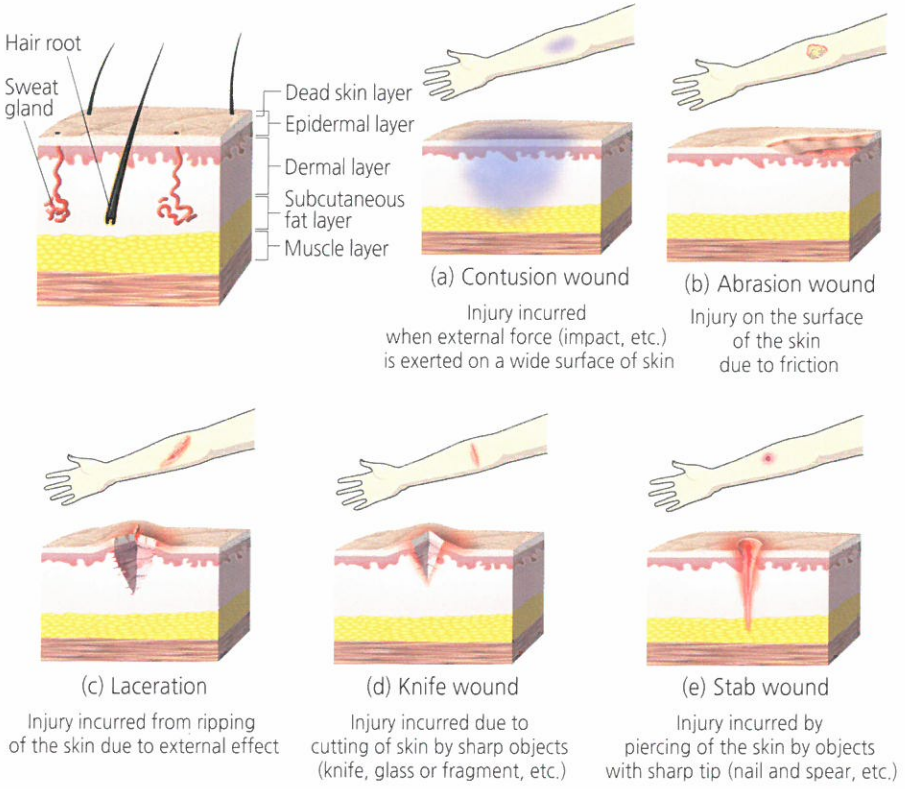


Fig. 2-4 Structure of the skin and types of wound

(1) Principles of treatment in accordance with the types of the wounds

① Concussion

It is the wound induced by dull objects such as hammer without the rupturing of the skin. Depending on the extent of the concussion, it is possible that not only bruises but also hematoma or blood clot due to bleeding in the areas below the subcutaneous tissues can occur. Moreover, malformation of the area of the wound through ingression after the treatment, although rare, can also be observed.

Basic treatment method includes application of cold pack for about 24 hours immediately after the incurring of the damage in order to reduce the progress of the edema and to alleviate of pain. After 48 hours of the incurring of the damage, hot pack can help with alleviation of edema and healing of the wound.

② Abrasion

It is the type of wound created by friction or crapping, resulting in damaging or falling off of the exterior layer of the skin. Wash the wounded area thoroughly with cleanser or saline solution with minor localized irritation. In the event of wound with depth that is limited only to the epidermal layer, it is advisable to apply the wet dressing until the wound is completely healed.

Unless there is secondary progress of the laceration infection due to pathogens, the basic treatment method of applying antibiotic ointment is effective with the wound healing without leaving scar.

③ Laceration, knife wound and piercing wound

These are wounds caused by sharp objects that always accompany incision of the skin. Wash the wounded area thoroughly with cleanser or saline

solution with minor localized irritation, and, in particular, cleansing must be performed carefully for soiled wound to prevent infection. Damages to the blood vessels may be accompanied depending on the depth of the laceration and knife wound, which requires hemostasis by visiting medical institution. Particular precautions must be exercised for the piercing wound resulting from being pierced by sharp objects such as nail. There are frequent cases in which deeper wound has been induced in the skin or underneath the dermal layer than outwardly visible wound, and may need measures against tetanus and etc. Piercing wound or penetration wound has small entry point of piercing with the infectious substance penetrating deep into the tissues, making washing off or discharging of the infectious substances difficult. Therefore, greater care must be taken against the infection of the skin.

(2) Basic disinfection of the wound

① Washing and disinfecting the wound

If there is no bleeding or if it has stopped to certain extent, wash the wound under flowing water to get rid of as much soil or other contaminating substance from the wound as possible. If it is not possible to purchase appropriate cleansing solution from the vicinity, visit hospital immediately after having put pressure on the wound with dry towel.

② Precautions at the time of washing the wound

- Immersing the wounded area in stagnant water does not help with the disinfection of the wound.
- Sucking on the wound with mouth should be avoided since there is possibility of increasing the risk of infecting the wound due to the large quantity of germs in the mouth.

- Although alcohol or hydrogen peroxide solution is helpful in disinfecting the areas around the wound, if their concentration is high, cells within the wound may be killed.
- If the wound is wrapped with adhesive band, there is high possibility of infection due to contamination of the wound by pathogens.

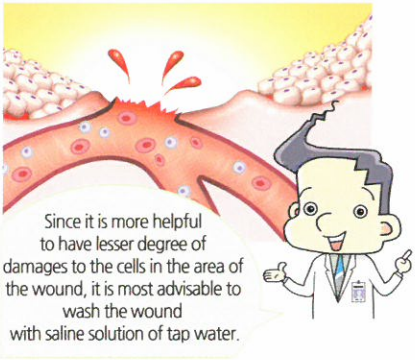
Wash the wound with flowing tap water after the bleeding stops to certain level.

Immersing the wounded area in stagnant water does not help with the disinfection of the would

Sucking on the wound with mouth should be avoided since there is possibility of increasing the risk of infecting the wound due to the germs in the mouth

Fig. 2-5 Method of washing the wound

Types of cleansing solutions	Extent of damages to normal cells (%)
Alcohol	100
Hydrogen peroxide(H_2O_2)	100
Ordinary soap	90
Diluted betadine solution (Povidon-iodine)	5
Tap water and distilled water	5
Saline solution	0



(100% damage: Almost all cells die, 0% damage: Almost all cells survive)

Fig. 2-6 Damages to the skin cells in accordance with the types of disinfectant for the wounds

③ Wound that necessitates treatment at hospital

There are cases in which professional examination and treatment is necessary by visiting hospital depending on the types of the wound. Take particular precaution for the following wounds:

- Hemostasis is not achieved
- Deeply cut or ripped wound
- Wound reaches the muscle or bone
- If foreign substance has pierced deep into the body
- Wound is wide with open gap

④ Initial dressing of the wound

Dressing refers to covering of the wound to protect the wounded areas. It is advisable to induce healing of the wound at the initial stage by performing treatment through the selection of appropriate dressing material. Dressings that can be applied to the wound at the initial stage include gauze dressing, closed type wet dressing, and etc.

a. Gauze dressing

Refers to the treatment of the wounded area by using gauze. It is economical and has the function of absorbing exudation from and protecting the wound. However, it has disadvantages of maintenance of damp environment, vulnerability to pathogenic infection, leaving of residues on the wound, and etc. Accordingly, it is applied mostly for the lacerations that need simple protection irrespective of the functions for promotion of healing of the wound.

b. Wet dressing

When the wound is maintained in closed state of moistness without forming scars, speed of healing the wound is faster. The purpose of wet

dressing is to maintain the state of moistness of the wound by tightly sealing the wounded area. When tightly sealing the wound, not only the wounded area but also the surrounding normal skin is tightly sealed with the moist state inducing permeation of moisture into the surrounding normal skin. Therefore, dressing materials with appropriate absorbency and permeability must be used in accordance with the type and state of the wound. Wet dressings that are readily available in the market include hydrocolloid, film, polyurethane foam, hydrogel, and etc.

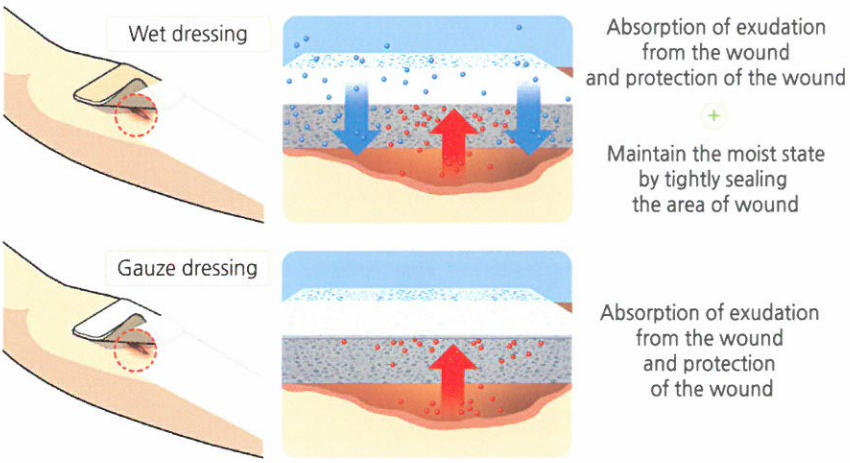


Fig. 2-7 Types of wound dressings

⑤ Intravenous injection for prevention of tetanus

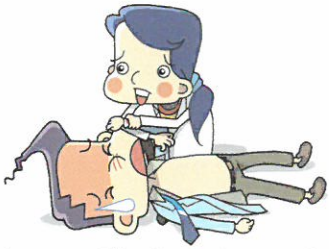
If wound had occurred by being pierced by nail or object contaminated by dirty substance, disinfect the area of the wound and take appropriate measures such as cutting out dead tissues in order to prevent tetanus. In particular, since tetanus is a disease caused by toxic substance, it is not possible to prevent tetanus by using antibiotics.

(3) Treatment of wound accompanied by bleeding

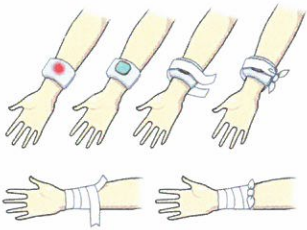
When laceration occurs, majority are accompanied by bleeding. Therefore, the first thing to be performed is hemostasis to stop bleeding. First, check bleeding from the wound visually by taking off or cutting off the clothing at the wounded area, and apply direct pressure on the area of laceration by using clean towel or gauze.

To ensure that wound does not become infected, be careful prior to contact with the wound. In addition, it is advisable to wear glove to protect oneself.

Completely cover the areas of wound with disinfected gauze or clean cloth, and apply direct pressure on the wound with finger or palm of the hand.



In the event of bleeding in the arm or leg, keep the area of the wound higher than heart while continuing to apply pressure on the wound.



Once bleeding stops after more than 10 minutes of hemostasis, fix the gauze by using clean towel to ensure that there is no bleeding again.

Fig. 2-8 Hemostasis method at the time of bleeding due to laceration

① Method of hemostasis for bleeding wound

- Even if there is no other method available, avoid touching the wounded area with bare hands as much as possible.

- Pressure applied must not be too weak and must be consistent.
- If bleeding does not stop within 10 minutes of application of hemostasis, there is high possibility that the pressure applied was too weak or placed at the wrong place. Increase the area and the force of application of pressure for another 10 minutes.
- If the bleeding stops and the treatment is completed, make sure to thoroughly wash hands with soap.
- Application of pressure directly on the wounds such as eye injury or fractured skull, or when foreign matter is visible can induce even greater damages. Visit medical institution immediately.
- Applying ointment or powdered type drug on the laceration wound for the purpose of hemostasis should be avoided since it is not only helpful to stop bleeding but also interferes with the discharging exudate and disposing of contaminating substance on the wound.

(4) How to use elastic bandage

It is convenient if you know the method of using elastic bandage in providing emergency treatments for the wound on arms and legs at the site. Although the elastic bandage does not differ much from the use of the ordinary bandage, it is necessary to check the status of blood circulation on a regular basis in the peripheral areas after the application.

(5) Measures to be taken for serious bleeding

If the bleeding at the wounded area differs or spews out from the heartbeat, the possibility of bleeding of artery must be considered and if hemostasis is not achieved even after 10 minutes of application of pressure, call 119 immediately to undergo treatment by medical staffs.

4. Treatment of burns

When heat or chemical substances come into contact with the skin, the skin and the epidermal tissues become damaged, which is referred to as burn. Burn induces loss of electrolytes and bodily fluid as well as infiltration of pathogens due to the loss of normal skin. Heat also affect the lung. The damages to the lung can be induced directly by heat as well as due to the inhalation of carbon monoxide and dusts. Types of the burns according to the causes are illustrated in the table below.

Table 2-3 Category and definition of the burns

Categories	Definition
Hot water burn	Burn due to contact with hot "water"
Fire burn	Burn generated due to contact with hot "fire (flame)"
Contact burn	Burn generated due to contact with hot "substance"
Chemical burn	Burn generated due to contact with "chemical substances"
Inhalation burn	Burn generated due to inhalation of "hot air or harmful dust"
Electrical burn	Burn generated due to contact with "electricity"

① Basics of burn

Burns refer to the damages that occur on the skin and adnexa of skin mostly by heat. Approximately 90% of the burns occur due to hot liquid, object, flame and sunlight. In the cases of electric burn or burn by chemical substances can leave severe after effects. In particular, diagnosis by medical doctor is essential for electrical burn since damages to the internal tissue or organ such as swell or arrhythmia of heart can occur.

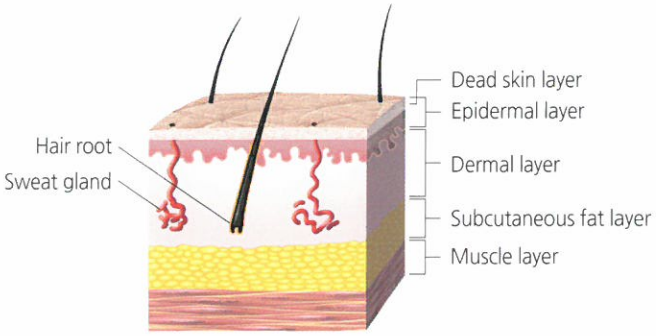


Fig. 2-9 Structure of skin

a. Classification of the severity of burns

Damages to the tissues are classified into 1st degree burn if only the epidermal layer is damaged, 2nd degree burn if epidermal layer the entire epidermal layer and substantial portion of the dermal layer are damage and 3rd degree burn if the entire dermal layer and even to the subcutaneous tissues are damaged, depending on the depth of the tissue damages.

The 1st degree burn refers to the damages only to the epidermal layer accompanied by red spots at the area of the burn. It is generated due to long-term exposure to direct sunlight or spontaneous contact with high temperature. Slight pain and edema occurs in such cases with majority of these symptoms disappearing within 48 hours. Defense against infection of the skin is maintained and healed naturally without leaving scar. Normally, this type of burns are healed within 3~6 days.

The 2nd degree burn refers to the damages to deeper tissues than the 1st degree burn and occurs due to contact with boiling water, flash of light, flame and hot oil. Damages include entire epidermal layer and portions of the dermal layer. In most cases, blisters are formed and accompanied by edema of the subcutaneous tissues. When the blisters are burst, exudate is discharged, revealing red colored glossy dermal layer. If this area of

wound is exposed to the air, it becomes deeper with increased risk of infection. Therefore, it is advisable to leave the blisters intact or remove only the liquid in the blisters while leaving the top skin intact, and visit hospital immediately.

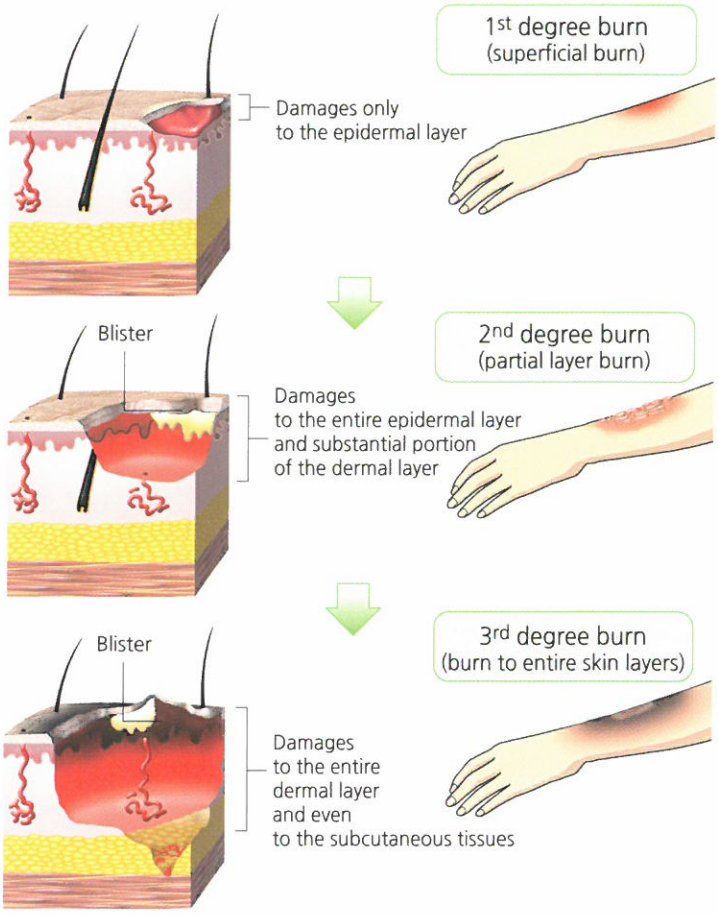


Fig. 2-10 Classification of burns depending on the depth of the damages

The 3rd degree burn is induced frequently by flame, hot vapor, hot oil, chemical substances, high pressure and electricity. Damages are spread entirely to the epidermal layer and dermal layer, and portion of the subcutaneous fat layer. Although there is severe edema due to the extensive necrosis of the tissues in the area of laceration, there is little pain on the contrary. Burn to the entire skin layers cannot be healed completely unless the damaged tissues are removed and intact skin is grafted.

b. Temperature of the source of heat that induces burns

When the temperature of the source of heat that induces burns is below 45℃, there is little damage to the tissues. However, in the temperature range of 45℃~50℃, there is partial damage of the cells with deformation of the protein ingredients of the cells at the temperatures of more than 50℃.

Table 2-4 Temperature and duration of time for inducing of 3rd degree burn

Water temperature (℃)	Time taken for the occurrence of 3rd degree burn
68	1 sec
64	2 sec
60	5 sec
56	15 sec
52	1 min
51	3 min
48	5 min

c. Characteristics in accordance with the causes of the burns

Damages arising from chemical substances are those that include both burns and chemical changes, which are referred to as corrosion. Substances that causes damages including acid, alkaline and metal bases. Normally, such burns occur on the skin due to mistakes in the

experimental laboratory or in the stomach or digestive tract of people who consume chemical substances. Ordinarily, burns due to exposure to alkaline is deeper and leave greater after effect than the burns due to acids.

The extent of the seriousness of the electric burns is determined by many factors including the type of current, voltage and quantity of current applied, resistance of the bio tissues, and flow of and duration of application electricity passed into the body.

② Treatment of burns

Treatment of the burns is normally divided into acute and observational stages. It is important to minimize the damages of the burns during early stage emergency treatments and to promote the healing of the wound and prevent infection while reducing the pain as well.

a. Removal of the foreign matters

If it is not a serious burn, take off the clothes that cover the area of the burn immediately. Take off the cloth contaminated by chemical substances as well to ensure that damages will not be sustained. If it is difficult to take off the cloth that is not adhering to the skin, remove by cutting it and clothing that is adhering to the skin should be removed by washing it.

b. Cooling and cleaning

Thoroughly clean the immediate areas of the burns by using cold and clean water for more than 15 minutes and continue to keep the temperature of the area low. Effective cooling of the area immediately following the burn for several hours will reduce the pain. The best method is to wet sterilized gauze with physiological saline cooled to the temperature of about ℃ and place directly on the area of burn. However, avoid putting ice directly onto the area of the injury.

c. Drug treatment

There is no need to use antibiotics in the case of slight burn since the risk of infection is only comparable to that of abrasion.

③ Emergency treatment for laceration burn

a. Emergency treatments method

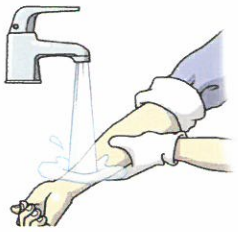


Fig. 2-11
Washing the laceration burns

- Move the patient to safe location and take measures to ensure that the burn does not progress any further (remove the burnt clothing), and take off watch and rings before the skin begins to swell.
- When burnt by hot water while wearing clothing, cool the clothing with flowing cold water for 15~30 minutes prior to taking the clothes off. If it is difficult to take off the clothing, cut off only the affected area with scissor. If the face is burnt, put entire face into the water in the wash basin.
- Put Vaseline or burn gauze over the area of the burn and lightly wrap it with bandage.
- Keep the area of the burn higher than heart to minimize swelling.

b. Precautions

- Measure of removing the blister – Unnecessary removal of the blister (substance) has high possibility of pathogenic infection. Do not purposefully peel off or rupture the blister. Transfer the patient to the hospital for proper treatment.
- Treatment of directly putting ice on the area of burn – Although it can reduce pain temporarily, it can also induce frostbite, thereby needing particular care.

- It is very easy for infection to occur in the event of burns. Therefore, do not put dirty finger or cloth on the area of burns.

④ Emergency treatment for chemical burns

Chemical burn occurs when substance that induce chemical reactions come into contact with the skin. Burns by acid and alkaline have the risk of the acid and alkaline infiltrating and reaching the depth of the skin. Therefore, it must be washed off by using tap water immediately. In addition, changes in the symptoms must be observed since it can affect the eyes or respiratory tract. In addition, if skin is exposed to solid chemical substances (quicklime or soda ash, etc.), these substances will undergo serious chemical reactions if they come into contact with water. Therefore, it is important to brush them off at first hand before prior to washing them off.

a. Methods of emergency treatment

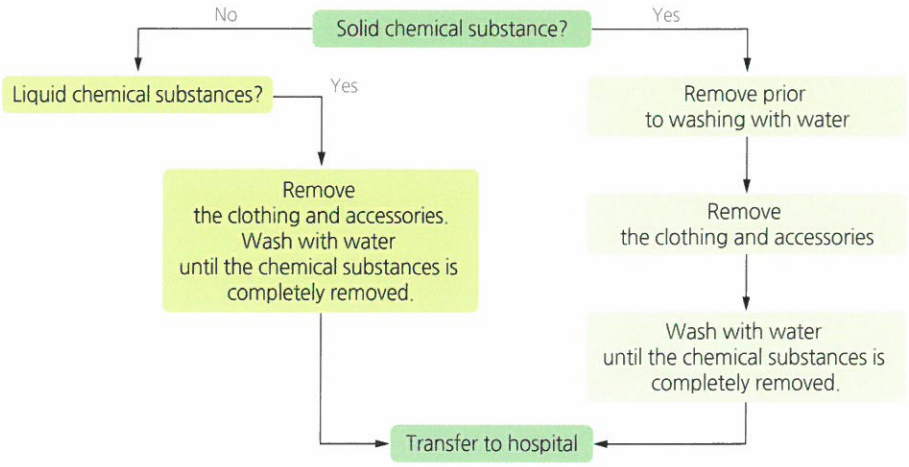


Fig. 2-12 Flow chart on the method of treating burn

- Transfer the patients to safe location and take measures to ensure that burn does not progress any further.
- If the chemical substances is solid rather than liquid, brush them off first prior to washing them off.
- Immediately remove the clothing and shoes that is covered with the substance and wash continuously under flowing water until all the chemical substances are washed off. If they are not washed off sufficiently, it could lead to deep wound.

⑤ Emergency treatment for electric burn or electrocution

Electrocution is the most common accident related to electricity, which can also induce explosion accident if the person comes in contact with other substances. One of the characteristics of electric burn is that damages of the internal tissues of the body is more serious than the external damages, with the wound at the exit point of the electricity substantially larger and more severe than that of the entry point.

a. Method of emergency treatments

- First, turn off the power to prevent electric shock. If it is not possible to turn the power off, wear rubber glove or get on corrugated cardboard and remove the electric cable and touch the patient's body with dry stick.
- It is necessary to take rest and maintain stability for at least several hours after electrocution. If there is no reaction from the patient, execute cardiac massage.
- Treat the burn after having taken care of the breathing and cardiac problems.
- For the area of the burn (entry and exist points of the current), sufficiently cool even the internal portions of the body.

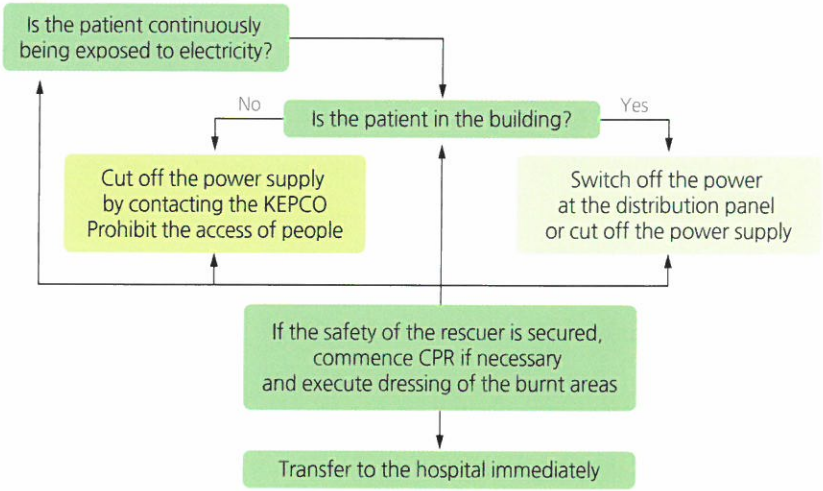


Fig. 2-13 Flow chart on the method of treating electrical burn or electrocution

b. Precautions

- Do not make hasty actions when the safety of the rescuer has not been secured.

⑥ Emergency treatments for inhalation burn

In the event of occurrence of explosion accident or fire, serious respiratory disability can be induced if there is burn to the face or neck. Measures to maintain airway and provision of supplementary breathing must be taken as soon as possible. Situation for which inhalation burn can be suspected include being in the region or underground floor with occurrence of a lot of smoke, trace of burn on the face of the patient, rough breathing sound or breathing difficulties, black dust included in the phlegm, and etc.

a. Methods of emergency treatments

- Transfer the patient to safe location, loosen the clothing and enable the patient to breathe fresh air.
- In the event of occurrence of cessation of breathing or heart, perform CPR.
- Transfer to hospital immediately.

b. Precautions

- Do not make hasty actions under the situations in which the safety of rescuer has not been secured including tightly sealed space or location with a lot of smoke.

5. Emergency treatments in accordance with the types of injuries

① Bleeding

In the event of occurrence of bleeding, it is very important to perform hemostasis immediately. As the blood stagnate, the time taken for the areas below the location of tourniquet to become disabled is approximately 1.5 ~ 2 hours. When the tourniquet is loosened or untied to prevent such disability, there is a possibility of inducing shock. Therefore, emergency medical treatment institution must be contacted immediately. Method of hemostasis include direct compression method and arterial compression method. Since blood does not flow in the area in front of the tourniquet, there is a risk of necrosis of tissues due to the lack of oxygen. Accordingly, use of tourniquet is the last option to be taken in emergency treatments.

a. Severe bleeding in the leg

- **Use strong fabric**: Use fabric with width of approximately 5cm as tourniquet and if there is no tourniquet to be used, towel, necktie, blanket or rubber can be used instead.

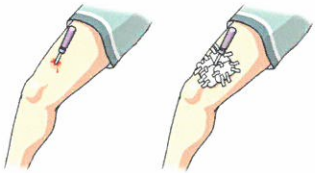


Fig. 2-14 Bleeding in the leg

- Cut clothing such as pants to the area of bleeding with scissor.
- Roll up the tourniquet fabric up to the area slightly above the area of bleeding. Do not use too thin tourniquet and those with large width has lower risk of tissue damages even if it is tightened strongly.
- Tie the fabric by using a rod. Make a tie knot and have the rod (tourniquet rod) through the knot and rotate as if pulling it up.
- Fixate the rod and record the time of hemostasis. If bleeding stops, fixate the rod to prevent it from moving, and write down the time of hemostasis at a visible location on the upper portion of the tourniquet in order to prevent the damaging of the tissues by being aware of the time at which hemostasis was performed.

b. Major bleeding in the arm

- Doubly warp fabric with width of approximately 5cm around the area slightly above the area of bleeding and tie it firmly (if there is a joint in this area, wrap it above the joint and if the patient is wearing thin clothing, it is advisable to wrap it on top of the clothing rather than directly on the bare skin).

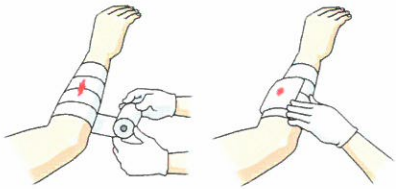


Fig. 2-15 Bleeding in the arm

- Penetrate short and durable rod (tourniquet rod) underneath the tie knot. This method can only be used in emergency situations in which life is threatened when hemostasis cannot be performed in any other manner.
- Rotate the rod as though pulling up and tighten until bleeding stops. If bleeding stops, wrap the both ends of the fabric with the rod to fixate.
- Fixate the rod and record the time of hemostasis and attach the card with the time of hemostasis on top of the tourniquet.

c. Nose bleeding

- Insert gauze rolled into a tube shape in the space between the upper lip and gum and put pressure by pressing down on the nose with finger and press on the gauze under the upper lip to assist with the hemostasis.
- Keep seated posture with head tilted forward as much as possible to ensure that the blood from the nose does not enter the area behind the nose or the lung.

d. Bleeding from the ear

- Tilt the ear towards the side damaged in order to have blood or liquid to flow out of the ear.
- Cover the ear with sterilized gauze and lightly fix it with adhesive tape. At this time, it must be ensured that ear is not blocked with cover or flow of blood is not interfered with.

② Fracture

Fracture can occur even with the slight external force that may not even be recognized. Strength of the bone differs for each individual and is greatly influenced by age, gender, nutritional state and presence of bone diseases. Fracture can be divided into open type fracture with laceration of skin or

muscles externally and closed type fracture with only simple fracture of bone without laceration in the skin. Open type fracture has a high risk of inducing infection and the patient is likely to experience shock due to bleeding, nerve damage and serious pain at the time of fracture.

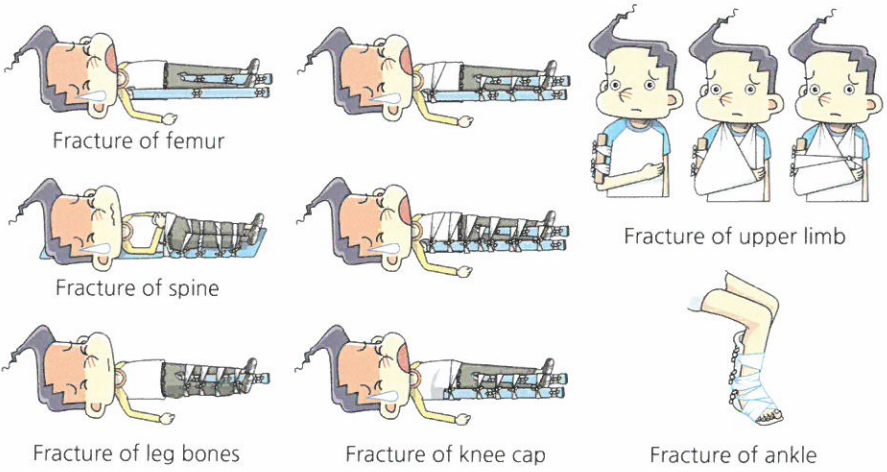


Fig. 2-16 Fixation methods in accordance with types of fracture

a. In the event of incurring bone fracture due to major wound or trauma

- If the patient is unconscious or does not breathe, commence CPR immediately.
- Check if there is pain induced by even a slight compression and movement.
- Check if there is no abnormality in the movement of arms, legs and joints.
- Examine whether the bone has punctured through the skin.
- Check if the patient has senses at the extremities of toes and fingers.

b. Measures to be taken until the medical staffs arrive

- Stop bleeding by performing hemostasis by placing disinfected gauze or cloth on the wound and pressing it down on the wound.
- Prevent the area of injury from moving and support the bones by placing splint at the area of fracture.
- If the patient displays shortness and quickness of breath and appears to faint, lower the head to elevation below the body while the legs are elevated higher than the heart.

③ Cuts

Accidents in which part of the body including fingers is cut off due to the impact or erroneous operation of the machines or highly pressurized equipment occur during the experiment. Cut off piece of skin or finger must be taken to the hospital for grafting.

- Lightly wash the cut off part of the body with physiological saline solution and wrap it with disinfected gauze wetted with physiological saline solution (if physiological saline solution is not available at the site, this must be omitted).
- Put the part of the body wrapped with gauze into vinyl bag or tightly seal with plastic wrap. If water comes in contact with the tissues, they will become swollen and reduce the success rate grafting of the cut off parts of the body.
- Put sufficient water into a large container and add ice to make water cold. Make sure that the quantity of ice is greater than water. If there is too much ice or not enough water, the tissues come in direct contact with the tissues and freeze, making grafting of the cut off parts of the body difficult.
- Store the vinyl bag containing the part of the body into this container with ice water.
- If there is bleeding at the cut part of the body (not the part that has been cut off), perform proper hemostasis and take measures to prevent infection by using sterilized gauze.

④ Foreign matters

Broken glass, splinters of broken timber, sand or soil, plastic fragment and various other foreign matters may enter the skin and subcutaneous fat layer as well as the muscle layers in severe case through the laceration in the skin. If there is possibility of such foreign matters entering the wound, radiological examination must be performed. However, small or thin fragments that are not made of metal cannot be distinguished from body tissues and may induce inflammation or granuloma later, which would necessitate resection of the affected areas.

a. Precautions

- Foreign matters embedded in any of the body parts must not be removed at the site. However, if the embedded foreign matters block the respiratory tract, it is unavoidable to remove them on the site.
- The embedded foreign matters must not move or shake during transportation of the patient. Therefore, fixate the foreign matters as they are and protect them in order to prevent them from moving.
- If substantial bleeding occurs in the area around the embedded foreign matters, perform hemostasis by pressing down on the areas around the foreign matters with the palm of the hand.

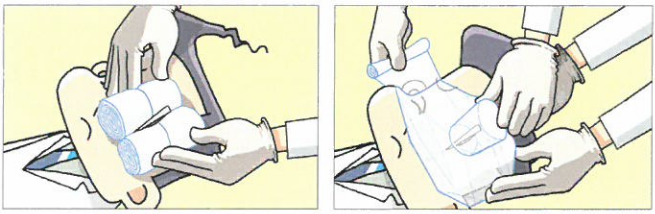


Fig. 2-17 Fixating the object imbedded in the eyes

(2) Guidelines on emergency treatments for each of the damages and areas

Head

Injuries to scalp	❶ Directly press down on the wound with clean sterilized gauze to stop bleeding.
Fracture of the skull	❶ Evaluate breathing and treat the wound if necessary. ❷ Stop bleeding by pressing down on the boundaries of the wound. ❸ Fix the head and neck of the patient to prevent it from moving.
Brain damage (cerebral concussion)	❶ Evaluate breathing and treat the wound if necessary. ❷ Fix the head and neck of the patient to prevent it from moving. ❸ Check bleeding in the scalp and if bleeding is confirmed, stop bleeding.

Chest

Facture of ribs	❶ Allow the injured to take comfortable posture. ❷ Support the ribs by using pillow, blanket or thick and soft fibrous material. ❸ Undergo treatment at a hospital.
Insertion of foreign matter into the thorax	❶ Leave the object in the wounded area as they are (do not remove the object). ❷ Fix the object by using several layers of thick gauze or clothing, or ❸ Call 119 and following the direction.
Aspirational laceration aspiration of thorax	❶ Cover the wounded area to prevent air from entering the chest. Use vinyl or hand if there is no sterilized glove available. ❷ Remove the cover on the wound depending on the status of breathing of the patients. ❸ Call 119 and following the direction.

* **Findings that lead to suspicion of the rib fracture**: In the event of feeling sharp pain in the chest when breathing deep, coughing or moving
* **Findings that lead to suspicion of laceration in the chest**: Seeping out of blood accompanied by bubbles from the wound in the chest

Eyes

Simple foreign matter in the eyes	❶ Find foreign matter under the eyelids on both sides. ❷ If foreign matters are visible, remove by using gauze.
Penetration would of the eyes	❶ If there is an object that penetrated the eyes, do not remove such object and preserve the eyes while fixating the object. ❷ Call 119.
Contusion in the area of the eyes	❶ Execute cold pack by using ice, etc. Do not put ice of ice pack directly on the eyeball. ❷ If there any problem occurs with the eyesight or if eyesight becomes blurred, visit ophthalmologist.
Ripped wound of the eyes	❶ Cover the eyes with gauze wetted with physiological saline solution without applying pressure. ❷ Call 119.
Cut eyelid	❶ If damages occur to the eyes, do not put pressure. ❷ If the eyelid has cut without damages to the eyeball, cover with gauze by carefully compressing on the wound. ❸ Call 119
Eye injury due to chemical substance	❶ Wash with lukewarm water for more than 20 minutes. ❷ Undergo treatment at a hospital.
Eye injury due to light	❶ Cover the eyes by using cold and wet gauze. ❷ Undergo treatment at a hospital.

Nose

Nose bleeding

1. Have the patient sit with the head tilted forward slightly.
2. Press on the soft area of the nose with the thumb and index finger for about 5~10 minutes.
3. If nose bleeding does not stop after 10 minutes, and the nose bleed enters into the tracts below the neck or nasal bone fracture is accompanied, undergo treatment at a hospital.

Fracture of nasal bone

1. Lightly perform hemostasis for nose bleeding.
2. Perform ice pack for about 15 minutes.
3. Undergo treatment at a hospital.

Tooth

Damages to teeth

1. Block the puncture hole made by the falling off of tooth with gauze, and etc.
2. Find the tooth that fell off and store it by using milk or saliva of the patient (make sure to hold the tooth by the crown area rather than the root).
3. Sent the patient and the tooth to the dental clinic.

Spine

Spinal damages

1. Fix the head and neck to prevent it from moving.
2. If there is no reaction from patient, open the airway and evaluate the status of breathing.
3. Call 119 and following the direction.

* **Findings that lead to the suspicion of spinal damages**: **1)** Cannot move arms or legs, **2)** complaint of pain or abnormal senses in the arm or leg, and **3)** occurrence of deformation in the head and neck areas (in the event of occurrence of impact of neck area or trauma due to falling in the accident)

Abdomen

(Closed type) contusion of the abdomen

1. Allow the injured to take comfortable posture by pulling the legs towards the abdomen.
2. Undergo treatment at a hospital.

(Open type) contusion of the abdomen

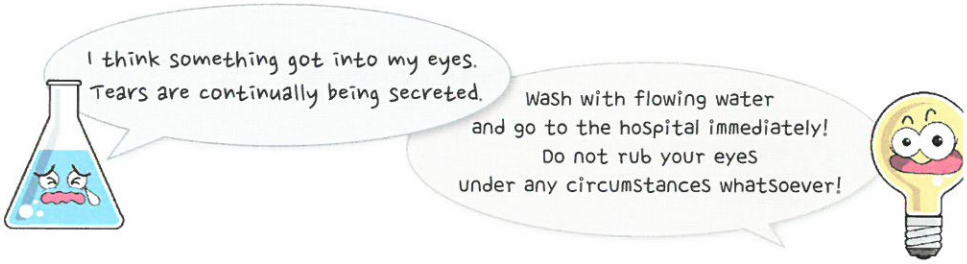
1. Allow the injured to take comfortable posture by pulling the legs towards the abdomen
2. Do not push in the organ that protruded out of the body back into to abdomen.
3. If there is sterilized large gauze, wet it with physiological saline solution and cover the organs.
4. Call 119 and following the direction.

Pelvis

Damages to the pelvis

1. Leave the patient along and prevent any movement.
2. If shock symptoms are accompanied, takes appropriate measures.
3. Call 119 and following the direction.

* **Findings that leads to suspicion of damages to pelvis (fracture)**: There was accident such as falling in which the impact is exerted onto the pelvis accompanied by **1)** pain in the areas of hip and back that aggravates when legs or hips are moved, **2)** condition that makes walking or standing impossible



(3) Emergency treatments according to the types of the injuries

Damages to the musculoskeletal system

Fracture	❶ Expose and examine the damaged area. ❷ Wrap all the open wounds with bandage. ❸ Fixate the damaged area. ❹ Keep the damaged areas cold. ❺ Undergo treatment at a hospital. Call 119 depending on the severity of the injury and following instruction.
Dislocation	❶ Expose and examine the damaged area. ❷ Fixate the damaged area. ❸ Keep the damaged areas cold. ❹ Undergo treatment at a hospital.
Contusion or sprain of muscle	❶ Take rest ❷ Put ice pack ❸ Compress the damaged area ❹ Slightly raise the affected area

Type of burns

Chemical burns	❶ Brush off the chemical covering the skin with brush ❷ Wash for about 20 minutes with large quantity of water. ❸ Remove the contaminated clothing and accessories while washing. ❹ Cover with sterilized gauze. ❺ Undergo treatment at a hospital.
Electrical burns	❶ Check safety first. ❷ Pull out the plug and cord, and cut off the power supply. ❸ Check the status of breathing and perform emergency treatments if needed. ❹ Call 119 and Undergo treatment at a hospital.

Bleeding

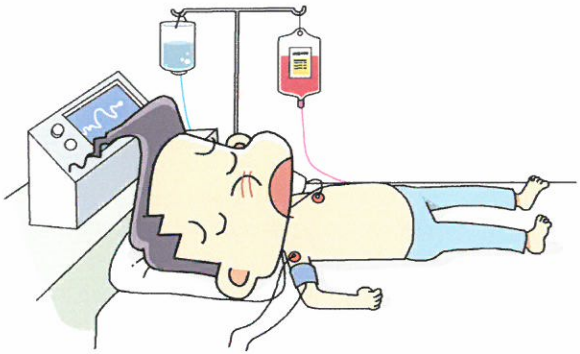
External bleeding	❶ Protect the rescuer by using glove, and etc. to prevent the blood from coming into contact with rescuer. ❷ Cover the wound with sterilized gauze. ❸ If possible, lift the wounded area. ❹ Wrap with compression bandage. ❺ If bleeding is not controlled, observe after having put pressure on the upper portion of the area of bleeding.
Internal bleeding (slight bleeding and contusion)	❶ Take a rest. ❷ Perform ice pack. ❸ Compress the area of wound with elastic bandage. ❹ Lift the wounded arm or leg
Internal bleeding (accompanied with shock)	❶ Call 119. ❷ Execute treatment for shock. ❸ If the patient is vomiting, turn the patient to his/her side.

Shock

are no reactions	❶ Observe the breathing condition and provide treatment if necessary. ❷ Call 119. ❸ Stop all confirmed bleeding. ❹ Put the patient in supine position. ❺ Raise the legs of the patient by about 30cm. ❻ If there is a fracture, do not move the patient. ❼ Cover the patient with blanket to prevent hypothermia.
Serious allergic reactions (anaphylaxis)	❶ Observe breathing, and prepare CPR. ❷ If there is no reaction, perform CPR. ❸ Call 119. ❹ If the patient is conscious, maintain the posture of holding the patient in seated posture to assist with breathing. Put patient in supine posture on his/her side if there are no reactions

Types of external wound

Open type wound	❶ Wash by using soap and water. ❷ Wash under flowing water by increasing the water pressure. ❸ Remove the small residual objects. ❹ If bleeding continues, put pressure onto the wound. ❺ Cover with clean sterilize gauze. ❻ Wound with high risk of infection and need for suturing, must undergo treatment at a hospital.
Cut	❶ Call 119. ❷ Stop bleeding. ❸ Observe to prevent shock. ❹ Protect the areas of cut and wrap with clean gauze. ❺ Put the severed part of the body by using vinyl bag and waterproof container. ❻ Keep it cold.
Foreign matters	❶ With exception of very small object such as splinter, do not remove the object. ❷ Stop bleeding by applying pressure to area around the object ❸ Fix the object with thick gauze or clean cloth. ❹ Undergo treatment at a hospital.



6. Emergency treatments in accordance with the types of chemical substances

(1) Emergency treatments for each of the channel of exposure to the chemical substances

① Intoxication through the skin

When substances such as sodium hydroxide or cleansing solution come into direct contact with skin or eyes, and etc., localized damages such as infection and burn or systemic symptoms are induced.

- When skin is exposed to toxic substances, the best emergency treatment prior to arrival at the hospital is to sufficiently wash the affected area with flowing water. When eyes are exposed to chemical substances, it is advisable to wash the eyes sufficiently under flowing water for more than 20 minutes. In this case, the eye being washed must be situated below the other eye not being washed.
- If the skin is exposed to acid or alkaline, washing them with substance with opposite property to neutralize them is never to be attempted since the chemical reactions between acid and alkaline can induce supplementary damages such as burn from the heat of reaction.
- In addition, immediately remove the clothing contaminated by the chemical substances or irritation inducing substance, and wash off the affected area of the skin with flowing water as soon as possible.

② Intoxication through inhalation

If gases such as carbon monoxide or chlorine gas generated from explosion, fire or reaction of chemical substances is inhaled, intoxication symptoms such as hypoxia and blocking of respiratory tract will be displayed.

- Emergency treatment at the time of exposure to toxic gas begins with the transfer of the patient to location with fresh air and taking necessary measures such as artificial respiration, and etc.
- What is of particular importance is that there frequently are cases in which the toxic gas remains in the site of intoxication by toxic gas. Therefore, particular precautions must be taken for the rescuer against the possibility of intoxication as well.
- Furthermore, if the patient is in a location with serious leakage of toxic gas, contact 119 in order for professional team to arrive as soon as possible to take care of the situation rather than trying to approach the patient hastily.

③ Intoxication through swallowing

If chemical substance was swallowed accidentally or intentionally, the easiest means of getting rid of the toxic substance is to induce the patient to vomit. However, the following precautions must be taken.

- Inducing vomiting should be performed only when there is instruction by medical doctor after having contacted the emergency treatment center or emergency medical treatment information center in the region, and while the patient is clearly conscious.
- In particular, never perform aforementioned emergency treatment when the patient's consciousness is not normal. If petroleum chemical products or polisher, and etc. enter the lung through the respiratory tract right next to the esophagus when these substances are vomitted, serious chemical pneumonia can be induced.
- In addition, even if the patient is clearly conscious, vomiting can induce damages to the esophagus again particularly if the toxic swallowed is strong acid (hydrochloric acid, sulfuric acid, and etc.) or strong alkaline (sodium peroxide, etc.) or enter the respiratory tract to induce serious pulmonary damages and breathing difficulties.

(2) Emergency treatments for each of the chemical substance

The following are symptoms and techniques of emergency treatment at the time of exposure to 15 types of chemical substances frequently used in the laboratory. The corresponding data was excerpted from the "HIOSH Pocket Guide to Chemical Hazards" published by the Center for Disease Control and Prevention of USA in 2007. This Guide includes a diverse range of information on the 678 types of chemical substances and safety, and can be viewed and downloaded from the following website. It is strongly recommended that they are used at the time of research activities.

NIOSH Pocket Guide to Chemical Hazards www.cdc.gov/niosh/docs/2005-149/

① Acetone

Symptoms	Irritation of eyes, nose and neck, headache, dizziness, deterioration of central nerve system, dermatitis	
Target organs	Eyes, skin, respiratory organ, central nerve system	
Emergency treatments	Contact with eyes	Wash the eyes with large quantity of water immediately and seek examination and treatment by doctor.
	Contact with skin	Wash the areas of contact with soap immediately and seek examination and treatment by doctor.
	Inhalation	- When large quantity has been inhaled, move the patient to location with clean air and let him/her breathe. - If the patient does not breathe, execute artificial respiration and keep the body warm. In addition, have the patient undergo treatment by medical doctor as soon as possible.
	Swallowed	Immediately seek examination and treatment by doctor.
Remarks	- Wear protective clothing and eye glasses to protect the skin and eyes from coming in contact. - If the clothing is soaked by the substance, take it off immediately since there is a risk of fire.	

② Acrylonitrile

Symptoms	Irritation of eyes and skin, suffocation, headache, sneezing, nausea, vomiting, lethargy, dizziness, blisters on skin	
Target organs	Eyes, skin, cardiovascular system, liver, kidney, central nerve system (cerebral tumor, lung & colorectal cancer)	
Emergency treatments	Contact with eyes	Wash the eyes with large quantity of water immediately and seek examination and treatment by doctor.
	Contact with skin	Immediately wash out the substance by spraying water on the areas of contact and seek examination and treatment by doctor.
	Inhalation	- When large quantity has been inhaled, move the patient to location with clean air and let him/her breathe. - If the patient does not breathe, execute artificial respiration and keep the body warm. In addition, have the patient undergo treatment by medical doctor as soon as possible.
	Swallowed	Immediately seek examination and treatment by doctor.
Remarks	- Wear protective clothing and eye glasses to protect the skin and eyes from coming in contact. - If the clothing is soaked by the substance, take it off immediately since there is a risk of fire. - Use under the environment equipped with eye washer and emergency shower facility.	

③ Ammonia

Symptoms	Irritation of eyes, nose and neck, breathing difficulties, chest pain, pulmonary embolism, skin burn and blister, frostbite (liquid)	
Target organs	Eyes, skin, cardiovascular system, respiratory organ	
Emergency treatments	Contact with eyes	Wash the eyes with large quantity of water immediately and seek examination and treatment by doctor.
	Contact with skin	Wash the areas of contact with water immediately and seek examination and treatment by doctor if there are relevant symptoms after washing.
	Inhalation	- When large quantity has been inhaled, move the patient to location with clean air and let him/her breathe. - If the patient does not breathe, execute artificial respiration and keep the body warm. In addition, have the patient undergo treatment by medical doctor as soon as possible.
	Swallowed	Immediately seek examination and treatment by doctor.
Remarks	- Wear protective clothing and eye glasses to protect the skin and eyes from coming in contact. - Use under the environment equipped with eye washer and emergency shower facility.	

④ Benzene

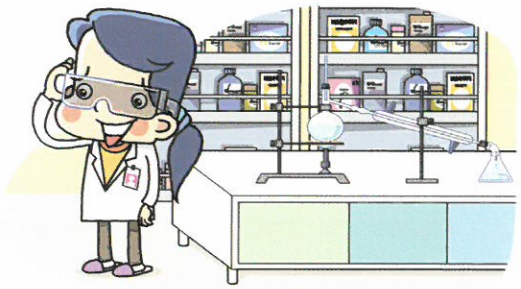
Symptoms	Irritation of eyes, skin, nose and respiratory organ, dizziness, headache, nausea, lack of appetite, lethargy, deterioration of bone marrow (possibility of carcinogenesis)	
Target organs	Eyes, skin, blood, central nerve system, respiratory organ, bone marrow(leukemia)	
Emergency treatments	Contact with eyes	Wash the areas of contact with soap immediately and seek examination and treatment by doctor.
	Contact with skin	Wash the areas of contact with water immediately and seek examination and treatment by doctor if there are relevant symptoms after washing.
	Inhalation	- When large quantity has been inhaled, move the patient to location with clean air and let him/her breathe. - If the patient does not breathe, execute artificial respiration and keep the body warm. In addition, have the patient undergo treatment by medical doctor as soon as possible.
	Swallowed	Immediately seek examination and treatment by doctor.
Remarks	- Wear protective clothing and eye glasses to protect the skin and eyes from coming in contact. - If the clothing is soaked by the substance, take it off immediately since there is a risk of fire. - Use under the environment equipped with eye washer and emergency shower facility.	

⑤ n-Butane

Symptoms	Sleepiness, state of coma, suffocation, frostbite (liquid)	
Target organs	Central nerve system	
Emergency treatments	Frostbite (eyes)	- Allow large quantity of water to flow onto the entire eyeballs for minimum of 15 minutes while flickering the eyelids - If symptoms such as irritation, pain, swelling and shedding of tears continue, seek examination and treatment by doctor.
	Frostbite (skin)	- Do not rub the area of contact or flow water onto the affected area, but rather, immediately seek examination and treatment by doctor. - Do not forcefully remove the clothing adhering to the frozen area. - If there is no area of frostbite, take off the clothing and wash off the substance with soap.
	Inhalation	- When large quantity has been inhaled, move the patient to location with clean air and let him/her breathe. - If the patient does not breathe, execute artificial respiration and keep the body warm. In addition, have the patient undergo treatment by medical doctor as soon as possible.
Remarks	- Wear appropriate protective clothing and protective eye glasses for protection against frostbite by the liquid. - If the clothing is soaked by the substance, take it off immediately since there is a risk of fire. - Use under the environment equipped with eye washer and emergency shower facility.	

⑥ Ethanol (Ethyl alcohol)

Symptoms	Irritation of eyes, skin and nose, headache, sleepiness, lethargy, nausea, coughing, damages to liver, anemia, reproductive disability and malformation	
Target organs	Eyes, skin, respiratory organ, central nerve system, liver, blood, reproductive	
Emergency treatments	Contact with eyes	Wash the eyes with large quantity of water immediately and seek examination and treatment by doctor.
	Contact with skin	Wash out the substance by spraying water on the areas of contact as soon as possible and if the symptom of discomfort continues, seek examination and treatment by doctor.
	Inhalation	When large quantity has been inhaled, move the patient to location with clean air and let him/her breathe.
	Swallowed	Immediately seek examination and treatment by doctor.
Remarks	- Wear protective clothing and eye glasses to protect the skin and eyes from coming in contact. - If the clothing is soaked by the substance, take it off immediately since there is a risk of fire.	



⑦ Ethyl acetate

Symptoms	Irritation of eyes, nose and skin, nausea, dermatitis	
Target organs	Eyes, skin, respiratory organ	
Emergency treatments	Contact with eyes	Wash the eyes with large quantity of water immediately and seek examination and treatment by doctor.
	Contact with skin	Wash out the substance by spraying water on the areas of contact as soon as possible and if the symptom of discomfort continues, seek examination and treatment by doctor.
	Inhalation	- When large quantity has been inhaled, move the patient to location with clean air and let him/her breathe. - If the patient does not breathe, execute artificial respiration and keep the body warm. In addition, have the patient undergo treatment by medical doctor as soon as possible.
	Swallowed	Immediately seek examination and treatment by doctor.
Remarks	- Wear protective clothing and eye glasses to protect the skin and eyes from coming in contact. - If the clothing is soaked by the substance, take it off immediately since there is a risk of fire.	

⑧ Formaldehyde

Symptoms	Irritation of eyes, nose, neck and respiratory organ, shedding of tears, coughing, breathing difficulties, possibility of carcinogenesis	
Target organs	Eyes, respiratory organ (nasal cavity cancer)	
Emergency treatments	Contact with eyes	Wash the eyes with large quantity of water immediately and seek examination and treatment by doctor.
	Inhalation	- When large quantity has been inhaled, move the patient to location with clean air and let him/her breathe. - If the patient does not breathe, execute artificial respiration and keep the body warm. In addition, have the patient undergo treatment by medical doctor as soon as possible.
Remarks	- Wear protective eye glasses to protect the eyes from coming into contact.	

⑨ Formic acid

Symptoms	Irritation of eyes, skin and neck, skin burn and blister, shedding of tears, nose bleeding, coughing, breathing difficulties, nausea	
Target organs	Eyes, skin, respiratory organ	
Emergency treatments	Contact with eyes	Wash the areas of contact with soap immediately and seek examination and treatment by doctor.
	Contact with skin	Immediately wash out the substance by spraying water on the areas of contact and seek examination and treatment by doctor.
	Inhalation	- When large quantity has been inhaled, move the patient to location with clean air and let him/her breathe. - If the patient does not breathe, execute artificial respiration and keep the body warm. In addition, have the patient undergo treatment by medical doctor as soon as possible.
	Swallowed	Immediately seek examination and treatment by doctor.
Remarks	- Wear protective clothing and eye glasses to protect the skin and eyes from coming in contact. - If the clothing is soaked with the substance, take the clothing off immediately. - Use under the environment equipped with eye washer and emergency shower facility.	

⑩ Hydrazine

Symptoms	Irritation of eyes, nose, skin and neck, temporary blindness, dizziness, nausea, dermatitis, skin burn	
Target organs	Eyes, skin, respiratory organ, central nerve system, liver, kidney	
Emergency treatments	Contact with eyes	Wash the areas of contact with soap immediately and seek examination and treatment by doctor.
	Contact with skin	Immediately wash out the substance by spraying water on the areas of contact and seek examination and treatment by doctor.
	Inhalation	- When large quantity has been inhaled, move the patient to location with clean air and let him/her breathe. - If the patient does not breathe, execute artificial respiration and keep the body warm. In addition, have the patient undergo treatment by medical doctor as soon as possible.
	Swallowed	Immediately seek examination and treatment by doctor.
Remarks	- Wear protective clothing and eye glasses to protect the skin and eyes from coming in contact. - If the clothing is soaked by the substance, take it off immediately since there is a risk of fire. - Use under the environment equipped with eye washer and emergency shower facility.	

⑪ Hydrogen chloride

Symptoms	Irritation of nose, neck and larynx, coughing, suffocation, dermatitis, skin burn(aqueous solutions), frostbite (liquid)	
Target organs	Eyes, skin, respiratory organ	
Emergency treatments	Contact with eyes	Wash the areas of contact with soap immediately and seek examination and treatment by doctor.
	Contact with skin	Immediately wash out the substance by spraying water on the areas of contact and seek examination and treatment by doctor.
	Frostbite (eyes, skin)	- Allow large quantity of water to flow onto the entire eyeballs for minimum of 15 minutes while flickering the eyelids. - If symptoms such as irritation, pain, swelling and shedding of tears continue, seek examination and treatment by doctor. - Do not rub the area of contact or flow water onto the affected area, but rather, immediately seek examination and treatment by doctor. - Do not forcefully remove the clothing adhering to the frozen area. - If there is no area of frostbite, take off the clothing and wash off the substance with soap.
	Inhalation	- When large quantity has been inhaled, move the patient to location with clean air and let him/her breathe. - If the patient does not breathe, execute artificial respiration and keep the body warm. In addition, have the patient undergo treatment by medical doctor as soon as possible.
	Swallowed	Immediately seek examination and treatment by doctor.
Remarks	- Wear protective clothing and eye glasses to protect the skin and eyes from coming in contact. - If the clothing is soaked by the substance, take it off immediately. - Use under the environment equipped with eye washer and emergency shower facility.	

⑫ Hydrogen peroxide

Symptoms	Irritation of eyes, nose and neck, dermal erythema and blister, hair discoloring	
Target organs	Eyes, skin, respiratory organ	
Emergency treatments	Contact with eyes	Wash the areas of contact with soap immediately and seek examination and treatment by doctor.
	Contact with skin	Immediately wash out the substance by spraying water on the areas of contact, seek examination and treatment by doctor.
	Inhalation	- When large quantity has been inhaled, move the patient to location with clean air and let him/her breathe. - If the patient does not breathe, execute artificial respiration and keep the body warm. In addition, have the patient undergo treatment by medical doctor as soon as possible.
	Swallowed	Immediately seek examination and treatment by doctor.
Remarks	- Wear protective clothing and eye glasses to protect the skin and eyes from coming in contact. - If the clothing is soaked by the substance, take it off immediately. - Use under the environment equipped with eye washer and emergency shower facility.	

⑬ Iodoform

Symptoms	Irritation of eyes and skin, dizziness, nausea, lethargy, deterioration of central nerve system, liver, kidney, cardiac damages, breathing difficulties, visual disability	
Target organs	Eyes, skin, respiratory organ, liver, kidney, heart	
Emergency treatments	Contact with eyes	Wash the eyes with large quantity of water immediately and seek examination and treatment by doctor.
	Contact with skin	Wash the areas of contact with soap immediately and seek examination and treatment by doctor.
	Inhalation	- When large quantity has been inhaled, move the patient to location with clean air and let him/her breathe. - If the patient does not breathe, execute artificial respiration and keep the body warm. In addition, have the patient undergo treatment by medical doctor as soon as possible.
	Swallowed	Immediately seek examination and treatment by doctor.
Remarks	- Wear protective clothing and eye glasses to protect the skin and eyes from coming in contact. - If the clothing is soaked by the substance, take it off immediately since there is a risk of fire.	

⑭ Isopropyl alcohol

Symptoms	Irritation of eyes, skin and nose, sleepiness, dizziness, headache, chapping of skin	
Target organs	Eyes, skin, respiratory organ	
Emergency treatments	Contact with eyes	Wash the eyes with large quantity of water immediately and seek examination and treatment by doctor.
	Contact with skin	Wash out the substance by spraying water on the areas of contact and if there is a symptom of dermal irritation, seek examination and treatment by doctor.
	Inhalation	- When large quantity has been inhaled, move the patient to location with clean air and let him/her breathe. - If the patient does not breathe, execute artificial respiration and keep the body warm. In addition, have the patient undergo treatment by medical doctor as soon as possible.
	Swallowed	Immediately seek examination and treatment by doctor.
Remarks	- Wear protective clothing and eye glasses to protect the skin and eyes from coming in contact. - If the clothing is soaked by the substance, take it off immediately since there is a risk of fire.	

⑮ Ethylene Glycol

Symptoms	Irritation of eyes, skin, nose and neck, nausea, vomiting, lack of appetite, lethargy, abdominal pain, lethargy, dizziness, spasm, deterioration of central nerve system, skin sensitization	
Target organs	Eyes, skin, blood, central nerve system	
Emergency treatments	Contact with eyes	Wash the areas of contact with soap immediately and seek examination and treatment by doctor.
	Contact with skin	Wash the areas of contact with water immediately and seek examination and treatment by doctor if there are relevant symptoms after washing.
	Inhalation	- When large quantity has been inhaled, move the patient to location with clean air and let him/her breathe. - If the patient does not breathe, execute artificial respiration and keep the body warm. In addition, have the patient undergo treatment by medical doctor as soon as possible.
	Swallowed	Immediately seek examination and treatment by doctor.
Remarks	- Wear protective clothing and eye glasses to protect the skin and eyes from coming in contact. - If the clothing is soaked by the substance, take it off immediately. - Make sure to replace the protective clothing if they are contaminated.	

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Standard Textbook for Safety in Laboratory

Safety Before and After the Experiment Ⅱ

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