Handbook on Climate Change and Relevant issues of MBBS Course Including Acute Emergency Health Care

Developed By
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Preface

Welcome to the "Handbook on climate Change and Relevant Issues for MBBS Course" This handbook has been carefully curated to bridge the gap between the fields of medicine and environmental science. As we navigate the 21st century, the interconnectedness of climate change and healthcare has become increasingly evident. The impact of climate change on human health a concern that healthcare professionals, including medical students, must understand and address.

Medical education traditionally focuses on diagnosing and treating diseases, but in today's world, physicians and medical students must also grasp the broader context in which healthcare operates. Climate change poses significant threats to human well being, including the spread of infectious diseases, heat -related illnesses, and disruptions to healthcare infrastructure. Therefore, a fundamental understanding of climate change and its implications is essential for aspiring doctors.

This handbook aims to provide medical students with a comprehensive overview of climate change and its relevance to their profession. It covers key topics such as the science of climate change, the impacts on public health, and the role of healthcare professionals in mitigating and adapting to these changes. By incorporating this knowledge into their medical practice, students can become advocates for sustainable healthcare and contribute to the global effort to combat climate change.

I hope that this handbook will serve as a valuable resource for medical students, educators, and healthcare professionals, equipping them with the knowledge and tools to address the intersection of climate change and healthcare in their future career. As we move forward, it is imperative that we recognize the vital role of healthcare in addressing one of the most critical challenges of our time: climate change.
Thank you for embarking on this educational journey, and may this handbook empower all concerns to make a positive impact on both the health of individuals and the health of our planet.

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Acknowledgement

It is with great enthusiasm that I introduce the "Handbook on Climate Change and Relevant Issues for MBBS Course". This handbook represents a crucial step forward in integrating the study of climate change into the education of future medical professionals.

Climate change is no longer a distant, abstract concern; it is a reality that directly affects human health on a global scale. As medical students embark on their journey to become doctors, they must recognize that their role extends beyond the confines of a clinic or hospital. They are, in fact, stewards of human well-being in a world facing unprecedented environmental challenges.

This handbook is a valuable resource that not only imparts knowledge about the science and consequences of climate change but also underscores the indispensable role of medical practitioners in mitigating its effects. It explores the intricate links between climate change and health, from the increased prevalence of vector-borne diseases to the mental health impacts of climate -related disasters.

Moreover, it provides practical insights into how medical professionals can contribute to climate resilience and sustainability within their healthcare practices. By emphasizing preventive measures, advocacy, and sustainable healthcare delivery, this handbook equips MBBS students with the tools they need to address the pressing issues of our time.

As our planet grapples with the consequences of a changing climate, the healthcare sector must adapt and innovate to protect and promote human health. This handbook empowers medial students to be leaders in this transformative journey towards a healthier and more sustainable future.

I commend the authors and contributors for their dedication to advancing climate literacy within the medical community. I trust that this handbook will inspire a new generation of healthcare professionals to embrace their roles as climate champions, working tirelessly to heal not only individual patients but also the planet we all call home.

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List of Content

Introduction

Background

This handbook is developed mainly for the MBBS students, intern doctors and teachers. This handbook is developed in line with **Climate Change and Relevant Issues of MBBS Course Including Acute Emergency Health Care** of MBBS course. This handbook is developed in simple form with essential information on Climate Change and Acute Emergency Health Care to make it user friendly for the students. This handbook will serve the student's academic purpose as well as teachers' service purpose.

Objectives of this handbook

- To provide updated knowledge about "Climate Change, Environmental Issues and Relevant Acute Emergency Health Care "
- To provide essential information to medical student and teachers regarding Climate Change and Acute Emergency Health Care and its management
- To aware learner about the global and Bangladesh situation of Climate Change and Acute Emergency Health Care
- To guide future physicians for management of Climate Change and Acute Emergency Health Care during practice.

Target group

Undergraduate medical students, intern doctors and also physicians; teachers of different concerned subjects

Extent of use of this handbook

Different departments related with teaching on "Climate Change, Environmental Issues and Relevant Acute Emergency Health Care " can use this handbook as a guide in addition to regular text book and other teaching materials. Teacher can teach students by several teaching methods for teaching purpose.

Teaching Methods

- Lecture
- Tutorial
- Bedside Teaching
- Problem Based Learning
- Integrated Teaching
- Community Based Teaching

Teaching Materials

- Multimedia and laptop
- Flip chart
- OHP
- Related posters and publications
- Related equipment & instruments

Assessment

- Formative (Written, oral & practical/OSPE)
- Summative (Written, oral & practical/OSPE)

Basics of Climate Change

Objectives:

After the completion of this chapter, the learners will be able to--

- Define climate change
- Explain the climate and its complex character as a phenomenon
- Mention the causes of Climate change
- Explain the interrelationship of the causes of climate change

Earth's climate is a dynamic and intricate system that governs the long-term patterns of temperature, precipitation, and atmospheric conditions on our planet. Driven by a complex interplay of factors such as solar radiation, greenhouse gases, ocean currents, and atmospheric circulation, the climate continuously evolves over extended periods. Human activities, particularly the emission of greenhouse gases like carbon dioxide, have introduced a new element of influence, leading to unprecedented changes. The consequences of these alterations, often referred to as **climate change,** encompass a wide spectrum of impacts, including rising global temperatures, shifting weather patterns, more frequent and intense extreme events, and sea-level rise. Understanding and addressing Earth's climate has become a paramount challenge for humanity, demanding collaborative efforts across nations to mitigate the impacts and foster sustainable practices that ensure the well-being of our planet and its inhabitants for generations to come.

Climate Change:

Climate change can be defined as the significant and lasting alteration of the Earth's climate, which can be observed over extended periods, typically decades to centuries. It is characterized by changes in average temperature, extreme weather events, and variations in precipitation. These alterations are linked to an increase in greenhouse gas concentrations in the atmosphere, primarily due to human activities such as burning fossil fuels, deforestation, and industrial processes.

Weather versus climate: Day-to-day changes in temperature, precipitation, cloudiness, humidity, air pressure of a particular area of specific time. Whereas climate means average of long period weather. How the atmosphere behaves over relatively long periods of times for a place (e.g. decade). While weather describes the state of temperature, rainfall humidity the climate is described as the affecting conditions of weather elements. E.g. hottest day, dry day, rainy day, hot and humid etc.

Causes of Climate change:

Both natural processes and human activities influence the Earth's climate, but they operate on different timescales and have distinct impacts. Understanding the distinction between natural climate variability and human-induced climate change is essential to grasp the complex drivers and implications of changes in the Earth's climate system.

Natural Climate Variability:

Natural climate variability refers to the inherent variability in the Earth's climate system that occurs over various timescales without any human influence. These natural processes have been shaping the Earth's climate for millions of years. Some of the key factors contributing to natural climate variability include:

- Orbital Variations: Changes in the Earth's orbit around the sun, known as Milankovitch cycles, influence the distribution of solar radiation reaching the Earth's surface, leading to ice ages and interglacial periods over thousands of years.
- Solar Radiation: Variations in solar output affect the amount of energy the Earth receives from the sun. These changes can lead to short-term climate variations.
- Volcanic Eruptions: Large volcanic eruptions release aerosols and gases into the atmosphere, blocking sunlight and causing temporary cooling of the planet. These cooling effects can last for a few years.
- Ocean Circulation: Natural variability in ocean currents, such as El Niño and La Niña events, influences regional and global climate patterns.

While natural climate variability has played a significant role in shaping the Earth's climate over geological time scales, its impact on recent and rapid changes observed in the past century is relatively limited.

Human-Induced Climate Change:

Human-induced climate change, also known as anthropogenic climate change, refers to alterations in the Earth's climate system primarily caused by human activities, particularly since the Industrial Revolution. The main driver of human-induced climate change is the increase in greenhouse gas (GHG) concentrations in the atmosphere. Key sources of human-induced GHG emissions include:

- Burning Fossil Fuels: The combustion of coal, oil, and natural gas for energy production and transportation releases carbon dioxide (CO2) and other GHGs into the atmosphere.

- Deforestation: The clearing of forests reduces the Earth's capacity to absorb CO2 through photosynthesis, leading to higher atmospheric GHG concentrations.

- Industrial Processes: Certain industrial activities release potent GHGs, such as methane (CH4) and nitrous oxide (N2O), into the atmosphere.

Human-induced climate change has led to accelerated global warming and impacts that are far beyond the range of natural climate variability. The Intergovernmental Panel on Climate Change (IPCC) and numerous scientific studies have unequivocally shown that human activities are the primary driver of the rapid warming observed since the mid-20th century. The consequences of human-induced climate change are wide-ranging and include rising temperatures, sea-level rise, extreme weather events, shifts in precipitation patterns, and disruptions to ecosystems and biodiversity.

Understanding the Greenhouse Effect

The greenhouse effect is crucial for sustaining life on Earth, as it keeps the planet's average temperature at around 15°C (59°F). Without the natural greenhouse effect, the Earth would be much colder and inhospitable. However, human activities have intensified this effect by releasing large quantities of GHGs into the atmosphere, mainly from burning fossil fuels, deforestation, and industrial activities.

The increased concentrations of GHGs trap more heat in the atmosphere, leading to global warming and climate change. This warming has far-reaching consequences, including rising sea levels, melting polar ice caps, more frequent and severe extreme weather events, disruptions to ecosystems, and impacts on agriculture and water resources. The main six greenhouse gases are: carbon dioxide, methane, nitrous oxide, hydrochlorofluorocarbons (HCFCs), water vapor and ozone.

Key Points

- Climate change is a global phenomenon which is experienced by the environment which is the home for all the living creature and is affected by its change.
- Although both natural and human cause the climate change, human activities are the main causes of climate change.
- Climate change caused by greenhouse effects and greenhouse affects are caused by climate change vise versa.
- Technological innovation eases human life but has detrimental effect on climate causing global warming.

Global warming and Green House Effect

Objectives

After the completion of this chapter, the learners will be able to--

- Define and describe the background of Global warming
- Define and describe the Background of Ozone Depletion
- Enlist the consequences of global warming
- Mention the preventive measures of global warming

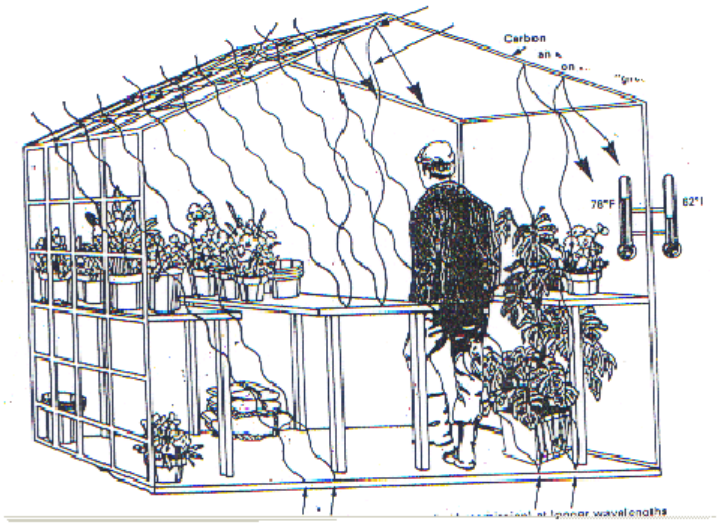
Global warming

Around 20,000 years ago, (last ice era)- the average global surface temperature was 4.5^0C cooler than now. From that until now the increase of temperature in the earth surface has been only 4-4.5^0C. Since industrial revolution the carbon dioxide concentration has been increasing now reached at a level of 353 ppm. Average global temperature is rising by 0.3^0C - 0.8^0C per decade since 1988. This temperature rise may be as much as 5^0C. Extinction level global warming is defined as temperatures exceeding preindustrial levels by 5-6° Celsius and extinction of all planetary life, or the eventual loss of our atmosphere.

Global warming is a term used for the observed century-scale rise in the average temperature of the Earth's climate system and its related effects. Scientists are more than 95% certain that nearly all of global warming is caused by increasing concentrations of greenhouse gases (GHGs) and other human-caused emissions.

Greenhouse

A green house is a large hall with glass roof and sides. This greenhouse allows the sunrays to enter and retains some of the temperature within the house itself. Sunlight enters it in short wave radiation through transparent glass. But glass cannot transmit longer wave radiation. A greenhouse stays warm inside, even during the winter. In the daytime, sunlight shines into the greenhouse and warms the plants and air inside. At nighttime it is colder outside, but the greenhouse stays pretty warm inside. That's because the glass walls of the greenhouse trap the Sun's heat.



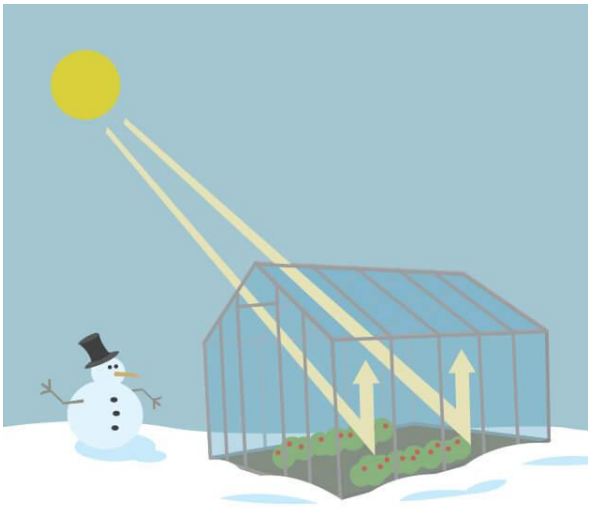


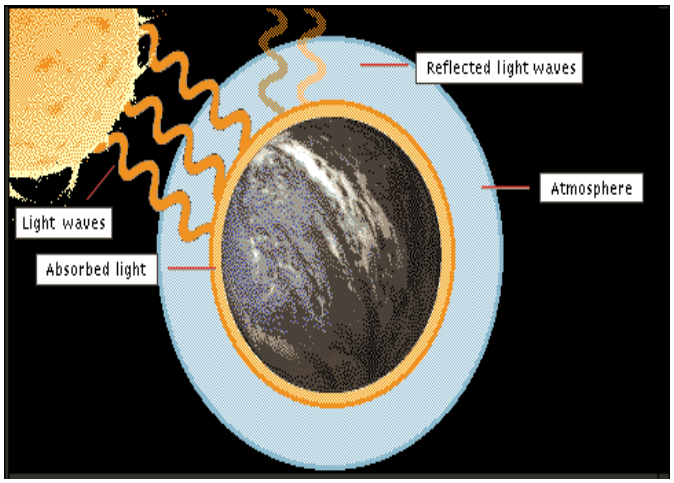
Figure 1: A greenhouse

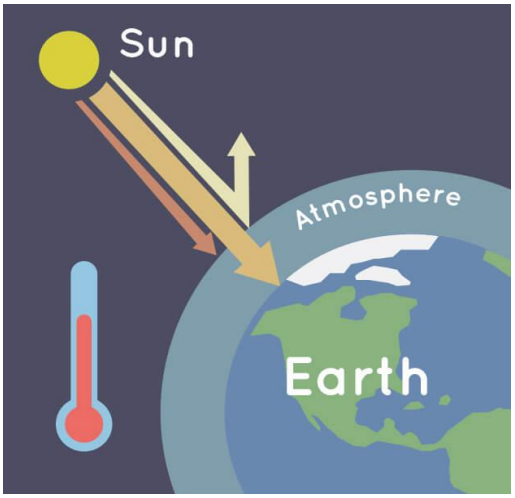
What is the greenhouse effect?

In a greenhouse, sunlight enters, and heat is retained. The greenhouse effect describes a similar phenomenon on a planetary scale but, instead of the glass of a greenhouse, certain gases in Earth's atmosphere trap the Sun's heat. This process makes Earth much warmer than it would be without an atmosphere. So it is a natural phenomenon that regulates the Earth's temperature. When the sun's energy reaches the Earth, some of it is absorbed and warms the surface, while the rest is radiated back into space as heat. Greenhouse gases (GHGs) in the atmosphere trap some of this outgoing heat, preventing it from escaping entirely, and re-radiate it back towards the Earth's surface. This process keeps the planet's average temperature at a habitable level (around 15°C).

Enhanced Greenhouse Effect: Human activities, particularly the burning of fossil fuels (coal, oil, and natural gas), deforestation, and certain industrial processes, have significantly increased the concentration of GHGs in the atmosphere. The most prevalent greenhouse gas is carbon dioxide (CO2), but others include methane (CH4), nitrous oxide (N2O), water vapour and fluorinated gases. This excess of GHGs intensifies the natural greenhouse effect, leading to the phenomenon known as the "enhanced greenhouse effect" or "anthropogenic greenhouse effect."

The gases that radiate/trap heat also known as greenhouse gases absorb the energy radiated out by the Earth and reflect a part of it back to Earth. Of all the energy that the Earth receives from the Sun, nearly 26 percent is reflected back to space by the atmosphere and clouds, while around 19 percent of it is absorbed by the atmosphere.





Mechanism of greenhouse effect causing global

A greenhouse captures heat from the Sun during the day. Its glass walls trap the Sun's heat, which keeps plants inside the greenhouse warm — even on cold nights. Credit: NASA/JPL-Caltech

Factors responsible for greenhouse effect

The following factors are responsible for greenhouse effect:

- Deforestation: This is considered to be one of the most important factors for the cause of the greenhouse effect. This is due to the reduction in the release of oxygen(O_2) and absorption of carbon dioxide (CO_2) by the plants.
- Fossil fuel burning: Fossil fuels such as coal, oil, and natural gases are used as a means of energy which releases a huge amount of harmful gases into the environment.
- Industrial Processes: Certain industrial activities release potent GHGs, such as methane (CH4) and nitrous oxide (N2O), into the atmosphere.
- Population: As the population increases, the need for space increases which again results in deforestation.

Key points

- Global warming is the long-term heating of Earth's surface observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere. This term is not interchangeable with the term "climate change."
- Global warming is the most significant problem facing the world due to climate change.
- Mechanism of Greenhouse effect.

Ozone Layer and its Depletion

Objectives:
After the completion of this chapter, the learners will be able to--

- Define ozone layer and ozone layer depletion
- Mention the causes and effects of ozone layer depletion

What is an Ozone Layer?

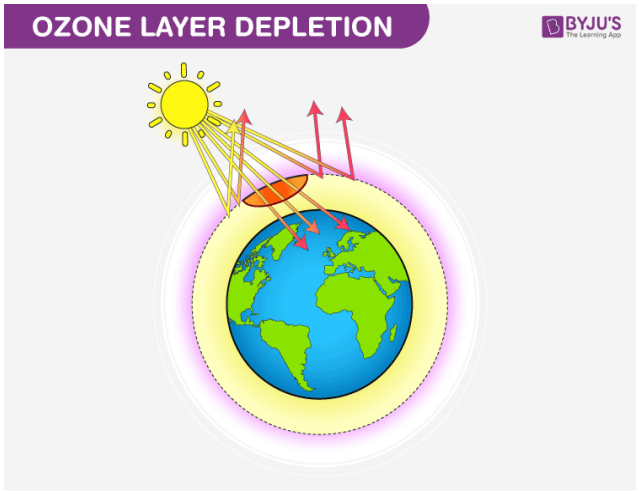
"The ozone layer is a region in the earth's stratosphere that contains high concentrations of ozone and protects the earth from the harmful ultraviolet radiations of the sun."

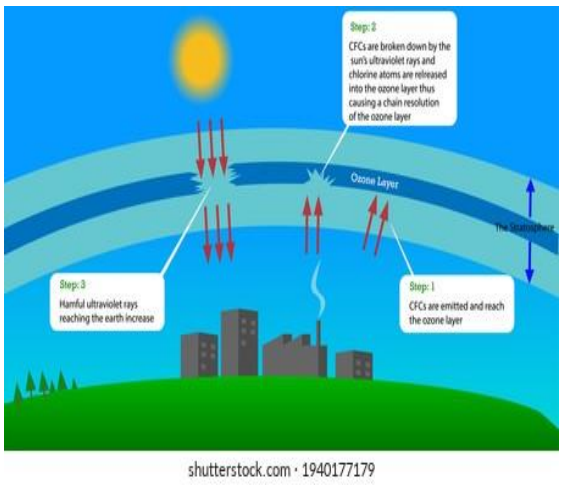
The ozone layer is mainly found in the lower portion of the earth's atmosphere. It has the potential to absorb around 97-99% of the harmful ultraviolet radiations coming from the sun that can damage life on earth. If the ozone layer was absent, millions of people would develop skin diseases and may have weakened immune systems.

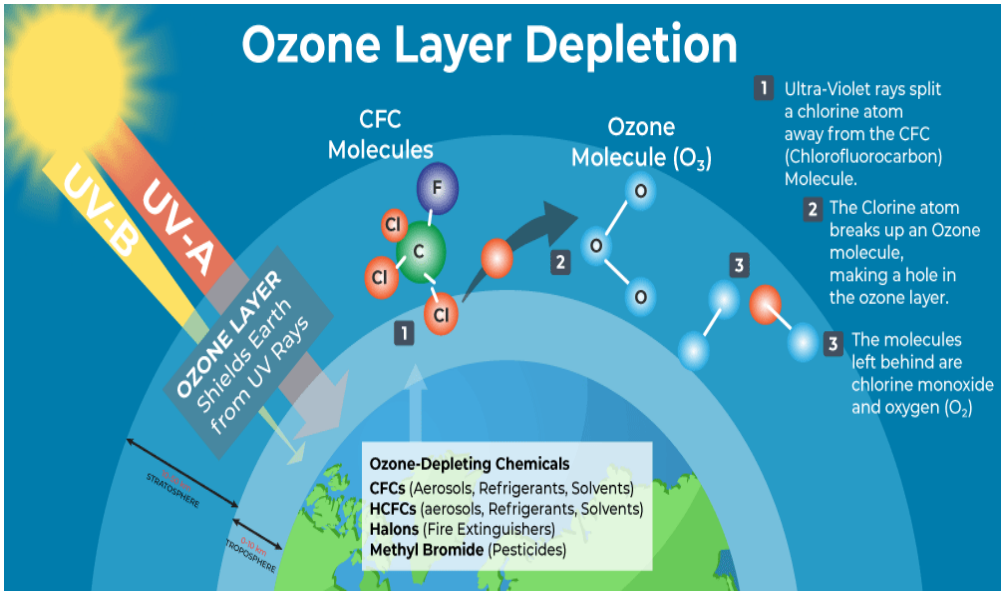
However, scientists have discovered a hole in the ozone layer over Antarctica. This has focussed their concern on various environmental issues and steps to control them. The main reasons for the ozone hole are chlorofluorocarbons, carbon tetrachloride, methyl bromide and hydrochlorofluorocarbons.

Ozone Layer Depletion

"Ozone layer depletion is the gradual thinning of the earth's ozone layer in the upper atmosphere caused due to the release of chemical compounds containing gaseous bromine or chlorine from industries or other human activities."







What is Ozone Layer Depletion?

Ozone layer depletion is the thinning of the ozone layer present in the upper atmosphere. This happens when the chlorine and bromine atoms in the atmosphere come in contact with ozone and destroy the ozone molecules. One chlorine can destroy 100,000 molecules of ozone. It is destroyed more quickly than it is created.

Some compounds release chlorine and bromine on exposure to high ultraviolet light, which then contributes to ozone layer depletion. Such compounds are known as Ozone Depleting Substances (ODS). The ozone-depleting substances that contain chlorine include chlorofluorocarbon, carbon tetrachloride, hydrochlorofluorocarbons, and methyl chloroform. Whereas, the ozone-depleting substances that contain bromine are halons, methyl bromide, and hydro bromofluorocarbons.

Chlorofluorocarbons are the most abundant ozone-depleting substance. It is only when the chlorine atom reacts with some other molecule, it does not react with ozone. Montreal Protocol was proposed in 1987 to stop the use, production and import of ozone-depleting substances and minimize their concentration in the atmosphere to protect the ozone layer of the earth.

Causes of Ozone Layer Depletion

Ozone layer depletion is a major concern and is associated with a number of factors. The main causes responsible for the depletion of the ozone layer are listed below:

Chlorofluorocarbons

Chlorofluorocarbons or CFCs are the main cause of ozone layer depletion. These are released by solvents, spray aerosols, refrigerators, air-conditioners, etc.

The molecules of chlorofluorocarbons in the stratosphere are broken down by ultraviolet radiations and release chlorine atoms. These atoms react with ozone and destroy it.

Unregulated Rocket Launches

Researchers say that the unregulated launching of rockets results in much more depletion of the ozone layer than the CFCs do. If not controlled, this might result in a huge loss of the ozone layer by the year 2050.

Nitrogenous Compounds

The nitrogenous compounds such as NO_2, NO, N_2O are highly responsible for the depletion of the ozone layer.

Natural Causes

The ozone layer has been found to be depleted by certain natural processes such as Sun-spots and stratospheric winds. But it does not cause more than 1-2% of the ozone layer depletion.

The volcanic eruptions are also responsible for the depletion of the ozone layer.

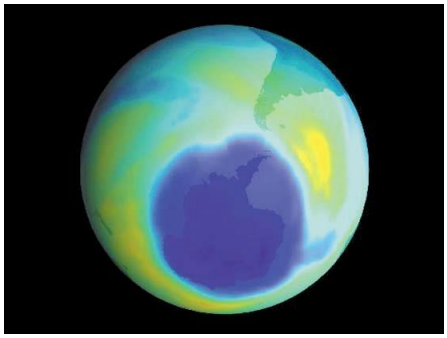
Ozone Depleting Substances (ODS)

"Ozone-depleting substances are the substances such as chlorofluorocarbons, halons, carbon tetrachloride, hydrofluorocarbons, etc. that are responsible for the depletion of the ozone layer."

Following is the list of some main ozone-depleting substances and the sources from where they are released:

Ozone-Depleting Substances	**Sources**
Chlorofluorocarbons (CFCs)	Refrigerators, air-conditioners, solvents, dry-cleaning agents, etc.
Halons	Fire-extinguishers
Carbon tetrachloride	Fire extinguishers, solvents
Methyl chloroform	Adhesives, aerosols
Hydrofluorocarbons	fire extinguishers, air-conditioners, solvents

Ozone hole



In the early 1980s, through a combination of ground-based and satellite measurements, scientists began to realize that Earth's natural sunscreen was thinning dramatically over the South Pole each spring. This thinning of the ozone layer over Antarctica came to be known as the ozone hole.

Effects of Ozone Layer Depletion

The depletion of the ozone layer has harmful effects on the environment. Let us see the major effects of ozone layer depletion on man and environment.

Effects on Human Health

Humans will be directly exposed to the harmful ultraviolet radiation of the sun due to the depletion of the ozone layer. This might result in serious health issues among humans, such as skin diseases, cancer, sunburns, cataract, quick ageing and weak immune system.

Effects on Animals

Direct exposure to ultraviolet radiations leads to skin and eye cancer in animals.

Effects on the Environment

Strong ultraviolet rays may lead to minimal growth, flowering and photosynthesis in plants. The forests also have to bear the harmful effects of the ultraviolet rays.

Effects on Marine Life

Planktons are greatly affected by the exposure to harmful ultraviolet rays. These are higher in the aquatic food chain. If the planktons are destroyed, the organisms present in the food chain are also affected.

Maximum ozone hole extent over the southern hemisphere, from 1979 to 2022

Source: European Environment Agency

How can we protect the ozone layer?

1. **Avoid the consumption of gases dangerous to the ozone layer**, due to their content or manufacturing process. Some of the most dangerous gases are CFCs (chlorofluorocarbons), halogenated hydrocarbon, methyl bromide and nitrous oxide.

2. **Minimize the use of cars.** The best transport option is urban, bicycle, or walking. If you use a car to a destination, try to carpool with others to decrease the use of cars in order to pollute less and save.

3. **Do not use cleaning products that are harmful to the environment and to us.** Many cleaning products contain solvents and substances corrosive, but you can replace these dangerous substances with non-toxic products such as vinegar or bicarbonate.

4. **Buy local products.** In this way, you not only get fresh products but you avoid consuming food that has traveled long distances. As the more distance traveled, the more nitrous oxide is produced due to the medium used to transport that product.

5. **Maintain air conditioners,** as their malfunctions cause CFC to escape into the atmosphere.

Changing Habits to Protect the Ozone Layer

1. **Drive less.** Nitrous oxide is now the largest ozone-depleting substance released by human activities (as well as a potent greenhouse gas), and it is produced in the internal combustion that powers most cars. In the U.S., about 5% of all nitrous oxide pollution comes from vehicles. To reduce the amount of nitrogen oxide your car produces, consider:
    i. Car pooling
    ii. Public transport
    iii. Walking
    iv. Biking
    v. Driving a hybrid or electric car
    vi. Neutralize your vehicle's greenhouse gas emissions with a Carbon Offset

2. **Eat less meat.** Nitrous oxide is also produced when manure decomposes, making poultry, beef, and dairy farms large producers of the gas.

3. **Buy local.** The further your food or other goods have to travel to reach you, the more nitrous oxide will be produced by the engines that bring them to you. Buying locally is not only a great way to find the freshest produce; it will also protect the ozone layer.

Key Points

- Ozone layer depletion is the thinning of the ozone layer present in the upper atmosphere. This happens when the chlorine and bromine atoms in the atmosphere come in contact with ozone and destroy the ozone molecules. One chlorine can destroy 100,000 molecules of ozone. It is destroyed more quickly than it is created.

- The longer ozone remains depleted, the warmer the oceans will become, and the longer Earth's warmer climate will persist.

- Without the ozone layer, too much harmful UVB radiation would have reached the Earth's surface. This would have been bad news. Increased exposure to ultraviolet radiation can cause skin cancer and eye cataracts, and damage crops, plants and micro-organisms, affecting ecosystems and food chains.

- Action to be taken to protect ozone layer.

Response to Climate Change

Objectives

After the completion of this chapter, the learners will be able to--

- Define Mitigation and adaptation
- Describe the mitigation strategies
- Explain the ways countries can adapt to the climate crisis

The global response to climate change involves a combination of mitigation efforts and adaptation strategies to reduce greenhouse gas emissions and to cope with the impacts of a changing climate respectively. Here are the key aspects of the response to climate change:

Mitigation:

Mitigation refers to actions taken to reduce greenhouse gas emissions or enhance their removal from the atmosphere. The goal is to limit the extent of future climate change and keep global temperature rise well below 2 degrees Celsius above pre-industrial levels, as outlined in the Paris Agreement.

Mitigation strategies include:

i) transitioning from fossil fuels to renewable energy sources (e.g. solar, wind, hydro, geothermal),
ii) improving energy efficiency,
iii) promoting sustainable transportation, and
iv) adopting low-carbon technologies.

Afforestation and reforestation efforts, as well as sustainable land-use practices, play a crucial role in sequestering carbon dioxide and mitigating climate change.

Adaptation:

Adaptation involves adjusting to the current and projected impacts of climate change to reduce vulnerability and build resilience. It aims to protect communities, ecosystems, and economies from the adverse effects of changing climatic conditions.

Adaptation strategies may include:

i) building climate-resilient infrastructure, climate resilient Healthcare Facilities,
ii) implementing early warning systems for extreme weather events,
iii) developing drought and flood management plans, and
iv) enhancing coastal protection measures.
v) Agricultural adaptation involves developing climate-smart farming practices, crop diversification, and

vi) water management strategies to ensure food security in the face of changing weather patterns.

Health adaptation to climate change:

Almost 50% of infectious diseases became worse by climate change. The floods, storms and heatwaves caused by global warming are changing the mode of transmission and increasing the risk of disease. The link between global warming and the increased risk of diseases transmission by microorganisms has been well known for the last decade – cholera, malaria, Lyme disease, West Nile virus and the Zika virus have already been proven to spread more easily due to climate change.

A review published in *Nature Climate Change* showed that of 375 infectious diseases studied, 218 (58%) have been aggravated by climate change; it could enhance emergence of more heat-resistant pathogens which may survive one of man's defense mechanisms: fever. One of the Intergovernmental Panel on Climate Change (IPCC) assessment released in March 2023 found that the a 1.5°C (2.7°F) rise over the next 20 years will exacerbate the spread of infectious diseases, the IPCC warned an increase to 2°C could accelerate the rise of infectious diseases even more.

There are many ways to adapt to what is happening and what will happen. Individuals can take some simple measures. Planting or preserving trees around home can keep temperatures cooler inside human dwellings. Mass awareness possibly needed regarding natural disasters. It may make safer the place where they live and what resources they have in case disaster happen. That might mean knowing where people can get disaster information and relief during a crisis.

Having clear perception for health adaptation, and the fact that it will affect human life, adaptation needs to take place on a greater scale. Modern economies and societies as a whole need to become more resilient to climate impacts. Roads and bridges need to be built or adapted to withstand higher temperatures and more powerful storms. Human settlements on coastal areas may have to establish systems to prevent flooding, hilly areas have to find ways to limit landslides. Many communities may need to move to new locations as because it will be too difficult to adapt.

Priority for the most vulnerable

While the case for adaptation is clear, some communities most vulnerable to climate change are the least able to adapt because they are poor and/or in developing countries already struggling to come up with enough resources for basics like health care and education.

All Parties to the Paris Agreement committed to strengthening the global response to climate change by increasing the ability of all to adapt and build resilience and reduce vulnerability. At COP26, counties adopted the Glasgow Climate Pact, which calls for a doubling of finance to support developing countries in adapting to the impacts of climate change and building resilience. Glasgow also established a work programme to define a global goal on adaptation, which will identify collective needs and solutions to the climate crisis already affecting many countries.

Sectors affected by climate change

Climate change is a cross-cutting issue that affects various sectors of society and the economy. Its impacts are diverse and widespread, posing significant challenges and opportunities for different industries and communities. Here's an overview of how climate change affects various sectors:

A. Health Impacts:

Climate change has direct and indirect effects on human health. Rising temperatures can lead to heat-related illnesses and heatwaves, which can be particularly dangerous for vulnerable populations.

Changes in precipitation patterns may influence the spread of vector-borne diseases like malaria and dengue. Extreme weather events can result in injuries and fatalities, disrupt healthcare services, and cause mental health issues due to stress and displacement.

Climate change can also affect food and water security, leading to malnutrition and waterborne diseases.

B. Water Resources and Availability:

Climate change impacts water resources, affecting both quality and quantity. Changes in precipitation patterns can lead to altered river flows, reduced groundwater recharge, and increased risks of droughts and floods.

Water scarcity can impact agriculture, energy production, and industrial processes. Competition for water resources may increase, leading to potential conflicts.

Sea-level rise can cause saltwater intrusion into freshwater sources, further reducing the availability of safe drinking water in coastal areas.

C. Energy and Transportation:

Climate change affects energy production and consumption patterns. Increased demand for cooling during heatwaves can strain energy systems. Changes in water availability can impact hydropower generation.

Transitioning to renewable energy sources, such as solar and wind, becomes crucial for mitigating greenhouse gas emissions and building a sustainable energy future.

Transportation, particularly reliant on fossil fuels, contributes significantly to greenhouse gas emissions. Climate change can impact transportation infrastructure through extreme weather events like storms and floods.

D. Urbanization and Infrastructure:

Climate change poses risks to urban areas and infrastructure. Sea-level rise and storm surges threaten coastal cities and critical infrastructure, including ports and airports.

Extreme weather events can damage buildings, roads, and utility networks, disrupting services and causing economic losses.

Urban heat island effect, where cities are significantly warmer than surrounding rural areas, can

exacerbate the impacts of heatwaves on human health and energy consumption.

E. Economy and Socio-Economic Implications:
Climate change can have far-reaching socio-economic implications. Disruptions to agriculture, water resources, and energy supply chains can impact food prices and energy costs.

Natural disasters and extreme weather events can result in direct economic losses from damage to infrastructure, property, and agricultural yields.

Industries reliant on climate-sensitive natural resources, such as agriculture, forestry, and fisheries, may face challenges due to changing environmental conditions.
Climate change can affect livelihoods and employment opportunities, particularly in vulnerable communities dependent on climate-sensitive sectors.

Overall, the diverse impacts of climate change call for integrated and comprehensive approaches to adaptation and mitigation. Effective responses require collaboration among various sectors, stakeholders, and policymakers to build climate resilience, reduce greenhouse gas emissions, and foster sustainable development. Investing in climate action and building adaptive capacity can lead to a more sustainable and equitable future for all.

National response to climate change
Early warning systems
Research shows that just 24 hours warning of an oncoming heatwave or storm can reduce the subsequent damage by 30 per cent. Early warning systems that provide climate forecasts are one of the most cost-effective adaptation measures, yielding around nine dollars of total benefits for every dollar invested. With timely warnings, people can take early action by blocking up doors with sandbags to anticipate floods, stockpiling resources, or in some extreme cases, evacuating from their homes.

In Bangladesh for example, even as climate change becomes more severe, the number of deaths from cyclones has fallen by 100-fold over the past 40 years, due mainly to improved early warnings.

Ecosystem restoration

The UN Decade on Ecosystem Restoration launched by the UN Environment Programme (UNEP) and partners in 2021 triggered a global movement to restore the world's ecosystems. This global restoration effort will not only absorb carbon but also increase 'ecosystem services' to defend the world from its most devastating impacts.

In cities, restoring urban forests cools the air and reduces heatwaves. On a normal sunny day, a single tree provides a cooling effect equivalent to two domestic air conditioners running for 24 hours.

On coasts, mangrove forests provide natural sea defences from storm surges by reducing the height and strength of the sea waves. Moreover, protecting mangroves is 1,000 times less expensive per kilometre than building seawalls.

UNEP is working with governments around the world to implement these nature-based solutions to the climate crisis – known as ecosystem-based adaptation. Some projects are taking place on a large scale. Such as in Lao PDR, where UNEP and partners are helping restore urban ecosystems in four major cities to reduce flooding for 700,000 people – roughly 10 per cent of the entire population.

Climate-resilient infrastructure

Climate-resilient infrastructure refers to assets and systems such as roads, bridges, hospitals and power lines that can withstand shocks from extreme climate impacts. Infrastructure is responsible for 88 per cent of the forecasted costs for adapting to climate change.

A World Bank report finds that climate-resilient infrastructure investments in low- and middle-income countries could produce roughly US$4.2 trillion in total benefits, - around US$4 for each dollar invested. The reasoning is simple. More resilient infrastructure assets pay for themselves as their life-cycle is extended and their services are more reliable.

Water supplies and security

The story of climate change is, in many ways, a story about water, whether it is floods, droughts, rising sea levels, or even wildfires. By 2030, one-in-two people are expected to face severe water shortages. Investing in more efficient irrigation will be crucial, as agriculture accounts for 70 per cent of all global freshwater withdrawals. In urban centres, roughly 100-120 billion cubic metres of water could be saved globally by 2030 by reducing leaks. Governments are being encouraged to develop holistic water management plans, known as Integrated Water Resource Management, that take into account the entire water cycle: from source to distribution, treatment, reuse and return to the environment. Research shows that investments in rainwater harvesting systems need to be sustained to make them more widely available. UNEP is working with government partners to build over 1000 rainwater harvesting systems around the world and provide expert guidance on construction and usage, whether it is solar-powered wells, boreholes, micro-irrigation technologies, or water reuse systems.

Long-term planning

Climate adaptation solutions are more effective if integrated into long-term strategies and policies. National Adaptation Plans are a crucial governance mechanism for countries to plan for the future and strategically prioritize adaptation needs. A key part of NAP is to examine climate scenarios decades into the future and combine these with vulnerability assessments for different sectors. These can assist in planning and guiding government decisions on investment, regulatory and fiscal framework changes and raising public awareness. Around 70 countries including Bangladesh have developed a National Adaptation Plan, but this number is growing rapidly. WHO has supported Bangladesh to develop a NAP for the health sector called HNAP.

Climate resilience

Climate change is associated with both rapid-onset events such as floods, hurricanes or wildfires and slow-onset events such as sea level rise or desertification.

Climate resilience is the ability of social, economic and environmental systems to withstand these impacts so that they can thrive in spite of the impact.

We define resilience as the ability of a system, community, or society to pursue its social, ecological, and economic development and growth objectives, while managing its disaster risk over time in a mutually reinforcing way.

Why climate resilience

Climate change has triggered an increase in extreme weather events such as cyclone, floods and droughts. It's also causing long-term changes to weather patterns that are destroying livelihoods. As the effects of climate change become increasingly tangible, vulnerable and hazard-prone communities face growing, complex, and worsening challenges.

Climate resilience is especially critical in countries that are most vulnerable to climate change and are already feeling the impacts on a daily basis. Poorer areas are often hardest hit. Poverty forces people into disaster-prone areas where making a living is almost impossible. And it means they're ill-equipped to adapt to the changing climate, leaving them even more vulnerable to future disasters. Therefore, it has become a major priority to take actions that reduce vulnerability to these impacts, especially by taking actions to increase their capacity to enact climate change adaptation. The climate crisis is already here. Climate hazards like storms and extreme heat

threaten health directly, and a changing climate also shifts how people live and interact with the world around them. This can exacerbate existing vulnerabilities and inequities, keeping women, girls, and other marginalized community members from the table.

To build a more climate-resilient future, we need everyone to be able to participate in creating climate solutions. Doing that means building a future that is healthier and more equitable for all. Climate change affects every aspect of life. It increases health risks, hinders sexual and reproductive health and rights, increases food and water insecurity, and worsens existing inequities—in every country where we work. These negative impacts are not gender neutral: women and girls are often disproportionately affected.

Key Points

- Learn about adaptation strategies to climate change.
- Action to be taken to climate change adaptation
- Importance to building climate resilience

Climate Change and Human Health

Objectives :

After the completion of this chapter, the learners will be able to--

- Narrate the global situation on health due to climate change
- Describe different impacts of climate change on human health.

The global health impact of climate change, health Impact of climate change - direct and indirect health effect of climate change, impact on infectious diseases, physical health and mental health.

Climate change has been dubbed **"the greatest health threat of the 21st century"** because of its extensive effects on human health. Extreme heat, wildfires, droughts, and other extreme weather events are all caused by global warming, and they have a disproportionately negative impact on vulnerable populations around the world.

The impact of climate change on human health will vary greatly depending on many variables including the behavior, age, gender, race, and economic status of individuals. Moreover, such variables can also be expanded to include region, the sensitivity of populations, the extent and length of exposure to climate change, and society's ability to adapt to change. People living in small islands and coastal regions, megacities, and mountainous and polar regions are particularly prone to such degrading environmental condition. Likewise, children living in poor countries, the elderly, and those with infirmities or pre-existing medical conditions will be affected most sensitively by these alterations.

Global Health Impact of Climate Change

Climate change affects the social and environmental determinants of health – clean air, safe drinking water, sufficient food and secure shelter.

Between 2030 and 2050, climate change is expected to cause approximately 250 000 additional deaths per year, from malnutrition, malaria, diarrhea and heat stress.

The direct damage costs to health (i.e. excluding costs in health-determining sectors such as agriculture and water and sanitation), is estimated to be between USD 2-4 billion/year by 2030.

Areas with weak health infrastructure – mostly in developing countries – will be the least able to cope without assistance to prepare and respond.

Reducing emissions of greenhouse gases through better transport, food and energy-use choices can result in improved health, particularly through reduced air pollution.

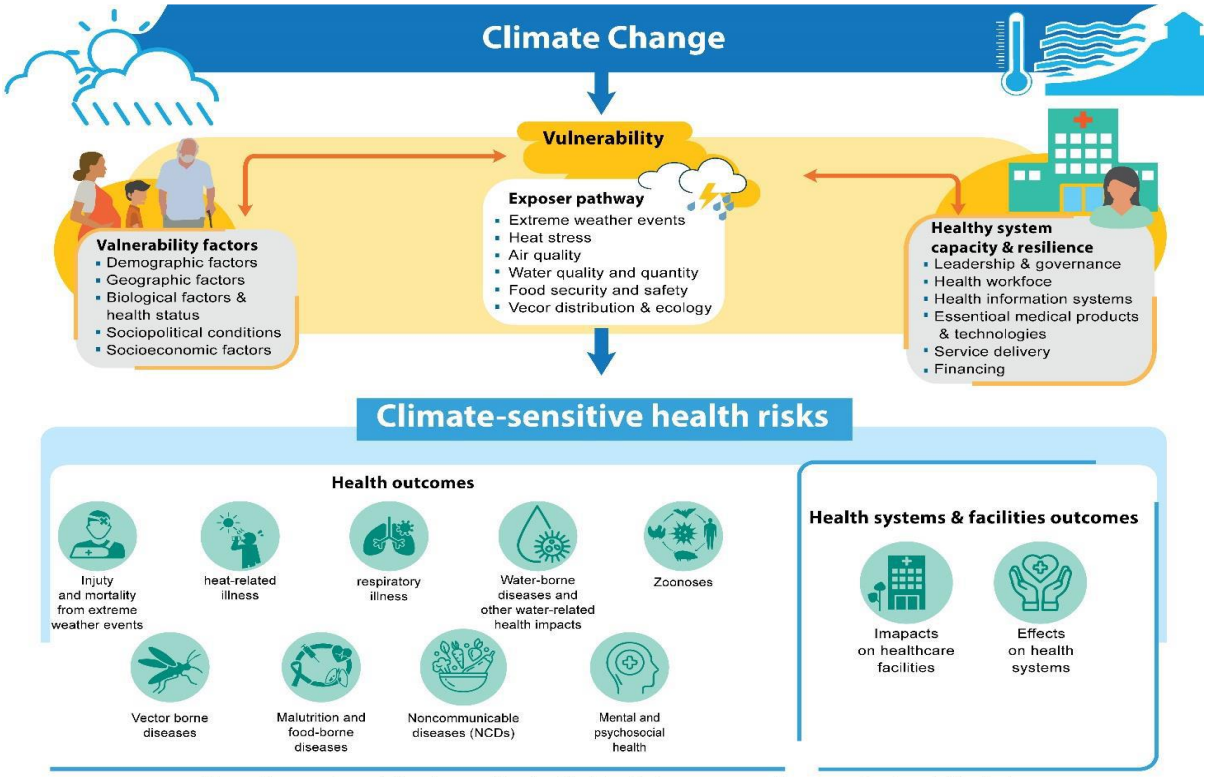


Figure: An overview of climate-sensitive health risks, their exposure pathways and vulnerability factors. Climate change impacts health both directly and inderctly, and is strongly mediated by environmental, social and public health determinants.

Impact of Climate Change on Health

A change in climatic conditions can have direct and indirect kinds of health impacts.

Direct impacts are caused by weather extremes e.g., impacts of thermal stress, death/injury in cyclones and storms, etc.

Indirect impacts can be in two forms: (a) health consequences due to environmental change and ecological disruption that occur in response to climate change; and (b) the diverse health consequences e.g., traumatic, infectious, nutritional, psychological, etc.

Direct Impacts
Climate change can affect human health in numerous ways. Some of the possible direct impacts of climate change on human health are as below:

The impact of temperature rises and heat waves:

- Heat stress or hyperthermia
- Diarrheal diseases
- Cardiovascular and respiratory diseases
- Seasonal peak of "Escherichia coli" diarrhea
- Heat stroke among the people working in industries has increased in the recent years.

- Rise of temperature can also increase the renal disease and mental disorders especially among the elderly people.
- Organic illnesses, including symptomatic mental disorders; dementia; mood (affective) disorders; neurotic, stress related, and somatoform disorders; disorders of psychological development; and senility.

The impact of frequent natural disasters

- It has been projected that climate change will cause more frequent and severe floods, cyclones and droughts.
- Increase of extreme weather events will cause more losses of lives. Threatened or actual loss of valued resources due to natural disaster might lead to psychological distress i.e., negative mood, stress-related physical symptoms, and psychological symptoms.

The impact of stagnant weather conditions and air pollution

Dull weather conditions can trap both warm air and air pollutants leading to smoke episodes with significant health impacts i.e., cardiovascular, respiratory and allergy diseases including lung infections, asthma, chronic obstructive pulmonary disease, lung cancer, coronary artery disease, heart-rhythm problems.

Indirect Impacts

Indirect impacts of climate change on public health will be much more severe and diverse compared to direct impacts. Some of the possible indirect impacts are discussed below.

- ***The impact of frequent floods and water-logging***
- Enteric infections and infectious diseases are common due to the tropical climate, combined with the existence of large open waterbodies and dense population.
- Waterlogging, destruction of freshwater resources and contamination of drinking water wells caused by frequent floods and cyclones may increase the health-related problems such as cholera, diarrhea, malnutrition and skin diseases.

The impact of increased breeding of vectors

- Climate change is likely to have important effects on the prevalence of vector borne diseases.
- Breeding period of mosquitoes may be shifted and prolonged, leading to a possible change in malaria pattern.
- Global warming would produce more rapid replication of the dengue virus which is a major emerging infectious disease.

- Japanese encephalitis virus is an emerging cause of encephalitis due to higher breading of mosquitoes can accelerate the transmission to other parts of the world.
- Visceral Leishmaniasis (also known as kala azar) cases seem to cluster near flood control embankments. Building more embankments, a likely response to sea-level rise, may favor Visceral Leishmaniasis vectors and result in increasing cases of Visceral Leishmaniasis,

The impact of sea-level rise

- Sea-level rise due to global warming may cause an increase of salinity in river water,
- Increase salinity in drinking water will increase the risk of diarrhea and skin diseases. Prolonged exposure to water containing salts can cause kidney stone.
- Inland intrusion of salt water may turn former freshwater habitats into salt-marsh areas which could act as a breeding ground of salt-marsh mosquitoes and may in turn increase the vector-borne diseases in the coastal areas.

The impact of increased recharge in monsoon and groundwater pollution

Presence of toxic pesticides in groundwater may increase the cases of nervous, reproductive and endocrine systems damages. Specially, children are more susceptible to pesticides as they are still developing and have faster metabolisms.

The impact of decreased food production and malnutrition

Food production will be reduced due to the elevated temperature. Chronic malnutrition may be caused by shrinking food-grain absorption. Protein-energy deficiency may increase the child death. Deficiencies in micro-nutrients (vitamins and minerals) can also affect mental and physical health.

The impact of hostile conditions

Due to sea level rise, prolonged water logging in the coast region due to frequent flooding and severe droughts can create hostile conditions that may cause extensive damage to already be shrinking food supplies and force many people to become so called ‘refugees of climate change’ and create diverse health consequences e.g., trauma and psychological stress. Anxiety, depression, suicidal thinking and other psychiatric symptoms are common among the refugees.

Impact on Physical Health –

Respiratory illnesses are likely to increase with rising temperature and humidity. 1°C increase in temperature rises the likelihood of contracting a respiratory infection by 5.7 percentage points.

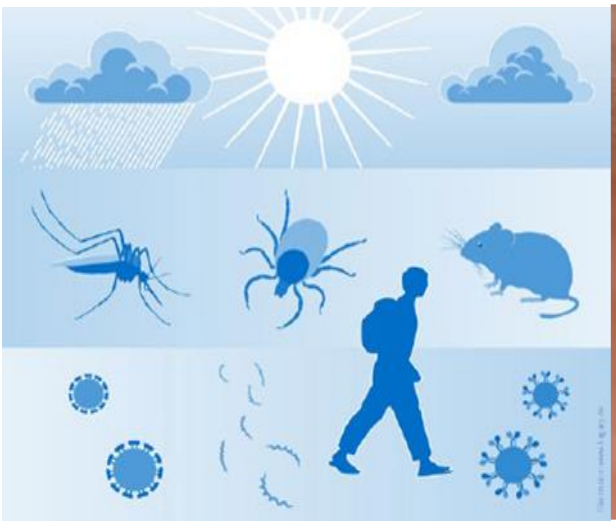
Waterborne diseases like cholera are likely to decrease with rising humidity and temperature.

Dengue is likely to increase for because of the climatic conditions become more suitable. Weather data between 1976 and 2019 indicate Dhaka is experiencing falling humidity levels, rising temperatures, and heavier summer rainfall. These together with factors like urbanization are increasing the risk of the spread of dengue in Dhaka city.

Impact on Mental Health

- Changes in weather can cause mood swings.
- The level of anxiety disorders increases with temperature and humidity. Increase in mean humidity and mean temperature increases the probability of having anxiety by 0.3 percent and 0.8 percent, respectively.
- More people suffer from depression during winter. Increase in temperature lowers the probability of depression by 1.6 percent.
- Further, women are at higher risk than men for depression, while men are more susceptible to anxiety.

Vector-borne Diseases and Climate Change



Objectives :

After the completion of this chapter, the learners will be able to--

- Define vector-born diseases
- List the key factors for vector- borne diseases.
- Describe the effect of climate change on vector-borne diseases

Vector-borne diseases are human illnesses caused by parasites, viruses and bacteria that are transmitted by vectors.

Vector-borne diseases account for more than 17% of all infectious diseases, causing more than 700 000 deaths annually.

- Malaria is a parasitic infection transmitted by Anopheles mosquitoes, causes an estimated 219 million cases globally, and results in more than 400,000 deaths every year.

- Dengue is the most prevalent viral infection transmitted by Aedes mosquitoes. More than 3.9 billion people in over 129 countries are at risk of contracting dengue, with an estimated 96 million symptomatic cases and an estimated 40,000 deaths every year.

- Other viral diseases transmitted by vectors include chikungunya fever, Zika virus fever, yellow fever, West Nile fever, Japanese encephalitis (all transmitted by mosquitoes), tick-borne encephalitis (transmitted by ticks)

Among these, 1.30 million are caused by mosquito-borne diseases (WHO, 2004). The leader of this

deadly procession is malaria, with an annual death levy of 1.27 million (WHO, 2004). Important mortality is also caused by trypanosomiasis (around 51000 deaths per year), leishmaniasis (around 51000 deaths) and dengue (19000 deaths) (WHO, 2004) 24.

At the beginning of the 21st century, vector-borne diseases still cause a severe threat to human health. Out of about 11 million annual deaths to infectious diseases (about 19% of total annual deaths), 1.43 million can be attributed to vector-borne diseases (including malaria, trypanosomiasis, Chagas disease, leishmaniasis, lymphatic filariasis, onchocerciasis, dengue and Japanese encephalitis).

Vectors:

Vectors are living organisms that can transmit infectious pathogens between humans, or from animals to humans. Many of these vectors are bloodsucking insects, which ingest disease-producing microorganisms during a blood meal from an infected host (human or animal) and later transmit it into a new host, after the pathogen has replicated. Often, once a vector becomes infectious, they are capable of transmitting the pathogen for the rest of their life during each subsequent bite/blood meal.

List of Vector Borne-Diseases and the organism

Vector		Disease caused	Type of pathogen
Mosquito	*Aedes/Albopitus*	Chikungunya Dengue Lymphatic filariasis Zika	Virus Virus Parasite Virus
	Anopheles	Lymphatic filariasis Malaria	Parasite Parasite
	Culex	Japanese encephalitis Lymphatic filariasis	Virus Parasite
Fleas		Plague (transmitted from rats to humans) Tungiasis	Bacteria Ectoparasite
Lice		Typhus Louse-borne relapsing fever	Bacteria Bacteria
Sandflies		Leishmaniasis Sandfly fever (phlebotomus fever)	Parasite Virus
Ticks		Crimean- Congo haemorrhagic fever Lyme disease Relapsing fever (borreliosis) Rickettsial diseases (eg: spotted fever and Q fever) Tick-borne encephalitis Tularaemia	Virus Bacteria Bacteria Bacteria Virus Bacteria

Effect of Climate Change on Vector-borne Diseases

Climate change increasing the potential for transmission of vector borne disease and hindering the future control of disease. Vector-borne diseases (VBD) are infections transmitted by the bite of infected arthropod species, such as mosquitoes, ticks, bugs, sand-flies and black-flies.

Climate directly influences the development of vector of malaria-dengue. Climate also has an indirect effect on malaria-dengue through its influence on suitable vegetation and vector breeding sites. Precipitation is important because mosquitoes require water to lay their eggs, as well as for the subsequent development of larvae. Projections indicate that, in the future, malaria is most likely to extend its range into the extremes of established endemic areas.

The WHO estimates that one-sixth of the illness and disability suffered worldwide is owing to vector-borne diseases, with more than half of the world's population currently at risk. Every year, more than one billion people are infected, and more than one million people die from vector-borne diseases, including malaria, dengue, schistosomiasis, leishmaniasis and Chagas disease.

Kala-azar or visceral leishmaniasis (VL) is a parasitic disease caused by Leishmania donovani. Environmental changes often modify the transmission patterns of vector-borne diseases. Increases in temperature due to climate change provide a better breeding environment for vectors, including the sand fly, in places where temperatures were previously below optimum, and so, a higher rate of human VL infection may result26.

By 2100 it is estimated that average global temperatures will have risen by 1.0-3.5 degrees C, increasing the likelihood of many vector-borne diseases in new areas. The greatest effect of climate change on transmission is likely to be observed at the extremes of the range of temperatures at which transmission occurs.

Climate Change and Non Communicable Disease

Objectives:

After the completion of this chapter, the learners will be able to--

1. Mention the effect of climate change on respiratory and cardiovascular health.
2. Narrate the effect of climate change on mental health.
3. Describe the potential impact of climate change on cancer.

Respiratory diseases

Recent research presented scientific evidence that the risk of premature death among respiratory patients is up to six times higher than in the rest of the population with the rise of every one Celsius degree in temperature.

Increases in temperature (and ozone concentration levels) can lead to an increase in the burden of diverse diseases ranging from **airway injury and inflammation to acute decrease in lung function.**

Inhaled ozone causes an inflammatory response, manifested by increased airway permeability and bronchial hyperactivity, which can lead to increasing incidences of **asthma and respiratory diseases.** Approximately one-fourth to one-third of those deaths have been attributed to the effects of increased particulate air pollutants and ozone, which spiked in concentration with the soaring temperatures.

Warmer air temperatures can influence the **regional distribution of aeroallergens.**

Allergenic pollens tend to grow more profusely in a warmer climate, spreading respiratory disorders such as **asthma, emphysema, chronic bronchitis, and allergy problems.**

Changes in the climate can also affect a number of pulmonary diseases like **chronic obstructive pulmonary disease, pneumothorax, and respiratory infections in children.**

There are also indications of a relationship between air pollution and **tuberculosis.**

Further, there is a line of evidence suggesting that **dust storms in deserts** (as well as high altitude areas) can cause **respiratory problems for people in distant areas.**

Cardiovascular health

Because of climate change, the risk of **cardiovascular disease rises both directly and indirectly** via air pollution and changes in dietary options.

The physiological reactions to increased heat exposure include a number of symptoms (such as increased core body temperature and heart rate, shift of blood flow from central organs to skin, and greater sweating and associated dehydration), if sufficient quantities of liquid are not provided.

Extreme cold and extreme heat can increase hospital admissions for chest pain, stroke, cardiac dysrhythmia (irregular heart beat), and other cardiovascular diseases.

Increased ozone formation (due to temperature rise) is suspected to cause heart attacks by damaging pulmonary gas exchange processes with enhanced heart stress.

Droughts can also facilitate the rise of particulate matters levels in the atmosphere, it may help the development such symptoms as systematic inflammation, compromised heart function, deep venous thrombosis, pulmonary embolisms, and blood vessel dysfunction.
As a result of extreme weather events, growth in stress and anxiety levels can also lead to heart attacks, sudden cardiac death, and stress-related cardiomyopathy (heart disease).

Mental health

The impact on mental health induced by extreme weather conditions (like hurricanes, tornados, floods, fires, drought, tsunamis, etc.) is expected to be reflected by **anxiety, post-traumatic stress, depression, etc.**

Even in the absence of direct physical impacts, the perception and fear of climate change may threaten mental health to a great extent. Nevertheless, such impact may differ according to the type, suddenness, and scale of the catastrophe, while being distinguished in the context of the social, historical, and cultural factors.
Droughts are predicted to become more frequent and severe in many subtropical regions of the world due to climate change, and they are subsequently expected to cause **hunger, anxiety, and depression with the reduction of agricultural productivities.** Consequently, suicide rates, especially of farmers.
Heat waves that can engender increased interpersonal violence, anxiety, depression, and reduced work capacity (apart from sickening) can also lead to the deaths of those who are unable to find the means to remain cool.
Social isolation is another aspect of heat stress, as some people may not venture outdoors during hot days, which may promote the further depression.

Cancer

Climate change is also suspected to exert a potential impact on cancer both directly and indirectly. Increased exposure to suspected carcinogenic toxic chemicals is likely to increase due to heavy rainfall and volatilization of chemicals due to increased temperature.

Melting glaciers and ice sheets can also release cancer-causing pollutants into the oceans and air.

By damaging the stratospheric ozone layer, climate change may dramatically raise the chance of UV exposure, which can increase the dangers of skin cancer.

A decline in air quality with the rise of air pollutant level may also increase the risk of lung cancer. As weather patterns become more erratic with climate change, liver cancer (through aflatoxin contamination) has been suspected to become an increasing problem.

Climate change is also expected to increase heavy precipitation and flooding events, that may also affect the potential for leakage of toxic contaminants from storage facilities or their runoff into water from land containing toxic pollutants. Some of these chemicals are known carcinogens with their ultimate impact of bringing about greater incidences of cancer.

Heat Related Illness

Objectives:

After the completion of this chapter, the learners will be able to--

1. Definition of heat related illness.
2. Types of heat related illness.
3. Risk factors for heat related illness.
4. Pathophysiology of Heat Stoke
5. Management.

Heat-related illness defines a spectrum of pathology from benign heat oedema to lethal heat stroke. There is a growing risk of heat-related illness with global temperatures predicted to rise by between 1.7°C and 5.6°C within this century alone; the World Health Organization predicts over 250 000 additional deaths a year from 2050 as a result of heat exposure.

Heat-related illness is often categorized as either environmental or exertional heat illness depending on the primary underlying mechanism. Environmental heat illness results from elevated ambient temperatures.

With increased incidence seen at the extremes of age, due to suboptimal homeostatic thermoregulation. Peaks of incidence are common during heatwaves, exemplified by the 70 000 heat-related deaths reported during the 2003 European heatwave.

Exertional heat illness predominantly affects young, physically fit individuals (such as soldiers and athletes), reflecting a failure to dissipate intrinsic heat production from physical activity.

Heat related illness	**Important Points**
Heat Edema	Mild limb swelling due to interstitial edema due to increased plasma volume, vasodilatation, and pooling,
Heat Cramp	Loss of sodium due to excessive sweating who replace the fluid with plain water causing muscle cramp.
Heat Syncope	Multifactorial – elderly, having heart disease, taking diuretic, prolonged standing causing the loss of conscious with rapid return to normal.
Heat Exhaustion	Excess loss of fluid salt causing lethargy, weakness, thirst, headache and nausea with intact mental capacity.
Heat Stroke	When core temperature exceeds more than 40 there is neurological impairment – tremor, confusion, aggression, loss of consciousness.

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12.6 Risk factors for the development of heat-related illness

Risk factor	Mechanism
High ambient temperatures	Increased radiant heat gain
High humidity	Ineffective evaporative heat loss at humidities > 75%
Little shade	Increased radiant heat gain
Intercurrent illness	Raised core temperature
Extremes of age	Suboptimal homeostatic thermoregulation
Overweight/unfit	The main identifiable risk factor for heat illness during military training was a body mass index (BMI) ≥ 30 kg/m^2
Effects of alcohol and medication (diuretics, ACE inhibitors, β-adrenoceptor antagonists, vasodilators, antidepressants, anticholinergics, antihistamines and stimulants)	Either through dehydration, decreased cardiovascular and peripheral response to dissipate heat, reduced sweating or increased metabolic rate
Inappropriate clothing	Reduced heat loss through combination of radiation, convection and evaporation
Dehydration	Regardless of body habitus or fitness level, fluid losses that result in a 2%–3% decrease in body weight correlate with decreased aerobic performance, increased perception of fatigue, and greater core temperatures at a given workload
Previous heat-related illness	Impaired homeostatic thermoregulation
No acclimatisation	Body fluid deficits are reduced by around 30% in acclimatised individuals, despite increased sweat rates of up to 18%, as a result of a more accurate thirst response
Intense work/duration	Increased heat generation

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Pathophysiology of heat stroke

The pathophysiology of heat stroke can be summed up as end-organ ischemia due to decreased blood flow and organ dysfunction from the high temperature itself.

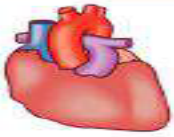
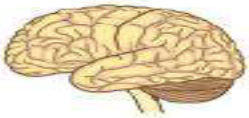
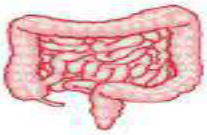
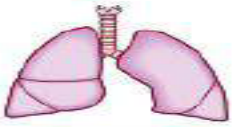
Dehydration from increased perspiration and blood pooling in vasodilated peripheral vasculature cause a reduction in effective blood volume.

As blood viscosity rises, heart strain results.

At 40 °C, enzymes begin to denature, and at 41 °C, mitochondrial function ceases.

The loss of oxidative phosphorylation that follows causes organ ischemia. First to be impacted are the muscles and digestive system, then the circulatory, coagulation, and central nervous systems. Similar to sepsis, severe trauma, and severe burns.

12.7 Pathophysiology of heat stroke

	Increased heart rate and an increase in cardiac output by 3 L/min for each 1 °C rise in core temperature. Increased peripheral blood flow from 0.2 L/min up to 8 L/min. Dehydration with sweat rates increasing from 0.5 L/day up to 15 L/day. Risk of heart failure if pre-existing cardiac disease
	Ischaemia and cerebral oedema due to the high temperature itself and vascular endothelial damage
	Intestinal mucosal impairment results in toxins entering the portal vein and circulating systemically resulting in sepsis
	Tachypnoea and pulmonary vasodilatation result in acute respiratory distress syndrome (ARDS) (p. 201)
	Acute renal failure due to ischaemia, dehydration and rhabdomyolysis (p. 198)
	Acute liver injury from ischaemia and high levels of circulating inflammatory cytokines (p. 879)
	Microthrombus formation causing further ischaemia and disseminated intravascular coagulation (p. 988)
	Multiple electrolyte abnormalities including hypokalaemia, hypomagnesaemia, hypoglycaemia and metabolic acidosis

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Management

Urgent cooling should start at the site before transportation to the hospital. The goal should be to bring the core temperature down to about 39°C.

A patient should be removed from the heat source and put into shade to reduce radiant heat gain.

Clothes should be removed,

High flow oxygen administered,

Intravenous access established and a rectal temperature taken.

If temperature measurement is unavailable but the history and clinical findings are consistent with heat illness, initiation of treatment with cooling techniques should not be delayed.

Ice water immersion is the most effective treatment strategy with cooling rates of 0.20–0.35°C/min for iced water and 0.11°C/min for wet towels.

The placement of ice/cold packs in the axillae, groin and neck has been recommended as an easy method to use in the field,

Evaporative cooling involves the removal of clothing, spraying tepid or cool water over the patient, and facilitating evaporation and convection with the use of a fan.

Prevention of heat illness is therefore paramount. Strategies include:

1. Ensuring adequate hydration. The 2019 Wilderness Medical Society heat illness guidelines identify hydration as the 'most readily modifiable physiologic risk factor'. Fluid ingestion is also identified as the most effective approach to mitigate the rise in core temperature amongst athletes.

2. Expedition participants should receive high-level education pre departure on the dangers of heat-related illness with evidence based advice on risk reduction. Increased hydration and cooling strategies have been documented following educational material targeting older people prior to heatwaves.

3. If possible, implementing a period of acclimatization with at least 1–2 hours of mild exertion in a hot environment for at least 8 days. Body fluid deficits are reduced by around 30% in acclimatized individuals as a result of a more accurate thirst response.

4. WHO recommends following steps to avoid the development of heat related illness during extreme weather condition/ Heat waves -

- Resting to the coolest room in the home, especially at night.
- Avoiding outside work during the hottest time of the day.
- Avoiding strenuous physical activity. If needed, it may be done during the coolest part of the day, which is usually in the morning between 04:00 and 07:00.
- Staying in the shade.
- Avoiding leaving children or animals in parked vehicles.
- Keeping the body cool and hydrated by taking cool showers or baths during a heatwave. Wearing light, loose-fitting clothes of natural materials.
- In outside, wearing a wide-brimmed hat or cap and sunglasses.
- Using light bed linen and sheets, and no cushions, to avoid heat accumulation.
- Drinking regularly, but avoiding alcohol and too much caffeine and sugar. Eating small meals and eat more often. Avoiding foods that are high in protein.

Health Emergencies Due to Climate Changes: -

- Extreme weather events due to climate changes may impact the human health in several ways. Apart from the changes and consequences that are already described the follow emergencies may occur which need EMS (Emergency Medical Services)
- Heat Related Events mainly – Heat stroke due to heat waves.
- Cardiac arrest due to extreme change in temp like extreme heat or cold.
- Injury due to extreme weather events like cyclone leads to bleeding.
- Wild fire may cause sudden respiratory distress (ARDS due to upper airway burn)
- Flooding may cause drowning.
- Snake bite due to Deforestation and frequent flooding.

Key Points

- Climate change is having widespread impacts on human health and has been called "the greatest health threat of the 21st century."

- From rising sea levels to more extreme weather events to fast disappearing sea ice, the planet is changing quicker than people and animals can adapt to the change, leading to significant damage to our health and wellbeing.

- Elderly, children and those with existing health conditions, are particularly vulnerable to the impacts of climate change. Low-income communities and indigenous populations may be disproportionately affected by climate change because of limited access to healthcare and greater exposure to environmental hazards.

- Rising temperatures and changing rainfall patterns are enabling the increased spread of diseases such as Malaria, Dengue, West Nile virus and Lyme disease as the mosquitoes and other insects that carry them are able to expand their habitat.

- Climate change can affect the availability and quality of water and food resources, lead to dehydration and the spread of water-borne diseases as clean water becomes even scarcer.

- Warmer temperatures can lead to increased ground-level ozone formation and worsened particulate matter pollution responsible for long term respiratory illness.

- Reduced crop yields lead to food shortages and price increases, leads to malnutrition. Being undernourished weakens the immune system, putting people at greater risk of disease.

Climate Change and Acute Emergency Health Care Service

Objectives :
After the completion of this chapter, the learners will be able to--

- Mention the essential aspects of acute emergency health care.
- Acquire knowledge and skills required to excel in the field of acute medicine.
- Identify patients who require immediate care versus those who can wait.
- Use medical resources judiciously to maximize patient outcomes and minimize waste.
- Conduct drills and simulations to maintain preparedness and improve response times.

Climate change is not only affecting our natural surroundings but also placing immense strain on our healthcare systems. As global temperatures continue to rise, the intensification of natural disasters such as hurricanes, floods, and wildfires often results in traumatic injuries and exacerbates existing health conditions.

Acute emergency health care service refers to the immediate and specialized medical attention given to individuals experiencing severe and potentially life-threatening medical conditions or injuries.

The primary targets of acute emergency care is to stabilize the patient's condition, prevent further deterioration, potentially save their lives and ensure they receive appropriate treatment as quickly as possible. In times of crisis, quick and efficient emergency health care services can make a significant difference between life and death. Our Acute Emergency Health Care Services across the country is dedicated to providing immediate medical attention and critical care to those facing life-threatening situations.

Acute Emergency Health Care:
Acute emergencies refer to medical situations that demand immediate attention to prevent further complications and potentially save lives. These emergencies can occur due to various factors such as accidents, sudden illnesses, severe injuries, or exacerbations of pre-existing medical conditions.

The Role of a Medical Student in Acute Emergency Health Care:
As a medical student, you might encounter acute emergencies during your clinical rotations or internships. Understanding how to respond quickly and effectively during these critical moments is essential. Your role includes:

- **Assessment and Triage:** Rapidly assess the patient's condition and prioritize care based on the severity of the situation. Triage is crucial to allocate resources efficiently.

- **Basic Life Support (BLS):** Learn and practice BLS techniques, including cardiopulmonary resuscitation (CPR), to provide immediate aid to patients with cardiac arrest or respiratory distress.

- **First Aid:** Master basic first aid skills to address injuries, burns, and wounds promptly. Quick and appropriate first aid can significantly impact patient outcomes.

- **Assisting Senior Medical Professionals:** In the emergency department, you may assist senior doctors and nurses in various procedures, such as suturing, wound dressing, or medication administration.

Key Principles of Acute Emergency Health Care:

- **Safety First:** Ensure the safety of yourself, your team, and the patient. Be aware of potential hazards in the environment.

- **Effective Communication:** Clear and concise communication is crucial during emergencies. Provide accurate information when contacting higher-level medical personnel or emergency services.

- **Teamwork:** Acute emergencies require coordinated efforts. Work collaboratively with other healthcare providers to deliver the best possible care.

- **Empathy and Respect:** Even in stressful situations, treat patients and their families with compassion and respect.

Tips for Effective Acute Emergency Health Care:

- **Stay Calm:** Maintain composure and think logically during high-pressure situations.

- **Prioritize:** Focus on the most critical tasks first to ensure time-sensitive interventions are not delayed.

- **Know Your Limits:** Understand your capabilities and seek help when needed.

- **Continuous Learning:** Keep updating your knowledge and skills through workshops, seminars, and simulation training.

Key Components of Acute Emergency Health Care:

- **Emergency Medical Services (EMS):** This is the initial response system that dispatches trained professionals and ambulances to the scene of an emergency. EMS personnel assess the patient's condition, provide necessary interventions, and transport them to the nearest medical facility.

- **Emergency Room (ER) Care:** Hospitals have emergency departments that operate 24/7 to handle acute medical emergencies. ER physicians and nurses are trained to respond quickly and effectively to various critical situations.

- **Triage:** Upon arrival at an emergency room, patients are prioritized based on the severity of their condition. This process ensures that the most critically ill or injured individuals receive immediate attention.

- **Life-Saving Interventions:** Medical professionals in acute emergency care are trained to perform life-saving procedures such as cardiopulmonary resuscitation (CPR), tracheal intubation, and defibrillation for cardiac arrest, among others.

- **Diagnostic Imaging and Laboratory Tests:** To assess the patient's condition accurately, emergency health care providers may conduct rapid imaging studies (e.g., X-rays, CT scans) and blood tests.

- **Intravenous (IV) Fluids and Medications:** IV therapy is often administered to stabilize the patient's blood pressure, replace lost fluids, and deliver medications rapidly.

- **Pain Management:** Emergency care providers also address pain relief when necessary to ensure patient comfort during treatment.

- **Consultations and Specialized Care:** Depending on the patient's condition, specialists may be called upon for consultations or immediate interventions (e.g., surgeons, cardiologists, neurologists).

- **Transfer to Higher-Level Care:** In some cases, patients may need to be transferred to a higher-level care facility, such as a trauma center or specialized hospital, for more intensive treatment.

Let's drive into the core aspect of our acute emergency health care services. Now you will be learning about some acute emergency situations with their management.

1) Assessment of the ABCs

Assessment of the ABCs (Airway, Breathing and Circulation) is a critical initial evaluation used in emergency medicine to quickly assess and address life-threatening conditions in a patient. It is a systematic approach that focuses on three vital components:

A) **Airway:** The first step in the ABC assessment is to ensure that the patient's airway is open and unobstructed. A clear airway is essential for the passage of air into the lungs, allowing for proper oxygenation. To assess the airway, check for signs of obstruction, such as foreign bodies, vomit, or blood, and ensure that the patient's head and neck are properly aligned to maintain an open airway.

B) **Breathing:** After confirming the airway is clear, the next step is to assess the patient's breathing. Check for the presence of breathing and observe its rate and pattern. Normal breathing should be regular and comfortable. Signs of compromised breathing include rapid, shallow breathing, gasping, or abnormal sounds like wheezing or gurgling.

C) **Circulation:** Once the airway and breathing are assessed, the focus shifts to the patient's circulation. The primary goal is to check for the presence of a pulse. A pulse indicates that the heart is beating and circulating blood throughout the body. Additionally, observe the patient's skin color, temperature, and capillary refill time, as they can provide essential clues about circulation and perfusion.

The ABC assessment is a rapid evaluation, and each step should take no more than a few seconds. If any life-threatening issues are identified during the assessment, immediate interventions should be initiated, and emergency medical services should be summoned.

In emergency situations, medical professionals follow the ABC assessment with further evaluation and treatment based on the patient's condition. For example, in cases of cardiac arrest, cardiopulmonary resuscitation (CPR) may be initiated to maintain circulation and oxygenation until advanced medical support is available.

However, it's essential to remember that the ABC assessment is just the initial step in a comprehensive medical evaluation. Once the patient's ABCs are stabilized, a more thorough assessment, diagnosis, and appropriate treatment should follow.

2) Cardiopulmonary Resuscitation (CPR) and Basic Life Support (BLS)

Cardiopulmonary Resuscitation (CPR) is a life-saving emergency procedure performed on individuals who are experiencing cardiac arrest or are not breathing adequately. The goal of CPR is to maintain blood flow and oxygenation to vital organs until advanced medical help can be provided.

CPR typically involves a combination of chest compressions and rescue breaths to support the heart and lungs. It can be administered by trained professionals, such as healthcare providers, or by bystanders who have learned CPR techniques.

The CPR process generally follows these steps:

A) **Assess the Scene:** Before starting CPR, ensure the area is safe for both the victim and the rescuer. Look for any potential hazards and ensure that there are no immediate dangers.

B) **Check for Responsiveness:** Tap the victim and shout loudly to check for any response. If there is no response, call for help immediately. If someone else is available, ask them to call emergency services while you begin CPR.

C) **Open the Airway:** Tilt victim's head back gently and lift the chin to open the airway (Figure 1). Look, listen, and feel for normal breathing. If the victim is not breathing or is only gasping, proceed with CPR.

D) **Chest Compressions:** Place the heel of one hand on the center of the victim's chest, just below the nipple line. Place the other hand on top of the first hand, interlocking the fingers. Position yourself with your shoulders directly above your hands. Keep your arms straight, and use your full body weight to compress the chest downward at least 2 inches (5 centimeters) deep and at a rate of about 100-120 compressions per minute. Allow the chest to fully recoil between compressions.

E) **Rescue Breaths** (if trained and comfortable to do so): After every 30 compressions, provide two rescue breaths. Ensure the airway is open, pinch the victim's nose shut, and cover their mouth with yours, creating an airtight seal. Give two slow breaths, each lasting about one second, watching for the chest to rise with each breath.

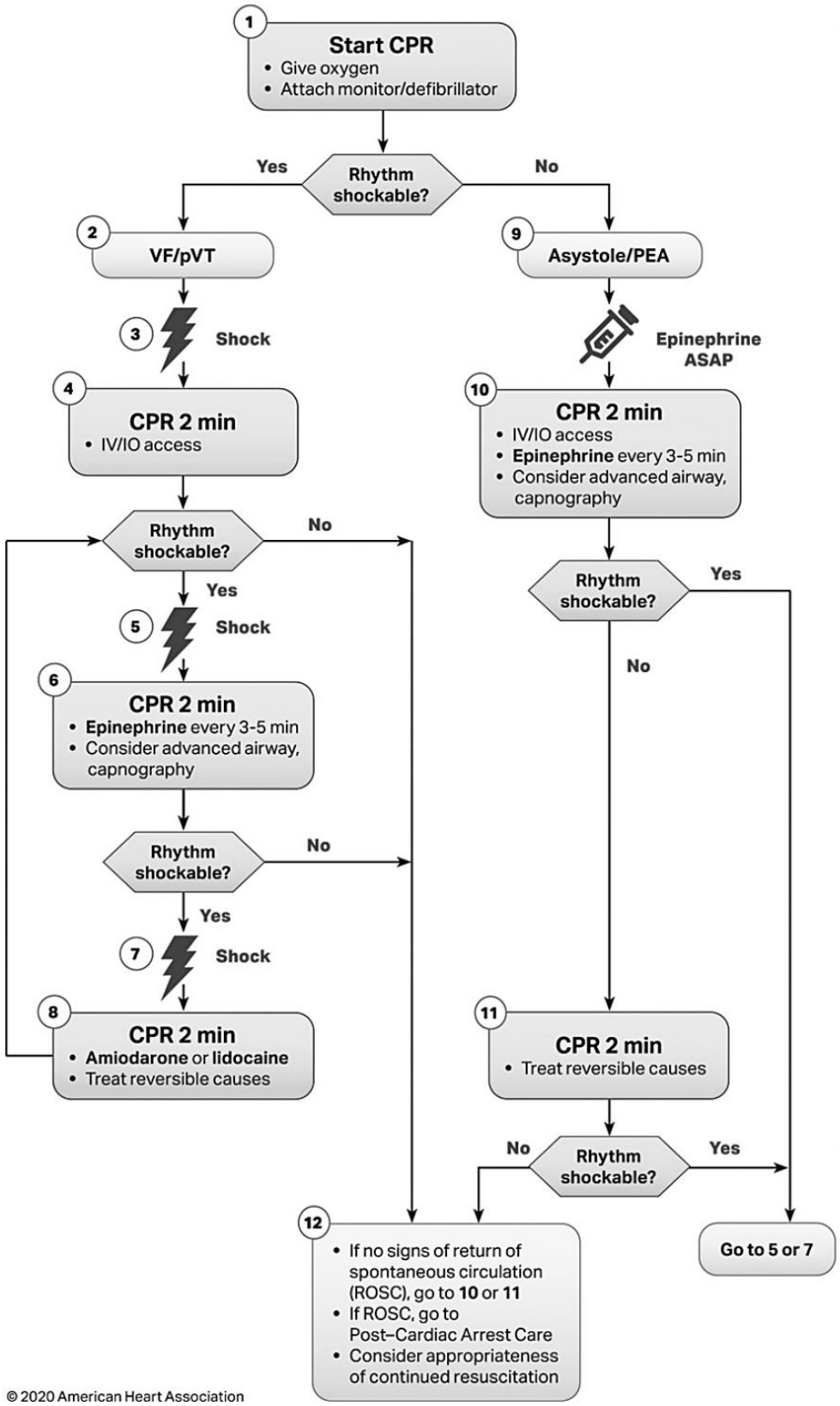
F) **Continue CPR:** Alternate between 30 chest compressions and two rescue breaths until emergency medical help arrives, an automated external defibrillator (AED) becomes available, the victim shows signs of life, or you are too exhausted to continue.

It's important to remember that CPR is an emergency intervention and should only be performed on unconscious individuals who are not breathing or only gasping. If you are not trained in CPR, perform hands-only CPR (chest compressions without rescue breaths) until professional help arrives.

CPR can significantly increase the chances of survival for a person experiencing cardiac arrest, but it is essential to seek advanced medical care as soon as possible for the best possible outcome. Therefore, always call for emergency medical services immediately when encountering a situation that requires CPR.

CPR and emergency cardiovascular care (ECC) should be considered any time an individual cannot adequately oxygenate or perfuse vital organs- not only following cardiac or respiratory arrest. 2020 American Heart Association (AHA) Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care provides revised recommendations for establishing and maintaining the **CABDs** of cardiopulmonary resuscitation: **Circulation, Airway, Breathing**, and **Defibrillation**.

Adult Cardiac Arrest Algorithm



CPR Quality

- Push hard (at least 2 inches [5 cm]) and fast (100-120/min) and allow complete chest recoil.
- Minimize interruptions in compressions.
- Avoid excessive ventilation.
- Change compressor every 2 minutes, or sooner if fatigued.
- If no advanced airway, 30:2 compression-ventilation ratio.
- Quantitative waveform capnography
  - If $PETCO_2$ is low or decreasing, reassess CPR quality.

Shock Energy for Defibrillation

- **Biphasic**: Manufacturer recommendation (eg, initial dose of 120-200 J); if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered.
- **Monophasic**: 360 J

Drug Therapy

- **Epinephrine IV/IO dose:** 1 mg every 3-5 minutes
- **Amiodarone IV/IO dose:** First dose: 300 mg bolus. Second dose: 150 mg.
  or
  Lidocaine IV/IO dose: First dose: 1-1.5 mg/kg. Second dose: 0.5-0.75 mg/kg.

Advanced Airway

- Endotracheal intubation or supraglottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ET tube placement
- Once advanced airway in place, give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions

Return of Spontaneous Circulation (ROSC)

- Pulse and blood pressure
- Abrupt sustained increase in $PETCO_2$ (typically ≥40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

Reversible Causes

- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

3) Foreign Body Removal from the Airway

Any vomitus or foreign body visible in the mouth of an unconscious patient must be removed. If the patient is conscious or if the foreign body cannot be removed by a finger sweep, the **Heimlich maneuver** (Figure 2) is recommended. This subdiaphragmatic abdominal thrust elevates the diaphragm, expelling a blast of air from the lungs that displaces the foreign body. Complications of the Heimlich maneuver include rib fracture, trauma to internal viscera, and regurgitation with aspiration. A combination of back blows and chest thrusts is recommended to clear foreign body obstruction in infants.

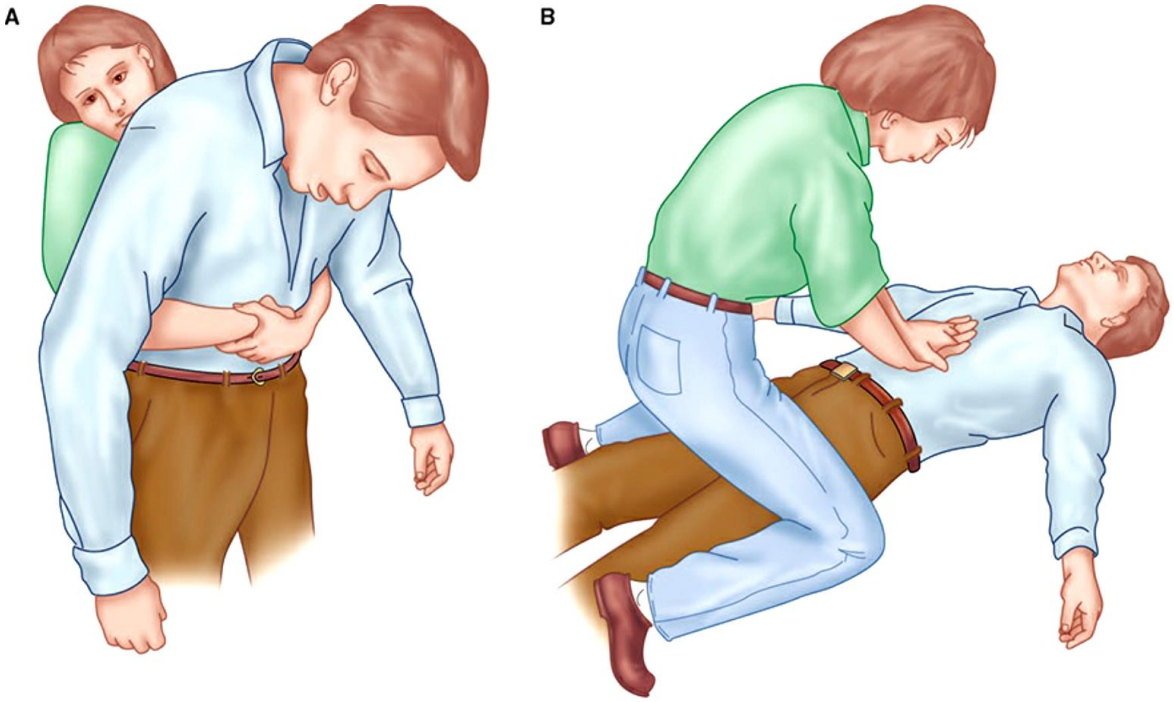


Figure 2: The Heimlich maneuver can be performed with the victim standing (A) or lying down (B). The hands are positioned slightly above the navel and well below the xiphoid process and then pressed into the abdomen with a quick upward thrust. The maneuver may need to be repeated.

4) Foreign Body Airway Obstruction (Choking)

Some causes of airway obstruction may not be relieved by conventional methods. Furthermore, endotracheal intubation may be technically impossible to perform in certain circumstances (e.g., severe facial trauma), or repeated attempts may be unwise (e.g., cervical spine trauma). Cricothyrotomy or tracheotomy may be necessary in such situations. Cricothyrotomy involves placing a large intravenous catheter or a commercially available cannula into the trachea through the midline of the cricothyroid membrane (Figure 3). Proper location is confirmed by aspiration of air.

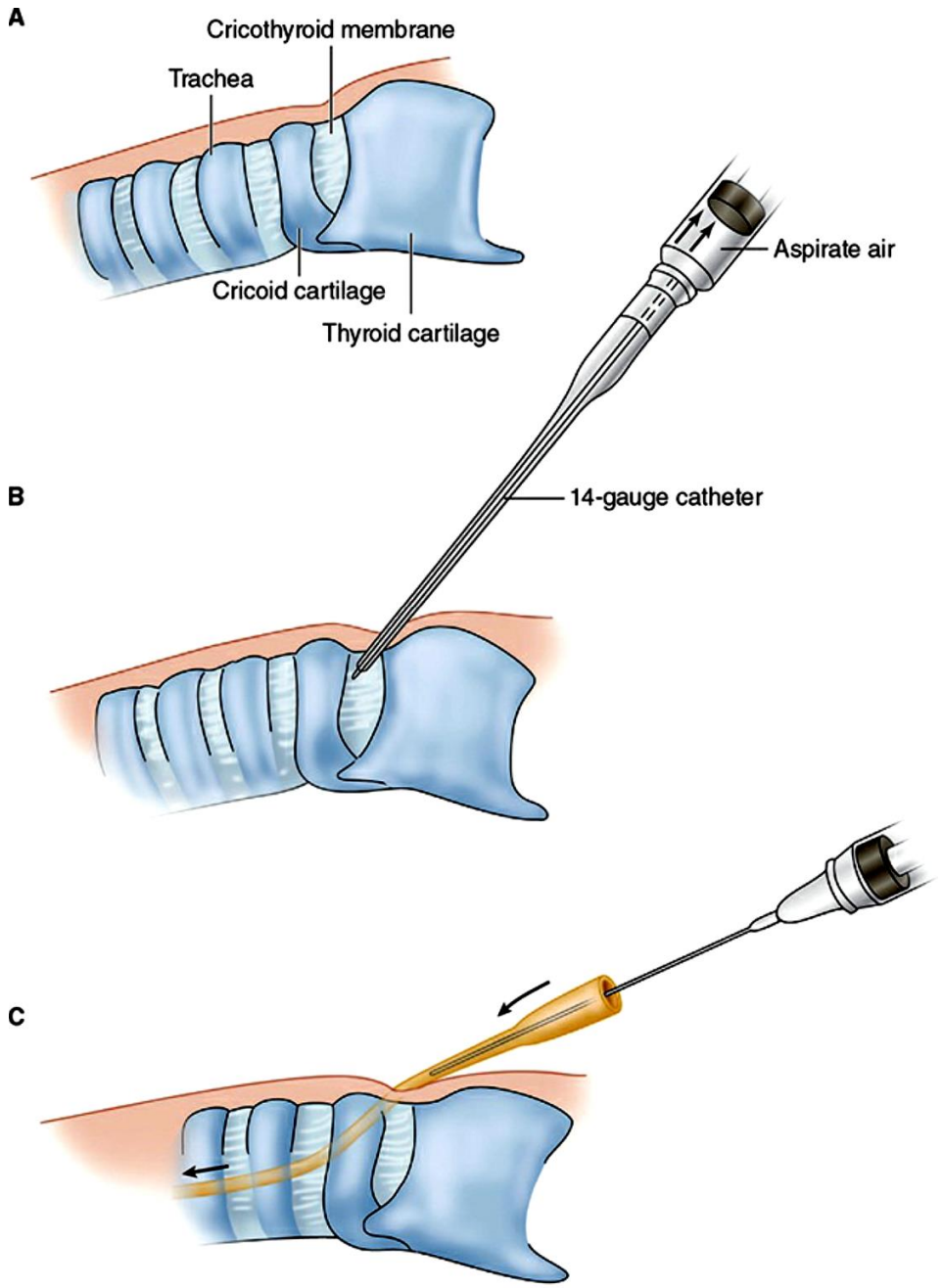


Figure 3: Percutaneous cricothyrotomy with a 14-gauge over-the-needle intravenous catheter. A: Locate the cricothyroid membrane. B: Puncture the membrane at the midline while stabilizing the trachea with the other hand.

5) Bleeding Control

Bleeding control is a critical skill that can save lives in emergencies. The primary measures for bleeding control are commonly referred again to the "ABCs" of first aid: Airway, Breathing, and Circulation. Here's a step-by-step guide on how to manage bleeding:

A) **Assess the Situation:** Ensure your safety and the safety of others before approaching the injured person. Survey the scene for any potential hazards.

B) **Call for Help:** Dial emergency services (e.g., 999) or ask someone nearby to do it for you, especially if the bleeding is severe.

C) **Protect Yourself:** If available, put on disposable gloves or use a barrier like a clean cloth to protect yourself from bodily fluids and potential infections.

D) **Position the Injured Person:** Help the injured person lie down flat on their back unless there is suspicion of a spinal injury. In that case, avoid moving their head and neck.

E) **Elevate the Injured Area:** If possible, raise the injured limb above the level of the heart. This can help reduce blood flow to the injured area and minimize bleeding.

F) **Apply Pressure:** Use clean cloth, sterile dressing, or your gloved hand to apply direct pressure on the wound. Maintain continuous pressure for at least 5 – 10 minutes to promote clotting.

G) **Add More Dressings if Needed:** If the bleeding continues, do not remove the initial dressing. Instead, add more dressing on top and continue applying pressure.

H) **Tourniquet as a Last Resort:** Tourniquets should only be used as a last resort when direct pressure and other measures have failed. Apply a tourniquet 2-3 inches above the bleeding wound. Make sure it's tight enough to stop the bleeding but not excessively tight. Note the time the tourniquet was applied.

I) **Comfort and Reassure:** Offer emotional support and reassurance to the injured person to help keep them calm.

Remember that these measures are meant to control bleeding temporarily until professional medical help arrives. If possible, have someone else take over first aid so you can provide updates and

additional information to the emergency services when they arrive. Always stay with the injured person until help arrives.

Key Points

Acute emergency health care service is both challenging and rewarding. As medical students, you have the opportunity to make a significant impact on patients' lives during their most critical moments. Your dedication to acute emergency care will help shape you into competent and compassionate healthcare professionals, ready to serve Bangladesh and its people.

- Stay committed to learning.
- Practice your skills.
- Approach every emergency with confidence and empathy.
- Every second counts in an emergency – be prepared!

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