

SECTION

5

# MEDICAL DIAGNOSTIC DEVICES



# BIOMEDICAL INTERVENTION

## Diagnostic Devices

### INTRODUCTION

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In this section, you will be introduced to the fundamental concepts of biomedical interventions. Specifically, you will define medical interventions in relation to the key domains of diagnosis, therapy, and prevention, as well as explore the significance of such interventions. Additionally, you will investigate medical interventions employed for the therapy and prophylaxis of diseases and disorders. You will also draw comparisons between primitive medical interventions and modern techniques. Furthermore, you will elucidate the importance of these interventions, the challenges associated with them, and the application of both traditional and contemporary methods within the healthcare delivery system in Ghana. You will conclude the section by analysing common diagnostic devices and examining their respective functions.

#### At the end of this section, you will be able to:

- Define medical intervention in relation to diagnosis, therapy and prevention.
- Compare and contrast primitive diagnostic and medical interventions and modern diagnostic devices.
- Explore the significance of the various diagnostic devices used for medical intervention.

#### Key Ideas

- Medical interventions are diverse actions and procedures used by healthcare providers to prevent, diagnose, and treat health conditions.
- Diagnostic interventions include physical examinations, laboratory tests, and imaging to identify the cause of a patient's medical condition.
- The goal of medical interventions is to promote health, alleviate suffering, improve quality of life, and/or prolong life expectancy. They are typically guided by evidence-based practices and tailored to meet the specific needs of each patient.
- Primitive diagnostic medical interventions were heavily relying on using your own senses and personal opinions to make judgments, rather than using precise tools or following standard procedures and scientific methods.
- The lack of comprehensive understanding of human anatomy and physiology in early societies hindered the ability to accurately diagnose and devise effective treatments for medical conditions.
- Modern diagnostic devices utilise scientific principles, advanced medical knowledge and technology.

- Medical interventions are crucial for accurate diagnosis, effective treatment, disease management, and preventive care that improves health outcomes.

## DEFINITION OF MEDICAL INTERVENTION IN RELATION TO DIAGNOSIS, THERAPY AND PREVENTION

Figuring out what is wrong with someone's health is the first step for healthcare professionals to be able to treat them properly. That is why healthcare professionals use all kinds of special tests and tools to examine patients and gather information about their medical condition. Here, you will explore the concepts of medical intervention for diagnosis, therapy, and prevention as well as examples of these medical interventions and their importance.



### What is medical intervention? Why is it relevant?

**Medical intervention** can be defined as *any action, procedure, or treatment performed by healthcare professionals to prevent, diagnose, treat, or manage health conditions or diseases in individuals. Medical interventions include a wide range of activities, such as vaccinations, lifestyle modifications, complex surgical procedures, and medications.*

The goal is to promote health, alleviate suffering, improve quality of life, and/or prolong life expectancy.

**Medical intervention for diagnosis:** This can be defined as *the various procedures, tests, and techniques used by healthcare professionals to identify and determine the cause of a patient's medical condition.*

**Medical intervention for therapy:** This can be defined as *treatments and procedures that healthcare professionals use to manage, alleviate symptoms, promote healing, and improve the overall well-being of individuals with medical conditions.*

**Medical intervention for prevention:** This can be defined as *measures taken by healthcare professionals to minimise the risk of developing certain diseases, injuries, or health conditions.*

## Some examples of medical interventions or diagnosis, therapy and prevention

**Diagnosis:** *The examples below indicate various techniques and procedures employed by healthcare professionals to be able to diagnose a patient's medical condition.*

1. **Physical Examination:** This is a thorough evaluation of a patient's body to assess their overall health and identify any visible abnormalities or symptoms. This includes checking vital signs like temperature, blood pressure, heart rate, and respiratory rate.
2. **Medical History:** This involves gathering detailed information about a patient's past and current medical conditions, their family's medical history, and the lifestyle factors that may be contributing to their health issues.

3. **Laboratory Tests:** Healthcare professionals analyse samples of a patient's blood, urine, or other bodily fluids to measure specific markers, detect infections, assess organ function, and identify any abnormalities. This test is mostly done by medical laboratory scientists.
4. **Imaging Studies:** Here, advanced techniques like X-rays, computed tomography (CT) scans, magnetic resonance imaging (MRI) scans, ultrasounds, and positron emission tomography (PET) scans are used to obtain detailed images of the patient's internal structures which aid in diagnosing various medical conditions. Taking medical images is done by radiologists or sonographers.
5. **Genetic Testing:** Healthcare professionals examine a patient's DNA to identify any genetic mutations or variations that may be causing or contributing to certain diseases or health problems.

**Therapy:** *Below are some treatment procedures used by healthcare personnel to treat a patient's condition*

1. **Medication:** Doctors prescribe pharmaceutical drugs to treat various medical conditions. This includes antibiotics for infections, pain relievers (analgesics) for pain management, and blood pressure medications (antihypertensives) for hypertension.
2. **Physical Therapy:** Therapists use exercises, stretches, and other physical modalities to help patients improve their mobility, strength, and flexibility after sustaining injuries or undergoing surgical procedures.
3. **Psychotherapy:** Mental health professionals provide talk therapy or counselling to address issues like depression, anxiety, and trauma.
4. **Radiation Therapy:** Radiotherapists use high-energy radiation to target and destroy cancer cells in specific areas of the patient's body.
5. **Chemotherapy:** Chemotherapists administer drugs that kill cancer cells or inhibit their growth throughout the patient's body.
6. **Occupational Therapy:** Therapists help patients regain independence and functionality in their daily activities after illness or injury.
7. **Speech Therapy:** This involves assisting individuals with speech and language disorders to improve their communication skills.
8. **Immunotherapy:** Treatments that boost the body's immune response to target and fight against cancer cells.

**Prevention:** *Explore the examples below to abreast yourself with measures that healthcare personnel use to reduce the risk of getting infections*

1. **Vaccination:** Healthcare professionals administer vaccines to stimulate the body's immune system and protect individuals against infectious diseases, such as influenza, measles, mumps, and rubella.
2. **Screening Tests:** Regular health screenings help to detect diseases or risk factors early. Examples are mammograms for breast cancer, colonoscopies for colorectal cancer, and blood pressure checks for hypertension.
3. **Lifestyle Counselling:** Healthcare professionals provide advice and support to help individuals adopt healthier behaviours, including smoking cessation, healthy diet planning, and regular exercise.

4. **Genetic Counselling:** Professionals offer information and guidance about the risk of inheriting certain genetic conditions and the available options for prevention or early detection.
5. **Environmental Interventions:** Measures are implemented to reduce exposure to environmental hazards that may cause health problems, such as air pollution controls or lead abatement.
6. **Injury Prevention Programs:** Initiatives designed to prevent injuries. They include car seat safety education, fall prevention measures for the elderly, and workplace safety programs.
7. **Health Education and Awareness Campaigns:** Public awareness about various health issues is promoted, and individuals are educated on preventive measures and early warning signs.



Did you know that *Ghanaian-American physician Dr. Kwabena Ofori-Acquah is a pioneer in the field of sickle cell disease research and treatment, having developed innovative techniques to improve the diagnosis and management of this genetic disorder, which disproportionately affects people of African descent?*

## The Importance of Employing Various Medical Interventions

Medical interventions, including diagnosis, disease treatment and management, and preventive care, are essential for promoting positive health outcomes and improving the overall well-being of individuals.

*Below are some of the importance of each medical intervention such as diagnosis, therapy and prevention*

### 1. Diagnosis

- a. **Effective treatment:** Getting an accurate diagnosis is key for effective treatment. Without a clear understanding of a patient's condition, it is difficult to provide proper care.
- b. **Early Detection:** Diagnosing diseases early can lead to better treatment outcomes.
- c. **Disease Management:** Knowing the exact condition allows healthcare providers to create tailored treatment plans and provide necessary education and support to patients.

### 2. Therapy

- a. **Disease Management:** Therapeutic interventions are crucial for managing chronic conditions, controlling symptoms, and preventing the worsening of diseases.
- b. **Pain Relief:** Many therapies aim to reduce pain and improve the quality of life for patients.
- c. **Preventing Complications:** Early and effective therapy can prevent complications associated with certain medical conditions, reducing the risk of severe outcomes.
- d. **Restoring Function:** Therapies like physical and occupational therapy can help



patients regain lost abilities and independence.

- e. **Psychological Support:** Psychotherapy and counselling provide emotional support and guidance, promoting mental well-being.
- f. **Prolonging Life:** Some medical interventions, such as cancer treatments, can extend a patient's life expectancy and improve survival rates.

### 3. Prevention

- a. **Reduced Disease Burden:** Preventive measures can lower the overall burden of diseases on individuals, families, and communities, leading to better health.
- b. **Cost-Effectiveness:** Prevention is often more cost-effective than treating advanced diseases, as it reduces the need for expensive medical care and hospitalizations.
- c. **Improved Quality of Life:** Preventing diseases and injuries helps people maintain better physical and mental well-being, leading to a higher quality of life.
- d. **Longer Lifespan:** Preventive measures can contribute to increased life expectancy and healthy aging.
- e. **Public Health Impact:** Widespread preventive interventions can improve population health and control infectious disease outbreaks.
- f. **Health Equity:** Targeted preventive measures can address health disparities and ensure everyone has access to essential preventive services.
- g. **Empowerment:** Medical interventions for prevention empower individuals to take control of their health and make informed decisions about their well-being.

Well done! It is now time to explore some activities. Go have fun as you learn. Remember to make some notes for reference.

#### Activity 5.1: Moment of Reflection

1. Do you remember any moment that you were sick? What happened when you were sick?
2. Share with a colleague or relative what you went through and how you recovered.
3. How were you diagnosed? What therapy was given? What preventive measures have you put in place to reduce the risk of getting it again?

#### Activity 5.2: Essence of medical intervention for diagnosis

Click [here](#) to watch a video on some diagnostic tests. From the video, which diagnostic tests have you done before? Why do healthcare professionals request diagnostic tests? If you are a healthcare personnel, which diagnostic test would you recommend? Share your suggestions with someone

### Activity 5.3: Online search

Use any available medium to surf the internet to search for examples of medical interventions for diagnosis, therapy and prevention relating to

- a. the diseases and disorders studied in section 4.
- b. different aspects of medicine such as cardiology, oncology

### Activity 5.4: Public education

Develop a short PSA (public service announcement) promoting the importance of a specific preventive medical intervention (e.g., vaccination, regular check-ups) for any current or trending disease.

1. Present this to your class, and friends in your church, community or mosque.
2. Consider a wider audience (e.g., school announcements).
3. Use online search where necessary.

### Activity 5.5: Healthcare Professionals examining a patient



**A**

**Fig.5.1 A**



**B**

**Fig.5.1B**

Consider Figure 5.1 A and B.

1. Critically observe the different tools and techniques the health professionals might be using in both pictures to understand each patient's condition.
2. Share your observations with colleagues, relatives or friends. Include the importance of techniques employed in each figure.

### Activity 5.6: Case Study

Emma, a 35-year-old elementary school teacher, has been experiencing persistent coughing, fever, and difficulty breathing for the past week. She visited her primary care physician, who suspects she may have contracted pneumonia.

1. Brainstorm different medical interventions that might be used for diagnosis, treatment, and preventing the spread of the illness. Use the guidelines below:

For Diagnostic Interventions, consider:

- a. Medical tests or examinations the doctor might order to confirm the diagnosis of pneumonia?
- b. How could these interventions help provide an accurate and timely diagnosis?

For Treatment Interventions, consider:

- a. Types of medical treatments might be prescribed to manage Emma's pneumonia.
- b. How could these interventions help alleviate her symptoms and promote recovery?

For Preventive Interventions, consider:

- a. Measures that could be taken to prevent the further spread of pneumonia, both for Emma and her community
- b. How might these interventions contribute to better public health outcomes?

### Self-reflection

1. How well do you feel you understand the latest advancements and best practices in utilising medical interventions to improve patient outcomes?
2. Are there any gaps in your knowledge that you would like to address further? Feel free to explore further.

## COMPARING AND CONTRASTING PRIMITIVE DIAGNOSTIC MEDICAL INTERVENTIONS AND MODERN DIAGNOSTIC DEVICES

In this lesson, you will be introduced to the concepts of primitive and modern medical interventions for diagnosis. You will examine the transition from primitive to modern medical diagnostic interventions including the challenges encountered in the primitive diagnostic medical interventions. You will also explore the differences and similarities



between these two interventions. Prepare to be amazed as we examine the evolution that has reshaped the foundations of diagnosis and treatment.

## The Primitive Diagnostic Medical Intervention and the Challenges Encountered

*Primitive diagnostic medical interventions refer to the early methods and techniques used by early human societies to diagnose medical conditions and ailments.* These interventions are often based on observations, traditional knowledge, and rudimentary tools (basic and simple tools).

Below are some traditional diagnostic interventions used in Ghana, especially in rural or underserved areas, include:

1. **Observation and History Taking:** Traditional health attendants often rely on careful observation and detailed patient histories to identify symptoms and patterns indicative of specific illnesses. This method is still widely used, especially in communities where access to medical facilities and technology is limited.
2. **Physical Examination:** Traditional health providers conduct physical examinations to assess patients' overall health and identify physical signs of illness or disease. This may involve percussion (tapping the surface of a body part to learn the condition of the parts beneath by the resultant sound), and auscultation (listening to heart rate and respiratory rate) to detect abnormalities in different body systems.
3. **Herbal Medicine and Traditional Healing:** Traditional healers in Ghana often use herbal remedies, spiritual rituals, and traditional diagnostic methods based on cultural beliefs and practices. These may include divination, consultations with ancestors or spirits, and the use of plants, herbs, and other natural substances for diagnosis and treatment.
4. **Pulse Diagnosis:** Traditional healers may assess the pulse to gather information about the patient's health status and diagnose underlying conditions. Different pulse qualities, rhythms, and characteristics are believed to correspond to specific organs and imbalances in the body.
5. **Palpation and Inspection:** Traditional healers also rely on palpation and inspection techniques to examine specific areas of the body, such as the abdomen, to identify tenderness, swelling, or other abnormalities.

It is worth noting that while traditional diagnostic methods may have been prevalent in the past, they continue to play a significant role in healthcare delivery, especially in rural and remote areas where access to modern healthcare services is limited.

### Challenges of primitive diagnostic medical intervention

The primitive diagnostic medical intervention laid the foundation for modern medicine. However, they have also encountered significant challenges due to their limited understanding of anatomy, physiology, disorders and diseases.

*Below are some of the key challenges of the early diagnostic medical interventions:*

1. **Observation and empirical knowledge:** Early diagnostic methods relied mainly on observation of physical signs and symptoms, with physicians gathering information through visual examination, palpation, and patient questioning. While this subjective approach could sometimes lead to accurate diagnoses, it was also prone to errors due to a lack of standardized techniques. Additionally, primitive medical practices were often passed down orally without adequate documentation, making it difficult to refine diagnostic methods or share knowledge across generations and cultures.
2. **Herbal remedies and traditional healing:** Many ancient civilizations used herbal remedies and traditional healing practices to diagnose and treat illnesses. Healers would rely on their knowledge of medicinal plants and their properties to alleviate symptoms and restore health. While some herbal remedies did have medicinal value, many were based on folklore and superstitions, leading to inconsistent and unpredictable outcomes.
3. **Astrology and superstitions:** In some ancient cultures, diagnoses were influenced by beliefs in astrology and superstitions. The alignment of celestial bodies or other supernatural factors were often seen as indicative of a person's health and illness. This approach lacked scientific validity and could lead to misdiagnosis and inappropriate treatments. The reliance on astrology, religious beliefs, and superstitions in medical diagnosis resulted in unfounded conclusions and irrational treatments, hindering the development of more accurate diagnostic methods. These practices delayed the development of evidence-based medicine and hindered scientific progress.
4. **Limited understanding of anatomy and physiology:** Due to their limited understanding of human anatomy and physiology, early healers and physicians struggled to accurately diagnose and treat medical conditions. This lack of knowledge hindered their ability to identify the root causes of illnesses and devise effective treatments.
5. **Ineffective treatments:** Many early diagnostic methods were based on inaccurate theories, lacked scientific evidence. As a result, the treatments were often ineffective and even harmful, leading to patient suffering and loss of life. Different cultural medical beliefs and practices resulted in contradictory diagnostic approaches, making it difficult to establish an effective, unified medical system. For example, bloodletting was a common ancient medical intervention based on the humoral theory - the belief that illnesses were caused by imbalances in bodily fluids. However, this practice frequently caused severe complications and did more harm than good.

## The Modern Diagnostic Medical Intervention and the Steps Taken to Advance the Primitive Interventions

Diagnostic medical interventions have evolved significantly from the primitive methods used in ancient times. There have been advancements in medical science, technology, and research leading to more accurate, reliable, and evidence-based diagnostic techniques. *Modern diagnostic medical interventions refer to the advanced techniques and technologies*

*used by healthcare professionals to identify and understand a patient's medical condition or illness.*

Some key aspects of modern diagnostic medical interventions and the steps taken to progress from the primitive methods are given below.

1. **Scientific method and evidence-based medicine:** One of the major advancements in modern medicine is the adoption of the scientific method. Doctors and medical professionals now base their decisions on empirical evidence, clinical trials, and rigorous research, rather than relying on superstitions or traditions. This evidence-based approach helps ensure accurate and effective diagnostic techniques.
2. **Anatomy and physiology:** Our knowledge of human anatomy and physiology has grown tremendously over time. The detailed understanding of the body's organs, systems, and functions provides a strong foundation for making accurate diagnoses. This knowledge allows medical professionals to better identify the underlying causes of illnesses and develop targeted treatment plans.
3. **Laboratory Tests:** Developments in laboratory technology have revolutionized diagnostic medicine. Advanced blood tests, genetic tests, and other biomarker analyses can now identify specific diseases, assess organ function, and detect abnormalities at the cellular level. These sophisticated tests aid in diagnosing a wide range of conditions and tracking the progress of treatments.
4. **Telemedicine and Remote Diagnostics:** The advancement of technology has made telemedicine a valuable tool for diagnostic support. Patients in remote or underserved areas can now receive expert consultations and diagnostic evaluations through telemedicine platforms like video calls, improving access to healthcare.
5. **Continuous Professional Development:** Modern healthcare professionals undergo extensive education and training to stay up-to-date with the latest diagnostic techniques and medical advancements. This continuous learning helps improve their diagnostic skills and ensures patients receive the highest quality of care.

## Similarities and Differences Between Primitive and Modern Modes of Medical Diagnosis

The history of medical diagnosis is a captivating tale of transformation - from primitive, belief-driven practices to cutting-edge, scientifically grounded methods. Exploring the similarities and differences between past and present diagnostic approaches unveils a fascinating story of human ingenuity, technological innovation, and the relentless pursuit of medical excellence.

### The similarities between primitive and modern modes of medical diagnosis

1. **Observational approach:** Both primitive and modern diagnostic methods rely on observing patients' physical signs and symptoms. Healthcare providers in both eras gather information through visual examination, physical touch (palpation), and patient questioning.

2. **Need for patient history:** both primitive and modern diagnostic approaches require obtaining a patient's medical history. Understanding a patient's past medical issues, family history, and lifestyle factors can provide valuable insights for diagnosis.
3. **Diagnostic reasoning:** the process of diagnosing medical conditions involves reasoning based on available information. In both primitive and modern settings, healthcare providers use their knowledge and experience to analyse the symptoms and make an educated diagnosis.
4. **Limitations and challenges:** Both diagnostic approaches face inherent limitations. Past methods were constrained by limited knowledge and rudimentary tools, while today's challenges stem from complex diseases and varied patient presentations.

## The differences between primitive and modern modes of medical diagnosis

1. **Scientific basis:** The key distinction is that modern diagnosis is grounded in scientific evidence, whereas primitive methods rely on traditional beliefs and folklore.
2. **Technological advancements:** Whereas primitive diagnosis relied on rudimentary techniques like herbal remedies and observation, modern methods employ advanced technologies - medical imaging such as X-ray, MRI and CT scans, laboratory tests, molecular diagnostics, and sophisticated instruments - providing greater precision and enabling early, targeted detection of diseases and genetic abnormalities.
3. **Specialisation and expertise:** Modern medicine has led to specialisation, where healthcare professionals focus on specific areas of medicine, such as cardiology, oncology, neurology, etc. This specialisation allows for more in-depth knowledge and improved diagnostic accuracy in specific medical domains, which was not prevalent in primitive times.
4. **Global Collaboration and Knowledge Sharing:** Primitive diagnostic methods were limited by localized, isolated practices while modern approaches benefit immensely from global collaboration. The global exchange of knowledge and collaboration among researchers, clinicians, and medical professionals worldwide leads to faster progress and better patient care.
5. **Documentation and Standardization:** Modern medicine emphasises documentation, record-keeping and Modern medicine emphasizes standardized documentation and procedures, ensuring consistent diagnosis and treatment across healthcare settings - a key advantage over the lack of standardization in primitive practices. Hence, ensuring consistent diagnosis and treatment across healthcare settings. This is a key advantage over the lack of standardization in primitive practices.

Great work done! Prepare to embark on an electrifying journey through the evolution of medical diagnostic practices as you undertake the following activities!

### Activity 5.7: Developments in medical diagnostic devices and interventions

Click [here](#) to watch developments in medical diagnostic devices and interventions from ancient to modern times.

- a. Critically observe each medical diagnostic device.
- b. Make a small note of the relevance of each medical device

### Activity 5.8: Diagnostic Dilemma - from Primitive to Modern

#### Step 1. Primitive Diagnostic Dilemma

Imagine you are a healthcare provider in a remote village, tasked with identifying and treating an unknown ailment. Your resources are limited - you only have access to basic tools like herbal remedies and rudimentary observation techniques.

- a. Take a few minutes to reflect on the key limitations and drawbacks of these primitive diagnostic methods.
- b. Consider how you would approach the challenge of making an accurate diagnosis with such limited resources, and the obstacles you might face in providing effective treatment to your patients.
- c. Make notes on the key challenges you have identified, as you will be revisiting them in the next step.

#### Step 2: Transitioning to Modern Diagnostics

Now, let's explore the remarkable steps that have been taken to transform primitive diagnostics into the sophisticated, precision-driven approaches we have today.

- a. Research and identify at least 3 key innovations or advancements that have enabled this progress.
- b. Consider areas such as technological breakthroughs (e.g., medical imaging, lab tests, molecular diagnostics), collaborative research and clinical trials, and the standardization of diagnostic protocols and knowledge sharing.
- c. Prepare and share your findings with your colleagues, relatives or friends. Let them know how these advancements have revolutionized the field of medical diagnostics.

#### Step 3: Global Collaboration and Knowledge Sharing

Collaboration and knowledge sharing have been crucial in driving the development of modern diagnostic devices.

- a. Use online search to explore how researchers, clinicians, and medical professionals around the world have come together to accelerate progress.
- b. Reflect on how international cooperation and the pooling of resources have impacted the advancement of diagnostic techniques.

- c. Consider the benefits of this global collaboration in terms of patient outcomes and the overall progress of the field.
- d. Provide examples of how insights and innovations can be rapidly shared and adopted globally today.
- e. Share your insights and engage in a thought-provoking discussion with your colleagues or friends.

### Activity 5.9: Similarities and Differences Between Primitive and Modern Medical Diagnosis

1. Refer to the video in **activity 5.7** and together with this [video](#),
2. Create a flowchart on the various stages in the advancement of diagnostic devices from ancient to modern times
3. Create a table on the similarities and differences between primitive and modern modes of medical diagnosis.

### Activity 5.10: Observe the use of Pulse Oximeter

1. Click [here](#) to watch a video on how to use a pulse oximeter and [here](#) to watch on how to use an aneroid sphygmomanometer
2. Note down the techniques involved in using each device.

### Self-Reflection

1. Take a step back and reflect on the challenges of primitive diagnostics and the remarkable strides made in modern medical practices.
2. Consider how you can appreciate both the local, traditional knowledge and the foreign, cutting-edge technologies that have converged to transform the way we approach healthcare.

## EXPLORING THE SIGNIFICANCE OF THE VARIOUS DIAGNOSTIC DEVICES USED FOR MEDICAL INTERVENTION

Now that we have explored medical interventions for diagnosis, therapy and prevention, and compared primitive and modern diagnostic interventions, it is time to examine the significance of various medical devices. In this lesson, you will examine various medical diagnostic devices and their functions. These technologies have revolutionised modern



healthcare by providing unprecedented clinical insights. Yet, proper maintenance and troubleshooting are crucial to ensuring these devices deliver the reliable data needed for accurate diagnoses and effective treatment. Hence, you will conclude with troubleshooting techniques.

## List the Various Diagnostic Devices and their Functions

In the fast-paced world of modern healthcare, the ability to quickly and accurately diagnose medical conditions is paramount. Diagnostic devices play a crucial role in medical practice by helping healthcare professionals assess and diagnose various conditions and diseases with ease. Let us explore some of them.

### Here is a list of some common diagnostic devices and their functions:

- 1. Thermometer:** Measures temperature of the body, helping to identify fever or hypothermia.



Fig. 5.2: Thermometer

- 2. Blood Pressure Monitor:** Measures blood pressure to assess cardiovascular health and identify hypertension or hypotension. It gives the systolic and diastolic blood pressures and the heart rate or pulse. These monitors can be digital (Fig 5.3a) or analogue (Fig 5.3b)



Fig. 5.3a: Digital blood pressure monitor



Fig. 5.3b: Sphygmomanometer

- 3. Stethoscope:** Allows doctors to listen to internal sounds such as heartbeats, lung sounds, and bowel sounds to detect abnormalities. For example, assessing breath sounds (such as crackles, wheezes, or diminished breath sounds) may indicate respiratory conditions such as pneumonia, asthma, chronic obstructive pulmonary disease (COPD), or pulmonary oedema. An example is shown in Fig. 5.4



**Fig 5.4:** *Stethoscope*



**Fig. 5.5:** *Pulse oximeter*

- 4. Pulse oximeter:** Measures the oxygen saturation level in the blood. It gives real-time measurements of oxygen saturation and pulse rate. It helps assess respiratory function and detect *hypoxemia* (i.e., when oxygen levels in the blood are lower than normal) by aiding in the assessment, monitoring, and management of various respiratory and cardiac conditions. (See fig 5.5)
- 5. Glucometer or blood glucose meter:** Measures blood glucose levels in patients with diabetes. (See fig.5.6)



**Fig. 5.6:** Blood Glucose Meter



**Fig. 5.7:** Otoscope

- 6. Otoscope:** for examination of the ear canal and eardrum, aiding in diagnosing ear infections and other ear-related conditions. (See Fig. 5.7)
- 7. Ophthalmoscope:** for the examination of the interior of the eye, aiding in the diagnosis of eye disorders and diseases. (See Fig. 5.8)



**Fig. 5.8:** Ophthalmoscope

**8. Endoscope:** a flexible tube with a camera and light source, used to visualise internal organs and structures for diagnostic and surgical purposes. See Fig. 5.9. It is inserted through one of the body's natural openings, such as the mouth, urethra, or anus for diagnostic purposes.



**Fig. 5.9:** Endoscope

**9. Electrocardiogram (ECG or EKG) and Echocardiogram:** ECG (See fig.5.10) records the electrical activity of the heart, helping to diagnose various cardiac conditions. It helps to show how fast, regular, strong and timed the heartbeats are whereas an echocardiogram uses ultrasound to check for anomalies in the heart's structure.



**Fig. 5.10:** Electrocardiogram (ECG or EKG)



**Fig. 5.11:** Electroencephalogram (EEG)



- 10. **Electroencephalogram (EEG):** records the electrical activity of the brain, assisting in diagnosing epilepsy and other neurological conditions. (See Fig. 5.11)
- 11. **Haematology Analyser:** measures and analyses various components of blood, aiding in the diagnosis of anaemia, infections, and other blood-related disorders. See Fig. 5.12.



Fig. 5.12: Haematology Analyser

- 12. **Rapid Diagnostic Test (RDTs) Kits:** these are devices for rapid and convenient testing for the diagnosis of malaria (Fig. 5.13 (a)), HIV (Fig. 5.13 (b)) and Pregnancy (Fig. 5.13 (c)) which are commonly used in Ghana.

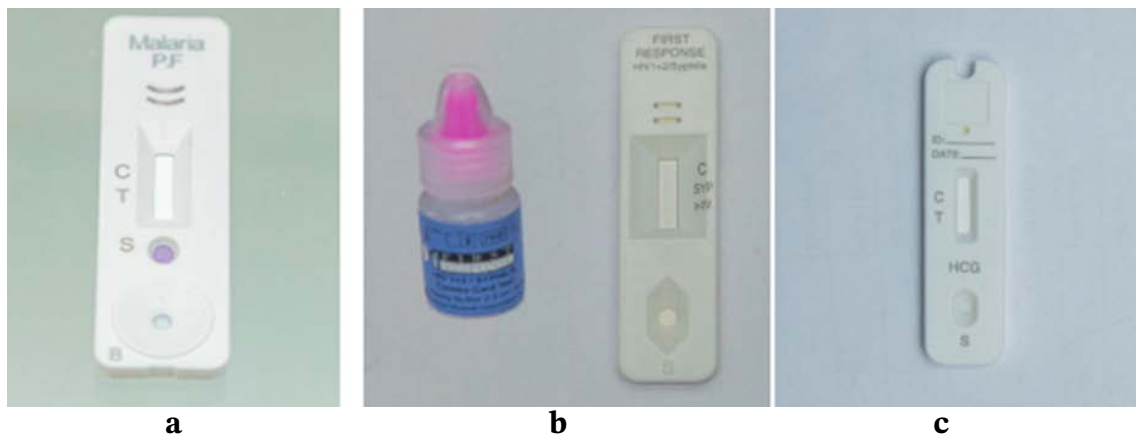


Fig. 5.13 Rapid Diagnostic Tests (RDTs) Kit

- 13. **Urinalysis Strip:** used to test urine for various markers, aiding in diagnosing urinary tract infections and kidney disorders. See Fig. 5.14.



Fig. 5.14: Urinalysis Strip

- 14. Spirometer:** measures lung function and helps diagnose respiratory conditions such as asthma and chronic obstructive pulmonary disease (COPD). See Fig. 5.15



Fig 5.15: Spirometer

- 15. Imaging tools:** They are essential in modern medicine for diagnosing, monitoring, and treating various medical conditions. They provide detailed visualisations of the internal structures and functions of the body, allowing healthcare providers to accurately assess the presence, location, extent, and severity of diseases or abnormalities. See Fig. 5.16 for various imaging tools and techniques for diagnosis.

**Some common imaging tools and their uses for medical diagnosis are given below:**

- a. X-ray Machine:** This medical device uses radiation to produce images of internal structures that help detect bone fractures, lung infections, and other abnormalities within the body. See Fig. 5.16(a).



Fig. 5.16(a): X-ray Machine and some internal images.

- b. Ultrasound Machine:** uses high-frequency sound waves to create images of internal organs, foetus during pregnancy, and other soft tissues. See Fig. 5.16(b). It does not use ionising radiation like X-rays.



Fig. 5.16 (b): Ultrasound Machine

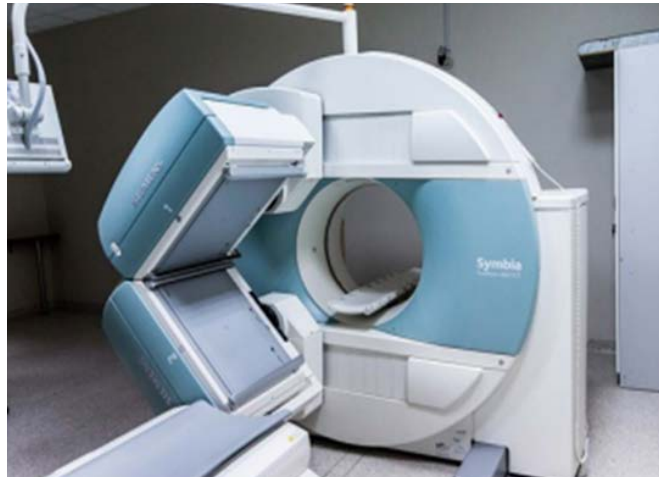


Fig. 5.16 (c): Magnetic Resonance Imaging (MRI)

**c. Magnetic Resonance Imaging (MRI):** MRI utilises strong magnetic fields and radio waves to generate detailed images of internal organs and structures. See Fig. 5.16(c). It does not use radiation.

**d. Computed Tomography (CT) Scanner:** Combines X-rays and computer technology to produce cross-sectional images of the body. See Fig. 5.16(d)



Fig. 5.16(d): Computed Tomography (CT) Scanner

Fig. 5.16: Imaging Tools

## Troubleshooting and its Importance for the Various Diagnostic Devices.

Though high-tech medical diagnostic devices can encounter problems, skilled biomedical professionals are essential for maintaining their reliable performance through preventative measures and rapid troubleshooting. Their expertise in resolving device issues is crucial for providing the accurate data needed to support effective healthcare.



*Troubleshooting is the process of identifying, analysing, and resolving problems or malfunctions that occur in various systems, devices, equipment, or processes. It involves systematic investigation and problem-solving techniques to diagnose the root cause of a malfunction and implement solutions to restore functionality or improve performance. Troubleshooting diagnostic devices is essential in the medical field.*

## Importance of troubleshooting diagnostic device

Here are some reasons highlighting the importance of troubleshooting diagnostic devices:

1. **Accuracy of diagnoses:** diagnostic devices are designed to provide accurate and reliable results. Regular troubleshooting helps identify and rectify any issues that could affect the accuracy of test results, ensuring that patients receive the correct diagnosis and appropriate treatment.
2. **Patient safety:** malfunctioning diagnostic devices can pose risk to patient's safety. Troubleshooting ensures that these devices are functioning properly and are safe to use, preventing potential harm to patients.
3. **Quality assurance:** regular troubleshooting is an essential part of quality assurance programs in healthcare settings. It helps maintain the standard and consistency of test results, contributing to better patient care and treatment outcomes.
4. **Cost-effectiveness:** timely troubleshooting can prevent the need for costly repairs or replacements of diagnostic devices. By addressing issues early, healthcare facilities can extend the lifespan of their equipment and optimise their investment.
5. **Efficient workflow:** well-functioning diagnostic devices improve the efficiency of healthcare processes. Troubleshooting helps identify and resolve equipment-related bottlenecks, enabling smoother workflow and faster turnaround times for test results.
6. **Compliance with regulations:** Troubleshooting is essential for maintaining compliance with regulatory standards and guidelines. Healthcare facilities must adhere to specific requirements related to the calibration, maintenance, and performance of diagnostic devices.
7. **Data integrity:** diagnostic devices generate critical patient data. Troubleshooting ensures that the data produced is reliable, accurate, and securely stored, supporting evidence-based decision-making in patient care.

## List of basic troubleshooting for the various diagnostic devices

Below are some general steps and troubleshooting tips for common diagnostic devices:

1. **Thermometer**
  - a. Check the battery: make sure the battery is functional and properly inserted.
  - b. Calibration: ensure the thermometer is calibrated correctly to provide accurate readings.
  - c. Cleaning: clean the thermometer probe before and after each use to avoid contamination.

## 2. Blood Pressure Monitor

- a. Positioning: ensure the patient's arm is positioned correctly and at heart level during measurement.
- b. Cuff fit: verify that the cuff size is appropriate for the patient's arm circumference.
- c. Calibration: regularly check and calibrate the device to maintain accuracy.

## 3. Stethoscope

- a. Check tubing and earpieces: inspect the tubing for cracks or damage that may affect sound transmission. Ensure earpieces fit properly.
- b. Cleanliness: keep the stethoscope clean and free from debris to avoid sound distortion.

## 4. Pulse Oximeter

- a. Proper placement: ensure the oximeter is correctly placed on a finger or earlobe for accurate readings.
- b. Battery: check the battery level to ensure sufficient power for operation.
- c. Motion artefacts: advise the patient to remain still during measurements to avoid false readings.

## 5. Electrocardiogram (ECG or EKG)

- a. Electrode placement: confirm that the electrodes are placed correctly on the patient's skin as per the standard positions.
- b. Cable connection: check the cable connections to the ECG machine for any loose or damaged wires.

## 6. X-ray Machine

- a. Positioning: ensure the patient is positioned correctly for the desired X-ray view.
- b. Technical issues: if the X-ray image quality is poor, check for technical malfunctions or calibration errors.

## 7. Ultrasound Machine

- a. Probe positioning: ensure proper probe placement for the desired ultrasound image.
- b. Calibration: regularly calibrate the machine to maintain image accuracy.

## 8. Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) Scanner

- a. Technical support: if the machine is not functioning correctly, contact the manufacturer's technical support or a service engineer.

## 9. Spirometer

- a. Calibration: regularly calibrate the spirometer as per the manufacturer's instructions.
- b. Proper use: train users on how to perform a spirometer correctly to obtain reliable results.

## 10. Glucometer

- a. Test strip compatibility: ensure the test strips used are compatible with the specific meter model.
- b. Test strip storage: store the test strips according to the manufacturer's guidelines to maintain accuracy

Excellent work! You have grasped the key concepts we have covered so far. Now, dive into the hands-on activities below and apply what you have learned.

### Activity 5.11: Field trip or virtual tour

1. Under the guidance of your parents, teacher or healthcare professional, take a trip to a nearby hospital or diagnostic lab
2. Consider a virtual tour of a hospital or diagnostic lab. This can be done through pre-recorded videos by a supervisor or simply watching interactive websites that show various diagnostic medical devices
3. Interact with various diagnostic medical devices

### Activity 5.12: Diagnostic devices and their uses

Click [here](#) to watch a video of various diagnostic devices and their uses. Watch another [one here](#). Make notes on all the devices seen and educate your colleagues, friends or relatives on their uses.

### Activity 5.13: How to use the ultrasound machine

1. Click [here](#) to watch a video on how to use the ultrasound probe to scan the lower abdomen
2. Click [here](#) to watch a video on how to operate ultrasound keypads and note the changes that occur in each instance.
3. How do you prepare a pregnant woman for the scan? How many ways can the probe be moved?

### Activity 5.14: How to use a blood pressure monitor

1. Click [here](#) to watch a video on how to take manual blood pressure reading
2. Click [here](#) on how to check a manual blood pressure monitor.
3. Click [here](#) to watch a video on how to use digital blood pressure at home

How must you tie the cuff around your arm? Which arm is preferred, right or left?

### Activity 5.15: How to use Glucometer

1. Click [here](#) to watch a video on how to use a glucometer.
2. Click [here](#) to watch a second video on glucometer usage
3. What is the right finger to use?

### Activity 5.16: Troubleshooting

1. Under the guidance of a supervisor, perform troubleshooting on any available medical device.
2. Write a report on the techniques you used
3. Did the troubleshooting yield a positive test result?

### Activity 5.17: Online search

Surf the internet for other images of the various diagnostic devices explored so far. Include some troubleshooting techniques for them.

### Self-reflection

How easily did you perform each activity? How will the uniqueness of the various devices discussed contribute to healthcare delivery in Ghana?

# Review Questions

1. Analyse the case study below and answer the questions that follow:

Davidson, a 28-year-old tutor at Bosomtwe Girls' STEM at Deduako, has been experiencing persistent coughing, fever, and difficulty breathing for the past week. He visited his primary care physician at Kuntense Government Hospital, who suspects he may have contracted pneumonia. The physician therefore ordered for chest X-ray to check for inflammation or fluid buildup in the lungs, a sputum test to analyse a sample of mucus for the presence of bacteria or viruses, and blood tests to check for signs of infection. The physician gave him some preventive measures.

- a. What type of medical intervention has the physician utilised?
  - b.
    - i. Describe the two medical treatments the physician may prescribe to manage Davidson's pneumonia.
    - ii. Explain the essence of these therapeutic interventions to
  - c. Discuss two preventive measures that could be taken to limit the spread of pneumonia, both for Emma and her community.
2. What factors should a healthcare provider consider when determining the appropriate diagnostic tests and examinations to confirm a suspected medical condition? How can the selection of these diagnostic interventions impact the accuracy and timeliness of the diagnosis?
  3. Discuss the key principles healthcare providers should keep in mind when prescribing medical treatments for a patient. How can the choice of therapeutic interventions affect the management of the patient's condition and their overall health outcomes?
  4. Imagine you are a public health official tasked with developing strategies to prevent the spread of a highly contagious illness in a community. Discuss the range of preventive interventions would you recommend
  5. Give two characteristics of the primitive diagnostic medical intervention.
  6. Case study

In a remote African village, Dr. Amina faced an outbreak of a mysterious illness, but with limited medical resources, she had to rely on primitive diagnostic tools. The lack of reliable tests forced her to solely use physical examinations, palpation and observations leading to difficulty differentiating symptoms and misdiagnosis. The community's reliance on traditional practices also posed a hurdle, as villagers were doubtful of Dr. Amina's Western methods. The isolation of the village further complicated matters, as she lacked transportation and communication to coordinate with larger centres, limiting her ability to provide timely, appropriate care as patients' conditions deteriorated.

- a. Enumerate two primitive diagnostic tools used by Dr. Amina

- b. What medical challenges did Dr. Amina face in the remote African village due to limited resources?
  - c. How did the lack of reliable diagnostic tests impact Dr. Amina's ability to accurately diagnose patients?
  - d. What additional obstacles did the isolation of the village create for Dr. Amina in providing care?
- 7.** Discuss why primitive diagnostic medicine could no longer function in the 21st century and why there is the need to use the modern diagnostic devices in the 21st century.
- 8.** Evaluate the various diagnostic devices used in healthcare and explain which ones would be most appropriate for the following scenarios:
- a. Quickly and accurately measuring a patient's body temperature.
  - b. Monitoring a client's blood sugar levels to manage a chronic condition.
  - c. Assessing a friend's vital signs, such as pulse and blood pressure.
  - d. Obtaining images of the body without exposing the patient to ionizing radiation.
  - e. Visualizing internal organs using advanced imaging techniques like MRI.
  - f. Performing minimally invasive procedures to examine the body's internal structures.
- 9.** Sarah, a healthcare professional, conducted a routine checkup on her long-term patient Emily, who has type 2 diabetes. Sarah began by quickly measuring Emily's body temperature and automatically recording her vital signs, including blood pressure and heart rate. Emily then shared the results from the portable device she uses at home to regularly monitor her blood sugar levels, which had been well-controlled. To get a more comprehensive view of Emily's health, Sarah ordered an imaging scan that could visualize her internal organs without radiation exposure. She also scheduled a minimally invasive procedure to closely examine one of Emily's joints causing discomfort. After reviewing all the test results, Sarah was able to work with Emily to refine her diabetes management plan and recommend appropriate treatment for the joint issue.
- a. What device did Sarah use to
    - i. quickly measure Emily's body temperature.
    - ii. automatically check Emily's blood pressure and heart rate.
  - b. What device did Emily use at home to monitor her blood sugar levels?
  - c. What type of imaging scan did Sarah order to visualize Emily's internal organs and tissues without using radiation?
  - d. What are some good things and bad things about Emily using a portable device to check her own blood sugar levels at home, instead of only getting tested at the doctor's office?
  - e. How might the type of imaging scan Sarah ordered, which does not use radiation, be better for Emily compared to other scanning options?



# Answers to Review Questions

1. a. Medical intervention for diagnosis
  - b. i.
    - The physician may prescribe antibiotic medications to treat the bacterial infection causing the
    - pneumonia.
    - Oxygen therapy may be provided to assist with breathing and ensure adequate oxygen levels.
    - In severe cases, hospitalization and supportive care, such as intravenous fluids and respiratory therapy, may be necessary.
  - b. ii. These therapeutic interventions can help alleviate Emma's symptoms, such as coughing, fever, and difficulty breathing, by fighting the infection and supporting her respiratory function. This can ultimately promote her recovery and return to good health.
  - c.
    - Davidson should be advised to stay home and rest to avoid spreading the infection to her students and colleagues.
    - Public health education campaigns can raise awareness about the importance of vaccination, good hygiene practices, and seeking medical attention for respiratory symptoms.
    - Vaccination programs, especially for high-risk populations like the elderly and those with underlying health conditions, can help prevent the spread of pneumonia-causing pathogens.
2. When determining the appropriate diagnostic tests and examinations, healthcare providers should consider several key factors
  - The patient's symptoms, medical history, and risk factors for the suspected condition
  - The accuracy, reliability, and availability of different diagnostic tools
  - The potential risks or side effects associated with the diagnostic interventions
  - The timeliness of the diagnostic process and the need for prompt diagnosis
  - The cost-effectiveness and resource utilization of the diagnostic approach
3. When prescribing medical treatments, healthcare providers should keep the following principles in mind:

- **Effectiveness:** The treatment should be evidence-based and proven to be effective in managing the patient's condition.
  - **Safety:** The potential risks and side effects of the treatment should be carefully weighed against the potential benefits.
  - **Personalization:** The treatment plan should be tailored to the individual patient's needs, preferences, and overall health status.
  - **Holistic approach:** Providers should consider a combination of pharmacological, non-pharmacological, and supportive interventions to address the multifaceted aspects of the patient's condition.
  - **Monitoring and adjustment:** The treatment plan should be regularly evaluated and adjusted as needed to ensure optimal outcomes and minimize adverse effects.
- 4.** I would recommend the following range of preventive interventions:
- **Public education and awareness campaigns:** Educate the community about the illness, its modes of transmission, and the importance of preventive measures.
  - **Vaccination programs:** Implement widespread vaccination efforts, targeting high-risk populations and promoting vaccine uptake.
  - **Improved disease surveillance:** Enhance monitoring and reporting systems to quickly identify and respond to new cases.
  - **Non-pharmaceutical interventions:** Promote the use of personal protective equipment, hand hygiene, and social distancing measures.
  - **Community engagement and partnerships:** Collaborate with local organizations, schools, and businesses to ensure a coordinated and comprehensive approach to prevention.
- 5.**
- Lack of reliable diagnostic tests
  - Difficulty differentiating symptoms
  - Reliance on physical examination and observation alone
  - Ineffective treatment due to misdiagnosis
- 6. Case Study (Hint)**
- a.** Primitive diagnostic tools used by Dr. Amina used physical examinations, palpation and observations.
  - b.** In a remote African village, Dr. Amina faced an outbreak of a mysterious illness, but with limited medical resources, she had to rely on primitive diagnostic tools.
  - c.** The lack of reliable tests forced her to solely use physical exams, leading to difficulty differentiating symptoms and misdiagnosis.

- d. The isolation of the village further complicated matters, as she lacked transportation and communication to coordinate with larger centres, limiting her ability to provide timely, appropriate care as patients' conditions deteriorated.
7. A few key reasons why primitive diagnostic medicine could no longer function effectively in the 21st century, and why the use of modern diagnostic devices is now necessary:
- **Medical complexity has increased**  
In the 21st century, the range of medical conditions and diseases has become far more complex compared to earlier eras. Primitive diagnostic methods are inadequate to accurately identify and differentiate the various, often subtle symptoms
  - **Technological advancements**  
Modern medical technology, including advanced laboratory tests, imaging techniques, and computerized diagnostic systems, have significantly improved the ability to detect, diagnose, and monitor medical conditions. These tools provide far more accurate and reliable information than basic physical exams.
  - **Demand for higher standards of care**  
In the 21st century, patients expect and demand a higher standard of medical care, with more accurate diagnoses and effective treatments. Primitive methods are no longer seen as sufficient or acceptable.
  - **Evolving disease patterns**  
Many modern diseases, such as new infectious diseases or complex chronic conditions, require specialized testing and monitoring that goes beyond basic physical examination. Primitive methods cannot keep pace with these evolving medical needs
- 8.
- a. The most appropriate device would be a digital thermometer. Digital thermometers are fast, accurate, and easy to use for quickly taking a patient's temperature, whether orally, rectally, or under the arm.
  - b. Monitoring a client's blood sugar levels to manage a chronic condition. A glucose meter would be the best device. Glucose meters allow clients to regularly check their own blood sugar levels at home, which is crucial for managing conditions like diabetes.
  - c. Assessing a friend's vital signs, such as pulse and blood pressure. An automated blood pressure monitor would be the most suitable device. These monitors can quickly and easily measure both blood pressure and pulse, providing an accurate reading without the need for a healthcare professional.
  - d. Obtaining images of the body without exposing the patient to ionizing radiation. An ultrasound machine would be the ideal choice. Ultrasound

uses sound waves to create images, avoiding the ionizing radiation associated with X-rays or CT scans, making it a safer option, especially for repeat imaging.

- e. Visualizing internal organs using advanced imaging techniques. A magnetic resonance imaging (MRI) machine would be the most appropriate device. MRI uses powerful magnetic fields and radio waves to generate highly detailed images of internal structures, including organs, tissues, and the nervous system.
- f. Performing minimally invasive procedures to examine the body's internal structures. An endoscope would be the best choice. Endoscopes are long, flexible instruments with a camera and light at the tip that can be inserted into the body to visually inspect internal organs and structures with minimal invasiveness.

## 9.

- a.
  - i. Sarah used a thermometer to quickly measure Emily's body temperature.
  - ii. Sarah used vital signs monitor to automatically check Emily's blood pressure and heart rate.
- b. Emily used a glucose meter, a portable device, to monitor her blood sugar levels at home.
- c. Sarah ordered an ultrasound scan to visualize Emily's internal organs and tissues without using radiation. MRI can also be used
- d. **Good things** about Emily using a portable device to check her own blood sugar levels at home:
  - i. Emily can check her levels more frequently at home, which helps her better manage her diabetes on a daily basis.
  - ii. Home testing is more convenient and allows Emily to be more actively involved in her own care.

**Bad things** about Emily using a portable device to check her own blood sugar levels at home:

- i. The portable device may not be as accurate as the professional equipment used at the doctor's office.
  - ii. Emily needs to remember to use the device regularly and properly record the results.
- e. Using an imaging scan without radiation exposure is better for Emily because:
    - i. It avoids the potential health risks associated with repeated exposure to radiation from other scans like X-rays or CT scans.
    - ii. This makes the procedure safer for Emily, especially if she needs to have it done multiple times.

## Extended Reading

- Diagnostic Interventions:  
(<https://jamanetwork.com/journals/jama/article-abstract/2767890>)
- **Therapeutic Interventions:**  
(<https://www.nejm.org/doi/full/10.1056/NEJMra1809315>)
- Preventive Interventions  
:(<https://www.annualreviews.org/doi/abs/10.1146/annurev-publhealth-040119-094401>)
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