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Towards Improved Medical Equipment Management: Awareness and Mitigation of the Common Faults of Medical Equipment in Nigeria

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ABSTRACT: The reliability of medical equipment is very important for effective health care delivery. Yet, in Nigeria, frequent equipment faults continue to affect the service quality, patient safety, and cost efficiency. This paper evaluates the common faults of medical equipment within the Nigerian health care system, with emphasis on their root causes, clinical implications, and practical strategies for mitigation. This study identifies frequent challenges such as inadequate preventive maintenance, poor power quality, insufficient user training, limited availability of spare parts, and manufacturing errors. The findings reveal that a significant proportion of equipment failures could be prevented through adequate management practices, including routine calibration, staff capacity-building, and integration of biomedical engineering expertise into hospital operations. Furthermore, the study brings to light the importance of gentle handling, routine maintenance practices, and training of health care workers to reduce the rate of equipment downtime and also the need for sustainable improvement of medical devices by investing in local capacity for maintenance and repair, By raising awareness of common equipment faults and proposing feasible mitigation strategies, this paper contributes to the ongoing discourse on strengthening Nigeria's health care infrastructure and advancing patient-centered care.

KEYWORDS: Medical equipment, Handling, Management, Common faults, Awareness and Training, Maintenance culture, Calibration, Safety, Quality assurance.

1. INTRODUCTION

Medical equipment refers to the tools, devices, and machines used in health care settings to diagnose, monitor, treat, and prevent illnesses or medical conditions (Zubair, 2010; Zubair *et al.*, 2017). These include a wide range of equipment, from basic instruments like stethoscopes and thermometers to advanced technologies like Magnetic Resonance Imaging (MRI) scanners, ventilators, and robotic surgical systems. Medical equipment serves as the backbone of modern health care, enabling medical professionals to deliver accurate diagnoses, provide effective treatments, and monitor patient health effectively (Kutor *et al.*, 2017).

The importance of medical equipment in health care delivery cannot be overstated (Zamzam *et al.*, 2021). It enhances the accuracy and efficiency of medical procedures, minimizes human error, and supports evidence-based decision-making. For example, diagnostic tools such as X-ray machines and laboratory analyzers help identify illnesses early, improving the chances of successful treatment. Life-support equipment like ventilators and defibrillators play a critical role in saving lives during emergencies. Additionally, monitoring devices such as Electrocardiograph (ECG) machines and blood pressure monitors ensure continuous assessment of a patient's condition, aiding in timely interventions (Zubair and Eneh, 2018).

Also, Preventive health care relies heavily on medical equipment. Vaccination devices, screening tools (mammograms and colonoscopy equipment), and sterilization devices are essential in identifying and mitigating health risks early (Ahmed *et al.*, 2020; Nicosia *et al.*, 2023). By detecting potential health issues before they develop into severe conditions, these tools contribute to reducing the burden of disease in populations.

1.1 Overview of the Nigerian health care system and its dependence on technology

The Nigerian health system is structured in primary, secondary, and tertiary levels, with the three tiers of government sharing responsibility for the provision of health services (Aregbeshola, 2021). The Federal Government is responsible for tertiary care, development of national health policy, as well as providing technical assistance to State Ministries of Health (SMOH) and Local Government Health Authorities (LGHA). The State Governments (SG) are responsible for state tertiary and secondary care, regulation as well as providing technical assistance to LGHA while the LGHA are responsible for primary health care (PHC) service delivery. The health system comprises the public and private health sectors. The Nigerian health system is a complex mixed system with private hospitals operating as free market entities and public hospitals operating as government entities with staff salaries paid by the government and all buildings and equipment owned by the government (Aregbeshola, 2021). Primary healthcare serves as the first point of contact, focusing on basic services like immunizations, maternal care, and treatment of common illnesses, primarily in rural areas. Secondary health care includes general hospitals and specialist clinics offering more advanced diagnostic and therapeutic services, while tertiary health care, delivered through Teaching Hospitals (TH) and Federal Medical Centers (FMC), provides specialized care for complex and critical conditions (Oyedeji and Abimbola, 2014; Akande, 2004).

Despite its potential, the system faces significant challenges, including underfunding, infrastructure deficits, rural-urban disparities, and a shortage of skilled personnel exacerbated by brain drain. Additionally, the country grapples with a dual burden of infectious diseases like malaria and tuberculosis, alongside a rising incidence of non-communicable diseases. While private health care facilities cater to urban populations, public institutions are overburdened and often lack resources. Despite these obstacles, efforts to integrate technology and expand health care access through telemedicine and public health campaigns show promise for improving the system's efficiency and equity (Zubair and Ogunware, 2018).

Technology is becoming an integral part of the Nigerian health care system, which has led to an enhancement in the quality, availability, and efficiency of health care delivery. In diagnostics, powerful tools such as X-ray machines, CT scanners, and laboratory analyzers are used for accurate identification and management of diseases at secondary and tertiary care health facilities. The technology is also bridging the gap in rural areas that have limited access to health care infrastructure. The integration of Digital Health Technologies, like Electronic Health Records (EHR) and telemedicine platforms, into patient management systems is a transformative change, facilitating easier access to medical history, enhanced care coordination, and improved connectivity to specialists, particularly in remote areas (Zubair and Ogunware, 2018). Other health tools are utilized for health education, vaccination campaigns, and disease tracking, all of which are important public health efforts. But the adoption of technology has been hampered by a host of issues such as erratic supply of electricity, the high cost of equipment, and a shortage of trained manpower.

1.2 Overview of Medical Equipment in Nigeria

Medical equipment is critical for Nigeria as a country in terms of its health care system, and it is used in diagnosing, treating, monitoring, and preventing diseases. The presence and functionality of these tools have a major impact on the quality of care provided within a given country. Although many of these devices are proven lifesavers, access to them is often fractured, with the most advanced equipment disproportionately found in tertiary hospitals; urban centers and rural and primary health care facilities often lack necessary medical equipment. Medical equipment is still a vital part of modern health care despite difficulties like lack of funds, poor infrastructure, and maintenance problems (IAEA, 2000, Zubair, 2010; Massimino Ucin *et. al.*, 2024).

1.2.1 Diagnostic Equipment

Diagnostic equipment forms a critical collection of devices and instruments for the detection and identification of particular diseases or medical conditions. These instruments are the basis for accurate diagnosis and are the foundation for adequate treatment and health care for patients. Diagnostic equipment uses specialized methods to analyse the body's internal and external conditions, biological samples, and physiological conditions that monitor the patient's status in a holistic view. Some types of these instruments are presented in Table 1.

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Table 1: Some types of diagnostic instruments

TYPES	EXAMPLES
Imaging Devices	X-ray Machine, Ultrasound Machines, CT Scanners (Computed Tomography), MRI Machines (Magnetic Resonance Imaging), Mammography Machines, Fluoroscopy Machine, Angiography Machines.
Laboratory Diagnostic Equipment	Blood Analyzers, Centrifuge, Microscope
Cardiovascular Diagnostic Tools	Echocardiography Machine, Electrocardiography Machine

1.2.2 Monitoring Devices

Monitoring equipment encompasses medical devices designed to observe and measure physiological functions and vital signs in real-time. These tools are essential in health care for tracking a patient's health status, identifying any abnormalities, and ensuring timely interventions. Monitoring equipment is commonly used in various environments, including primary care, intensive care units (ICU), operating rooms, and even in home health care settings.

These devices provide continuous or periodic data, allowing health care providers to evaluate the effectiveness of treatments, detect complications early, and make informed decisions. Monitoring equipment is crucial for managing both acute and chronic conditions, as well as in emergencies where quick responses are often necessary. Some examples of these monitoring devices are Blood Pressure Monitors (Sphygmomanometers), Pulse Oximeters, Thermometers, Capnographs, Neonatal Apnea Monitors, Spirometers, Fetal Heart monitor, Patient monitor, and Glucometer.

1.2.3 Life-Support Equipment

Life-support equipment encompasses medical devices that are intended to sustain or restore vital bodily functions in patients who are critically ill or injured. These devices are utilized in Intensive Care Units (ICU), emergency departments, and during surgical procedures to maintain essential physiological processes like breathing, circulation, and organ function. Life-support equipment plays a vital role in saving lives, stabilizing patients, and allowing time for medical interventions or recovery. Some examples of these life-support equipment are Ventilators, Defibrillators, Heart-Lung Machines (Cardiopulmonary Bypass Machines), Incubators, and Anesthesia Machines.

1.2.4 Therapeutic Equipment

Therapeutic equipment is any type of medical device that is used to treat, rehabilitate, or assist in the management of health. These tools are an essential part of modern health care, helping to restore, maintain, or improve a patient's physical, mental, or functional well-being. Therapeutic equipment is an important aspect of the primary issues faced, such as acute and chronic conditions, rehabilitation, and general quality of life. Some examples of these therapeutic equipment are Dialysis Machine, Infusion Pump, Ventilator, Continuous Positive Airway Pressure (CPAP) Machine, Nebulizer, and Orthopedic Devices.

1.2.5 Surgical Instruments and Equipment

Surgical instruments and equipment are specialized tools and devices used during surgical procedures to perform precise tasks such as cutting, dissecting, suturing, clamping, or manipulating tissues. These instruments are essential for ensuring the safety, effectiveness, and success of surgeries, ranging from minor procedures to complex operations. They are designed to meet specific needs based on the type of surgery and the anatomical area being operated on. Some examples of these surgical instruments are Scalpels, Scissors, Forceps, Retractors, Needle Holders, Surgical Lights, Suture Needles, and Surgical Staplers.

1.3 Challenges faced in acquiring and maintaining medical equipment

Acquiring and maintaining medical equipment poses several challenges that greatly affect health care delivery, especially in resource-limited environments like Nigeria. These challenges can be grouped into financial, technical, infrastructural, and human resource-related categories (Zubair, 2010).

1.3.1 High Cost of Acquisition

The cost of medical equipment, particularly advanced diagnostic and therapeutic devices, is often prohibitively high, making it challenging for many health care facilities to obtain them. Limited government funding, steep import tariffs, and dependence on foreign manufacturers worsen this situation. Private facilities may transfer these costs to patients, further increasing the financial strain on the community.

1.3.2 Poor Maintenance Culture

After equipment is acquired, ongoing maintenance becomes a significant hurdle due to the absence of structured maintenance schedules and inadequate funding for repairs. This lack of maintenance often leads to frequent breakdowns, shortening the lifespan of the equipment and resulting in inconsistent service delivery.

1.3.3 Power Supply Issues

Medical equipment is heavily dependent on a reliable electricity supply, which is a major challenge in Nigeria. Regular power outages and unreliable energy sources can damage sensitive devices or make them inoperable, especially in rural areas where backup systems like generators or inverters are not always accessible.

1.3.4 Insufficient Technical Expertise

A significant challenge is the shortage of properly trained biomedical engineers and technicians who can install, calibrate, and repair medical equipment. Many health care facilities depend on external experts, which can lead to delays and higher costs. This lack of expertise also hampers the training of health care workers in the correct use of equipment.

1.3.5 Dependence on Imported Equipment

Nigeria's health care system is heavily reliant on imported medical equipment, which often incurs high procurement and shipping expenses. Additionally, sourcing replacement parts can be difficult, resulting in prolonged downtime for malfunctioning devices. Compatibility issues with local conditions, such as climate variations and power fluctuations, further complicate the effective use of imported equipment.

1.3.6 Substandard and Counterfeit Equipment

The rise of low-quality or counterfeit medical devices in the market presents a serious risk. Such equipment is more likely to fail, yield unreliable results, and jeopardize patient care. Weak regulatory enforcement allows these inferior products to enter the health care system.

2. COMMON FAULTS IN MEDICAL EQUIPMENT

2.1 Common Electrical Faults

2.1.1 Improper grounding

Improper grounding or lack of proper grounding can lead to electrical shocks, equipment malfunctions, or even fire. Medical devices rely on grounding to ensure that any excess electrical charge is safely dissipated. If grounding is inadequate, sensitive electronic components in equipment such as defibrillators or ECG machines can be damaged or may not function correctly, creating safety risks for both patients and health care providers. Proper grounding of equipment is essential.

2.1.2 Power Surges

Power surges may lead to burns in circuits, damage to wiring and other internal components, making them unusable. These medical appliances, particularly sensitive diagnostic machines such as CT scanners, MRI machines, and respirators, require a very stable power supply during their course of operation for optimal performance. Under normal circumstances, electrical equipment is supplied with proper voltage supply. However, in certain parts of the world like Nigeria, power supply is very erratic, and voltage fluctuates so severely that the equipment may malfunction. Use of power conditioning devices such as stabilizers and surge arrestors is recommended.

2.1.3 Current inrush at start

When equipment is left connected to the mains when there is power outage. When the mains power is restored unexpectedly, the initial high inrush current can damage the equipment. Hospital equipment should be switched off when not in use. When the mains power is restored, the health care worker should wait for some minutes before switching ON the equipment to avoid high inrush current.

2.1.4 Poor Wiring or Loose Connections

Faulty wiring or loose electrical contacts within medical equipment or in the hospital power supply system may cause sparking, short circuits, and electrical arcing. It may ultimately inflict irreversible damage to sensitive circuitry, resulting in the failure of the equipment. Proper equipment installation and proper connection in the hospital power supply system are essential. Proper protection with appropriate fuses and circuit breakers must not be compromised at any time.

2.2 Common Mechanical Failures

Mechanical failures refer to breaking or malfunctioning components of a medical device due to old parts, misalignment, and mechanical stress. They predominantly affect the function and reliability of medical devices, which are critical in delivering diagnosis, remedy, and patient care. Mechanical failures can lead to disruptions in health care provision, delays in patient treatment, and in some instances, harm to patients.

2.2.1 Misalignment of Components

Some medical equipment involves very precise mechanical alignments, especially in MRI machines, X-ray systems, and robotic surgical instruments. When these components become misaligned due to either mechanical shock or mishandling or improper installation, the machine may operate contrary to its intended purpose. Because of misalignment, some machines may offer erroneous images or not position a patient correctly during treatment or surgery. Some equipment may not perform its operations at all due to being out of alignment.

2.2.2 Material Fatigue

Over time, the materials used in medical equipment can experience fatigue, which refers to the weakening or deterioration of the material due to repeated stress or mechanical loading. For example, metal parts in surgical instruments or hospital beds can crack or break under continuous mechanical stress, such as the constant pressure of adjusting bed positions or repeated insertion and removal of instruments. This can result in components becoming loose, bent, or completely failing, making the equipment unusable.

2.2.3 Improper handling

If equipment is mishandled or dropped, it may misalign and damage internal mechanical components. Drops or shaking may damage internal hinges or latches inside a medical imaging machine. Alternatively, prolonged exposure of already highly ventilated equipment to damp or dry environments may cause parts to corrode, rust, or become too brittle; thereby leaving them susceptible to mechanical failures.

2.2.4 Wear and Tear

After a period of constant utilization, the medical machines' different mechanical parts will suffer from wear and tear, which would include mobile gears in surgical instruments, patient lifts or infusion pumps undergoing friction, stress, and fatigue from a long operating time. For example, gears in the dialysis machine may not now be as smooth as they used to be at the time of installation, which consequently causes irregularities in its operation. Likewise, the electrical motors in ventilators or defibrillators break down with age and refurbishment, resulting in equipment failure when it is most needed.

2.2.5 Insufficient Lubrication and Maintenance

Mechanical devices need frequent lubrication and maintenance when they are operational for smooth functioning. As a result, parts may start rubbing, heating up, and then get completely stuck up in about 90 days, if there is not enough lubrication or if the maintenance schedule is neglected. Surgery depends so much on smooth operation that, for instance, gears and motors of surgical drills or power tools can lock up or not engage properly, rendering them useless, compromising the surgery.

2.2.6 Overloading or Excessive Use

Medical devices are built to withstand loads or cycles of operation. When these cycles are increased or exceeded beyond those recommended by the manufacturer, then mechanical failure occurs. For example, an anesthesia machine may experience failure if the mechanical valves or pumps are overused without proper servicing or if they are subjected to extreme pressure for prolonged periods. Similarly, wheelchairs or patient transport equipment may break down if they are used for heavier loads or more frequent cycles than intended, stressing components like wheels or frames.

2.2.7 Environmental Factors

Environmental conditions, including extremes of temperature, humidity, or dust, have a critical impact on mechanical components in medical equipment. Dust buildup, for example, can hinder the movement of parts or clog them in ventilators or surgical instruments. Temperature variations expand and contract mechanical parts and induce mechanical stress cracking in parts. High humidity may lead to corrosion of equipment, especially metal parts. This can hence result in malfunctioning.

2.2.8 Component Defects or Manufacturing Errors

Sometimes, mechanical faults are often tied to inherent defects from the manufacturing process or substandard components. Though equipment is relatively new, failure can still occur early, such as when the critical component has a defect, such as a

faulty pump in the dialysis machine or a defective valve in a ventilator. It is well-known that such equipment is usually searched for faults and errors before its use by patients. However, operational faults can occur since sometimes defects made in the production line remain undetected at the point of release.

2.2.9 Inadequate Calibration or Faulty Adjustments

Some medical equipment is dependent on mechanical components that require regular calibration to maintain their accuracy. Off-calibration or wrong adjustment of such items as scales in weighing machines could render such devices inoperative or give erroneous results. All Calibration may be performed by assistants. Some health care facilities usually program their devices for automatic calibration. So, as soon as such devices are put into practice, no need for manual calibration; such devices should still be checked and confirmed for proper calibration. Unfortunately, most of the health care workers in charge of equipment are not well trained on care and calibration of equipment, hence, most electrical, mechanical, electro-mechanical scales or measuring devices and medical equipment are poorly calibrated. Calibration is essential for reliability, quality control, and quality assurance.

Calibration errors arise when a medical device does not read a measurement correctly or operates out of the specified ranges. This happens mainly due to imprecise calibration and, over time, the degradation of calibrated settings. Calibration is performed to substantiate the correctness of the functioning of medical equipment per the manufacturer's specifications so that the outcomes produced can be accepted as correct. Calibration is significant for various types of medical devices; these include diagnostic machines, patient monitors, as well as therapeutic equipment. Errors in this process will give misleading data and result in wrong diagnosis and treatment, thus compromising patient safety as well as care.

2.2.9.1 Infrequent Calibration

Medical devices that are not routinely evaluated can lead to differences in performance over time. Devices such as blood pressure monitors, thermometers, and ECG devices can gradually slip out of their original range, making measurements inaccurate, resulting in measurement errors that can persist for an unpredictable period, and result in misreading that can confuse health care professionals and affect clinical decisions

2.2.9.2 Improper calibration procedure

If the calibration procedure is not performed properly, calibration errors may occur. This can be due to inadequate training, improper equipment, or human error. Improper adjustment of the systems or use of inappropriate measuring instruments will result in incorrect measurements. Failure to follow standard operating procedures or missing important calibration steps can also result in incorrect measurements.

2.2.9.3 The environment

Measurement errors can be exacerbated by environmental factors such as temperature, humidity, and pressure fluctuations. Many medical devices, especially those that rely on sensors or sensitive electronics, are very sensitive to environmental changes such as extreme temperatures and high humidity; examples of such devices are MRI machines, blood gas analyzer, electrocardiogram (ECG), and Linear accelerator. These devices may malfunction or give abnormal results when operated outside the range of temperature or humidity specified by the manufacturers.

2.2.9.4 Software or firmware issues

Many modern medical devices rely on software or firmware for measurements. Software errors, corrupt files, or firmware errors may cause errors in the calibration process or interfere with the device's ability to maintain calibration over time.

2.2.9.5 Invalid or outdated calibration standards

Standards for measuring medical devices may change over time, particularly as a result of technological advances or updates to health regulations. If the health care industry continues to use outdated standards for measurement, the devices may not meet the latest requirements for accuracy. For example, if a blood glucose meter is not recalibrated according to new industry guidelines, results may be inaccurate.

2.3 Software and Technology Malfunctions

Software and technology malfunctions in medical equipment refer to failures arising from defects or errors in the software that controls these devices. Such malfunctions can compromise patient safety, lead to wrong diagnoses, or cause treatment delays. A study analyzing 15 years of medical device recall data found that software failures were a significant contributor to device recalls, underscoring the critical need for robust software quality practices in medical device development

(Wallace and Kuhn, 2001). There are common causes of software-related malfunctions.

2.3.1 Programming Errors

Bugs or mistakes in the code can lead to device malfunction. For instance, incorrect programming in infusion pumps has resulted in over- or under-delivery of medication.

2.3.2 Lack of Updates

Failure to update software can leave devices vulnerable to malfunctions or cybersecurity threats. The Food and Drug Administration (FDA) has emphasized the importance of regular software updates to maintain device functionality and security.

2.3.3 Interoperability Issues

Incompatibility between different devices or systems can lead to malfunctions. As medical devices become more interconnected, ensuring seamless communication between them is essential to prevent errors.

2.4 Environmental Damage

Environmental damage is a prevalent issue affecting the performance and longevity of medical equipment. Factors such as heat, humidity, dust, and inadequate climate control can lead to equipment malfunctions, compromised patient safety, and increased maintenance costs.

2.4.1 Heat

Elevated temperatures can cause overheating in medical devices, leading to component failure and reduced operational efficiency. For instance, excessive heat can degrade electronic circuits, resulting in the malfunctioning of critical equipment.

2.4.2 Humidity

High humidity levels can lead to condensation within electronic components, causing short circuits and corrosion. This is particularly detrimental to devices like medical computers, where moisture can compromise functionality.

2.4.3 Dust

Accumulation of dust can obstruct ventilation systems, leading to overheating, and can interfere with mechanical parts, causing operational failures. In medical device manufacturing, controlling environmental factors like dust is crucial to ensure product quality. To reduce the effect of dust, the equipment room should be swept with a vacuum cleaner and not with a broom.

2.5 Poor Maintenance Practices

Poor maintenance practices in medical equipment management can lead to significant challenges, including equipment failures, compromised patient safety, and increased operational costs. Neglecting regular maintenance, inadequate calibration, and improper repairs are common issues that contribute to these problems. Poor maintenance culture has adverse consequences on health care delivery.

2.5.1 Increased Equipment Failures

Lack of proper maintenance can result in frequent equipment breakdowns, reducing the availability and reliability of medical devices. A systematic review highlights that deficiencies in managing and maintaining medical equipment conditions often lead to malfunctions, adversely affecting health care service delivery.

2.5.2 Compromised Patient Safety

Malfunctioning equipment due to poor maintenance can cause medical errors, leading to patient harm. For instance, improper repair of health care devices may reduce their functionality and waste resources, ultimately impacting patient care.

2.5.3 Operational Disruptions

Equipment downtime resulting from inadequate maintenance can disrupt health care services, leading to delays in patient care and rescheduled procedures. Such disruptions compromise patient safety and the overall efficiency of health care facilities.

2.5.4 Increased Costs

Neglecting maintenance can lead to higher repair costs and the need for premature equipment replacement. Additionally, unplanned downtime due to equipment failures can disrupt health care appointment schedules and referrals. Health care facilities may have to refer patients to other facilities at a higher cost.

2.6 Specific Equipment and their common faults

Table 2 presents a list of some specific medical equipment and their common faults. This list provides awareness for health care worker and will enhance better handling and management of the equipment.

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Table 2: Specific Equipment and their common faults

S/N	MEDICAL EQUIPMENT	COMMON FAULTS
1	Suction Machine	Leaks (Tube Leak, Lid leak), Tube blockage, Missing/damaged parts (Bad motor, Bad power supply, No collection bottle, No filter, Clogged bacterial filter), Float valve closing pathway, Insufficient Pressure.
2	Ventilator	Power, Switch, clogged filters, Bad breathing circuit/leakage, faulty inspiratory and expiratory valves, Expired oxygen sensor, Faulty flow sensor, Faulty humidifier/heater, Board-related issues, Faulty alarm system.
3	Diathermy machine	Bad diathermy plate, Faulty electrode cable, Faulty power switch, Bad capacitor, Defective high-voltage transformer, Incorrect or damaged grounding wire, Faulty footswitch, Damaged or worn-out electrode handle, Clogged or damaged cooling system/overheating, Faulty temperature sensor.
4	Patient Monitor	Power failure, Faulty switch, Damaged Non Invasive Blood Pressure (NIBP) modules, Faulty sensors, Damaged display, Board-related issues
5	Cardiotocography Machine	Faulty fetal heart rate (FHR) sensor, Incorrect FHR calibration, Defective uterine activity (UA) sensor, Malfunctioning tocodynamometer, Faulty maternal heart rate (MHR) sensor, Incorrect MHR calibration, Clogged or damaged ultrasound transducer, Faulty printer, Incorrect or damaged paper roll, Malfunctioning alarm system, Power supply issues, Faulty display screen or incorrect display settings, damaged cables or connectors.
6	Sphygmomanometer	Leaks in the cuff, Incorrect or damaged cuff size, damaged valve, Malfunctioning pressure gauge, Incorrect calibration, Clogged air inlet or outlet, Faulty pump, Power supply issues (for digital models), damaged LCD display (for digital models), damaged battery or battery compartment (for portable models).
7	Phototherapy light	Faulty lamps, Incorrect intensity setting, damaged sensors, Power supply issues, damaged control panel, damaged cables or connectors, Malfunctioning alarm system, damaged stand or mounting system.
8	Incubator	Faulty temperature sensor, Incorrect temperature calibration, Defective heating element, Malfunctioning cooling system, Clogged or damaged air circulation system, Defective door seal, Faulty alarm system, damaged thermocouple, Malfunctioning timer, Power supply issues.
9	Radiant warmer	Faulty heating element, Incorrect temperature setting, Malfunctioning temperature sensor, damaged control panel, damaged air vents, Power supply issues, Malfunctioning timer, Faulty or damaged alarm system.

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10	Pulse Oximeter	Faulty or damaged sensor or probe, Incorrect sensor placement, Incorrect or poor calibration, Power supply issues, damaged display screen, damaged alarm settings.
11	Weighing Scale	Incorrect calibration, Malfunctioning display screen, Power supply issues, damaged sensor or transducer, Incorrect zero-point adjustment, damaged weighing platform, damaged battery compartment.
12	Operating Table	Faulty hydraulic system, Incorrect table height adjustment, damaged table top or mattress, Power supply issues, Faulty control panel or hand control, Incorrect or damaged patient positioning accessories.
13	Electric Patient Bed	Faulty or damaged electric motor, Malfunctioning bed height adjustment, inadequate backrest or headrest adjustment, damaged side rail or guardrail, Faulty control panel or hand control, Power supply issues, Faulty or damaged actuators, damaged casters or wheels, Malfunctioning bed return.
14	Centrifuge	Uneven rotor loading, damaged motor, Malfunctioning speed control or regulator, damaged rotor or bucket, Improperly secured rotor or buckets, Power supply issues, Faulty or damaged safety lid switch, Excessive vibration or noise.
15	Autoclave	Faulty heating element, Malfunctioning temperature control or sensor, Incorrect pressure gauge calibration, Leaks in the chamber, damaged valve or solenoid, Power supply issues, damaged safety valve, Malfunctioning door lock or seal, Excessive corrosion or scale buildup, damaged vacuum pump for vacuum autoclaves.
16	Infusion pump and Syringe drive	Infusion Pump: Occlusion or blockage in the infusion line, Malfunctioning flow rate or dose calculation, Incorrect calibration, Power supply issues, damaged control panel or keypad, Incorrect alarm settings, Malfunctioning air-in-line detection, damaged pressure sensor. Syringe Drive: Damaged syringe clamp or holder, Malfunctioning syringe drive motor, Incorrect syringe size, Power supply issues, faulty or damaged control panel or keypad, Malfunctioning end-of-infusion detection, Clogged syringe or infusion line, Faulty or damaged pressure sensor.

2.7 Impact of Faults

Faults lead to delayed or incorrect diagnosis and treatment. There is an increased risk for patient harm or fatalities. A medical device is supposed to contribute to the improvement of the health of patients, however, it can do the opposite if care is not taken. Frequent repairs and replacements lead to financial strain on health care facilities. Faults in medical equipment erode public trust in the health care system.

3. RECOMMENDATIONS

There is a need to establish a maintenance culture. Maintenance starts right from the time of procurement. Proper selection of equipment and equipment manufacturers is very important. Acceptance operational tests must be carried out for newly supplied equipment. Any device that does not work properly the first time it arrives at a health care facility may never work. It might have a manufacturing defect. It might not have passed quality control tests before release from the manufacturer. It might be a second-hand or previously used device. Such a device should not be accepted and should be returned to the supplier or the manufacturer, or the contractor. No politics should be involved in procurement.

The manufacturing date, the expiry date, and the life span of every equipment must be noted on a card or a record, or a file. Every equipment

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must have a card or a file, just like every patient has a card or a file. Health care facilities should avoid expired equipment or equipment that has spent 100% of its life span. Nigerian hospitals should not become a dumping ground for discarded medical equipment from the Western world in the guise of donation. Enforcing strict standards for importing medical equipment, penalizing suppliers of substandard or counterfeit devices, prioritizing the purchase of durable and reliable equipment, and encouraging local production of medical devices are recommended.

The medical equipment life cycle has nine phases as illustrated in Fig. 1 (Worm, 2015). Starting from Planning and Assessment, Budgeting and Financing, Technology Assessment and Selection, Procurement and Logistics, Installation and Commissioning, Training and Skill Development, Operation and Safety, Maintenance and Repair, and ending with Decommissioning and Disposal. There should be due process, diligence, professionalism, ethics, and best practices during the nine phases.

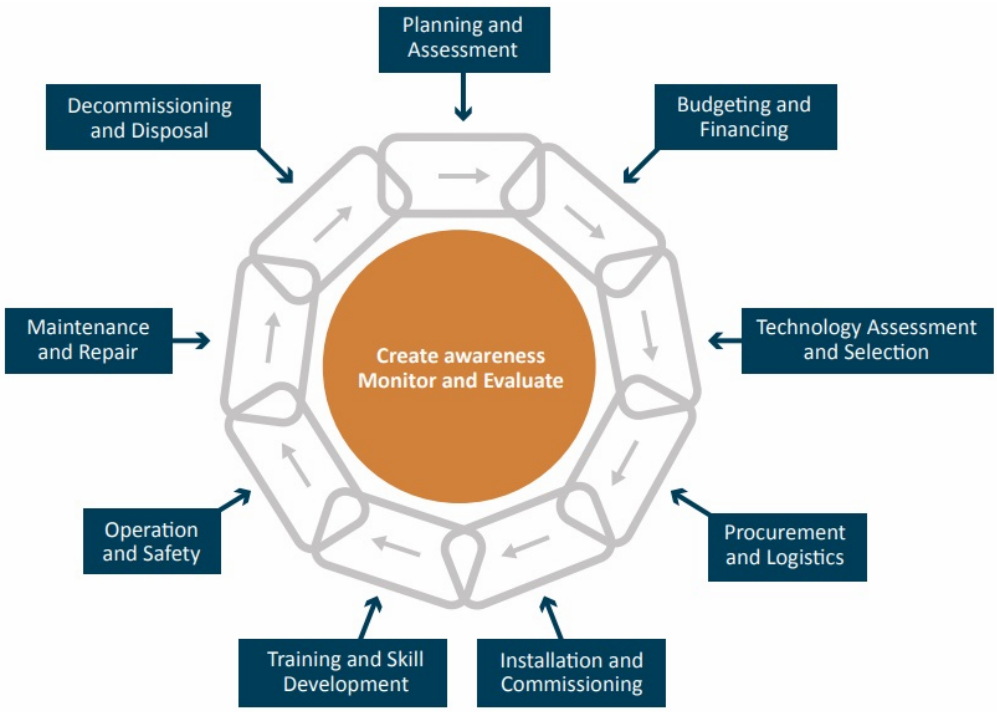

Fig. 1: Medical Equipment Life Cycle (Worm, 2015)

In-house maintenance teams should be established in health care facilities. Regular training for equipment operators and technicians is recommended. Hospitals are encouraged to adopt the concept of a card or file for each device for recording the installation, acceptance test procedures and results, times or periods of operation, history of breakdowns or faults, details of maintenance procedures, observations, repairs, and

responses to repairs. Every patient has a card. Let every medical device also have a card.

Provision of reliable electricity and backup power solutions and creation of controlled environments to protect sensitive devices are essential. Engaging health care workers, government agencies, and private organizations in addressing equipment challenges is highly recommended. Increased funding for health care is advocated.

4. CONCLUSION

The significance of addressing medical equipment faults and challenges in Nigeria cannot be overemphasized. There is a need for awareness of the common faults of medical equipment among health care workers. There is a need for regular training and re-training of health care workers on proper handling, operation, and care for medical equipment for improved health care delivery for patients. It's high time the stakeholders prioritize maintenance, quality assurance, and proper funding. Improved medical equipment management is essential for a sustainable health care system.

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