Computerized Preventive Maintenance Management System (CPMMS) for Haematology Department Equipments

Hosam H. Osman, Mawia A. Hassan, Nihal M. Elhady and Reem M. Elrasheed
Biomedical Engineering Department, Sudan University of Science and Technology, Khartoum Sudan

ABSTRACT
Medical devices and equipment have become very complex and are expected to operate under stringent environments. Equipment's should be properly maintained in order to fulfil their objectives. The signs of equipment's failure may not be apparent to clinical staff. Therefore they should be inspected periodically. Scheduled inspections help ensure the safety and efficacy of the medical equipment. A software tool is developed to implement a risk oriented prioritization of devices for equipment maintenance. First establishing an effective, efficient Computerized Preventive Maintenance Management System, collecting the data of equipments in laboratories and implement them to the system. The reports based on the inspection results, help determining a better maintenance's schedule.

General Terms
Computerized Maintenance Management System (CPMMS), clinical engineering, database.

Keywords
Preventive Maintenance (PM), Inspection Preventive Maintenance (IPM), Computerized Maintenance Management System (CMMS), World Health Organization (WHO), Joint Commission on Accreditation of Healthcare Organizations (JCAHO), Graphical User Interface (GUI), Log Book.

1. INTRODUCTION
Medical devices are devices that directly affect human lives, so using a Preventive Maintenance program will insure the best return for money spent by prolonging device's life and avoiding expensive corrections and emergency repairs, also it plays an important role in the process of reliability optimization [1]. In addition, a computerized maintenance management systems (CMMS) are required to manage and control asset, plant, and maintenance of devices in today's hospitals. A CMMS is much more than just a way to schedule preventive maintenance (PM). By using a CMMS, you can create equipment logs to record events associated with a piece of equipment, provide complete inventory control system, and much more [2].

Preventive maintenance (PM)schedule, service contracts, safety procedures, measurement points, multiple meters, inspection routes, specification data (name plate), equipment downtime, and related documentation. This equipment data is used for managing day-to-day operations and historical data that can be used to help make cost effective replace or repair decisions. The data can also be used to develop additional management information, such as building equipment down time failure code hierarchies for use in maintenance management metrics [3].

If there is no clear preventive maintenance system in laboratories that leads to unexpected device's malfunctions and high cost repairs, PM helps eliminate hazards before they develop, but there are many Problems that occur suddenly and therefore cannot be detected and prevented by PM procedures, sometimes the suppliers may not offer training to the public hospital maintenance team as result they become incompetent, not conversant with the equipment model and servicing arrangements [4].

It is important to have a well-planned and managed maintenance programme that is able to keep the medical equipment in a health-care institution reliable, safe and available for use when it is needed for diagnostic procedures, therapy, treatments and monitoring of patients. In addition, the Maintenance managers should ensure that the equipment are safe to use and complies with all required standards, specified performance criteria and should not be damaged. They should also match with the order and arrive complete with specified accessories. Equipment should be placed on a routine maintenance programme and the maintenance personnel must be trained and conversant with its use and servicing arrangements, also the availability of the technical and operational manual in every equipment being installed guarantees proper management of devices. Joint Commission on Accreditation of Healthcare Organizations (JCAHO) states "all equipment is tested at intervals not to exceed six months, unless a different interval is approved" [4], there for the procedures and Schedules are completed using the PM Form. The PM Form consolidates the processes of creating a PM work order (PM Procedure, PM Procedure Steps, PM Schedule and selecting Equipment) into one computerized preventive maintenance Management system for hematology department to ensure that medical equipment operate optimally and cost-effectively, Ensure health care services, accuracy and increase the life span of the device [5].

2. PLANNED PREVENTIVE MAINTENANCE
Planned preventive maintenance is regular, repetitive work done to keep equipment in good working order and to optimize its efficiency and accuracy. This activity involves regular, routine cleaning, lubricating, testing, calibrating and adjusting, checking for wear and tear and eventually replacing components to avoid breakdown.

Productive preventive maintenance refers to the proper selection of equipment to be included in planned preventive maintenance. Decisions must be made on what to include, to reduce costs; inexpensive units that are not necessarily included in the planned preventive maintenance program can

be replaced or repaired when they break down. The overriding consideration is cost effectiveness.

An important aspect of planned preventive maintenance is the participation and commitment of the user. Preventive maintenance should start with users, and the bulk of the work should be their responsibility. The task must be performed daily, with joint activities involving the user and a technician engineer at the end of the week. Highly technical repairs, which are the engineer's responsibility, may be scheduled every six months.

Setting up a planned preventive maintenance system:

In order to establish an effective, efficient planned preventive maintenance system, a registry filing system is needed. The manufacturer's manual for preventive maintenance of the equipment can be supplemented by computer packages in setting up such a system; if a computer is not available, a manual file can be set up.

The planned preventive maintenance administrative system requires the following:

2.1 Equipment Inventory

It is essential to determine the types of devices that need to be included in the programme. This will depend on the types of facilities to be covered by the programme, ranging from primary care clinics to tertiary hospitals, and the range of devices in those facilities. The clinical engineering department should identify and select the devices to be included in the inventory, and which of those to include in the maintenance programme.

2.2 Identification and Association of Equipment

Identify equipments to distinguish them from each other. There are different ways to label equipments preferably. A system of labelling methods is used in line with the needs of the computer.

All major equipments contain items associated to it and which to be counted, listed with the master device and to be inspected and examined.

2.3 Check Lists of Equipment's Categories

A lists that specify all the tests and maintenance steps that must be implemented for the technician to inspect the Devices specified in certain periods of time, daily, weekly, monthly ... etc... Steps of preventive maintenance for each Device are determined in accordance with the written maintenance established by the manufacturer of the device.

2.4 Determine the Time Period's Examination

Determine the time periods for examination and preventive maintenance preferably, study the instructions, operating and maintenance established by the manufacturer with maintenance technicians, install the necessary adjustments to these instructions, especially time periods in line with the working conditions that often differ from those described in the books of operation and maintenance [6].

3. DATA COLLECTION

Assembled functional data related to the devices of hematology department based on WHO medical devices series are used [1], which contain how to operate the devices, maintenance and problem's troubleshooting. Then the data are implemented to the software database for more effective management.

A statistical analysis of a questioner (table 1) that been asked to number of biomedical engineers and users in twelve health facilities (hospitals and medical labs) which show the lack and misunderstanding of PM programs (Fig.1).

4. SYSTEM SOFTWARE

The system designed using Microsoft Access database to combine data from various files through creating relationships, and can make data entry more efficient and accurate. The software has three main parts: data entry, reports and log book. Data entry to tables is done through the graphical user interface (GUI) (Fig.2 and Fig.3). Several reports are available to schedule the risk-based management of the equipment. The log book can be used to pre-process physical and financial details of the maintained device ,compress and archive equipment files, establishing good security and restructure the user log records [7].

5. IMPLEMENTATION

5.1 Installation

Many common problems with maintenance system can be avoided if it is properly installed.

Before installing the system, a system administrator is assigned who is responsible for the technical maintenance of the system and for managing data security.

Installation and Training Services ensure smooth setup and training for your new system.

The CPMMS can be implemented as a complete system, by individual modules, by equipment type or by location. This is a decision of the clinical engineering department and will depend on the resources available. The software is installed on the health facility server or on the individual user's personal computer. All other hardware devices such as line printers and scanners must also be installed and configured.

5.2 Calibration

Whenever the system is installed, it is necessary to execute the calibration procedure (setup) before connecting it to the service, it's nothing more than the comparison of the system or software performance to a known standard of accuracy.

At calibration, a series of tests should be performed to define the acceptable range of parameters that will be monitored in the system software.

Calibration status of the system, the date of calibration, the next calibration date and the identification of person performing calibration should be readily available.

Table 1: Questions Included in the Questionnaire

Numbers	Question
1	Do you have a preventive maintenance system?
2	Do you have an idea of the preventive maintenance?
3	Do you think PM system will be useful to the institute?
4	Is there a plan to implement a PM?

5	Do you have a budget to implement a PM system?
6	Does the regular calibration part of (PM) maintenance?
7	Is detailed cleaning of equipment done well?
8	Do you have a periodic maintenance?
9	Does the user do the daily recommended maintenance?
10	Is there a follow up to the user from the medical engineer?
11	If there is any problem in the device, do you call the company engineer?
12	Do you know how satisfactory PM is done today?

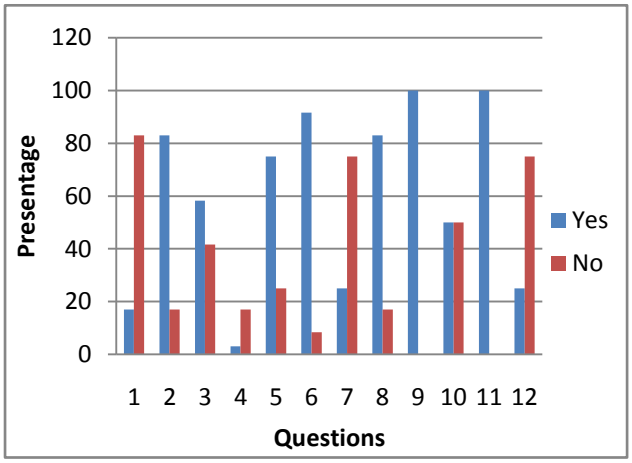

Fig. 1: A graph shows the result of the questionnaire

5.3 Troubleshooting

It requires an organized and logical approach to problems with computer software and other components. A logical approach to troubleshooting allows you to eliminate variables in a systematic order.

Before you begin troubleshooting problems, always follow the necessary precautions to protect data on a system. Some repairs, such as reinstalling an operating system, might put the data on the computer at risk. Make sure that you do everything possible to prevent data loss while attempting repairs.

Identification of a device failure occurs when a device user has reported a problem with the device. As mentioned earlier, it may also occur when a technician in the clinical engineering department finds that a device is not performing as expected during IPM.

6. EVALUATION

The evaluation was an integral part of the system development. It has been accomplished in three levels including: testing, verification and validation. The scope was to ensure the system functionality. Testing procedures involved internal evaluators, as well as, professionals in software evaluation, having knowledge of the system structure. Testing goal was to determine the proper functionality of the system, monitoring of problems, related to database management, weak points in the software packages. Moreover the integrated system has been distributed for verification to a number of external end-users – the preventive maintenance system. Feedback comments have been collected, analyzed and consequently improvements were introduced. The installation of the system includes training and education of the preventive maintenance system staff, and technical support.

Planned, ongoing evaluations help identify what aspects of the program. They also identify what is working successfully and should continue into the future. Data collected through evaluations help determine the costs and benefits of preventive Maintenance practices.

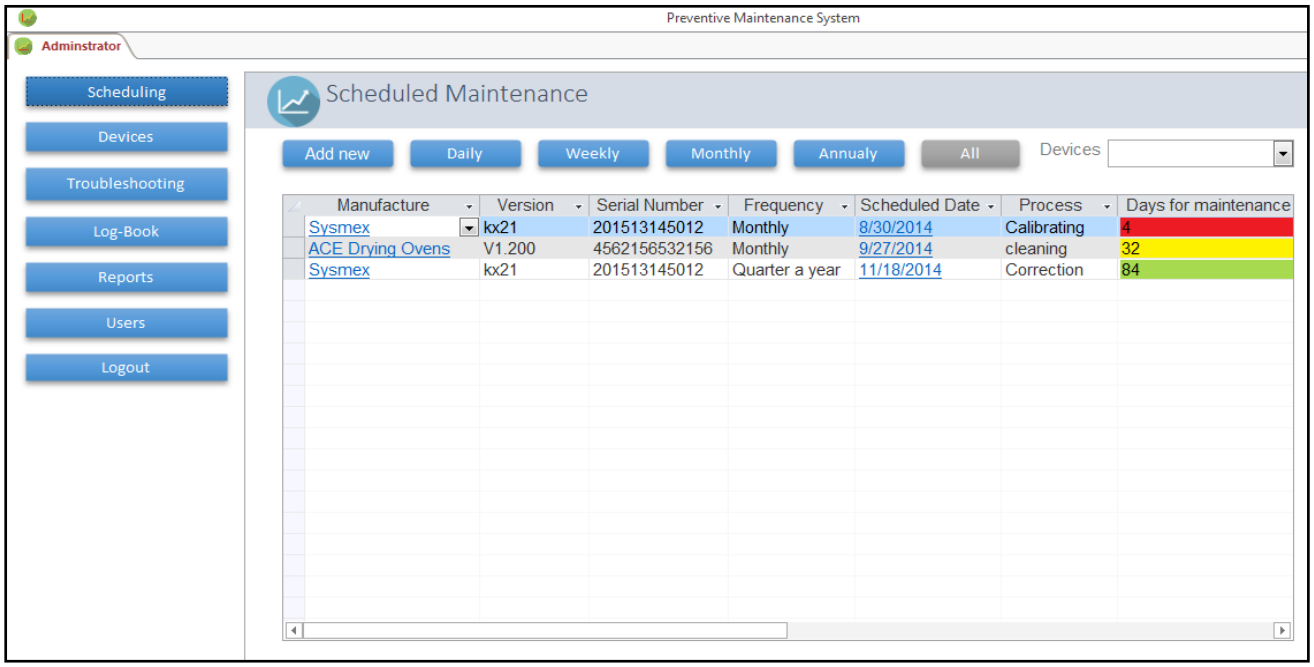

Fig. 2: The Main Interface of the CPMMS Software

Engineers may evaluate preventive maintenance in any of several ways, some of which are set measurable, formal goals for the program and measure progress toward meeting them. Also Analyze work orders to mark progress in the preventive Maintenance program.

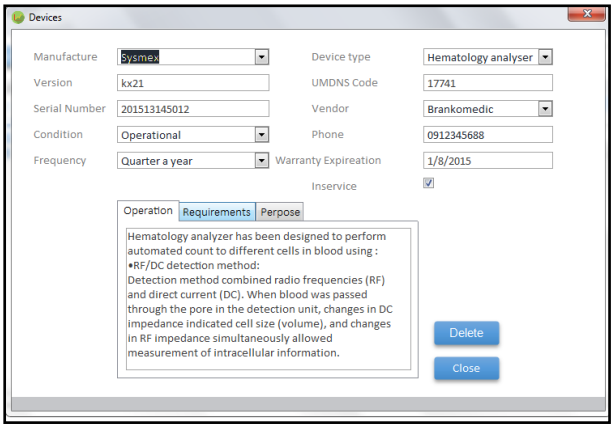

Fig. 3: Device details

Set standards for various tasks performed by employees. Once employees understand the standards, engineer periodically inspect employees' completed work to measure how well it meets the standards.

7. OPERATE AND TRAINING

After installing the preventive maintenance system software and ensure that it works properly then comes the stage of training the technical staff.

The technical staff and the clinical engineering department manager have dual responsibility for ensuring that the technical personnel as well as the clinical users are informed, trained and versed on their specified responsibilities. Training and education is not a one-time activity but a continual process to improve reliability and success in future problem solving. Training of technical personnel can be provided from:

7.1 Inside the Health-Care Organization

For operating the equipment: To be given by Manufacturer/Supplier periodically and preferably to be mentioned in Tender Enquiry Document. To deal with routine maintenance and repairs: Use of toolkits, knowledge about common and recurrent failure's causes of equipment's and how to rectify minor causes of them and calibration.

7.2 Outside the Organization

Whether for operating the equipment (if required) or to deal with routine maintenance.

The methods of training suggested above, progress from the least expensive to the most expensive to implement. So depending on hospital resources, local availability of information sources and the ability to coordinate with other hospitals who might have technicians to train as well, the hospital can choose a methodology that best matches their resources. It should be noted however that the most effective training methods for sophisticated equipment are the more expensive options.

8. CONCLUSION

An effective maintenance program is designed to minimize downtime and maintain equipment in good operating condition. Scheduled maintenance reduces incidence of failure through inspection designed to detect potential problems before they become reality. Scheduled maintenance is performed on an annual or semi-annual basis, according to equipment use or history.

Implementation of the computer program improved the maintenance practices by detecting the faults in the shortest duration. This reduced the time allocated for repair of equipment because the information required will be accessed immediately. The facility maintenance management practices and process and the quality of patient care will be improved. Paper work and loss of data in the maintenance management will be reduced.

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