Case Study Approach for Medical Equipment Management: An Agenda for Research

Dr. G Sudath K Dharmaratne*

Technological transition is one of the major concerns today, making current health managers to use modern medical equipment. However, progressive development of the production of newer medical equipment has created many issues, particularly related to its usage and maintenance (1). Introducing case study approach to determine outcomes of medical equipment would mitigate some of the issues to a certain extent.

Defining Concepts

At the outset, it is important to differentiate some of concepts related to the fields of logistics and Biomedical engineering.

A) Reliability

'Reliability' is shown as a characteristic of the design of equipment which results in durability of the item. It is the capability of equipment to work well and work whenever called upon to do the job for which it is designed (2). Reliabilty of equipment depends on the qualilty of its manufacturing process. This indicates the probability that the equipment would not fail in the long run.

B) Maintainability

'Maintainability' is defined as the probability that an equipment will be restored to a certain specific condition within a given period, when maintenance is done with prescribed proceedure and resources (3). This indicates the probability that an equipment is successfully restored after failure. Service agreements must reflect this aspect .

C) Equipment Availability

It is argued that if one considers both relability (probability that the equipment will not fail) and maintainability (probability that an equipment is successfully restored after failure), then additional metric is needed for the probability that the component is operational at a given time. This metric is 'availability' and it is described as a performance criterion for repairable equipment that accounts for both reliability and maintainability of the equipment (4). Availability is generally defined as the ratio of available hours to target hours of operation of equipment and indicates the readiness of the equipment for use. There are many causes of downtime which may hinder the availability of equipment; frequent breakdowns, delay in repairs, non-availability of operator staff, to name a few. Hence, the availability has been considered as a performance measure and shows the effectiveness of maintenance and logistic support of the system in which equipment operates (5).

D) Utilization

"Utilization" of equipment is defined as ratio of operating hours to available hours or percentage of plant operating time during which equipment is in production (6). Hence, it gives capacity utilization for a section or plant and indicates the performance of the production department (7). In health care settings, this is dependant on the number of patients who obtain services from a particular equipment.

Both of these concepts; "availability" and "utilization" are being used to denote two different aspects of equipment performance (8). In order to illustrate these concepts, a category of equipment in following two healthcare settings can be considered.

Case 1

Hospital A has one ETU where only one defibrillator is available. This has a reputed brand name and four years old. Service agreement has been signed with the maintenance organization. Physician in the hospital provide excellent inward care and follow up. ETU MOs have encountered hardly any cardiac arrest patients during last two years. What would be the anticipated outcomes pertaining to the equipment?

Case 2

Hospital B provides care has a defibrillator in the ETU and it was donated by a philanthropist. It looks old but it is being daily tested for working order. All cardiac arrest patients have been successfully managed but there is no maintenance organization. What would be the anticipated outcomes?

Table :1 Anticipated outcomes of the Defibrillators

Measure	Defibrillator 1	Defibrillator 2
Reliability	Seems to be high	unsure
Maintainability	Seems to be high	Seems to be low
Equipment availability	Seems to be high	Seems to be high
Utilization	Seems to be low	Seems to be high

*Medical Superintendent, District General Hospital, Gampaha

E) Downtime

'Downtime' is described as the length of time an equipment is not operational during the planned or targeted hours of operation. There are many sources of downtime. Downtime losses can be categorize as planned and unplanned; shift changes, lunch breaks and maintenance shutdowns are considered as 'planned' where as equipment breakdown, non-availability of operator staff, lack of consumables are identified as 'unplanned' causes(9).

Calculation of Downtime and Determining Equipment Availability

Downtime can be measured using available data in the maintenance registers retrospectively. It can also be observed prospectively over a period of time. Some newer equipment may have inbuilt clocks to record downtime. Equipment availability can be determined using the mathematical formula "(Available hours - down time) x 100/Available hours". Following two hypothetical scenarios will illustrate the application of the formula.

Case 3

Hospital C has a spectrophotometer in laborotory. The planned hours of operation is 6 hours per a day. The MLT has taken a leave for 2 hours in the afternoon. What is the availabilty of the equipment in that day?

Case 4

Hospital D has a ventilator in the SICU. It is planned to function round the clock. It has been shutdown for planned preventive maintenance for abour 4 hours. What is the availabilty of the equipment in that day?

Table : 2 Anticipated Equipment Outcomes of Spectrophotometer and the Ventilator

Measure	Spectrophotometer	Ventilator
Planned hours for operation	6 hours	24 hours
Downtime	2 hours	4 hours
Equipment availability	(6-2)/6x100 =66%	(24-4)/24x 100=83%

Conclusions

In Hospital A, the defibrillator was ready for use round the clock (High availability). However, utilization was low due to few numbers of patients. Hence, 'Availability' is a more important measure than the utilization with regard to a defibrillator.

In Hospital C, the spectrophotometer achieved 66% availabilty and the resultant 33% loss was due to the non-availabilty of staff. Ventilator of the hospital D achieved 83% availabilty and planned preventive maintenance shutdown accounted for loss of 17% availabilty. As "availability" is a pre-requisite for utilization, both of these measures are important with regard to perfomance of equipment .

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