

## Equipment Management Systems for Use in Developing Countries – An Evaluation and Selection Protocol

a report by

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A healthcare equipment management system assists with the management of medical equipment, from initial purchase through to decommissioning and replacement. It has been widely reported that a significant proportion of healthcare equipment in developing countries is not used.<sup>1,2</sup> The World Health Organization estimates that up to 60% of medical equipment in developing countries may not be in service at any given time. Although many explanations have been offered, it was commonly expressed that better equipment management would improve usage in developing countries.<sup>3</sup>

Inappropriate technology transfer has led to many work environment and productivity problems.<sup>4</sup> From a review of the relevant literature, the authors propose an evaluation protocol that could be used as a selection tool for the transfer of medical technology to developing countries. In this article, the protocol is applied to four types of commonly used healthcare equipment management systems that could be used in a developing country. These equipment management systems include a user-based system, a paper-based filing system, an in-house developed computer-based system and an off-the-shelf system.

### Overview of Four Healthcare Equipment Management Systems

- The simplest system is the user-based system, where equipment support activities are initiated solely by user request. This has been found to operate well where resources and services are limited. An important requirement of this system is a reliable means of communication. However, because equipment records are not stored, it does not facilitate certain management

functions such as planning nor comply with legislation in many countries.

- The paper-based filing system is a manual filing system where each item of equipment has an individual file. Typically inexpensive, it can facilitate scheduled maintenance but not report generation without significant manual input. A paper-based filing system can also become cumbersome, requiring much storage space. Generally, this type of system is appropriate for use in small to medium-sized hospitals.
- The in-house developed computerised system is a tailor-made solution using general software applications. Development of in-house computerised systems requires programming expertise, computer hardware and application development software. These systems usually take time to develop, are poorly documented, reliant on a dedicated programmer and have no guarantee of transfer to different operating systems.
- Generally, an off-the-shelf system is a relatively expensive computerised management and maintenance software package that is available in turnkey form, which facilitates a computer-literate operator to perform a range of management tasks. Usually, commercial systems are well documented, well supported in developed countries and under continuous development with available upgrades.

### Selection Criteria

A review of the relevant literature revealed a number of important criteria for consideration when selecting

1. B Wang and S Calil, "Clinical Engineering in Brazil: Current Status", *Journal of Clinical Engineering*, Vol. 16, No. 2, 1991.
2. M Mridha, P Ask and P Oberg, "Clinical Engineering Challenges and Problems with Medical Instrumentation in Bangladesh", *Journal of Clinical Engineering*, Vol. 13(4), 1988.
3. K Taylor, M Frize, N Iverson and C Paponnet-Cantat, "The Need for Integration of Clinical Engineering and Sociological Perspectives in the Management of Medical Equipment within Developing Countries", *Journal of Clinical Engineering*, 1994, pp. 296–297.
4. N Shahnava, "Role of Ergonomics in the Transfer of Technology to Industrially Developing Countries", *Ergonomics*, Vol. 43(7), 2000, pp. 903–907.

an equipment management system for use in developing countries.

- A system must be robust, easy to maintain and adapted to the prevailing environmental conditions while still meeting basic safety requirements.<sup>2</sup> For example, a dependable electricity supply is needed for a computer-based system.<sup>3</sup> Therefore, in the absence of a dependable electricity supply, it may be sensible to use a paper-based system.
- According to Wang, et al., it is not uncommon to find that private companies provide a poor back-up service so they recommend selection biased towards companies that provide a comprehensive range of user support.<sup>1</sup> In a similar sense, Taylor, et al. encourage users to develop in-house support for their systems if possible. They believe that this is more possible using systems designed specifically for use in developing countries.<sup>3</sup>
- In general, medical equipment tends to become underutilised in the absence of trained operators or support personnel. Taylor observed that a significant cause of underusage of equipment in developing countries is due to a lack of competent users. This may be a result of poor training opportunities or a drain of trained personnel for more lucrative positions in developed countries.
- A vital aspect of any system under consideration is the likelihood that it will receive user acceptance.<sup>5</sup> In that respect, the operating language of a management system should not limit its use. For example, some computer-based packages designed for use in developed countries may have many powerful features but are useless in a developing country if the operators do not understand the language used in the presentation of the system.
- A review of the literature reveals many cultural issues for consideration when procuring systems for hospital use.<sup>5</sup> For any equipment management system to operate, there must be a willingness to adopt a culture of record-keeping. If a computer-based system is evaluated then the culture of using technology is important. An acceptance of home-based technical expertise is also important.
- Hospitals in developing countries often operate on limited funds.<sup>2</sup> It is important that, at the time of evaluation, all the financial implications of purchasing, operating and maintaining the systems are identified and included in the process. Particular emphasis should be paid to this criterion because a lack of funds may leave a system redundant.

- Preference should be given to systems with minimum maintenance and on-going cost requirements. A well-established system should be selected that has a proven maintenance back-up record (with regard to hardware and software). This is of particular importance when setting up a computer-based system. In-house back-up systems should be implemented and a level of in-house expertise agreed and established.
- To meet the wide range of requirements of hospitals in developing countries, it is preferred that the system can be adapted or modified to suit the particular use (system flexibility).<sup>5</sup> Flexibility in report generation is a requirement as the information collected will be used in a variety of circumstances. For computer-based systems, the ability to generate user-defined reports or fields should be included in the system. A mechanism to allow input into the on-going development of the system should also be negotiated at the time of purchase. Commitment from the supplier to provide on-going upgrades and additions to the system will be a requirement if the system is to develop and meet the challenges imposed by changes in technology and the requirements of changes in regulations and standards.

### Evaluation

Evaluation of the systems took consideration of the multifactorial nature of the derived criteria. The systems were evaluated using a scoring index, taking into account the most adverse conditions for each of the criteria. For example, the user system was considered compliant with all possible adverse environmental conditions (extreme heat, high humidity and poor electricity supply, etc.). Each management system was scored for compliance with the criteria according to the following formula: three for full compliance, two for part-compliance and one for non-compliance. The total recorded scores are shown in *Table 1*.

While the selected criteria may remain the same from institution to institution, the factors affecting the evaluation of a system will change. The following are examples of the factors taken into account when evaluating each system for the selected criteria.

- Environmental – a system affected by extreme heat, high humidity, unstable electricity supply, poor accommodation, etc., scored low and a system not affected scored high.
- Customer support – a system requiring specialised

5. G Kahen and B McSayers, "Health-Care Technology Transfer: Expert and Information Systems for Developing Countries", *Methods of Information in Medicine, Vol. 36, 1997, pp. 69-78.*

**Table 1: Compliance Scores for the Equipment Management Systems**

| Evaluation Criteria      | Equipment Management Systems |             |                    |               |
|--------------------------|------------------------------|-------------|--------------------|---------------|
|                          | User-driven                  | Paper-based | In-house developed | Off-the-shelf |
| Environmental conditions | 3                            | 3           | 1                  | 1             |
| Customer support         | 3                            | 3           | 1                  | 1             |
| User competence          | 3                            | 3           | 1                  | 2             |
| Language                 | 3                            | 3           | 1                  | 1             |
| Culture                  | 2                            | 1           | 2                  | 2             |
| Financial                | 3                            | 3           | 1                  | 1             |
| Maintenance              | 3                            | 3           | 1                  | 1             |
| System flexibility       | 2                            | 3           | 2                  | 3             |
| <b>Total</b>             | <b>22</b>                    | <b>22</b>   | <b>10</b>          | <b>12</b>     |

Scoring formula: Full compliance = 3; Part-compliance = 2; Non-compliance = 1.

support scored low and a system requiring little or no support scored high.

- User competence – a system requiring specialised competence scored low while a system requiring no special competence scored high.
- Language – a system where language could affect its operation was scored low and a system where language was not an issue scored high.
- Culture – a system reliant on a culture of record-keeping scored low while a system unaffected by lack of record-keeping scored high.
- Financial – a system requiring an initial financial outlay and an on-going cost scored low and a system requiring a small initial financial spend and no on-going cost scored high.
- Maintenance – a system requiring on-going maintenance scored low and a system requiring no maintenance scored high.
- System flexibility – a system that would not be affected by change in personnel scored high while a system that could be affected by a change in personnel scored low.

### Discussion

Equipment management systems may not seem a high priority for resource-limited developing countries, but the Irish experience, which had its own development issues in the last few decades, indicates that best equipment usage is achieved by proper equipment management.

Literature that examined equipping issues in developing countries was consulted to establish criteria for selecting and evaluating equipment management systems. The resulting criteria do not reflect the requirements of one particular country. However, it is

felt that they could be used as a template that can be modified to suit any individual situation.

According to the method of scoring, the equipment management system most appropriate for use in a developing country accumulated the highest score. The results in *Table 1* indicate that the user system is the most appropriate for areas that do not have basic utility infrastructural elements. If compliance with standards and legal requirements were an issue then the paper-based filing system would appear to be more appropriate.

Automatic report generation and a broad range of utilities are some of the advantages that computerised systems offer. However, with the additional requirements, it is not surprising that the computer-based systems scored much lower than the paper-based systems. It is believed that many developing countries have certain areas, for example urban areas, with relatively stronger infrastructural elements. In these areas, it may be possible to implement a combination of systems, i.e. a computerised system with a paper-based system for back-up.

### Conclusion

Use of the selection criteria derived by the authors revealed that the paper-based systems, because of their robustness and ease of use, were more appropriate for developing countries. However, where possible, the authors believe it is beneficial to use computer-based systems because of their extra functionality.

Equipment management systems are a useful tool and will contribute to the effective selection and lifetime use of equipment, if the correct system is selected. It is believed that these selection and evaluation criteria can be adapted to meet the various circumstances that might prevail in developing countries.

The criteria could be applied to existing management systems to highlight strengths and weaknesses or, alternatively, could be used to select and evaluate a potential new equipment management system. For future work, this type of selection and evaluation system could be expanded to take a holistic view of equipment management systems at the initial selection stage and include areas such as day-to-day operational requirements and retrieval of information. ■

### Additional Reference

*J Mahady, J McCullagh, P Grainger and R Kinsella, "Some Equipment Management Systems for Use in Developing Countries", IEE Seminar on Appropriate Medical Technology for Developing Countries IEE, Savoy Place, London, UK, 2002.*