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Improving Bed Repair Turn Around Time through Parts Management

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Abstract— **Hospital beds requiring service spend an average of 20 days in the biomedical engineering department at the University of Ottawa Heart Institute (UOHI) due to delays in receiving parts and limited part storage. Analysis of the work orders was completed to determine what parts should be stored onsite to improve the turnaround time. During analysis it was found that more discrete data should be captured in the Computerized Maintenance Management System (CMMS) work orders to provide better insight into part usage and delivery time. This paper provides recommendations for improvements to CMMSs to ensure sufficient information for predictive analysis of parts usage can be collected. These include discrete 'received dates' for purchase order line items, standardizing quantity data for multiunit item orders, and providing user prompts to record parts. Measures which can be implemented in the interim to reduce the turnaround time of hospital beds are also discussed. These measures include completing storage space organization as well as holding work order reviews and stand-up meetings to provide updates on large equipment repairs.**

Keywords— **Parts management, biomedical engineering, corrective maintenance, health technology management.**

I. Introduction

Biomedical Engineering departments are responsible for ensuring clinical teams have the right type and quantity of medical equipment to treat their patients. Many management practices are used to maintain the equipment used in health care including budgeting, procurement, asset tracking and maintenance. An important part of medical equipment maintenance is the management of the spare parts and materials used to keep equipment in working order. Inefficiencies in this area delay the return to service for equipment requiring repair. This causes equipment to fill limited Biomedical Engineering department workspace and impacts the quality, efficiency, and sustainability of health services [1].

At the University of Ottawa Heart Institute (UOHI), the Biomedical Engineering Department often has beds and stretchers in the shop for prolonged periods. An analysis of the 963 hospital bed work orders completed between 2018 and 2023 revealed that it takes an average of 20 days for beds to return to service. Consultation with the UOHI biomedical engineering technologists revealed that these long turnaround times were largely due to lead times for the delivery of ordered parts. Given the variety of bed models used at the UOHI as well as the large size of the equipment and their associated parts, both bed maintenance and part storage take up a lot of space. This makes bed part management especially important to the workflow and function of the Biomedical Engineering Department.

In response to the observed delays in bed repairs, a project was undertaken to improve the turnaround time of hospital beds requiring repairs by optimizing the management of their spare parts. The initial goal of this project was to perform an analysis of the bed part usage history using the department's Computerized Maintenance Management System (CMMS) data to generate a prediction of which parts should be ordered ahead of time and at what quantity and frequency they should be ordered. This would minimize unnecessary parts kept in the limited storage spaces and would prevent delays arising from part ordering. However, an analysis of UOHI's records demonstrated that the CMMS database structure is critical to ensuring all data required for quantitative analysis can be captured in the work history and purchase orders. This paper will outline the challenges found while attempting to analyze data, recommendations for future CMMSs implementations as well as strategies taken to achieve improved turnaround with limited quantitative data.

II. Challenges in Parts Tracking in CMMS

At the UOHI, all medical equipment procurement, installation, and maintenance is managed by the Biomedical Engineering Department. All medical equipment is assigned a unique asset number which allows for the capture of all information related to the asset's life, including purchase information, work history, disposal and other costs associated with the device. When a medical device is due for maintenance or requires a repair, a work order associated with the equipment's asset number is created to track the work done. When parts are used to complete the maintenance or repair, they are to be added to the work order as well. The CMMS is also used to track all purchase orders for new parts and equipment. These purchase orders are opened once the order has been sent to the vendor and are marked as completed once all the items of the purchase order have been received.

The initial plan for this project was to analyze data within the CMMS to determine the usage of the bed parts and their mean reception time, which is the time required for ordered parts to arrive. From these trends, the goal was to determine which parts are most responsible for delays in returning hospital beds to service. However, investigation of the part data revealed that the information entered in the database was not fully reflective of the flow of parts through the department.

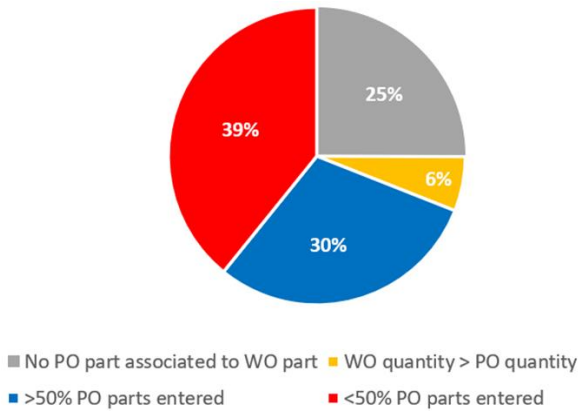

Fig. 1 Comparison of parts included in purchase orders (PO) to parts included in work orders (WO)

For instance, a comparison of the quantity of bed parts listed in purchase orders did not match the quantity of parts used in work orders. As noted in Fig. 1, 25% of the parts analyzed were not associated with a purchase order. This could be due to staff not knowing what PO the part was ordered on, not knowing if spares are on hand, or due to differences in part labelling. For 6% of the parts analyzed, the quantity of parts entered in work orders exceeded the quantity entered in purchase orders. This suggests that more parts are being used than are being ordered. A likely explanation for this occurrence is that in the case of packages of multiple items, a quantity of one is indicated in the purchase order for a single pack, but the pack contains multiple units of a given part which can be entered in multiple work orders. Finally, for 39% of parts analyzed, less than half of the number of parts ordered are reflected in work orders. This means that not all parts are being added to work orders when they are being used.

Other challenges encountered pertain to the reception time of parts, which is the time elapsed between a purchase order being placed and its parts being received. Consultation with the department's biomedical technologists revealed cases where reception time in the database did not reflect the actual wait times for parts. This can be attributed to the fact that purchase orders are not indicated as completed until all parts from that purchase order are received. This means that the reception time of a purchase order is only reflective of the part which takes the longest to receive and is not an accurate representation of the delivery time of the other parts.

III. Parts Management Recommendations

A. CMMS Improvements

There are several practices that can be implemented to improve the accuracy of spare parts usage and reception time data in the CMMS. To maintain inventory accuracy within the database, a reminder or fail-safe should be established to ensure that all necessary parts are added to their corresponding work order. An example of this is a pop-up window that asks the technologist "Have you entered all the necessary parts?" when the status of a work order is changed from 'In Progress' to 'Completed'. To ensure the alignment between the number of parts ordered and the number of parts entered in work orders, items having multiple units of parts should have their quantity and price per unit fields in purchase orders adjusted accordingly. For instance, a four-pack of casters should have a quantity of four and a price per unit that is a quarter of the total cost of the item. Finally, the date fields in purchase orders indicating when the parts have been received should be specific to each item in the purchase order rather than the whole order. This will cause the reception times of items to accurately represent how long it takes for each part type to be delivered.

B. Workflow Improvements

Unfortunately, Biomedical Engineering departments may not be able to implement these recommendations in their existing CMMSs and they should instead be considered when designing and implementing new CMMSs. In the interim of obtaining a new CMMS, the UOHI Biomedical Engineering department implemented several other strategies to minimize equipment turnaround.

Fig. 2 Sections of shelving unit before parts organization

Fig. 3 Shelving unit after parts organization

Firstly, the parts storage space was organized to maintain the accessibility of parts and tools used in bed servicing. Shelf by shelf, all parts were removed and sorted by part type and bed model, where applicable. Once returned to their shelves, these groupings of parts were labelled to encourage new parts to be placed in their assigned location, as shown in Fig. 3. During this process, the storage capacity of the room was also optimized. For instance, additional shelves were added to the existing shelving unit which increased the shelving surface area without increasing its footprint. Furthermore, since it was observed that the headboards and footboards were difficult to access when they were stored in piles, a rack was designed and built to allow these pieces to be stored upright, as shown on the bottom shelf of Fig. 3. Improvements to layout of the storage room were also implemented by taking measurements of the room, its shelving units, and other large equipment and modeling the layout digitally. From this visualization of the floorplan, a new layout was created which placed tools used by all staff members in a more accessible area and created space for an additional bed to be serviced within the room.

Other efforts to improve turnaround time on beds include weekly department standup meetings to discuss the status of beds being serviced. These meetings provide the opportunity for staff to discuss delays they have encountered and to find alternative methods for repairing the equipment when there are large lead times on parts. Finally, the department also performs work order reviews to discuss best practices for record keeping and to ensure the high quality of data in work orders.

In addition to the practices already undertaken by the UOHI Biomedical Engineering Department, equipment turnaround time can be improved by completing an inventory of the parts storage space to have an accurate baseline of the type and quantity of parts available. Additionally, existing CMMS can be reviewed to compare the frequency of use of parts to the number of purchase orders associated with them. If a part is both used and ordered frequently, this is an indication that the part should be ordered in advance and in larger quantities to limit order wait times.

IV. Conclusions

It can be challenging to accurately predict the demand for parts and minimize repair turnaround times due to delays from part ordering. One way to improve this is to collect complete and reliable information on parts usage and reception time. When possible, CMMSs should be implemented with the following features to allow for accurate collection of part usage and delivery time. A protocol or reminder should be created to ensure that all used parts are added to their corresponding work order. In purchase orders, quantities and unit prices must be altered to reflect packages with multiple units and most importantly, a date field must be added to indicate the date that each part was received. With these changes, a predictive analysis of part demand is possible. Until this data can be collected, strategies to improve turnaround time include holding meetings to review best data entry practices and provide updates on the repair status of large equipment, organizing storage spaces and using existing data to determine some of the parts which should be ordered in advance.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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