TITLE: A BATTERY MANAGEMENT PROGRAM CONTRIBUTES TO PATIENT SAFETY

AUTHORS: Robblee,J. Cleland,M. Zakutney,T.

OBJECTIVE: The objective of the study was to determine an effective method for analyzing the batteries in IV infusion pumps to insure that the pumps provide sufficient run time to prevent unexpected failure during transport or power disruption from any cause.

METHODS: Background: A patient who required significant hemodynamic support following an aortic valve procedure suffered an adverse event during transport to the Critical Care Unit when the battery failed on an infusion pump that was delivering vasoactive medications. A sentinel event review was done and recommended that a preventative maintenance program for batteries that power mobile medical devices be developed. The study was undertaken on IV infusion pumps.
Problems with intravenous infusion pumps are an important cause of mishaps that can seriously affect patient safety. Failure of rechargeable batteries is one of a number of possible causes of errors that may lead to adverse events.
As IV infusion pumps were returned to Biomedical Engineering for maintenance or planned preventative maintenance, the batteries were removed and tested. A convenience sample of 100 batteries was selected for testing. Capacity measurements were determined for each pump (n=100) using fully automated Cadex Battery Analyzers. Each battery was subjected to a complete capacity analysis.
An infusion pump was equipped with a single battery and set up to deliver an infusion at 100 ml/hr and allowed to run until it shut down. The time to alarm and the time to shut off were recorded. The spearman correlation was used to provide a measure of the strength of linear association between variables. Diagnostic testing methods were used to determine if the battery capacity could be used to determine when batteries should be removed from service. A run time of greater than 180 minutes was chosen as the optimal time (reference standard) since this is the time required for a safe transfer of a patient from the CSICU for an MRI procedure on a nearby campus and return to the original location. A receiver operating characteristic curve (ROC) was used to determine the cut point for battery capacity that has the optimal sensitivity and specificity to achieve the run time of greater than 180 minutes

Results: There was a strong positive correlation between battery capacity, the time to alarm of the pump ($r = 0.93$, $p < 0.001$), and the run time of the pump ($r = 0.93$; $\rho < 0.001$). As battery capacity decreases, the remaining run time prior to failure decreases.
Using diagnostic testing methods, the optimal cut point for battery capacity to detect a run time greater than 180 minutes was 40%. There is good sensitivity (73%) and specificity (100%) at 40%. Using these same methods, it was possible to show that at a capacity greater than 40% can detect a time from alarm to failure greater than 30 minutes with a sensitivity of 81% and specificity of 83%.

Conclusions: a) It is important to ensure that batteries on mobile medical devices are sufficiently reliable to function when necessary.
b) The project achieved the objective of determining that battery capacity is an acceptable method of evaluating battery performance.
c) A battery management program was developed for all mobile medical devices in the organization.