SCOTT-CLARK MEDICAL™

TURN THE POWER ON…

THE FUTURE OF HEALTHCARE

IS TO HELP CHANGE IT…

Flexible Mobile Cart Power Technology

Scott-Clark Medical

May 1, 2016

Management Overview

"Mobile Carts," or Computers on Wheels have been in service in U.S. hospitals since 1995 and have been useful yet bothersome to clinicians ever since. The bulk of complaints along and highest support costs center on the operation of the necessary battery subsystem that powers the carts. This document introduces a powerful unique power system that addresses reliability, support, functional improvements and cost in an effort to improve user acceptance. *The product is designed to simplify cart use*.

Scott-Clark Medical employs some of the pioneer designers of the hospital workplace tool commonly called Mobile Cart. We hold that if there is a greatest difficulty with battery subsystems it stems from the need to have a ready source of reliable electrical energy on a moving device that has no scheduled rest period. Various attempts have been made over the years to make that energy source longer lasting, lighter weight, safer and with a longer service life. As new energy storage technologies appear, each is examined for its suitability to improve power to these mobile carts. This search is aimed at providing an unlimited, simple, reliable and safe source of electrical energy at the lowest possible cost.

One improvement in this area is with a power system that allows an exchange of an exhausted battery from the mobile device with a freshly charged replacement on "dry land." Here again, compromises are necessary. The movable battery must be lightweight, save to move without dropping and durable to be handled and live through accidental impact with floors when it does slip from a user's hand. To approach "inexpensive," it might be small or made of the cheaper battery cell chemistries. Even at that, it will carry a cost premium.

In recent years hospitals have increasingly specified these swappable battery systems in their purchases. Some do so because an internal survey has shown that many or even most users prefer the battery swap method. This choice is sure to leave those users unhappy who voted against, of course. A power system that allows both methods might be preferred. That is, a power system whose battery modules can be charged off-cart AND on-cart, at the option of each user and according to the need of the moment.

Such a system is now available, and we offer its description here. We call it the Flexible Mobile Cart Power Technology (FMCPT), and it is offered as a standard component on Scott-Clark's line of Workstations on Wheels and as a retrofit on otherwise suitable carts in use, and through select partners on new carts. FMCPT products are listed under IEC 60601-1 "Medical Grade" as a complete power system for both US and international markets.

Use

FMCPT can power most mobile carts, and in all cases the need for operator attention to the power status is minimized. A bright but small intuitive state of charge indicator displays charge status at all times. Also, if the user peeks at the battery pack, a small bright LED display with the same pattern showing the charge status can be seen. These indicators give the user confidence that the cart will continue to be powered for a known period of time. This indicator displays both state of discharge and recharging progress. Finally, a Last Hour Alert on the user-facing display lights up when the cart has about one more hour of use and flashes when that is about half gone. That amber light might be the only indicator many users pay attention to.

When a previous user left the batteries in a low charge condition, the user can immediately exchange one or both batteries and be prepared to run the cart without delay.

Choices

Lithium ion battery chemistry brought in many improvements over the sealed lead acid batteries that were commonly used in earlier mobile carts. Among these improvements are lighter weight, longer service life and faster charging options. Less well known are a flatter discharge voltage profile, far better "holdout" and the ability to manage and monitor the battery far more accurately. Some cart makers focus on the lighter weight quality of lithium ion power and the contest to see who can promise the longest service life, usually measured in battery "cycles."

Our choice of chemistry was guided by our desire to implement the safest of the technologies having also the longest service life (as lithium iron phosphate, "LiFe," or "LiFePO4" cells have). News reports about failing lithium batteries of a different chemistry on new passenger aircraft are unsettling to hospitals. We agree that potentially dangerous technologies in the hospital hallways or patient rooms is unacceptable. It seemed to us that the benefits of these lithium-based batteries are great enough to manage the risk rather than discard lithium-based chemistries altogether. So, our choice from the available lithium batteries has a slightly larger footprint, weight and cost but is the safest and has a much longer service life. We believe we have overcome the cost disadvantage by judicious engineering and the weight by other means.

Because most hospitals decide their purchases by first evaluating technical elements, followed by financial comparisons, service life and even safety considerations can get lost in the second step. This is made worse by the fact that the lithium chemistries most prone to disastrous failure are also the least costly. To provide the optimal battery technology in hospitals we have chosen to use lithium iron phosphate chemistry in our new FMCPT product for the present. In addition, we have also implemented a group of safety-specific software routines that continually search for problems in the batteries and the demands of the powered devices, ready to quickly shut down upon detecting a problem.

A great benefit of our lithium iron phosphate chemistry choice is its long service life. In the past five years, some hospitals have found that the warranties on carts and computers can expire before the batteries reach their end of life. Where a sealed lead acid battery might live through 400-600 charge cycles, and NiMH cells might live through 1,000, lithium ion batteries might last 1,200 cycles. Our newer LiFePO4 chemistry cells will live through 4,000-5,000 full discharge/charge cycles before expiring. Most experienced users of lithium ion battery systems are now unwilling to consider bringing in anything other than LiFe chemistry. A safe and lightweight power system like this that can easily transition to a hospital's current and new carts makes sense. That it is likely to have over twice the service life should factor into the cost.

System Design

Our FMCPT kit is comprised of one or two battery packs mated to an intelligent controller/charger ("BCS"). The controller provides interconnection among all system elements: source power, output power, batteries, monitoring and command. This new product performs tasks that greatly ease the burden on the cart user by automatically:

- Supporting hot-swap function without interruption
- Monitoring battery health and safety
- Choosing the more suitable battery to be on-line at all times
- Intelligently managing on-cart charging to maximize energy flow to the batteries
- Directing electrical energy to the cart from a battery or from a wall outlet when the cart is plugged in and batteries are charging
- Providing constant state of charge status to a light array and to the cart's computer
- Aggressively alerting the user when there is only one hour of battery life remaining

Using the system is simple and requires little more than familiarity with an automobile gas gauge. There is no penalty for allowing this battery chemistry to fully deplete, even with every cycle. These batteries do not develop a "memory," and have no long or short term effects from frequent full discharges or partial recharges. So, a user can ignore battery charge until the alert light appears indicating that one hour remains.

In a two-battery system, batteries are used in sequence, and the battery selection criteria for discharge are simple-we concluded that if there are two batteries on board, one should be emptied before the second is brought on line.

Charging

Battery recharge takes place while batteries are either on the cart attached to a wall outlet or while inserted into a Charge Station. The current Charge Station is a wall mounted assembly holding and charging two batteries. An enhanced State of Charge Indicator is equipped with a small TFT color display and icons clearly showing battery status. This new product is designed to provide three services, in order:

1. Provide diagnosis of every inserted battery, displaying test results in bright colors indicating battery status
2. Provide additional assurance to management and technical departments that the battery system is working properly
3. Charge batteries

The battery on a poorly- or non-functioning cart can be immediately qualified by a user using this new service.

In charging mode, we believe that the battery nearest being full should be charged before the other. Both of these modes are modified slightly: Lithium iron phosphate chemistry charges at a fast rate until about 85% capacity is reached. Energy absorption then gradually slows until the charge is complete. We honor this characteristic to maximize energy absorption during the time the cart is attached to the wall. When BCS in charge mode notices that one battery has reached 85%, it switches to charge the second battery until it also reaches 85%. Both batteries are then charged at the lower rate until the batteries are full or the cart is disconnected from the wall outlet. This feature is intended to absorb maximum energy into the cart in the time it is parked.

This routine is overruled in part if BCS determines that one of the two batteries has a much higher cycle count than the other, as recorded in internal records of all charge events. We suggest that a hospital will want all batteries to wear at similar rates, so BCS accelerates the use of new and otherwise less-used batteries where it can. This decision is invoked when the difference in cycle count exceeds 800, so it will not be a common event.

We limit our charge rate to a safe rate just under C/2, where C is the capacity of the battery. So the FMCPT charger will bring an exhausted battery to 85% in about two hours, the minimum time for a safe charge.

When BCS is attached to a wall outlet and able to charge, the batteries are taken off line for charging, and the cart is then powered from the wall outlet. This is done without interruption of power to the computer and without exposing the leakage to ground of computers and displays to the wall outlet.

Final Note

A power kit that gives maximum flexibility as FMCPT does has a distinct advantage for users who are not inclined to become familiar with the technology of batteries and charge rates. They can and usually will adapt to the cart quickly if it offers useful work assistance and improved time use and safety. This power system is the result of strategic design of powered cart products to the healthcare market for over twenty years and is the best that can be done using today's chemistries and controls. Chances are good that your current cart supplier can fit FMCPT to your carts economically. Call us for assistance.

Scott-Clark Medical

Scott-Clark.com

512-756-7300

Addendum

Objections

The capacity is right, why does it weigh more than others?

In the interest of safety, we selected LiFePO4 chemistry, the safest and longest-lasting among current rechargeable lithium batteries. The tradeoff is larger size and weight. In particular, it takes more individual battery cells to provide the capacity than other chemistries.

It costs more, why?

Although the cost of these battery cells is coming down, our battery will cost more than the old lead-acid variety and even other lithium chemistries. Calculations show that the longer service life of LiFe battery chemistry overrides the higher cost.

The battery could be prettier

We agree, but it would be impossible to get all 72 individual cells into a smaller package. Besides, the advanced operation of FMCPT overcomes any visual disadvantage, just like an ugly bird dog can. Users are happy to see FMCPT once they see how it works.

Why should we believe the long life claims?

No need for blind faith on that-the warranty provides for advance replacement during the first three years and prorated credit towards a replacement for two additional years until the battery provides 3,000 full discharge/charge cycles.

Discharging

When two batteries are being supported, our control system is programmed to first discharge the battery with the lower state of charge until it reaches a safe minimum condition. It then switches to the second battery until it is reduced to about one hour of energy, then turns the alert light on.

How Many Batteries?

Single

BCS is designed to support a cart where only one battery is mounted on the cart. Our battery packs hold 320 watt-hours of energy, so a one-battery kit can make sense for many configurations. The math involved shows that a laptop by itself, for instance, will exhaust a fully charged FMCPT battery in 10-12 hours. Since the off-cart charger will renew that battery in less than three hours, a good kit for a laptop cart is the BCS and one battery on the cart and one battery off the cart. The judicious reader will quickly see that even this is more batteries than required, and that two or three carts can be supported with a total of four batteries.

Battery exchange on a single battery cart is done by first attaching to a wall outlet and exchanging the battery from a wall charger, then unplugging the cart and getting mobile again. As an alternative, the cart can be provisioned with two battery holders for the user to swap in a fresh battery, without the need to attach to a wall outlet. In other cases, a laptop's internal battery serves to keep it operating through a battery exchange. All swaps are supported by fast internal switching to eliminate even momentary loss of power to the cart.

Dual

The electrical load of a fully equipped medication cart has been too heavy for swapping battery systems until now. The energy demands of an electrically operated lift can push such a cart's demands over the limit of today's swappable batteries, if that were not already done. FMCPT permits a constant load of more than 170 watts and occasional load even greater. FMCPT will, then, support most popular small form factor desktop computers and very large display, an electric lift, an electronically locking drawer case and bar code charging station on a swapping battery power system.

Note that a dual battery FMCPT kit holds 50AH (over 600 watt-hours) of energy, making it the largest useful energy store that can be found on any current WOW, and is 50% larger than the most frequently used fixed lithium ion battery system. FMCPT is a very capable power system even for users who do not want to exchange batteries.

Applications

As described above, Scott-Clark's new power system is a game-changer for hospitals that have come to depend on computer carts. Users whose workflow demands or have a preference can make good use of swapping cost-efficient single battery kits. Others with heavier electrical loads can also swap or not,

according to preference or workflow demands. Hospitals with limited budgets and older carts might consider breathing new life into them by replacing the power system with FMCPT.

Hospitals considering first time buys or replacement programs should look to FMCPT to enhance their cart population with these advanced power systems. The medical grade UL listing makes them suitable for supporting medical equipment of other kinds.

PACS Viewing

A PACS viewing cart is likely to have one or more very large displays and an unusually power-hungry computer to drive them. FMCPT can be installed in special arrangements, supporting four or even more battery packs to operate extended time and load by battery exchange.

Infection Controlled Rooms

Because FMCPT takes the batteries off line and powers the cart from the wall outlet while charging, it is a computer cart's ideal power system for rooms where the cart is usually stationary but must occasionally be mobile. Smart charging protects the batteries in that environment and keeps the cart ready for use at all times.

Vital Signs Monitor

A vital signs cart need never be plugged to the wall again, making it truly a 24 x 7 tool. In the case of two medical devices on a pole cart, FMCPT can provide uninterrupted power for the cart's nonstop use.

Unexpected Use

The FMCPT battery pack is lightweight and holds a surprising amount of energy. It is suitable for uses other than point of care mobile carts like gurneys, medical equipment that is not otherwise mobile, camera carts and other telemedicine equipment, and equipment that is mobile only occasionally.

Off-Cart Charging

To support battery exchanging, we offer a wall-mounting charging station that will simultaneously charge two batteries and report on each battery it sees as to condition, wear and other metrics.

Support

FMCPT is assembled and supported through our manufacturing partner Ultralife, Inc. Batteries carry a warranty against manufacturing defects for three years or the equivalent of 3,000 full charge cycles. A battery that holds less than 75% of the original nominal energy capacity will be replaced with a new unit without charge, beyond freight cost. Additional two years' warranty is provided as standard on a pro-rated basis. The electronics supporting the batteries carry a Manufacturing Defects warranty for three years. Application-specific applications and difficulties can be addressed by engineering resources from Scott-Clark. These services are subject to fees, depending on the nature of the tasks.

We welcome and support retrofit installers who help their customers extend the useful lives of older equipment with new components.

Alternatives

Hospitals now have more than one way to provide non-stop use of mobile carts. Most swapping battery designs use the less expensive lithium ion choices discussed above and few include an intelligent management method similar to FMCPT. The system provides superior service by virtue of its comprehensive control and management tools. Key differentiators are the intelligent control, quick charging method and high capacity discharging to support power hungry carts.

Some reviewers point out that the major feature of FMCPT is that all users of mobile carts are given some measure of relief in managing their cart power because they can choose to stop a few times during a shift for charge, exchange batteries for non-stop use, or switch between these choices at will.

Summary

An optionally removable battery with high charging and discharging rates can improve performance of Workstations on Wheels and other battery powered equipment. Having a choice of exchanging batteries or the traditional method will increase user satisfaction. As with all hospital equipment choices, safety is paramount. FMCPT features the best choice in all three areas.

_____

James S. Boyd
Chief Technology Officer
Scott-Clark Medical