Project Update

Ergonomics

Pill Crusher and Medication Cart Update

Background

In most healthcare settings, medications are prepared and delivered to patients several times per day. This often requires nurses to use a manual pill crusher (see photo) to crush pills for patients who have difficulty swallowing. The pill crusher is usually placed on top of a medication cart.

A standard pill crusher consists of a metal head attached to a lever arm.

The working surface height of most medication carts is in the range of 37" to 43", which is a height suitable primarily for precision tasks such as reading, note-taking, pill counting and pill sorting, but not for the more physical task of crushing pills. The height of the medication cart, in combination with the design of most existing pill crushers, results in awkward shoulder and wrist postures when nurses use the pill crusher. Due to the large number of patient medications that must be delivered each day, highly repetitive movements are often required. Forceful exertions are also sometimes required to push down on the lever arm of the pill crusher. These risk factors have been associated with an increased risk of musculoskeletal injury (MSI), particularly when they occur simultaneously. Signs and symptoms of MSI and complaints related to pill crushing are common among nurses.

Awkward postures and forceful exertions are required to push down on the lever arm of a standard pill crusher.

A standard medication cart.

Focus Group / Workshop

In response to concerns raised by nursing staff, OHSAH sponsored a two-day workshop in October 2000, at which nurses, care managers, and safety professionals from across British Columbia discussed pill crushing and medication cart problems and explored ways of addressing these concerns.

Pill crusher: At the initial workshop, the focus was primarily on pill crushing issues and concerns. Participants identified several problems including, among others:

- Airborne dust
- Awkward shoulder and wrist postures, contributing to wrist, shoulder, and neck pain
- Excessive force
- Highly repetitive motions
- Poor position on medication cart (clutter, storage, height of working surface)

OHSAH

in partnership with:

BCIT Health Technology Research Group

OCCUPATIONAL HEALTH AND SAFETY AGENCY FOR HEALTHCARE IN BC
#301 – 1195 West Broadway
Vancouver, BC V6H 3X5
Canada

TEL 604.775.4034
1.800.359.6612
FAX 604.775.4031
WEB www.ohsah.bc.ca

Medication Cart: Concerns about the pill crusher were closely linked to concerns about the medication cart. Participants identified several problems with standard medication carts:

- Height is the primary issue – the working surface height tends to be too high
- Medication carts are used for two different activities which require different work surface heights (crushing pills and filling out patient charts)
- Heavy and difficult to maneuver
- Difficulty accessing drawers
- Inadequate working space

A key outcome of the workshop was a collaboration between OHSAH and the British Columbia Institute of Technology (BCIT) Health Technology Research Group to research, design, develop, and test new pill crushing and medication cart prototypes.

Risk Factor Identification

Staff interviews and direct observations were conducted in acute care and long term care facilities to identify task requirements, understand the work environment, and identify risk factors associated with pill crushing.

Prototype Development - Pill Crusher

Automation of the pill crusher seemed to be the best way of eliminating physical risk factors. Five automated prototypes were developed and tested.

1) A metal piston that moved up and down repeatedly against the pills: This prototype generated excessive noise and did not adequately crush the pills.
2) A roller system through which a plastic bag containing the pills was inserted: This prototype did not generate enough force to crush the pills without destroying the bag. The plastic bag also tended to explode as a result of trapped air.
3) An ultrasonic probe that emitted high frequency sound waves to pulverize the pills in a liquid medium: This prototype was expensive and needed to be cleaned after each use.
4) A removable rotating blade that ground the pills in a liquid medium: This prototype generated excessive noise and the removable blade presented a safety issue, as well as an additional cost.
5) Of the five automated prototypes developed for this project, only one successfully met all of the design requirements (see box on next page). The fifth prototype consists of a rotating piston that simultaneously compresses and twists to crush the pills. To operate the device, pills are placed between two medication cups. The cups are then placed in the crushing chamber and the door closed. The crushing operation is started by pressing two buttons placed on either side of the top portion of the housing. Crushing takes approximately 20 seconds, during which time the operator can perform other duties such as preparing additional medications or chart writing. The device has multiple safety features to prevent fingers being accidentally crushed and also has a digital display to alert the operator of a low battery level.

Left: The automated pill crusher (prototype #5). Pills are placed between two medication cups and placed on the plastic base, which is then rotated closed to seal the crushing chamber.

Prototype Development - Medication Cart

One prototype of the medication cart was developed. The new automated and height-adjustable medication cart is highly flexible, with the capacity to be adjusted in height for

Design Requirements and Constraints

At the initial focus group, stakeholders verified pill crushing issues and identified functional and user requirements for both a new pill crusher and medication cart.

Pill Crusher

Functional Requirements

- Crush pills into powder form within 20 seconds
- Control powder dispersal into the air
- Prevent cross contamination of different medications
- Durable and strong
- Compatible with existing medication carts.
- Require minimal force to operate
- Crush pills quietly

User Requirements

- Safe to operate
- Easy to operate
- Easy to clean and maintain
- Must not add tasks/steps to the process

Medication Cart

Functional Requirements

- Account for two different tasks that require different working surfaces: 1) pill crushing and 2) preparing medications, reading charts (precision work)
- Height-adjustable
- Drawers and storage space must accommodate all standard work equipment and materials
- Must have space for pill crushers
- Must not require excessive force to push when fully loaded
- Durable, strong, and stable

User Requirements

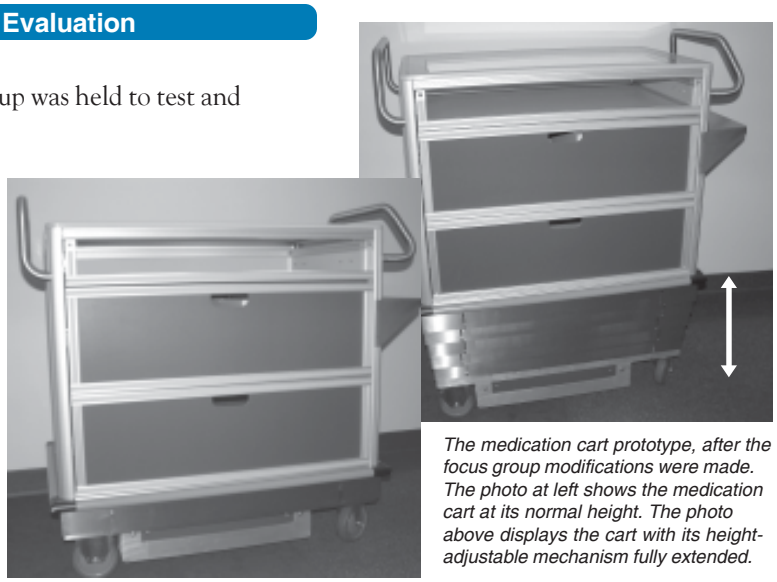
- Height-adjustment mechanism that is easy to operate
- Easy to maneuver
- Must have sufficient work surface space
- Easy to access drawers that minimize awkward postures
- Compatible with pill crusher operation
- Handles that allow for neutral wrist and forearm postures and a comfortable grip
- Easy to clean

each user. With a vertical height range of 10 inches, the cart can accommodate most of the general population (5th percentile female to 95th percentile male of the US population). A fixed shelf was also added to the side of the cart and placed at a lower height than the main work surface. This shelf is intended for a manual pill crusher, if required, with the lower height reducing risk of injury for care staff who crush pills.

To address the issue of inadequate working space, the top of the medication cart is equipped with a clear window, offering a view through to a shelf below (which easily slides open), upon which patient charts or the MAR binder may be placed. This increases the amount of working space available on the top of the cart. The new design includes ergonomically correct handles and high-quality castors to improve maneuverability and minimize the pushing forces required to move the medication cart. A locked box has also been added inside the main drawer of the medication cart to limit access to narcotics and other sensitive drugs.

Testing and Evaluation

In September 2002, a focus group was held to test and evaluate the medication cart and the pill crusher prototypes. Focus group participants provided feedback on the functionality and ergonomics of the prototypes through a group process that involved guided simulation of activities, round-table discussion, and a questionnaire for each of the pill crusher and medication cart concepts.



The medication cart prototype, after the focus group modifications were made. The photo at left shows the medication cart at its normal height. The photo above displays the cart with its height-adjustable mechanism fully extended.

Based on the feedback obtained from the focus group, additional modifications were made to the prototypes to satisfy the needs of the users. These include modifications to decrease the noise level of the pill crusher and permit easier access to the pill crushing chamber. Based on feedback from the focus group, the height adjustment mechanism of the medication cart was automated (the prototype depended on a manually-operated mechanism). Participants were also asked which handle configuration they preferred for the cart. As a result, two handle configurations were added, with one vertical set of handles placed on one side of the cart and another set of handles placed at a 45 degree angle on the other side.

Next Steps

Since the focus group, OHSAH has worked to secure patent protection for the pill crusher. OHSAH is now investigating several options for commercialization, and is seeking to establish a business partnership with manufacturers, in an effort to keep the pill crusher affordable for healthcare facilities across the province. This process is complex, and will require time to successfully secure a manufacturing partner, or similar arrangement, that will ultimately result in the availability of an automated pill crusher product.

The medication cart is now undergoing a similar process, as we are in the initial stages of filing for patent protection. Subsequent to filing for a patent, commercialization of the medication cart will be pursued.

The logistics of usability trials for both the pill crusher and medication cart prototypes are also being discussed. If funding can be secured to develop additional prototypes, users will be invited to trial these new devices, providing us with further feedback on their effectiveness.

Details related to the development process for these prototypes will continue to be made available on the OHSAH website (**www.ohsah.bc.ca**). News pertaining to commercialization and usability trials will also be updated on a regular basis.