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Clinical research article

A "Neurological Emergency Trolley" reduces turnaround time for high-risk medications in a general intensive care unit

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ABSTRACT

Objectives: To reduce medication turnaround times during neurological emergencies, a multidisciplinary team developed a neurological emergency crash trolley in our intensive care unit. This trolley includes phenytoin, hypertonic saline and mannitol, as well as other equipment. The aim of this study was to assess whether the cart reduced turnaround times for these medications.
Research methodology/design: In this retrospective cohort study, medication delivery times for two year epochs before and after its implementation were compared. Eligible patients were identified from our intensive care unit screening log. Adults who required emergent use of phenytoin, hypertonic saline or mannitol while in the intensive care unit were included. Groups were compared with nonparametric analyses.
Setting: 33-bed general medical-surgical intensive care unit in an academic teaching hospital.
Main outcome measures: Time to medication administration.
Results: In the pre-intervention group, there were 43 patients with 66 events. In the post-intervention group, there were 45 patients with 80 events. The median medication turnaround time was significantly reduced after implementation of the neurological emergency trolley (25 vs. 10 minutes, p = 0.003). There was no statistically significant difference in intensive care or 30-day survival between the two cohorts.
Conclusion: The implementation of a novel neurological emergency crash trolley in our intensive care unit reduced medication turnaround times.

Implications for clinical practice

- Our "Neurological Emergency Crash Trolley" contains neurological/neurosurgical equipment and medications, and can be brought to a patient's bedside during admissions/crises
- After implementation of this trolley, our median medication turnaround time was significantly reduced from 25 minutes to 10 minutes
- Adoption of the neurological crash trolley design in other intensive care units could lead to significant improvements in medication delivery times

Introduction

Medication-related errors, including medication delays, have received much attention as a major source of preventable harm to hospital inpatients (Institute of Medicine, 2000). Medication *turnaround time* is the interval between when a medication order is made (written or verbal) and it is administered to a patient. In a survey of 891 American nurses, Balas et al. (2004) showed that delays accounted for 33% of medication errors. Interventions that focus on reducing medication turnaround times, such as the implementation of electronic order systems, may be associated with improved patient outcomes (Mekhjian et al., 2002).

Neurological emergencies are common in the intensive care unit (ICU), with one large single-centre study showing that 12.3% of patients admitted for non-neurologic diagnoses subsequently suf-

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A. NEUROLOGICAL EMERGENCY TROLLEY

B. TROLLEY CONTENTS:

Top of trolley: External ventricular drain kit (EVD; not shown)

1st drawer: Medications, including 3% HTS, mannitol, phenytoin

2nd drawer: Supplies for all drugs (IV tubing, secondary sets, filters, mini-bags)

3rd drawer: Reference section (ventriculostomy "fast facts", ICP policy, drug guide for the medications found in 1st drawer, laser levels and flashlight, EVD and ICP monitor manuals)

4th drawer: Physician related supplies (gloves, gown, hairnet, sutures, razors, local anaesthetics, vials of normal saline, transducer and extra EVD drainage bag)

5th drawer: Craniotomy drill kit

6th drawer: ICP monitor/sensor, and cable for monitor interface

Fig. 1. (A) Photograph of neurological emergency trolley at its storage location in the intensive care unit. (B) Table of trolley contents, organised by drawer.

fered from a neurologic complication (Bleck et al., 1993). An earlier study by Isensee et al. (1989) suggested this number could be as high as 33%. These emergencies include stroke, intracerebral haemorrhage, seizures and encephalopathy. The occurrence of these neurological complications is associated with significant morbidity and mortality (Naik-Tolani et al., 1999) and treatment delays can be detrimental to patient outcomes. Cheng (2016) showed that a prolonged time to treatment initiation of status epilepticus was associated with increased mortality and functional status. Treatment of neurological emergencies requires specialised equipment and medication that may not be contained within standard ICU crash trolleys or stock rooms.

"Crash trolleys" are mobile units containing emergency life-support equipment and medications. Created in 1967 by an emergency room nurse who was looking for a way to save time during in-hospital emergencies, crash trolleys are now standard in the ICU (Fadale et al., 2000). Trolleys have been adapted to serve specific purposes, such as "difficult airway" trolleys, central venous access trolleys and fibre-optic bronchoscopy trolleys (Thompson et al., 2012). However, despite the high rate of neurological emergencies in the ICU, there are no reports on the use of a neurological emergency trolley.

In 2012, a multidisciplinary critical care focus group was formed at our institution with the objective of devising and implementing a "crash trolley" for neurological emergencies. Members of this team included the ICU Safety Coordinator, ICU Pharmacist, the Neurocritical Care Clinical Educator and a Neurologist who was completing his fellowship in adult critical care medicine. The medications that the trolley contains are phenytoin, mannitol, and hypertonic saline (3%) as well as the equipment required for their intravenous (IV) administration (including tubing and filters). Complete contents of the cart are listed in Fig. 1. The trolley was implemented in our ICU in September 2012. The implementation was coupled with both didactic and hands-on educational sessions for bedside nursing staff. Since then, all new staff receive orientation to the trolley and its contents, its use during neurological emergencies has become standard practice.

From an operational perspective, we use the neurological emergency crash trolley much like any other emergency trolley in the ICU. It is stored in a central location within our unit and brought to the outside of a patient's room when its use is anticipated. Typical reasons for bringing the neurological emergency crash trolley to a patient's room would include a new neurological/neurosurgical admission or a crisis arising in a patient's room with a known neurological/neurosurgical diagnosis. From its location, it would take maximum 3–4 minutes to arrive at any patient room. The stock is maintained by pharmacy technicians who ensure used and expired medication trays are replaced in a timely manner.

In this retrospective cohort study, we report on our four-year experience with the trolley and analyse its impact on medication turnaround times for the delivery of phenytoin, mannitol and hypertonic saline for neurological emergencies in the ICU.

Methods

This was a retrospective cohort study of adult patients admitted to our 33-bed closed medical-surgical ICU, which also serves as the region's level 1 trauma center. Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board approved this study (File # # 6018118). Where applicable, our results conform to the "Strengthening the reporting of observational studies in epidemiology (STROBE)" guidelines.

The neurological emergency crash trolley was implemented in the ICU on September 4, 2012. In order to determine its impact, the medication turnaround times for approximate two year epochs before and after its implementation were compared. The "post-implementation" epoch begins June 2013, to allow a period of time for ICU health care providers to be oriented to the use of the neurological emergency crash trolley. As this was an exploratory study, a sample size calculation was not performed.

Eligible patients were identified from the ICU research screening log, which tracks all patients admitted to the ICU on weekdays only. All adult (age >15) patients admitted to the ICU with a diagnosis that carried a high likelihood of requiring one of the medica-

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