RUTGERS

School of Nursing

Nurse Anesthesia Program

Simulation-Based Training with Cognitive Aids to Increase Provider Preparedness for Intraoperative Malignant Hyperthermia Crisis

Russell Lynn Memorial Student Lecture Series

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NO DISCLOSURES

There are no financial disclosure(s) or conflicts of interest with the material in this presentation

Background & Significance

- Malignant Hyperthermia (MH) presents as hypermetabolic crisis when susceptible individuals are exposed to volatile agents and/or succinylcholine
  - Can occur intra-op, post-op, and even after multiple prior anesthetic exposures
- Occurs in **1:100,000** people
- MH is a *low frequency,* **high risk** crisis
- For every 10 minutes dantrolene/ryanodex administration is delayed from time of symptom onset, complications substantially increase
- Patient outcomes **directly** linked to *prompt recognition, response, and treatment* by healthcare professionals
- Anesthesia professionals are:
  - Often first-line in the initial recognition of MH
  - Commonly designated as leaders in perioperative crises
- Few providers have experienced an MH crisis, and therefore lack confidence in proper recognition and management

Synthesis of Evidence
Literature Review

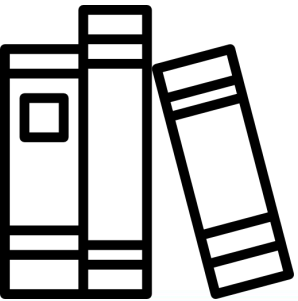
1) Simulation-Based Training (SBT)

- SBT Increases critical thinking, knowledge, and confidence that would take years to acquire due to infrequent nature of real-life events
- Provider knowledge of emergency protocols is reinforced with regular SBT
- Biannual education through simulation increase retention of skills
- SBT allows for identification of site-specific needs to crisis management
- Improves retention compared to classroom-only approaches

Synthesis of Evidence
Literature Review

2) Use of Cognitive Aids

- Checklists may be considered in two categories:
  - Those that are used electively and routinely
  - Those that are used in emergencies and rarely
- Improves technical and non-technical skills in emergency management
- The addition of a checklist can hasten the time to treatment with dantrolene during simulation training
- Addition of cognitive aids increases completeness of care



Current Guidelines

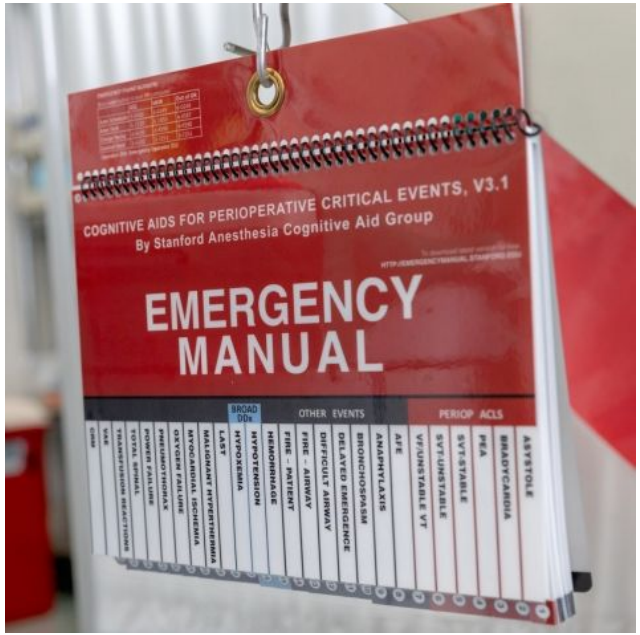
- Lack of universal protocols for MH preparedness
- According to the Malignant Hyperthermia Association of the United States (MHAUS) training requirements are facility dependent, however, it is suggested that a MH mock drill be performed annually

Project Site:

Englewood Health Medical Center (EHMC)

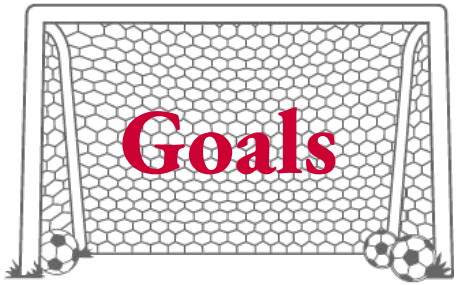
- Staff at EHMC receive annual MH training via a virtual module
- Successful prior simulation-based training scenarios
- Staff are not familiar with MH cart location/contents
- Lack of familiarity with the Stanford Emergency Manual

Aims



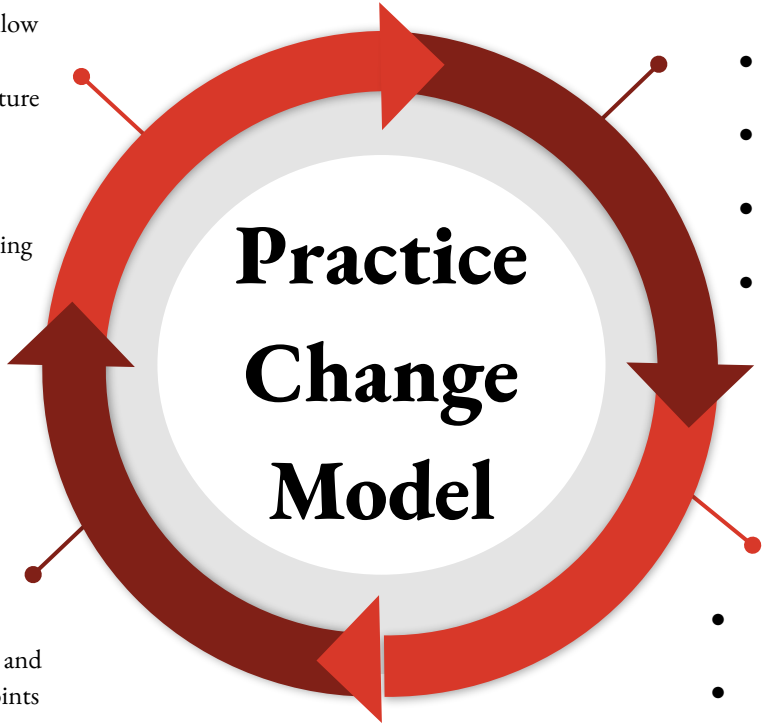
<u>Implementation of simulation-based training</u> to increase provider preparedness for an intraoperative MH crisis

<u>Introduction of the Stanford Emergency Manual as a cognitive aid</u> during a debriefing session after the initial simulation training scenario to encourage providers to utilize this guide during real life crises



1. Increase provider proficiency in recognition & management of an MH crisis
2. Increase awareness and promote provider utilization of the Stanford Emergency manual for MH
3. Project that can be replicated by future RRNA's and the EHMC Anesthesia Department

Practice Change Model



PLAN

- Propose quality improvement project to EHMC
- Obtain IRB approval from EHMC & Rutgers University
- Gather anesthesia team and assess baseline knowledge
- Prepare simulation along with hands-on items
- Assign members to OR rooms for simulation experience based on staff schedule

DO

- MH education in-service on June 21st, 2023
- Perform MH crisis simulation experience followed by debriefing sessions on July 26th, 2023 & September 27th, 2023

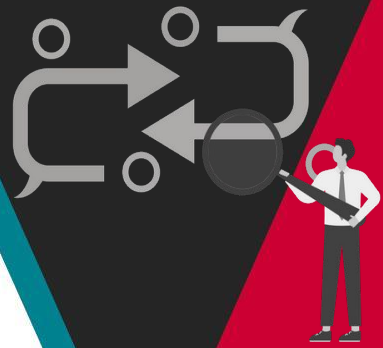
STUDY

- Analyze objective and subjective data points obtained from four simulation experiences

ACT

- Present data to EHMC staff in follow up
- Provide infrastructure of simulation to EHMC as part of annual MH crisis management training

Methodology



Site/Population: Englewood Health Medical Center (EHMC) Anesthesia Department in the Main OR area

June 21st, 2023: In-service education session for the anesthesia department

- Description of MH, prevalence, implications in practice, and management of acute crisis
- Interactive session with staff, utilized for CE credits

July 26th, 2023: First implementation day

- 31 total staff divided into two 30-minute sessions
- Data collected on key action items met and time to meet each key action item/complete simulation scenario
- Introduction of MH section of Stanford Emergency Manual and hands on experience with reconstituting dantrolene sodium

September 27th, 2023: Second implementation day

- Identical to simulation format from first day with the addition of the MH section of Stanford Emergency Manual on the MH cart for use during simulation
- Data collection included time to meet key action items, number of key action items met, and staff use of cognitive aid

Methodology

Simulation Supplies:
Volunteer patient, OR table, anesthesia machine, laminated Stanford Manual
Monitors:
SIMPL app technology
Mock MH cart:
Matched the appearance and layout of the carts at EHMC and utilized during the simulation
Evaluation:
Modified AORN checklist

Evaluation/Data Collection

Continue with the simulation until the following action/treatments are completed:

Responsibility	Skill met	Action/Treatment Checklist
1st Respondent Any Team Member		Call for an MH Cart AND code cart to the room Appoint a team leader.
Anesthesia Provider		Stop the triggering agent Hyperventilate with 100% oxygen Obtain lab tests per physician order Call or assign a team member to call the MH Hotline 1-800-644-9737 Start arterial line and/or any additional IV lines Treat hyperkalemia – calcium chloride 10mg/Kg or calcium gluconate 10-50mg/Kg; regular insulin 10 units IV in 50 mL of 50% glucose, give Na+ bicarbonate if metabolic acidosis is present (1-2 mEq/kg) Treat dysrhythmias -beta blockers (no calcium channel blockers) Monitor renal function Place nasogastric tube
Circulator/RN		Call for additional help Start dilution of dantrolene sodium of 9-12 vials. This will provide the initial dose (2.5 mg/kg for all patients). Reconstitute with 60 mL of diluent – preservative free sterile water only.
Circulator/RN II Other Respondents		Apply cooling measures; obtain chilled saline/ice and place on groin, axilla, around head Insert Foley catheter Insert rectal tube for lavage Cool IV fluids
Surgeon/Physician		Conclude procedure as soon as possible Notify the family of the patient's condition
OR Team		Call report to the intensive care unit

*& time component**

Task to be completed:	Task Completed (✓= yes; X =no)	Time to task completion from start of scenario (min:sec= 00:00)
Identify The problem -Someone sees change in vital signs and notifies team (anyone)		
Call for Help -Overhead anesthesia/additional help (circulator)		
Appoint a team leader (anes)		
Call for MH cart (anyone)		
Call for code cart (anyone)		
Call MHAUS Hotline (anyone)		
Discontinue triggering agents (anes)		
100% FIO2 with flows 10-15L/min (anes)		
Initiation of TIVA (anes)		
Application of charcoal filters to anesthesia machine (anes/tech)		
Insert secure airway if LMA/sedation case (anes)		
Placement of additional IV/arterial line (anes)		
IV fluids wide open (anes)		
Send labs and ABG (anes)		
Treatment of hyperkalemia -Hyperventilate -Calcium chloride (10mg/kg) or calcium gluconate (10-50mg/kg) -Regular Insulin 10u IV with 50ml D50 -Sodium Bicarb if metabolic acidosis (1-2mEq/kg) (anes)		
Treat Arrhythmias -Beta blockers (ex: esmolol 10-20mg) and/or -Amiodarone (150mg over 10-15 min) and/or -Magnesium sulfate 1g **Remember avoid CCB (anes)		
Calculate dose of dantrolene, initiate ryanodex reconstitution (circ)		
Active cooling: -Stop warming blanket (anes/circ RN) -Insert NGT/OGT and lavage (anes/circ RN) -Application of ice packs on groin, axilla, around head (anyone)		
Insertion of Foley (circ RN) -Measure urine output		
Conclude surgery/begin closure (surgeon & scrub tech)		
Call report to ICU (circ RN)		

Evaluation/Data Collection

MALIGNANT HYPERTHERMIA

By Stanford Anesthesia Cognitive Aid Group and Henry Rosenberg, MD

SIGNS

EARLY:
1. Increased $ETCO_2$.
2. Tachycardia.
3. Tachypnea.
4. Mixed Acidosis (ABG).
5. Masseter spasm/trismus.
6. Sudden cardiac arrest in young person due to hyperkalemia.

May be LATER
1. Hyperthermia.
2. Muscle rigidity.
3. Myoglobinuria.
4. Arrhythmias.
5. Cardiac Arrest.

1. **CALL FOR HELP.**
2. **CALL FOR MH CART.**
3. **INFORM TEAM.**
4. **START PREPARING DANTROLENE or RYANODEX!**

DDX

- Light anesthesia.
- Hypoventilation.
- Insufflation of CO_2.
- Over-heating (external).
- Hypoxemia.
- Thyroid Storm.
- Pheochromocytoma.
- Neuroleptic Malignant Syndrome (NMS).
- Serotonin Syndrome.

TREATMENT

1. **Discontinue** anesthetic triggers (volatiles and succinylcholine). Do **NOT** change machine or circuit.
2. Increase to **100% O_2, high flow** 10 L/min.
3. **Halt procedure** if possible. If emergent, continue with non-triggering anesthetic.
4. **Increase minute ventilation** (but avoid air trapping).
5. **Assign several people to prepare 2.5 mg/kg IV Dantrolene or Ryanodex bolus:**
   - **Dantrolene**: Dilute **each 20 mg Dantrolene vial in 60 mL** preservative-free **sterile water** (for **70 kg person give 175 mg so prepare 9 vials** of 20 mg Dantrolene each as above).
   - **Ryanodex** (new formulation of Dantrolene): Dilute **250 mg Ryanodex vial in 5 mL** preservative-free **sterile water** (for **70 kg person give 175 mg**).
6. **Rapidly give Dantrolene** or **Ryanodex**. Continue giving until patient stable (may need >10 mg/kg, call MHAUS 800-644-9737 for advice).
7. For metabolic acidosis, give **sodium bicarbonate** 1-2 mEq/kg.

MH Treatment continued on next page.

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Emergency Manual V3.0 2016

MALIGNANT HYPERTHERMIA
continued

TREATMENT

8. **Hyperkalemia** – or suspect from EKG, treat with:
   - **Calcium chloride** 10 mg/kg IV; Max dose 2000 mg or **Calcium gluconate** 30 mg/kg IV, Max dose 3000 mg.
   - **D50** 1 Amp IV (25 g or 50 ml Dextrose) + **Regular Insulin** 10 units IV (monitor glucose).
   - **Sodium Bicarbonate** 1-2 mEq/kg, Max dose 50 mEq.
9. Arrhythmias are usually secondary to Hyperkalemia. Treat as needed except **avoid calcium channel blockers. Go to ACLS events** as relevant and return.
10. Actively **cool patient** with ice packs, lavage if open abdomen. Stop cooling at 38°C.
11. Send **labs** for ABG, Potassium, CK, urine myoglobin, coagulation studies, lactate.
12. Place Foley catheter. **Monitor UO. Goal 1-2 mL/kg** per hour. Can give IV fluid and diuretics.
13. **Consider alkalinizing urine** if CK or urine myoglobin elevated (Sodium Bicarbonate 1mEq/kg/hour).
14. Arrange **ICU** bed. Mechanical ventilation usually required.
15. **Continue Dantrolene** or **Ryanodex**: 1 mg/kg every 4-6 hours or 0.25 mg/kg/hr infusion for at least 24 hours (**25 % of MH events relapse**). Observe patient in ICU for at least 24 hours.
16. Call **MH hotline** (below)for any suspected case with any questions.

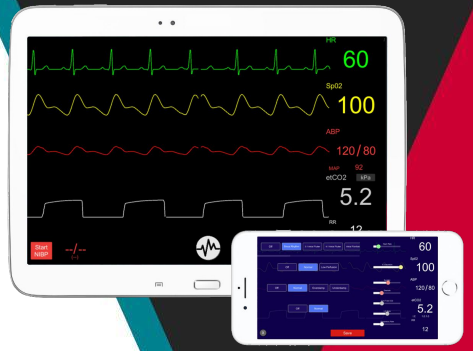
Contact the Malignant Hyperthermia Association of the United States (MHAUS hotline) at any time for consultation if MH is suspected:

1-800-MH-HYPER (1-800-644-9737)

or see suggestions online at http://www.mhaus.org

END

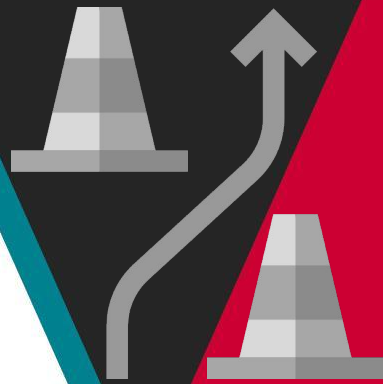
Supporting Factors



- RRNA presence at site of implementation
- IRB exemption status
- Utilization of education time to maximize anesthesia staff presence/attendance
    - *Willingness of staff/creation of schedule*
- Education session before implementation promoted staff buy-in
- Real-time vital sign alterations with *Simpl* App
- Adequate materials to make simulation realistic

    (i.e dantrolene/ryanodex, OR table, anesthesia machine, med syringes/vials, charcoal filters, etc.)

Limitations & Strategic Plans



- Awareness bias as staff knew what the simulation scenario was going to be about
  - *Encouragement of future simulation scenarios where staff are blinded to the crisis*
- Participants varied between sim days
- Population limited to anesthesia staff
  - *Possibility for project continuation where additional departments are included*
- Single OR room used for simulation experience
  - *Sessions broken into smaller groups to maximize participation with limited OR space*

Data Analysis

- Checklist data will be analyzed after each simulation scenario with items being scored as met or not met, including time component
  - Comparison of number of key action items met and time to completion from the initial simulation to those from the second simulation
- Assess if MH cognitive aid was utilized in second day of simulation
- Chi-squared specialized test: ***McNemar test*** for nominal level data: tasks completed
- ***Paired samples t-test*** for time component

Preliminary Subjective Data

- Identification of missing contents from EHMC MH carts
- Staff showed interest in:
  - Stanford Manual
  - Visual Aid for Ryanodex dosing
  - Tangible experience
  - Reconstitution of Ryanodex and Dantrolene
  - Dosing guidelines following initial 2.5mg/kg dose
  - Live vital sign adjustments/ABG strips

Preliminary Objective Data

- Staff did not remember to utilize the MH cognitive aid in second simulation scenario
  - Verbalized that a future Stanford Manual education session would be beneficial to reinforce use
- Lack of appointed leader in all simulation groups
- Smaller mitigating key action items were overlooked (i.e. turning off Bair hugger)
- Simulation times can not fully reflect real-time treatments (i.e. time to intubate, place an arterial line, etc.)

Ryanodex vs Dantrolene

Comparison of Dantrolene Formulations

Factor	Dantrium/Revonto	Ryanodex
Vial strength	20 mg	250 mg
Diluent volume per vial	60 mL	5 mL
Concentration after reconstitution	0.33 mg/mL	50 mg/mL
Mannitol content per vial	3,000 mg	125 mg
Number of vials needed	35	3
Average volume to be administered	2,100 mL	14 mL
Time to reconstitute	≥22 min for 13 vials	≤1 min for 1 vial
Shelf life	3 y	2 y
Approximate cost for suggested supply	$2,000-$3,000	$6,000

1 minute
1 vial
5mL
250mg per vial

> 22 minutes
12.5 vials
60mL
20mg per vial

Live Poll

Join at

slido.com

#4021 419

Interactive Stanford Manual PDF

Stanford Manual

Questions

Our Project Chair Dr. Maureen McCartney Anderson

Our Project Champion Dr. Stephen Pilot

Our Project Site Mentor Dr. Ulrike Berth

Englewood Health Anesthesia Department

Thank You

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