Malignant Hyperthermia Transfer Hand Off

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Malignant Hyperthermia

- Malignant Hyperthermia: A rare and potentially life threatening event[1]
- Incidence: 1:100,000 adult surgeries, 1:30,000 pediatric surgeries, 0.18:100,000 in ambulatory surgeries[2]
- Lower incidence in ASC: more rigorous screening?
- 1:2,000 adults have genetic abnormality resulting in susceptibility[3]
- Testing: costly, time consuming, not widely available[4]
- Must rely on anesthetic history, past medical history, familial history[4]
- MH management requires prompt recognition, immediate intervention, well coordinated response[1]

Malignant hyperthermia

- Dantrolene: definitive pharmacological treatment for MH, personnel intensive
- Dantrolene 20mg/vial
- Ryanodex 250mg/vial
- 2.5mg/kg initial dose= 9 vials for 70kg patient; redosed q5 minutes until stable
- ASC staffing appropriate for day to day; can face significant strain during an MH event[5,6]
- High risk, low frequency events: potentially catastrophic outcome; requires frequent training and preparation

Challenges unique to ASCs

- ASCs: attached to hospital vs freestanding
- Freestanding Challenges
  - Personnel intensive initial response
  - Effective and efficient utilization of staff
  - Coordination and communication with transfer team during planning phase
  - Transport team's capabilities-must be aware of knowledge, equipment, capabilities
    - Hospital based critical care transport vs. Flight crew vs. Local EMS
  - Transport time
    - Time of day impacts transport times.
    - Flight vs. Ground crew
  - Flight? Beneficial to have pre-arranged landing zone

Problem Statement

The adequacy of transfer of care in a malignant hyperthermia patient is paramount to patient safety. Although transfer plans for malignant hyperthermia exist, an exhaustive literature review illustrates a lack of research on this topic.

Purpose of Study

To assess the effectiveness of anesthesia providers' MH handoff from ambulatory surgical center to a receiving hospital before and after transfer checklist implementation.

Research Questions

- Do UVA CRNA's and MDA's currently possess the ability to effectively include the 8 most important malignant hyperthermia clinical indicators during a handoff from an ambulatory surgical center to a receiving healthcare facility?

- Does the implementation of an educational tool concerning malignant hyperthermia transfer handoff increase the effectiveness of UVA CRNA's and MDA's to include the 8 most important clinical indicators during a handoff from an ambulatory surgical center to a receiving healthcare facility?

Review of literature

- Specifically looking at MH in the ambulatory surgical center
- Current existing guidelines from MHAUS regarding transfer checklist
- Benefits of cognitive aid use
- The potential benefit of a transfer checklist

The Current Transfer Guidelines from MHAUS

- The College of Critical Care Medicine created detailed transfer of care guidelines in 2004 [8]
- The guideline did not address specific needs of MH patients
  - MHAUS created panel of experts to establish guideline for MH patients
- Significant variability in ASC requires broad guideline that can adapted for each ASC
- Each ASC should examine the guideline provided by MHAUS and adapt it to create a plan that fits their specific needs

MHAUS Transfer Guideline Highlights

- Recognize event, Discontinue triggering agent, Initiate treatment[9]
- RHCF
  - Have existing transfer agreement, be aware of capabilities[9]
- Transfer when stable
  - $ETCO_2$ declining or normal, HR stable or decreasing with no signs of significant dysrhythmias, dantrolene administered, temperature is declining, muscular rigidity resolving[9]
- Report - direct personal communication is preferred
  - Cardiovascular signs, temperature and site, $ETCO_2$ and minute ventilation, electrolytes, IV site, amount of dantrolene given as well as response, muscle rigidity, presence of foley and color of urine[9]
- Be aware of capabilities of transfer team[9]

Effectiveness of Cognitive Aid Implementation in the Management of MH

- Stanford Emergency Manual → cognitive aid for many medical emergencies
  - Manual referred to in a patient suspected to have MH[13,14] → immediate administration of dantrolene, ABG analysis, initiating cooling measures.

- Manual referred to at a dental ASC until EMS arrived to transport patient to emergency department[14]
  - The Emergency Department lacked knowledge on managing MH; manual received from anesthesia and EMS helped guide treatment[14]

Effectiveness of Cognitive Aid Implementation in the Management of MH

- Simulation study dividing CA1 and CA2 physician anesthesiologist residents[15]
  - Group that referred to MH cognitive aid had significantly higher treatment scores and more appropriate interventions for the management of MH[15]
  - Correct dose of Dantrolene administered and more quickly[15]

- Another study: 24 Physician Anesthesiologist → MH cognitive aid checklist proved to be more effective than not having one. Again, administered initial dose of dantrolene more readily.

Malignant Hyperthermia

May be early signs:	**Mixed (metabolic and respiratory) acidosis** **Increased $EtCO_2$, heart rate, respiratory rate** **Hyperthermia** **Masseter spasm/trismus** **Muscle rigidity without shivering, tremor, or clonus**
May be late signs:	**Myoglobinuria** **Arrhythmias including hyperkalemic cardiac arrest**

TREATMENT

Task	Actions
Crisis Resources	• Inform team • Get MH cart with **dantrolene** • Call for help • Consider pausing procedure
Stop MH Triggers	• **Stop volatile anesthetic and succinylcholine** • **Do NOT change machine or circuit** • **100% O_2 10 - 15 L/min** • If easily available, add charcoal filters to breathing circuit
Airway	• Maximize minute ventilation. Mechanical ventilation is preferred. Avoid air-trapping
Give Antidote Rapidly	• Initial dantrolene dose is 2.5 mg/kg IV. Formulations: • Concentrated, easily soluble formulation: **Ryanodex:** Dilute one 250 mg vial in 5 mL preservative-free **sterile water.** **70 kg patient dose: 175 mg = 3.5 mL** • Non-concentrated formulation: **Dantrium or Revonto: Assign several people to prepare.** Dilute each 20 mg vial in 60 mL preservative-free **sterile water.** **70 kg patient dose: 175 mg = 9 VIALS** • Repeat dantrolene 2.5 mg/kg every 5 min until hypercarbia and rigidity are resolved and temperature is not increasing. May need > 10 mg/kg
Team Recap	• If appropriate, stop procedure • **Give non-triggering maintenance anesthetic or sedation (e.g. propofol, benzodiazepine, opioid)**

RULE OUT

- CO_2 insufflation
- Hypoventilation
- Hypoxemia
- Iatrogenic warming
- Illicit stimulants
- Light anesthesia
- Neuroleptic malignant syndrome
- Pheochromocytoma
- Serotonin syndrome
- Thyroid storm

TREATMENT

Task	Actions
Treat Hyper-K+	• **Calcium** chloride 10 mg/kg IV, max 2 g • Regular **insulin** 5 - 10 units IV **with dextrose/D50** 1 amp IV (25 g); monitor glucose • **Albuterol** 8 - 12 puffs MDI or 2.5 mg nebulized • Sodium **bicarbonate**: 0.5 amp (25 mL) at a time; maintain minute ventilation to exhale additional CO_2 produced • If severe: consider emergent dialysis
Treat Rhythm	• Treat arrhythmias with amiodarone 150 mg IV over 10 - 15 min, esmolol 10 - 20 mg IV bolus followed by infusion, or magnesium sulfate 1 g IV; **avoid calcium channel blockers and sodium channel blockers (e.g. verapamil, diltiazem, lidocaine, procainamide)** • If unstable, call for code cart and also see ACLS event: **Asystole/PEA #1** **Bradycardia #2** **SVT #3** **VFIB/VTACH #4**
Active Cooling	• If core temperature > 38° C: **actively cool** with cold IV fluid (20 - 30 ml/kg normal saline or plasmalyte) • Additional cooling: **Stop active warming;** set forced air on ambient; cool room; put ice packs on head, axilla, and groin; wet skin; cool lavage if open abdomen or peritoneal catheter (avoid bladder lavage to preserve urine output measurement)
Access	• Consider additional IV access and arterial line placement
Labs	• Send ABG, K+, CK, urine myoglobin, coagulation panel, lactate
Urine Output	• Place Foley catheter and monitor urine output: goal 1 - 2 mL/kg/hr; consider IV fluids and diuretics
MH Hotline	• Call 24/7 for expert consultation: **1-800-MH-HYPER** (1-800-644-9737) http://www.mhaus.org
ICU Care	• Transport with experienced personnel after stabilization • Mechanical ventilation commonly required because **20% of MH events relapse within 16 hours.** Extubate once metabolically and hemodynamically stable • **Continue dantrolene: 1 mg/kg bolus every 4 - 6 hours or 0.25 mg/kg/hr infusion for up to 24 hours** • Monitor for rhabdo, DIC, hyperK^+, compartment syndrome
Post Event	• Complete AMRA (Adverse Metabolic Reaction to Anesthesia): https://anest.ufl.edu/namhr/ • Test genes: https://www.mhaus.org/testing/genetic-testing/

Effectiveness of High-Fidelity Simulations for MH Training

- Due to low frequency of MH, high fidelity simulations provide an effective way to increase knowledge on management of MH crisis.
- A simulation study was conducted with 16 CRNAs
  - 12 participants completed the pre- and post- testing material[18]
  - Simulation participation led to a significant increase in MH knowledge scores post-intervention[18]
  - Participants reported increased confidence with managing a MH crisis post-simulation[18]

Checklists + Patient Outcomes

- Effectiveness of checklists well studied
- Study conducted amongst CA1 and CA2 resident anesthesiologists showed statistically significant improvement in MH treatment[15]
- A similar study involving physician anesthesiologists also showed more effective and efficient treatment utilizing checklists and cognitive aids[16]
- Research indicates that stressful situations such as MH negatively influences clinical decision making[12]
- This negative impact has been shown to be mitigated with cognitive aids[12]

Checklists on Patient Handoff

- Improvement of patient report with checklists has been shown repeatedly in the literature
- Two studies in Europe showed a statistically significant improvement in pertinent information included in report
- Checklists also decrease the omission of important patient information
- Systematic review of 19 studies found that in 15 of those studies accuracy in handoff of information was improved with a checklist
- Measurements were based on number of errors and omissions in report

Effect of Checklist on Timespan of Hospital Report

- No consensus has been reached if checklists decrease duration of report[21]
- Studies have shown that checklists decrease, increase, and have no impact on the length of report[21]
- Additional research is needed in this area

Literature Review Highlights

- Although the transfer of an MH patient from an ASC to RHCF is a low frequency event, it is extremely high-risk. It is imperative that anesthesia providers are well prepared should the situation arise.
- The use of cognitive aids in MH treatment has proved to be of value in areas such as increasing the frequency of critical interventions[13-15]
- Simulation training in MH management has led to higher efficiency in MH treatment and more effective communication[19]
- Minimal research exists in MH patient transfer
  - surplus of research on the transfer of critical and high-acuity patient populations → research shows effectiveness of checklists in decreasing adverse events and improving patient outcomes[20,21]
- Document created by MHAUS and ASF outlines guidelines of transfer for a MH patient from an ASC to RHCF.

Methodology

Study Design

- One group quasi-experimental design
- This modality of scientific research evaluated anesthesia provider's current level of knowledge on MH handoff report from ASC to a RHCF.
- Additionally, it tested the effectiveness of an educational tool to create a more effective handoff report by anesthesia providers transferring a MH patient from an ASC to a RHCF.

Sample

- CRNAs and MDAs from University of Virginia Medical Center in Charlottesville, VA.
- Survey sent to approximately 69 CRNAs and 64 MDAs.
- Permission obtained from clinical site to distribute surveys.

Instrumentation

- **Qualtrics** used to build the Malignant Hyperthermia Transfer Handoff Survey

- The survey consisted of **5 major sections**
  - Consent
  - Demographics
  - Clinical scenario with question 1
  - The Malignant Hyperthermia ASC to RHCF Handoff Educational Tool
  - Clinical scenario with question 2

Section 1: Consent Page

Key Points Include:

- Survey is voluntary
- Time expectation: 10 minutes
- Risks and benefits of participation disclosed
- Primary investigator information provided
- Voluntary consent provided by continuing on to section 2: demographics

Section 2: Demographics

4 multiple choice questions

- Gender identity
  - 7 options + fill in box
- Age
- Years of CRNA Practice
- Highest level of education

Participants were not required to answer these demographic questions

Section 3: Clinical Scenario with Question 1

- Fabricated patient scenario about an anesthetized patient undergoing surgery in an ASC that undergoes a Malignant Hyperthermia event.
- Scenario includes many clinical details on the patient, the surgical procedure, and the MH event
- 16 clinical details appeared in a select-all-that-apply question
- 8 correct options were the clinical details that must be provided when handing off a MH patient from an ASC to a RHCF as indicated by the MHAUS Transfer Guidelines

Section 4: The Malignant Hyperthermia ASC to RHCF Handoff Educational Tool

Malignant Hyperthermia ASC to RHCF Handoff Educational Tool:

According to MHAUS and the ASF, there are 8 clinical indicators to include in a malignant hyperthermia patient handoff report from an ASC to a RHCF. The 8 patient data points include:

- Cardiovascular signs
- Temperature and site
- Minute ventilation with ETCO2
- Electrolytes (if available)
- IV site
- Amount of Dantrolene administered and response
- Presence or absence of muscle rigidity
- Presence of urinary catheter and color or urine

- Created from the information provided in MHAUS and the ASF's document titled "Transfer Plans for Suspected MH Patients"
- Contains the 8 clinical indicators agreed upon by MHAUS and the ASF that should be included in the handoff report of MH patients from an ASC to a RHCF

8 Clinical Indicators

- Cardiovascular signs
- Temperature and site
- Minute ventilation with ETCO2
- Electrolytes (if available)
- IV site
- Amount of Dantrolene administered and response
- Presence or absence of muscle rigidity
- Presence of urinary catheter and color of urine

Section 5: Clinical Scenario with Question 2

- With the knowledge from the previous section (educational tool), the same exact clinical scenario and select-all question is presented to the survey participant.

- The participant will once again be asked to choose the 8 correct options out of 16 that should be included when transferring a MH patient from an ASC to a RHCF.

Procedure

- Necessary IRB approval was obtained.
- Survey was dispersed using an email modifier to distribute the surveys only to CRNAs and MDAs.
- Survey was opened for approximately 2 months
- The survey was resent one more time 30 days after the initial email was sent.
- At conclusion of testing period an excel spreadsheet will be made from Qualtrics revealing results from the survey

Data analysis

- The data was statistically analyzed using statistical analysis software utilizing descriptive statistics for differences in outcomes based on
  - Gender
  - Age
  - Years of practice
  - Highest education level
- A paired sample t-test compared pre- and post-test results to assess for an increase in knowledge and a more effective patient handoff following the educational tool

Results: Demographics

- A total of 23 participants completed the pre- and post- intervention surveys

	n	%
Gender		
Male	9	39.1
Female	13	59.1
Missing	1	4.3

Age		
30-39	9	39.1
40-49	5	21.7
50-59	4	17.4
60-69	4	17.4
Missing	1	4.3

Years in Practice		
Less than 1	2	8.7
1-3	5	21.7
4-10	3	13.0
11-20	7	30.4
21-30	3	13.0
31-40	2	8.7
Missing	1	4.3

Education		
Masters	11	47.8
MD or DO	1	4.3
Doctorate	10	43.5
Missing	1	4.3

Results: Indicators Chosen (pre and post)

	Pre		Post			
	n	%	*n*	%	*Z*	*p*
Heart rate 130 bpm and blood pressure 187/102 mmHg	**17**	**73.9**	**22**	**95.7**	**2.24**	**.025**
ETCO2 58 mmHg with 10L minute ventilation	**17**	**73.9**	**19**	**82.6**	**1.41**	**.157**
Respiratory acidosis	5	21.7	3	13.0	0.82	.414
Esophageal temperature 39.5°C	**19**	**82.6**	**21**	**91.3**	**1.00**	**.317**
1 peripheral intravenous catheter 18 gauge left forearm	**11**	**47.8**	**17**	**73.9**	**1.73**	**.083**
Metabolic acidosis	9	39.1	2	8.7	2.65	.008
Masseter spasm	7	30.4	4	17.4	1.13	.257
Muscle rigidity	**6**	**26.1**	**17**	**73.9**	**2.84**	**.005**
Finger stick blood glucose 125mg/dL	1	4.3	1	4.3	0.00	1.00
Hyperkalemia 6.2 mEq/L	**22**	**95.7**	**22**	**95.7**	**0.00**	**1.00**

- 8 correct indicators are in bold
- Significance levels based on Wilcoxon signed ranks tests

Addition of charcoal filters to anesthesia circuit	4	17.4	2	8.7	1.41	.157
Ice packs applied to neck, axillary and groin areas	14	60.9	5	21.7	2.71	.007
Insertion of foley catheter and presence of dark colored urine	**14**	**60.9**	**19**	**82.6**	**1.67**	**.096**
100% FiO2 administered	7	30.4	4	17.4	1.34	.180
General anesthesia switched to a propofol infusion	12	52.2	5	21.7	2.65	.008
2.5 mg/kg of dantrolene administered without adequate response	**21**	**91.3**	**22**	**95.7**	**1.00**	**.317**

Results: Totals

- Prior to the educational intervention an average of **5.5 / 8** correct indicators were chosen
- After the educational intervention, an average of **6.9 / 8** correct indicators were chosen
- Significant vs not significant

Discussion

- Initial response to MH is crucial for a positive outcome for the patient
- Effective handoff between healthcare providers ensure high quality care continues
- The surveys distributed showed an improvement in handoff effectiveness after the educational intervention
  - This improvement was statistically significant
- The principal researches participated in high fidelity MH simulations; these did not involve recognizing indicators of stability or the transfer of care
- These results in conjunction with hands on high fidelity simulation experience indicate the need for additional research on the transfer of care of MH patients

Conclusion

- MH can occur in a wide array of healthcare environments outside of the hospital
- Seamless transfer of care to the receiving hospital
- All providers must be educated on the many different aspects of effectively caring for MH patients.
- Additional research must be conducted to address the adequacy of MH patient transfer of care between:
  - Anesthesia providers
  - Anesthesia provider to the nurse
  - Between nurses
- This will help to identify gaps in communication
- This will also help to establish seamless and coordinated are across all stages of treatment.

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