Current Practice of Thermoregulation during the Transport of Combat Wounded

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Introduction

• Hypothermia has been well documented to be associated with mortality in combat wounded. [1-4] and is considered a threat in military operations. [5,6]

• Hypothermia has been traditionally defined as a core temperature less than 35°C. Due to the unique physiology of trauma patients, and the increased incidence of mortality in hypothermic trauma patients [1-4], a different system of classification has been proposed. Hypothermia in trauma patients may be defined as a core temperature less than 36°C, with further classification described as mild hypothermia (36°C to 34°C), moderate hypothermia (34°C to 32°C), and severe hypothermia (<32°C). [2,4,7]

• During the global war on terrorism, many providers have found themselves in situations where extreme ambient temperatures and environmental conditions have direct effects on patient outcomes. Currently, providers in the field have no objective comparison data to support choices for hypothermia prevention in austere environments.

• Military medicine has placed an emphasis on the prevention and management of hypothermia [2,3,8-14] resulting in the publication of the Joint Theater Trauma System (JTTS) Clinical Practice Guideline (CPG) for Hypothermia Prevention, Monitoring, and Management. [4]

• Defining the methods of thermoregulation currently utilized and evaluating the effectiveness of each of these methods will allow best practices to be disseminated and employed throughout the combat areas of operation.

Objectives

Conduct a retrospective cross sectional cohort study using the Joint Theater Trauma Registry (JTTR) to answer the following questions:

1. Has the current CPG had an impact on the incidence of hypothermia in trauma patients in the theater of operations?
2. What thermoregulatory methods are being used most often in the current theater of operations?
3. Is there a significant difference in the efficacy of the various devices?

Methods

• This was a retrospective cross-sectional cohort study using data collected from the JTTR which was obtained under a human use protocol approved by the Institutional Review Board at Brooke Army Medical Center in San Antonio, Texas.

• Inclusion and Exclusion Criteria:

- For evaluation of the impact made by the CPG, any distinct patient entry in the JTTR with a date of admission to a Level III facility and a receiving temperature was included.
- For examination of the various thermoregulatory methods patients included patients with a Glasgow Coma Scale (GCS) of 13 or less who had a thermoregulatory method and a temperature recorded upon admission to a surgical facility. Patients who a received an emergency department thoracotomy were excluded, as were patients designated "special interest" or "detainee".

•Evaluation of the CPG: The JTTR was queried for all patients entered through April 2009 (33,931), with a date of admission entered, and an initial temperature recorded at a Level III facility (24,981). These records were sorted into two groups by month: patient encounters occurring prior to the issuance of the guideline (13,134), and patient encounters occurring after the issuance of the guideline (11,847). We examined both the percentages presenting hypothermic (defined in this study using both 35°C and 36°C as thresholds) by month, and the percent of the whole who presented prior to and after the issuance of the guideline using the chi squared test in order to evaluate the effectiveness of the guideline.

• Evaluation of Thermoregulatory Methods Frequency of Use and Efficacy: The JTTR was queried for all distinct patient entries from October 2007 to September 2008 (8770), and was sorted further into patients which met the study criteria (265). This included both patients presenting directly from the site of injury and those transported from a Level IIb facility to the Level III facility. The data were examined using the Kruskal-Wallis (nonparametric ANOVA) test, or the Wilcoxon two sample test, where appropriate, with patients separated into groups by origin of transport (site of injury to Level IIb or Level III, and Level IIb to Level III), and further broken into groups based on thermoregulatory method used.

LIMITATIONS:

•Incomplete recording of pre-hospital and Level IIb data.

•The number of thermoregulatory methods used resulted in less than optimal numbers of each group for evaluation, and decreased our ability to detect a significant difference between groups and prevented correlation with injury scoring systems or laboratory tests of physiologic function.

Devices

Devices available for entry from the pull-down menu in the JTTR:

1. Wool Blanket (WB)
2. Reflective Blanket, commonly referred to as a "Space Blanket" (SB)
3. Body Bag, official title: "Human Remains Pouch" (HRP)
4. Hypothermia Prevention and Management Kit (HPMK™), manufactured by North American Rescue Products® (HPMK)
5. The Bair Hugger® 505 temperature management unit (Arizant healthcare) (BH)

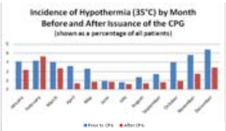
Combinations of the devices listed which were recorded in our patient set:

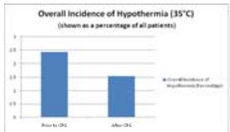
1. Wool Blanket + Space Blanket (WB+SB)
2. Wool Blanket + Space Blanket + Body Bag (WB+SB+HRP)
3. HPMK™ and Wool Blanket (HPMK+WB)
4. Body Bag and Wool Blanket (HRP+WB)
5. Bair Hugger® and Wool Blanket (BH+WB)

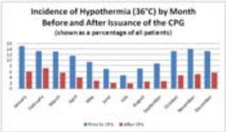
Results

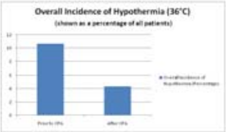
EFFECTIVENESS OF THE CLINICAL PRACTICE GUIDELINE

• Whether using either the traditional 35°C, or 36°C as suggested by Gentilello [7], as the threshold for hypothermia in trauma patients, we were able to show that the issuance of the CPG was associated with a significant reduction in the number of patients presenting hypothermic (p-value <0.0001).







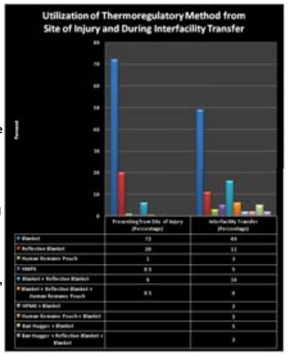


FREQUENCY OF USE AND TYPE OF THERMOREGULATORY METHODS UTILIZED OCT 2007-SEP 2008

• Of the 8770 individual entries into the JTTR during the time period studied, 1364 met the required criteria, 265 of which had sufficient data entered and available for analysis.

• In patients presenting from the site of injury the method of hypothermia prevention was: WB 72%, SB 20%, WB + SB 6%, HRP 1%, HPMK 0.5%, WB + SB + HRP 0.5%.

• In patients presenting from a Level IIb facility (FST, SSTP, FRSS, EMEDS) the method of hypothermia prevention was: WB 49%, SB + WB 16%, SB 11%, HRP + SB and/or WB 8%, BH + WB with or without SB 7%, HPMK 5%, HRP 3%, or HPMK + WB 2%.



Results (continued)

INCIDENCE AND DEGREE OF HYPOTHERMIA OCT 2007-SEP 2008

Using 35°C as the threshold for hypothermia

• Nineteen patients (7.2% of the total number) arrived at a surgical facility hypothermic. Data analysis revealed no statistically significant differences (p-value=0.7823) in the incidence of hypothermia between the pre-hospital group (14 of 202, 6.9%) and the inter-facility group (5 of 63, 7.9%).

• Hypothermic patients in each sub-set (pre-hospital, inter-facility) were then grouped by thermoregulatory method for analysis. When the degree of hypothermia was examined in the pre-hospital group, there was not a statistically significant difference in degree of hypothermia between thermoregulatory methods used (p-value=0.7992).

•The inter-facility group could not be analyzed due to low patient numbers.

Using 36°C as the threshold for hypothermia

• Forty five patients (17% of the total number) arrived at a surgical facility hypothermic. Data analysis revealed no statistically significant differences (p-value=0.3763) in the incidence of hypothermia in this study between the pre-hospital group (32 of 202, 15.8%) and the inter-facility group (13 of 63, 20.6%).

•When the hypothermic patients were further broken down into groups by thermoregulatory method, there was no statistically significant difference between thermoregulatory methods (pre-hospital p-value=0.5724, inter-facility p-Value=0.1367).

PRESENTING TEMPERATURES BY THERMOREGULATORY METHOD OCT 2007-SEP 2008

• In addition to analyzing the difference in the presenting temperatures of hypothermic patients using the various thermoregulatory methods, we analyzed the data to evaluate whether there was a difference in temperature upon patient presentation to a surgical facility regardless of hypothermia from the data. For this analysis all patients who had sufficient data entered for analysis and met the inclusion criteria were included.

•In all patients (regardless of hypothermia), there was not a significant difference between the presenting temperatures in patients using the various thermoregulatory methods described (Pre-Hospital p-Value = 0.1585, Inter-Facility p-value = 0.1062, combined p-value = 0.3686).

For pre-hospital analysis, two methods were excluded because they were single use methods:
HPMK
HRP+SB+WB

Pre-Hospital

Analysis Variable : Temp

BGroup	N Obs	Mean	Std Dev	Median	Minimum	Maximum
WB	145	36.9	2.1637474	37.0	32.3	39.6
HRP	2	38.4	2.8991378	38.4	37.2	39.5
SB	40	36.5	2.4664726	36.8	33.3	39.2
SB + WB	13	36.9	0.8088453	37.1	36.3	37.8

p-value=0.1585

For Inter-facility analysis, three methods were excluded because they were single use methods:
HPMK+WB
HRP+WB
BH+SB+WB.

Inter-Facility

Analysis Variable : Temp

BGroup	N Obs	Mean	Std Dev	Median	Minimum	Maximum
Bair + WB	3	35.6	2.4378953	35.1	34.6	37.2
WB	31	37.0	2.4069032	36.9	31.9	39.4
HRP	2	36.2	0.1414214	36.2	36.2	36.3
HRP + SB + WB	4	36.0	2.8118796	35.9	34.5	37.6
HPMK	3	36.2	1.1532563	36.3	35.6	36.8
SB	7	38.3	3.4750128	38.3	36.1	42.0
SB + WB	10	36.9	2.0197910	36.8	35.4	39.0

p-value=0.1062

For this analysis, three methods were excluded because they were single use methods:
HPMK+WB
HRP+WB
BH+SB+WB

All (Pre-Hospital and Inter-Facility)

Analysis Variable : Temp

BGroup	N Obs	Mean	Std Dev	Median	Minimum	Maximum
Bair + WB	3	35.6	2.4378953	35.1	34.6	37.2
WB	176	36.9	2.2018044	37.0	31.9	39.6
HRP	4	37.3	2.7837325	36.8	36.2	39.5
HRP + SB + WB	5	36.3	2.7180876	37.1	34.5	37.6
HPMK	4	36.3	0.9626353	36.4	35.6	36.8
SB	47	36.7	2.8405108	36.8	33.3	42.0
SB + WB	23	36.9	1.4236012	37.1	35.4	39.0

p-value= 0.3686

Conclusions

• The incidence of hypothermia decreased after the issuance of the JTTS Clinical Practice Guideline. This is most likely primarily due to a corresponding increase in attention to the problem of hypothermia rather than due to compliance with the CPG's recommendations on thermoregulatory methods.

•This study did not find a significant difference in the capability of maintaining temperatures between the different thermoregulatory methods used in theater during either pre-hospital or inter-facility transport, nor was there a significant difference in the incidence of hypothermia between patients presenting from the site of injury or from inter-facility transport. However, less than optimal patient data entry resulted in an underpowered analysis and further study with larger group numbers is required to confirm or refute this conclusion.

• As shown by the data presented, although multiple technologically advanced thermoregulatory devices are available for use by providers in theater, the wool blanket, which has been used since the Revolutionary War, is still the thermoregulatory method most commonly used during transport in theater.

• Patient data collected prior to Level III facilities, including temperature and thermoregulatory methods utilized, is not reliably entered into the JTTR. [2,14] No inconsistencies were found during routine analysis of the data used in this study, but there was a marked lack of entered data in patient records (particularly thermoregulatory methods utilized) prior to their arrival at Level III facilities and this was the major limitation of this study.

•Further prospective study with greater numbers is necessary to confirm the validity of the data presented concerning the effectiveness of the various methods or thermoregulation. The authors are involved in a four year, multi-center study including patients received by the two military Level III centers in Iraq, and should soon include the US Level III facility at Bagram, Afghanistan. This study will generate a prospective database separate from the JTTR with data collected by on-site research teams funded and manned by the United States Army Institute of Surgical Research.

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