



## ORIGINAL ARTICLE

## Preventative measures taken against hypothermia in selected Durban hospitals' emergency centres and operating theatres

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## ABSTRACT

**Introduction:** Hypothermia is common in emergency general surgical patients. It is known to be associated with major complications in multiple organ systems. It is also easily preventable with the use of safe and cost-effective equipment. However, by observation, it appears that this equipment is used too infrequently thus resulting in unnecessary harm to patients.

**Methods:** This descriptive, observational, cross-sectional study was conducted in two arms to evaluate both emergency centres and operating theatres in the major state hospitals in Durban. It was conducted as an audit as well as a questionnaire-based study, to ascertain the availability of equipment used to prevent hypothermia and also how appropriately the equipment was being used.

**Results:** There was good availability of equipment in both the operating theatres and the emergency centres. However it was being used very poorly, particularly in emergency centres (41% of responses deemed not beneficial to patients versus 29% from operating theatres; 39% of answers beneficial versus 54% from operating theatres). Institutions with hypothermia-prevention protocols scored significantly better than those without a protocol (59% versus 25% beneficial;  $p = 0.01$ ).

**Conclusion:** In the field of hypothermia prevention, there was sufficient equipment to result in optimal patient care. However there appears to be a lack of knowledge amongst health care providers, resulting in suboptimal use of this equipment. Protocolised management may provide a solution to this problem and improve patient outcomes.

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## African relevance

- South Africa has high incidence of trauma – it is therefore important to achieve optimal management.
- The study showed good availability but poor use of equipment that can maintain normothermia or address hypothermia.
- A proposed protocol for temperature monitoring and external temperature regulation is provided in the manuscript.

## Introduction

Hypothermia remains one of the most preventable causes of morbidity and mortality amongst emergency surgical patients. Defined as a core temperature of less than 36 °C it is commonplace in major trauma patients: studies indicate admission hypothermia

has an incidence of between 1% and 10% for all patients, but up to 36.8% for severely injured patients and an even higher incidence in patients after a prolonged extrication from scene [1–4]. Further heat loss then occurs in the emergency centres where patients are often disrobed and where cold intravenous fluids are administered. The impact of this problem is marked – even mild to moderate hypothermia is associated with major complications in multiple organ systems, including cardiovascular (depression of contractility, increased oxygen consumption, myocardial ischaemia, arrhythmias) and haematological (platelet and clotting factor dysfunction, increased blood transfusion requirements) [2,3,5]. Hypothermia increases the risk of wound infection through immune dysfunction as well as vasoconstriction and induces hyperglycaemia by suppressing insulin release. It increases the risk of gastrointestinal ileus and it results in confusion as well as central nervous system depression. Drug metabolism is also slowed [2,3,5–11]. There is now strong evidence to show a direct relationship between a decreasing core temperature and increasing mortality rates in trauma patients, and hypothermia

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forms an integral part of the “Lethal Triad” of trauma along with acidosis and coagulopathy [1,5,9,11–15]. So strong is the correlation, that a separate classification has been now developed for hypothermia in trauma patients where hypothermia is described as mild if the core temperature is below 36 °C, moderate if below 34 °C and severe if below 32 °C. Jurkovich [16] reported 100% mortality in trauma patients with admission temperatures less than 32 °C and while more recent trials [17] show some survivors, the case fatality rates remain disastrously high.

It is clear, therefore, that preventing hypothermia is a priority in trauma patients. There are several different measures which can be used to this end, including warm blankets, increased ambient temperature, forced air-warming devices and in-line fluid warmers. These devices have been shown to be effective at raising core temperature [18–20] and reducing mortality [21] and they are now recommended by the ASPAN and the NICE guidelines for the prevention of intra-operative hypothermia [22,23]. Importantly for hospitals in developing countries, the measures above have also been shown to be cost-effective, as they obviate the need to treat the numerous complications of hypothermia [24,25].

A recent South African review article made a number of recommendations concerning temperature regulation methods, based on the best available evidence [26]. These concepts have been adopted by the Trauma Society of South Africa, the Emergency Medicine Society of South Africa, the National Core Standards committee and the Netcare Group as the gold standard of care for South Africa and are a marker against which all institutions can be measured. The review stated that the ambient temperature in emergency centres and operating theatres should be between 21 and 24 degrees Celsius to minimise the risk of hypothermia, and that the use of both in-line fluid warmers and forced air warming devices should be the standard of care in South Africa, especially if the patient presents hypothermic or undergoes a surgery longer than 30 min, and for all paediatric patients.

The goals set out above are readily achievable, even in a resource-constrained setting and require no special skills or knowledge. However, by observation, these goals seem far from accomplished, especially in the emergency centres where it appears optimal care for the patients is not realised. A search of available literature revealed that no similar study has been performed in the region.

The current study aimed to evaluate how well the emergency centres and operating theatres in Durban’s major teaching hospitals are performing in terms of hypothermia prevention and management in trauma patients. Specifically, the objectives were firstly to determine if the hospitals had the necessary equipment and infrastructure to ensure normothermia, and secondly to determine if the equipment was being used correctly and frequently enough. These hospitals were selected since they manage the majority of emergency surgical patients in Durban (Kwa-Zulu Natal Province, South Africa), making it important that they have the necessary equipment and staff knowledge to provide the gold standard of care. Furthermore, these hospitals serve as training hospitals for Kwa-Zulu Natal’s medical students and interns, and thus practices learnt here will be applied to patients in a multitude of other locations.

## Methods

A descriptive, observational, cross-sectional study was undertaken with two arms. Firstly, an audit was performed of the emergency centres and emergency operating theatres of the five major teaching hospitals in Durban. The hospitals included one quaternary hospital, one tertiary hospital and three secondary hospitals. The hospitals are moderately sized (approximately 800 beds) and

the trauma burden is large [27]. The objective was to determine the availability of the items used for prevention of hypothermia, specifically: forced air-warming devices, in-line fluid warming devices and fluid warming ovens. Appendix A illustrates the audit form used.

The second arm was a questionnaire-based qualitative assessment of the practices in each area with regards to the use of the equipment as well as frequency of temperature monitoring. For this arm, two participants (one doctor and one nurse) from each venue at each hospital were asked to complete the questionnaire (a total of 20 participants by convenience sample). The study was approved by UKZN-BREC Ethics Committee (BE461/14) and permission to conduct the study in public hospitals was provided by the Department of Health, KwaZulu-Natal.

All respondents were permanent employees in their department (trainees and rotational staff were excluded) and were advised specifically to answer according to what practices were prevalent at each hospital, not according to the respondent’s individual practices. This was to minimise any possibility of variation in answers within each venue and give an indication of the performance of the venue rather than the respondent. This, combined with the study being purely descriptive meant that the sample size was adequate and no power analysis was necessary. The questionnaire had two sections – one for closed-ended questions where the most accurate answer was circled by the participant, and one for more open-ended answers. The answers of the closed-ended section of questionnaire were analysed in three pre-specified groups: answers that were “beneficial”, “probably not beneficial” and “not beneficial”. Beneficial answers were those representing actions or knowledge in keeping with best practice; Not Beneficial answers were those that represented actions/knowledge that have been shown to be associated with poorer patient outcomes and Probably Not Beneficial answers were those where the evidence was unclear or when the answer given was so close to beneficial it was deemed unlikely to cause patient harm (for example: setting theatre temperature 1 °C too low). The data from the closed-ended questions was entered into a spreadsheet on Microsoft Excel and then analysed with Strata 13. A *p* value of <0.05 was considered to denote statistical significance. A thematic analysis was done for the open-ended questions. Appendix B illustrates the questionnaire.

## Results

The questionnaire was hand-delivered and a 100% response rate was achieved. The data collection took place over a 60 day period between May and June 2015 and data analysis followed thereafter. The audit revealed good availability of equipment across the operating theatres. In-line fluid warmers as well as fluid-warming ovens were present in 100% of operating theatres. Forced air-warming devices were also widely available (100% of operating theatre complexes had at least one working forced air-warmer), however one hospital did not have any of the device-specific blankets available and another reported that two of the theatre complex’s three devices were currently out of order and had been for some time. The recording of daily temperature logs was only done at two of the theatre complexes, although both venues consistently reported values between 21 and 24 °C.

The audit of the emergency centres also revealed good availability of equipment. All but one emergency room had a fluid-warming oven. Two venues did not have an in-line fluid warming device and two of the five did not have a forced air-warming device in the emergency room. One venue reported that although they did not have their own forced air warmer, they could borrow one from the theatre complex if they thought it necessary.

No emergency centre kept a log of the daily temperature in their emergency room complex or resuscitation rooms. One emergency centre did not have an in-line fluid warmer or a forced air-warming device nor did they have any ability to alter the ambient temperature and relied only on cotton blankets and a fluid warming oven to keep their patients normothermic (Fig. 1).

The questionnaire revealed several trends. Firstly, the operating theatres had a higher proportion of “beneficial” answers and a far lower percentage of “not beneficial” answers compared to the emergency centres (54% vs 39% beneficial; 29% vs 41% not beneficial, respectively). This difference, however, did not reach statistical significance ( $p = 0.14$ ). The operating theatres also outperformed the emergency centres in terms of patient temperature monitoring: the question about frequency of monitoring revealed patients in theatres had continuous temperature monitoring, but this was only done in one emergency centre with the others monitoring temperature either only on admission or only every four to six hours. Also, the frequency of use of forced air warming devices varied considerably between operating theatres and the emergency rooms. The most common answer in operating theatres was that forced air-warming devices are used on all patients who undergo an anaesthetic lasting more than 30 min, while for the emergency centres forced air-warming devices are only used on some orange/red code patients and some hypothermic patients [28].

Post-hoc analysis of the data revealed that emergency centres that had a protocol governing the actions to prevent hypothermia had a significant increase in beneficial answers and a decrease in not beneficial answers compared to units with no protocol or unit guidelines. Beneficial answers were given in 59% of cases compared to 25% of non-protocolised emergency centres and not beneficial answers were given in 28% of cases, compared to 50%. This was statistically significant ( $p = 0.01$ ). Overall, in all centres combined, 46% of answers were deemed beneficial, 19% probably not beneficial and 35% not beneficial (Table 1).

Most respondents believed that the unit in which they worked was not managing patients optimally in terms of hypothermia prevention and management. The most common causal theme was a perceived lack of equipment. Other factors identified to be hindering the management of hypothermia prevention were as follows: overworked, understaffed work environments and a lack of knowledge about risks of hypothermia. Monetary concerns (awareness of limited resources) was also mentioned as a limiting factor.

**Table 1**

Protocol vs. no protocol in emergency centres.

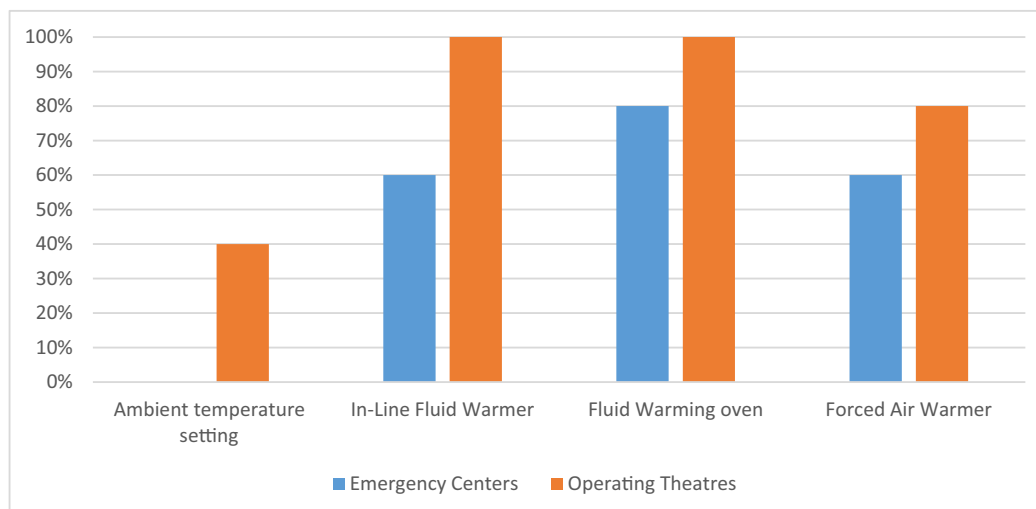
	Beneficial	Probably not beneficial	Not beneficial
Protocol	59%	13%	28%
No protocol	25%	25%	50%

## Discussion

The study revealed some interesting trends. Government hospitals within lower- and middle-income countries with an emerging trauma system often bemoan a lack of equipment and this complaint was a pervasive theme in the answers given to the open-ended questions. Yet, analysis of the audit of both the operating theatres and the emergency rooms suggested a good availability of equipment. One centre did not have an in-line fluid warming device or a forced air warmer, making it very difficult for practitioners to adequately prevent their patients becoming hypothermic. However, in all other emergency centres, at least one of these devices was present. All but one of the operating theatres had access to both of these devices. The answers given in the questionnaire about device usage show a very low percentage of beneficial answers (46% overall), thus showing a sub-optimal utilisation of the available equipment. This reveals an important shortcoming and one which is more easily addressed in a resource-constrained setting than a lack of equipment.

There was also a striking difference in performance between emergency centres with a protocol in place for hypothermia prevention and those without a protocol. Protocols have an established place in emergency medicine with several studies showing improved patient-centred outcomes [29–33]. They become especially important in the setting of an understaffed emergency centre where medical personnel are often attending to multiple problems at once. In the commotion, simple yet important interventions are all too often forgotten, and patients come to unnecessary harm. Furthermore, since the interventions proposed require no special skill and pose no inherent risk of patient harm, they can be applied by even trainee staff, freeing up the “decision-makers” to focus on other areas of care. A policy change in this regard would be easy to implement and is entirely feasible, even in an under-resourced setting.

Presumably the operating theatres performed better than the emergency centres as a result of the vastly improved ratio of



**Fig. 1.** Percentage availability of equipment at each venue.

medical staff to patients. The problem of understaffing in the hospitals in this study is unlikely to improve in the current economic and political climate. However this should not result in simply accepting a lower standard of care in the emergency centres. The combined set-up time of a forced air-warmer and an in-line fluid warmer is less than one minute and the devices require no increase in time spent monitoring. These actions simply need to be part of the treatment package provided to suitable patients.

A proposed protocol for Temperature Monitoring and External Temperature Regulation is provided in Fig. 2 for emergency centres to use as the basis for a local protocol, in conjunction with the recent South African position-statement [26,34,35]. Trauma patients with hypothermia require far tighter control of core temperature than isolated hypothermia patients owing to their significantly worse prognosis. Furthermore, while isolated hypothermia patients require a slow re-warming to avoid possible metabolic complications of this therapy, trauma patients have a reduced mortality rate if re-warmed rapidly [5,36]. A concern about the cost of the disposable items used in hypothermia prevention was proposed as a major limiting factor preventing patients from receiving optimal care. It is also the perceived reason why there is not always a ready supply of these items in each emergency centre and operating theatre. Yet research done across many different settings actually reveals a cost reduction because of a decrease in complications and length of stay in hospital [22,25,37].

This study has several limitations. Firstly, the number of respondents was small, meaning that several trends shown did not reach statistical significance. Secondly, some of the answers given appeared to reflect the “ideal” situation, rather than an actual one – one respondent commented that although the emergency centre he worked at did not have a forced air-warmer, one

could be borrowed from the operating theatre if necessary; however information obtained from operating theatre respondents showed only one forced air warmer was operational and the staff had not lent that out in the past six months. The cross-sectional nature of the study could also not account for periodic lack of disposable items necessary to successfully use the equipment. Although stock was replete at the time the audit was completed, it was reported that blankets used with the forced air-warmers and the giving sets used with the in-line fluid warmers were frequently out of stock, especially in the emergency centres. Therefore, the study may have under-estimated the problem of lack of equipment and over-estimated the performance of these emergency centres. This also holds implications for South African public hospital compliance with the National Core Standards [38].

The results of the audit are generalizable to many other South African secondary, tertiary and quaternary hospitals. This is because of the centralised allocation of budget by the Department of Health and the equal distribution of equipment by a central depot. Also, the equipment is likely to be used in a similar manner, owing to the similar nature of both undergraduate and postgraduate training by the different South African universities and nursing colleges. The results are not as generalizable to primary health care facilities, where a shortage of necessary equipment is more likely to be a problem. Looking more broadly at the rest of the African continent, the study is highly applicable to any trauma centre and operating theatre with the infrastructure and equipment detailed above, and still remains relevant where there is no such infrastructure. In less well-resourced settings, simple methods of hypothermia prevention, such as removal of cold, wet clothes, limiting the area of exposed skin and provision of warm cotton blankets will all assist in reducing heat loss.

### Clinical Guideline

## Protocol for Hypothermia Prevention

**For Use In:** All adult and paediatric patients presenting to emergency center  
**For Use By:** All medical personnel (nurses and doctors)

#### Purpose of Protocol

Prevention of hypothermia is an important aspect of care of all patients, however it has been shown to be very poorly performed. The interventions proposed are both safe and effective and lead to a reduction in hospital costs

#### On Arrival

- All patients are to have temperature recorded
- All patients are to be triaged according to South African Triage Scale

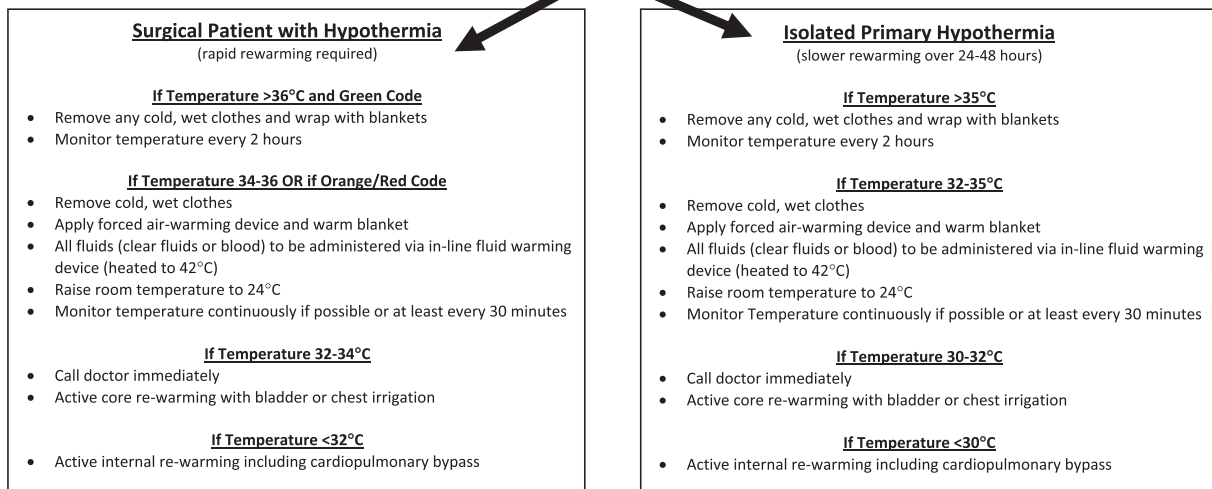


Fig. 2. Protocol for hypothermia prevention.

## Conclusion

South Africa bears a massive burden of trauma and acute general surgery patients and thus it is vital that service delivery is optimised for this large subset of the population. In the hospitals included in this study, the poor availability of equipment was often cited as a reason for suboptimal management in terms of hypothermia prevention. This study importantly highlights that the major obstacle to good patient care lies rather with the suboptimal use of the available tools. The proposed departmental protocol for hypothermia prevention presented in this study would be simple and cost-effective to implement and would likely lead to a reduction in patient morbidity and mortality (Fig. 2).

## Dissemination of findings

The study findings were discussed at the participating hospitals. Staff at poorly performing hospitals were provided additional input through informal discussion.

## Author contribution

MN and TH conceived the original idea. MN and TH designed the data collection tools. MN collected the data and carried out the data analysis. MN drafted the manuscript and TH revised it. MN and TH approved the final version that was submitted.

## Appendix A and B. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.afjem.2017.05.001>.

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