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Pre-hospital intercostal chest drains in South Africa: A modified Delphi study

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ABSTRACT

Introduction: Trauma is one of the most common causes of death in low- and middle-income countries, with thoracic injury accounting for 20–25% of these deaths worldwide. The current management of a life-threatening pre-hospital pneumothorax is with a needle chest decompression, however, definitive care for a pneumothorax and/or haemothorax is still the insertion of an intercostal chest drain. The aim of this study was to seek expert opinion and consensus on the placement of ICDs in the pre-hospital emergency care setting in South Africa.

Methods: A three-round modified Delphi study was undertaken with an expert panel drawn from local emergency care experts consisting of physicians and emergency medical service practitioners. Participants supplied opinion statements in round 1 under headings derived from common emerging themes found in the literature. During round 2 participants used a 9-point Likert scale to rate their consensus on each statement and in round 3 they were able to change their position based on the earlier panel distributions. A consensus percentage of 60% was set within a narrow margin of 'strongly agree' or 'strongly disagree'.

Results: A total of 22 experts took part as panel members. There were 123 opinion statements produced from round 1, of which 21 (17%) reached consensus in round 2. At the end of round 3 another four statements reached consensus, bringing the total up to 25 (20%).

Conclusion: Definitive care of a life-threatening pneumothorax and/or haemothorax must be sought emergently. The insertion of an ICD, under select conditions, may be required in the pre-hospital setting in South Africa.

African relevance

- Prevalence of thoracic injury in Africa results in a large treatment burden.
- Life-threatening thoracic injuries should be treated appropriately in the first instance.
- The pre-hospital use of intercostal chest drains may aid mortality reduction in Africa.

Introduction

Trauma is one of the most common causes of death in low- and middle-income countries [1,2]. Thoracic injury account for 20–25% of these deaths worldwide [1,3–5], either by blunt force or penetration to the thoracic cavity [3]. A consequence of such injury can be the development of a pneumothorax and/or haemothorax [5], including under tension, where respiratory and cardiac function become so

impaired that death may ensue if not treated and corrected emergently [3,4].

In KwaZulu-Natal, South Africa, 10.4% of trauma cases result in death [6]. Chest injuries account for 27.4% of such deaths, with 88.8% of them being a result of penetrating trauma [6]. A 2014 study in the same region found that in patients where an Intercostal Chest Drain (ICD) was indicated, 75% were from penetrating injury [7]. Of the 1050 ICDs that were performed over a 4-year period, 32% were for haemopneumothorax, 30% for haemothorax, 25% for simple pneumothorax, 8% for tension pneumothorax, and 5% for open pneumothorax [7]. Although no pre-hospital data currently exist on the need for ICDs, a trauma callout rate of almost 12/1000 population in KZN per year warrants the evaluation of this life saving procedure pre-hospital [2].

The indications for inserting an ICD are not clear cut as it relies on the size of the pneumothorax and/or haemothorax, its aetiology, and the clinical presentation of the patient [8]. A rapidly deteriorating

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patient condition following a chest injury, causing respiratory and/or circulatory compromise, may be easier recognisable than the roughly 8% of cases that develop over time when observed in hospital [9]. ICD placement does not come without risk; with insertional, positional, and infective complications being the major categories [10]. Even in a major trauma centre with experienced clinicians, a complication rate of 19% was observed in KwaZulu-Natal [7]. In the Cape Town region of South Africa, although a lower complication rate was seen at 9.5%, this is still considered too high and a push for more training is recommended [11].

Pre-hospital healthcare is provided through various public and private Emergency Medical Services (EMS) in South Africa [12,13]. These services are staffed by emergency care personnel with varying capabilities as set by the Health Professions Council of South Africa (HPCSA) [14]: basic, intermediate, and advanced. From an intermediate level upwards, practitioners can perform a needle decompression to temporarily alleviate a tension pneumothorax [14]. The insertion of an ICD is regarded as the definitive care for such cases [15,16]; however, its use in the pre-hospital setting for the management of life-threatening situations has not been established. The aim of this study was to seek expert opinion and consensus on the placement of ICDs in the pre-hospital emergency care setting in South Africa.

Methods

We undertook a three-round modified Delphi study [17]. This approach was chosen to ascertain consensus based on expert opinion on the placement of ICDs pre-hospital, and has been used successfully in other areas of emergency medicine in South Africa [18,19]. Delphi studies allow for complex problems to be investigated through gathering expert opinion in a structured manner and facilitating the convergence of consensus [20,21].

The study was set in South Africa with an expert panel consisting of local emergency physicians and trauma surgeons (physician group), paramedics and emergency care practitioners (EMS group). Emergency physicians and trauma surgeons are experts based on the nature of their medical speciality and contact with patients having chest injuries. Paramedics and emergency care practitioners perform Advanced Life Support (ALS) within EMS with first-hand experience of chest trauma pre-hospitally.

The University of Cape Town Human Research Ethics Committee (HREC REF: 317/2012) approved this study. Invitations to eligible participants were sent out nationally to emergency physicians and trauma surgeons through practitioner databases. Invitations to paramedics and emergency care practitioners were sent out to all universities, government, and private colleges in South Africa having alumni they educated. Word-of-mouth and social media communications were also used to invite eligible participants. There was a total of 37 eligible experts that showed their willingness to take part (11 emergency physicians, 4 trauma surgeons, 7 paramedics, and 15 emergency care practitioners), with participation and consent kept confidential.

Consensus does not indicate a correct answer, but rather the convergence or divergence of opinion among experts [22,23]. There are two factors for consideration when setting a consensus threshold: the percentage of opinion allocations (how many participants need to agree on a statement) and the margin of the scale used (distribution on a Likert scale). There is no definite threshold for the percentage of allocations, which may vary from 55% to 100%, nor a set margin to correspond [24]. Depending on the needs of the investigation, sample size and level of expertise, these operators can be adjusted to fit. For this study, investigating a controversial topic with a heterogenic sample of experts, a lower percentage with a narrow scale margin for consensus was applied.

This study regarded consensus as 60% or more of the participants strongly agreeing (positive consensus), or strongly disagreeing

(negative consensus), creating a narrow margin for consensus (Table 1). A distribution of 75% or more of participants that either showed overall agreement (or disagreement) were captured as a secondary trend measure which showed the tendency of the expert group.

Round 1

Following a search of the literature, the most common emerging themes were captured and formulated into a set of headings and sub-headings (Table 2). Participants then contributed opinion statements to capture the attributes or issues they felt important under each heading; using an online survey over a five-week period with two follow-up reminders. When completed, the data collected underwent a desk-based thematic analysis to organise, synthesise, and describe the emerging themes. Themed text was transposed into neutral statements under each heading for use in the consecutive rounds.

Round 2

Statements were compiled in a survey format and sent out to participants for completion over a four-week period, including two reminders. They were asked to rate their level of agreement or disagreement with each statement using a 9-point Likert scale (from 'strongly agree' to 'strongly disagree'). Data from this round were extracted from the survey platform and analysed using Microsoft Excel to determine participant agreement on each statement. Statements that received 60% or more participant allocations within the 'strongly agree' or 'strongly disagree' categories were considered as reaching consensus at this point.

Round 3

For statements that did not reach consensus in round 2, participants reviewed their scores against the distribution of the whole expert panel and were offered a chance to reconsider their view. A consensus and distribution analysis were conducted at the end of this concluding round using the same procedures as in round 2. The number of final participant allocations were tallied under each of the Likert scale categories as depicted in Table 1. Apart from the consensus determination, a distribution tendency was calculated as 75% or more of participant allocations distributed towards agreement or disagreement.

Results

Of the 37 eligible and interested experts, 16 (7 Physicians and 9 EMS) took part in round 1 by completing the survey (Table 3). These participants produced 123 statements spread across the seven headings (Appendix A). Round 2 was sent to all respondents ($n = 16$) and all non-respondents ($n = 21$) from round 1. There were 22 experts (8 Physicians and 14 EMS) who took part in round 2; the non-respondents ($n = 15$) were subsequently excluded from the process. These 22 participants were given the option in round 3 to review and reconsider their allocations. Nine participants (3 Physicians and 6 EMS) made changes to their original allocations.

Round 2 saw 21 (17%) of the 123 opinion statements reaching positive consensus (Appendix B), rising to 25 statements (20%) after round 3 (Table 4, Appendix C). There were no statements that reached negative consensus. In the end there were a further 32 statements (26%) that received a tendency toward agreement and 5 statements (4%) a tendency toward disagreement (Appendix D).

Discussion

The most important aspect of any invasive medical procedure is whether there is a need for it. ICDs have been used in the hospital setting for many years to manage both non- and life-threatening

Table 1
9-point Likert-scale with consensus and distribution delineation.

≥ 60 % Negative Consensus					≥ 60% Positive Consensus			
≥ 75% Negative agreement distribution					≥ 75% Positive agreement distribution			
1	2	3	4	5	6	7	8	9
Strongly Disagree		Disagree		Neither	Agree		Strongly Agree	

Table 2
Emerging literature themes.

Theme headings and sub-headings
Need for procedure
• Urban and rural settings, public and private healthcare systems
Safety of procedure
• Risk (complications) vs. benefit (improved patient outcomes)
Diagnosis of major pneumothorax, haemothorax
• Indications, contraindications, methods or clinical diagnosis
Effectiveness of procedure
• Treatment of injury, patient outcome measures
Skill level required to perform procedure
• Physicians, emergency care practitioners, paramedics
Equipment required to perform procedure
• Required and/or available to perform procedure
Other consideration of procedure
• Any other issues regarding the placement of pre-hospital intercostal chest drains in South Africa

Table 3
Expert panel engagement with Delphi rounds.

Expert panel contributions				
Groups	Professionals	Round 1 Statements	Round 2 Review	Round 3 Reconsideration
Physicians	Emergency Physicians	5	6	3
	Trauma Surgeons	2	2	0
EMS	Paramedics	2	5	2
	ECPs	7	9	4
Total:		16	22	9

pneumothorax and/or haemothorax [25]. There is no published evidence to support the need for this procedure in the pre-hospital setting as a life-saving intervention. However, the expert panel agreed that a patient's condition would determine the need for an ICD. There is a high incidence of trauma in South Africa with an associated high mortality rate [6]. Of these deaths, almost 30% are due to chest trauma, and 89% of those are caused by a penetrating injury [6]. No data is currently available to show how many patients have died because of a life-threatening chest injury pre-hospital in South Africa. Unconfirmed clinician experience suggest a high incidence of ICD insertions in hospital, especially in low-income areas, indicating that more data is required to inform the need for ICD placement pre-hospital [11].

Consensus on transport times of more than an hour or those reached by helicopter services does show a potential need for ICD placement where access to definitive care is delayed. A patient's condition may also deteriorate over time, especially in circumstances where a tension does not respond to a needle decompression [26]. Distance and travel to definitive care may also be prolonged in rural South Africa [13]. Physician led Helicopter Emergency Medical Services (HEMS) in Italy and the UK have shown that pre-hospital thoracostomy, with or without ICD placement, can be safe an effective, and dramatically reduce the time to definitive care [5,27,28].

The risk associated with ICD placement provides a counterbalance to its need. Every invasive procedure present with some degree of safety risk and it is the clinical rationale of risk vs benefit, based on the

patient's condition that determines its application. Most literature focus on the reduction of risk and mitigation of complications during ICD placement [28–30]. In South Africa the reported in-hospital complication rate is 10–20% [7,11], which raises concern regarding their use in an uncontrolled pre-hospital environment. The expert panel agreed that whomever inserts a pre-hospital ICD must be able to appropriately manage complications. Given the limited availability of emergency care resources in South Africa [2,13], there is a valid concern that the myriad of possible complications may not be manageable pre-hospital [29].

The diagnosis of a major pneumothorax and/or haemothorax and the late stage of tension [3] can be done routinely based on clinical judgement [31], and the expert panel agreed. Pre-hospital providers in South Africa from intermediate level upwards are able to diagnose and treat a tension pneumothorax with a needle decompression [14]. It shows that such providers can use evidence-based guidelines to identify life-threatening instances where chest trauma has led to a major pneumothorax and/or haemothorax. It is common for an X-ray to be taken prior to ICD insertion in non-life-threatening cases, however, in an emergency this is often foregone in the interest of time [32]. It is agreed that confirmation of ICD placement should routinely be done to identify any potential complications following insertion.

In Italy and the UK, the use of a thoracostomy, with or without ICD insertion, has been successful pre-hospital in a physician-led service [5,27,28]. The South African EMS is unique as its providers, especially at advanced life support level, have substantially more trauma experience than high-income country EMS [2]. The scope of practice of these providers is amongst the most extensive in the world, including invasive procedures such as needle decompression, suturing, surgical cricothyroidotomy, and rapid sequence intubation [14]. Although the panel could not reach consensus on the skill level needed, they showed a positive agreement tendency that emergency care practitioner qualified individuals with formal training should be able to perform an ICD in selected circumstances. They also showed disagreement that only physicians should perform an ICD. Irrespective of the type of practitioner, the main determinant to reduce complications is that of experience and the maintenance of competence [31,33].

Table 4
Expert panel positive consensus.

Consensus statements
<p>Need for procedure The patient's condition determines the need for this procedure pre-hospital There is a need for this procedure where transport times to hospital exceed 60 minutes There is a need for this procedure in aviation emergency medical care</p> <p>Safety of procedure Practitioners should be able to manage possible complications appropriately pre-hospital There is an increased risk using a Trocar device in performance of this procedure</p> <p>Diagnosis of major pneumothorax, haemothorax Practitioners should possess sound clinical judgement when diagnosing haemothorax Practitioners should possess sound clinical judgement when diagnosing pneumothorax X-ray diagnosis and placement confirmation should be done after the procedure Evidence based guidelines and norms should apply when diagnosing haemothorax pre-hospital Evidence based guidelines and norms should apply when diagnosing pneumothorax pre-hospital</p> <p>Effectiveness of procedure Long term efficacy of this procedure pre-hospital needs to be through a monitoring perspective (in terms of infection and discharge from hospital) Consultation with suitable practitioners should be available prior to performing this procedure pre-hospital</p> <p>Skill level required to perform procedure No statements</p> <p>Equipment required to perform procedure All equipment used during this procedure pre-hospital should be sterile packaged Pre-packaged kits should be available to perform this procedure pre-hospital All kits used during this procedure pre-hospital should be sealed All kits used during this procedure pre-hospital should be standardised Similar equipment utilised on aeromedical services to perform this procedure should be utilised pre-hospital Sufficient cleansing solutions need to be utilised to reduce the risk of infection Appropriate monitoring equipment should be utilised to evaluate a patient's condition during performance of this procedure</p> <p>Other considerations of procedure Practitioners will have to maintain a high skill level to perform this procedure pre-hospital Integration with hospital trauma units is required to maintain practitioner competency in the performance of this procedure pre-hospital Regular training and skill maintenance of this procedure pre-hospital is required to maintain practitioner competency Training of this procedure pre-hospital should be conducted under the guidance of a suitable medical practitioner Clinical governance and quality assurance need to be in place to manage the performance of this procedure pre-hospital A good record of information should be maintained regarding the performance of this procedure pre-hospital</p>

The availability of appropriate resources is a major concern for pre-hospital EMS; and it is known that rural areas are substantially less resourced than urban areas [2,13]. Although the expert panel agreed that proper equipment (traditional or specially designed alternatives) should be readily available pre-hospital, pre-packed and compact enough to be deployed and used in tough conditions, the reality of an under-equipped and poorly stocked system does not make it possible. Clinical governance is also crucial to provide oversight as limited exposure and inexperienced clinicians are far more likely to have complications occur during ICD placement [7,11,33]. Other than closely checked groups like HEMS, this may not be possible for broader services.

The effectiveness of an ICD to relieve life-threatening circumstances is uncontested. It is widely regarded as the standard of care for chest injuries that result in a moderate to severe pneumothorax and/or haemothorax. The pre-hospital setting is uncontrolled and scarcely resourced, with skill competency and clinical governance that cannot be ensured. Without a proven need and a lack of clinical data, the introduction of ICDs pre-hospital is still open for debate.

Limitations

The success of this study and its use of the Delphi technique to reach consensus on some of the statements is subject to credibility, reliability, validity and transferability checking [34]. It is acknowledged that the expert panel was heterogeneously split between in- and pre-hospital professionals having different medical training (Physicians and EMS). It was, however, important for the richness of the research to approach both groups. Delphi panel sizes may vary from tens to hundreds and are dependent on participant availability and level of expertise required [24,35]. It was disheartening that only 22 of the potential 37 interested experts decided to take part, however, the composition of the panel was sufficiently strong to provide induction of the findings to the broader

audience. Transposing the findings of this study into clinical practice will need further exploration and clinical trial.

Conclusion

Chest injuries sustained on a regular basis in South Africa have a mortality rate of 1 in 10. These patients are dealt with in the first instance by pre-hospital emergency care providers. Managing a patient with chest injuries is daunting, especially if there is progression to a life-threatening pneumothorax and/or haemothorax pre-hospital. Timely definitive care must be sought emergently in such instances, which is currently only available in-hospital. In cases where access to prompt definitive care is limited, it would be in the patient's best interest to have, under select conditions, ICD placement available in the pre-hospital setting in South Africa.

Dissemination of results

The results of this study were shared by the distribution of a MSc research report to the University of Cape Town. Further sharing occurred to EMS stakeholders at an Emergency Care Society of South Africa conference during a research presentation.

Author contribution

Authors contributed as follow to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; drafting the work or revising it critically for important intellectual content; and final approval of the version to be published: ED 60% and LW 40%. Both authors agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflicts of interest

Prof Lee Wallis is an editor of the African Journal of Emergency Medicine. Prof Wallis was not involved in the editorial workflow for this manuscript. The African Journal of Emergency Medicine applies a double blinded process for all manuscript peer reviews. The authors declared no further conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.afjem.2019.01.003>.

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