BMJ Open

Gaining consensus on a protocol for general surgery physician assistants in the management of non-compressible abdominal haemorrhage in military austere environments: a Delphi study

Donald Adams ,[1] Paige L McDonald,[2] Michael Mader,[3] Seth Holland,[4] Timothy Nunez,[5] Philip van der Wees[6]

To cite: Adams D, McDonald PL, Mader M, *et al*. Gaining consensus on a protocol for general surgery physician assistants in the management of non-compressible abdominal haemorrhage in military austere environments: a Delphi study. *BMJ Open* 2024;**14**:e088159. doi:10.1136/bmjopen-2024-088159

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (https://doi.org/10.1136/bmjopen-2024-088159).

Received 29 April 2024
Accepted 29 July 2024

For numbered affiliations see end of article.

Correspondence to
Dr Donald Adams;
Dadams89@GWU.edu

ABSTRACT

Background Non-compressible abdominal haemorrhage (NCAH) is a potentially preventable cause of death due to injury. Limited exploratory laparotomy by a non-surgeon is a temporary intervention to sustain life until definitive surgical intervention by trauma surgeons can be obtained. This study aims to establish consensus on a protocol for general surgery physician assistants performing limited exploratory laparotomy to manage NCAH in an austere environment.

Method This study included anonymised trauma surgeons and general surgery physician assistants from military and civilian backgrounds. Participants were recruited from various professional surgical organisations, including direct interaction with trauma surgeons and surgical physician assistants. Participants used a modified Delphi survey with a 9-point Likert scale in two rounds. The two surveys were categorised into three parts: protocol for NCAH (part A), the potential role of general surgery physician assistants (part B) and measures of success (part C). A total of 24 statements were voted on and assessed. Votes were divided into three zones: agreement (median 7–9), uncertain (median 4–6) and disagreement (median 1–3). To reach a consensus, 70% agreement was required within a zone. If more than 30% of the votes fell outside of a specific zone, consensus was not achieved. After consensus, the original protocol was revised in an online meeting with experts.

Results The initial analysis involved 29 participants. After 2 survey rounds, 19 out of 24 statements reached a consensus. Part A: 10 statements gained consensus, including in austere environments, controlling NCAH can be challenging. A qualified general surgery physician assistant should intervene. A focused assessment with sonography for trauma examination can be used for screening. Bleeding can be managed with packing and pressure. After managing the haemorrhage, the abdominal wall should be left open with a temporary closure technique. Part B: nine statements gained consensus, including in austere locations, a licensed general surgery physician assistant with a minimum of 3 years of experience working under the supervision of a trauma/general surgeon can perform interventions for limited exploratory laparotomy for patients with NCAH. Part C: general surgery physician assistants will be required to have the same success rates as any qualified surgeon.

Conclusion Gaining consensus and implementing a revised protocol for managing NCAH by general surgery physician assistants is attainable. General surgery physician assistants will need formal training to manage NCAH. With the support of trauma surgeons who provide direct and indirect supervision, general surgery physician assistants can develop a comprehensive understanding of the necessary skills and make sound decisions when treating patients with this condition. This teamwork can also increase surgical capacity and potentially decrease mortality rates for patients with NCAH in austere environments.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ We used a modified Delphi study with a 9-point Likert scale to assess the consensus on a protocol and the potential role of general surgery physician assistants in performing limited exploratory laparotomy on patients with non-compressible abdominal haemorrhage (NCAH) in austere environments.
⇒ The data was gathered through two rounds of survey questions, including an open discussion box for participants to provide additional input on the statements they were asked to evaluate.
⇒ The data was obtained from 29 anonymised trauma surgeons and general surgery physician assistants in the first survey and 27 in the second survey.
⇒ Our study is limited by the absence of an official registry for general surgery physician assistants in the USA, which prevented us from obtaining an equal sample of participants, potentially limiting the additional data that could have facilitated consensus.
⇒ The survey was categorised into three sections to obtain consensus on a protocol for NCAH, the potential role of general surgery physician assistants and measures of success.

BACKGROUND

Despite the development of innovative interventions such as resuscitative endovascular balloon occlusion of the aorta (REBOA) and whole blood resuscitation over the past 26 years, the trauma surgical community has not yet found a way to sustain the life of a patient experiencing non-compressible abdominal haemorrhage (NCAH) long enough to reach definitive surgical care within an hour.[1 2] Individuals who sustain injuries associated with NCAH will, on average, begin haemorrhaging within 30 min of sustaining injury.[3]

Future near-peer conflicts raise concerns about the availability of qualified surgical providers who can control bleeding and resuscitate. Despite more surgeon training, supply is expected to remain unchanged for 15 years, leading to a shortage of 10 100 to 19 900 surgeons by 2036.[4] Military trauma surgeons are in short supply, and the military's surgical capacity is dwindling.[5] Previous task shifting/sharing in the US Military has not been successful, and non-trauma surgeons, such as Obstetrics and Gynecology providers (OB/GYNs), are ill-equipped to manage trauma patients on the battlefield.[5] Training and working alongside trauma and general surgeons, general surgery physician assistants acquire skill acquisition, skill sustainment and develop a comprehensive understanding, which leads to better discipline-specific decision-making abilities in trauma surgery and critical care.[6] General surgery physician assistants can potentially help increase surgical capacity for the military and civilian surgical communities.

The current literature focuses on using surgical adjuncts to stop bleeding for up to 2 hours to sustain life until definitive surgical care can be delivered.[7] Although there have been discussions of assigning general surgical physician assistants assignments to military forward surgical teams to either first assist in the operating room or to perform damage control resuscitation in the trauma bay while surgeons are operating during combat operations, no scientific research has been conducted to evaluate such interventions.[8–10] General Surgical Physician Assistants performing emergency surgical interventions closer to the point of injury using currently developed interventions may potentially sustain life for up to 1 hour.[9 11 12]

This article proposes a protocol for trained non-surgeons managing patients with NCAH in austere environments, focusing on general surgery physician assistants performing limited exploratory laparotomy. Limited exploratory laparotomy performed by a non-surgeon is not a definitive abdominal haemorrhage control intervention; it is a temporising intervention to sustain life until definitive surgical intervention by trauma surgeons can be obtained.[8] General surgery physician assistants performing limited exploratory laparotomy in the austere environment may be the key to decreasing the mortality of service members and government personnel during combat operations. This study presents the findings of a modified Delphi study to explore the degree of consensus of a protocol for non-surgeons performing limited exploratory laparotomy to manage NCAH in the austere environment using a revised protocol (online supplemental appendix A).[6]

METHOD

Purpose of the study and rationale for using the Delphi technique

To establish consensus on a developed protocol, we developed two research questions:

1. What is the consensus on a protocol for managing NCAH using limited exploratory laparotomy in austere environments?
2. What is the consensus for a general surgery physician assistant to perform limited exploratory laparotomy using a protocol on a patient with NCAH in austere environments?

A modified Delphi study was conducted to address both research questions. The Delphi technique was used to reach a consensus among a panel of experts to explore a concept outside the current standard of practice of the trauma surgical community in austere environments.[13]

The Conducting and Reporting of Delphi Studies reporting requirements were followed to ensure appropriate reporting of this modified Delphi study.[14]

Definition of consensus

Establishing consensus through the Delphi method does not have specific guidelines regarding percentage or technique.[14–16] The definition of consensus was determined using the RAND/UCLA Appropriateness method.[17] A 9-point Likert scale was used to rate survey items. Votes were divided into three zones: agreement (median 7–9), uncertain (median 4–6) and disagreement (median 1–3). To reach a consensus, 70% agreement was required within a zone. If more than 30% of the votes fell outside of a specific zone, consensus was not achieved. See online supplemental appendix B and B2 for a detailed definition of consensus.

Focus group to assess perspectives and opinions

Three authors, DA, PLM, and PvdW, participated in a focus group with Committee on Surgical Combat Casualty Care members. The focus group lasted approximately 1 hour and discussed several important perspectives and opinions crucial to this study. One significant perspective that stood out was how general surgery physician assistants would develop the decision-making skills needed to potentially perform a limited exploratory laparotomy in an austere environment on a patient with NCAH.

Selection of Delphi panel

For this study, the Delphi panel comprised anonymised military and civilian trauma surgeons and general surgery physician assistants from across the USA. This research study recruited participants from the Eastern Association for the Surgery of Trauma member's site. Participants were also queried by direct interaction with trauma

surgeons at the Defense Health Agency San Antonio Military Medical Center and the American Association of Surgical Physician Assistants. Prospective participants were invited to participate in the Delphi rounds through email and letter via the US Postal Service. Those interested in participating responded using either of the two methods. A second email or letter was sent if no response was received within 1–2 weeks. All participants who acknowledged receipt of the invitation letter and agreed to participate in the Delphi study were sent a participant consent form approved by the George Washington University institutional review board. Those prospective participants who signed and returned the consent form were enrolled in the modified Delphi survey.

Expert committee

An expert committee was installed to advise on developing the protocol and revising it based on the consensus data from the Delphi rounds. The expert committee comprised five trauma surgeons (BS, SAS, MVB, DJ and TN) and two general surgery physician assistants (SH and AM). Two senior researchers (PLM and PVW) were commissioned to ensure the validity and reliability of the Delphi process.

The protocol integrates evidence-based practices to improve medical practitioners' decision-making skills, synthesising diverse literature from various medical and surgical research to address research inquiries.[11] The original protocol is available on request.

The survey contained three parts (parts A–C). Parts A and B aimed to reach a consensus about what is known about the study of NCAH and its incorporation into a protocol (part A) and on the potential role of general surgery physician assistants in limited exploratory laparotomy (part B). In addition, part C of the Delphi round 1 survey inquired about measures of success.

The survey items aimed to gather consensus on several areas of interest, including demographics, understanding of the problem, familiarity with current interventions, acceptance of general surgery physician assistants performing limited exploratory laparotomy, technical competencies required for such procedures, acceptance of the protocol and support for efficacy trials. Foundational tasks/skills/concepts were based on graduating from an approved general surgery physician assistant programme and completing postgraduation fellowship training such as trauma intensive care residency, as well as obtaining certifications in advanced trauma life support, fundamental of critical care support, advance surgical skills for exposure in trauma, advanced trauma operative management and REBOA. Additional training skills were also identified through the survey process.

The study gathered anonymous data from trauma surgeons and general surgery physician assistants through two rounds of surveys.[13] The limitation of conducting only two rounds was due to panellist fatigue.[16 17] The first-round survey was developed based on the outcomes of a previously published scoping review and through discussions of protocols/recommendations with one experienced trauma surgeon and one experienced general surgery physician assistant.[18] The survey was then pilot tested by two trauma surgeon opinion leaders and two senior general surgery physician assistants. After the initial pilot testing, the survey was distributed to eight emergency medicine physicians for review and comment on its appropriateness. No changes were made to the surveys following the pilot testing, and all participants expressed that the survey was clear and appropriate.

The complete surveys from the first and second rounds are available on request.[6] The initial survey was developed in Microsoft Word and distributed via email. The manually drafted survey was constructed to allow participants to write notes and answer openly and freely using a comment box and drafting on the survey sheet. The second survey was an electronic survey developed and distributed by REDCap. Both surveys aimed to assess the acceptability of a knowledge tool of a protocol for non-surgeons to perform limited exploratory laparotomy on patients with NCAH haemorrhage. The survey was designed with a 9-point Likert scale to gather ratings and responses, and each item was accompanied by a comment box for additional input by each trauma surgeon and general surgery physician assistant.

The survey's second round was sent out to the panellists after analysing the data from the first round. The summary of the first round was distributed to all panellists to keep them informed about the results of the previous round. By providing a feedback summary of the previous round, panellists could provide more relevant responses for the current round. The feedback summary included the mean, median, SD, IQR, per cent of agreement and disagreement and degree of consensus from the 29 Delphi panellists, along with comments and arguments provided by the panellists. Descriptive statistics were used to compare the surveyed panellists using interquartile ranges, and the coefficient of variation was used to evaluate the significance of other covariables that may have affected the outcome.[19]

The protocol underwent an iterative review by the knowledgeable panel. The protocol was revised after thoroughly reviewing the original protocol and consensus data.

Patient and public involvement

There is no involvement of any patients or members of the general public in this research.

RESULTS

Figure 1's flow chart illustrates the stages of this modified Delphi study. The flow chart has five stages: the development stage, survey stage 1, the revision stage, survey stage 2 and the agreement stage.[13] It provides a brief but comprehensive view of the modified Delphi process.

Participants

71 potential participants were invited to participate in this study. 40 expressed their interest in participating in the

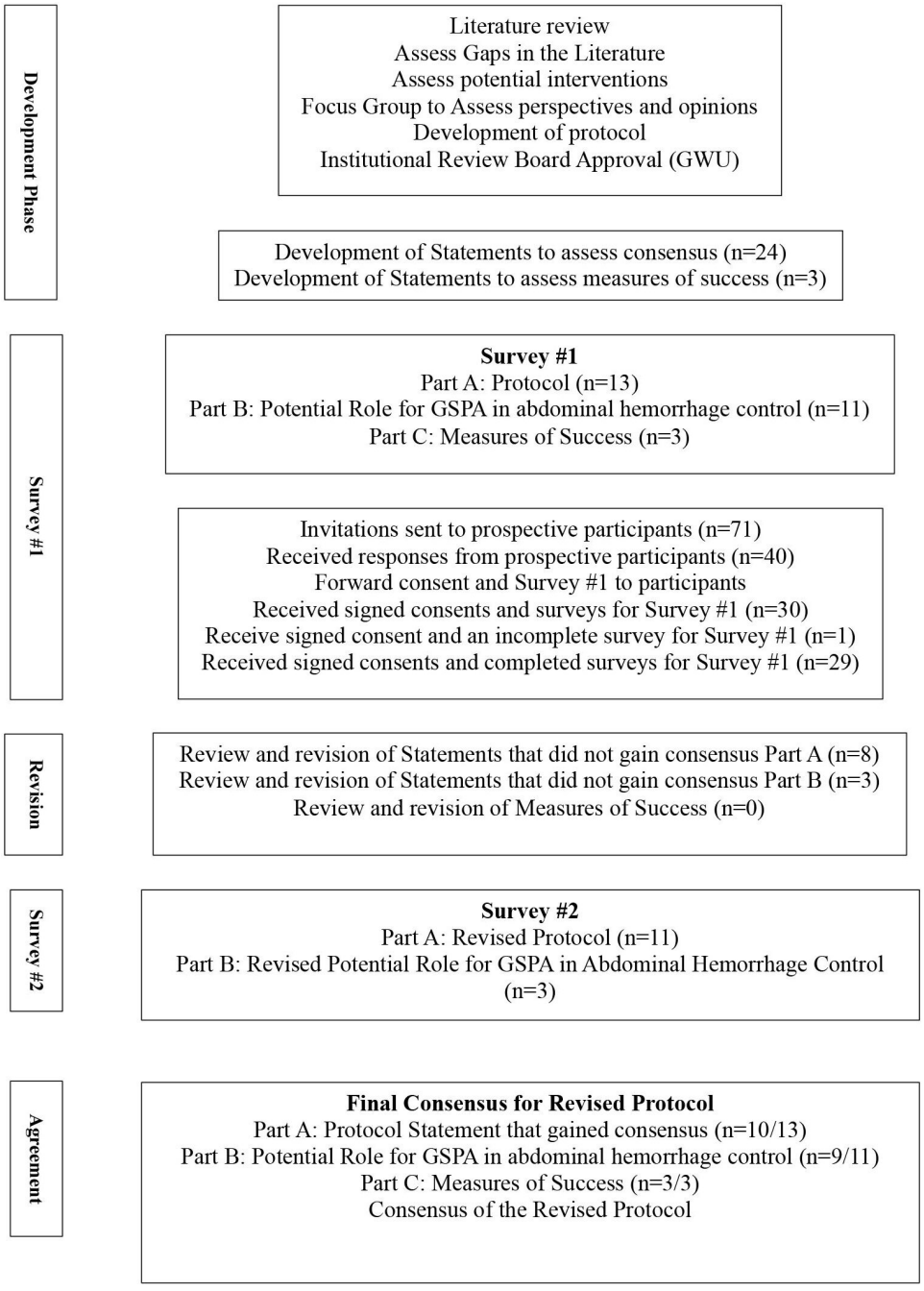

Figure 1 Modified Delphi study flow chart. GSPA, general surgery physician assistants; GWU, George Washington University.

modified Delphi study. Of the interested participants, 30 (75%) completed and returned a signed consent form and the initial survey. As shown in table 1, the first-round analysis included only 29 participants due to one incomplete survey. Of the 29 participants, 27 (93.1%) took part in the second round to reach a consensus, which was then used to revise the protocol.

Most of the study participants were between 40 and 49 years old, comprising 18 individuals (62.1%). In this study, most participants were physicians (doctor of medicine/doctor of osteopathy (MD/DO)), making up 17 individuals (58.6%). Furthermore, 9 participants (31.0%) reported working in their respective disciplines for 11–15 years, while 6 (20.7%) indicated 16–20 years of experience. Additionally, 11 participants (37.9%) indicated that they had deployed less than 3 times, while another 11 (37.9%) indicated that they had deployed 3–4 times. Finally, 16 participants (55.2%) deployed in non-special operation units during the global war on terror.

First-round consensus data (parts A and B)

In part A of the revised protocol, 5 out of 13 statements gained consensus in incorporating the study results into the protocol. Statement 5 gained consensus, indicating that four units of whole blood are enough to determine if a patient is a transient or non-responder during damage

Table 1 Demographics

Characteristics	Number (%)
Respondents, n	29
Gender	
Male	27 (93.1%)
Female	2 (6.9%)
Other	0 (0.0%)
Age group (years)	
20–29	0 (0.0%)
30–39	2 (6.9%)
40–49	18 (62.1%)
50–59	8 (27.6%)
60 and above	1 (3.5%)
Medical licence	
MD	14 (48.3%)
DO	3 (10.3%)
PA	12 (41.4%)
How many years have you been practising as a licensed MD, DO and PA?	
5 years or less	1 (3.4%)
6–10 years	3 (10.3%)
11–15 years	9 (31.0%)
16–20 years	6 (20.7%)
21–25 years	5 (17.2%)
26–30 years	3 (10.3%)
31–35 years	1 (3.4%)
36 to >36 year	1 (3.4%)
Number of deployments providing medical support for war on terror:	
<3 deployments	11 (37.9%)
3–4 deployments	11 (37.9%)
5–6 deployments	6 (20.7%)
>6 deployments	1 (3.5%)
Missing	0 (0.0%)
Type of unit supported	
Non-special operations	16 (55.2%)
Special operation only	2 (6.9%)
Special operation and non-special operations	5 (17.2%)
Special operations and federal government	1 (3.5%)
Special operation, non-special operations and non-special operations/non-federal government	1 (3.5%)
Special Operation, non-special operations and federal government	3 (10.3%)
Special operation, non-special operations, federal government and non-special operations/non-federal government	1 (3.5%)

DO, Doctor of Medicine; MD, Doctor of osteopathy; PA, Physician Assistant.

control resuscitation. Statement 9 also gained consensus, noting that most abdominal bleeding can be controlled with tight four-quadrant packing and/or direct pressure of bleeding vessels. For statement 10, in patients with severe haemorrhage that cannot be controlled with tight four-quadrant packing and/or direct pressure, REBOA can be used as an alternative to gain proximal aortic control over a left-sided thoracotomy and/or supraceliac aortic control. Statement 12 recommends that after all major bleeding is controlled, the abdominal cavity should be systematically explored for bleeding and intestinal leakage (from the ligament of Treitz to the rectum). Last, statement 13 suggests that in austere environments, the abdominal wall should be left open on managing intra-abdominal haemorrhage, with the use of a temporary abdominal wall closure technique such as a Bogota bag with a chest tube placed on low suction to remove intra-peritoneal fluid.

The remaining eight statements did not meet consensus, as noted in online supplemental appendix C. There was disagreement with these eight statements, indicating that 30% of the votes were outside the median region. Despite the median being within the 'agreement zone', greater than 30% of the votes were not within that region, contributing to the non-consensus.

In part B, 8 out of 11 statements about the potential role of general surgery physician assistants in controlling abdominal haemorrhage gained consensus. A licensed general surgery physician assistant with at least 3 years of experience working in an operative general/trauma surgery environment can be an asset to the general/trauma surgery disciplines in managing patients with NCAH in austere environments. General surgery physician assistants can assess and identify indications for exploratory laparotomy, place an ultrasound-guided REBOA to assist in the management of Zone I and III haemorrhage, perform a full midline laparotomy incision (from the xiphoid to the pubic symphysis), perform a tight four-quadrant abdominal packing, systematically explore the abdominal cavity for bleeding and intestinal leakage (from the ligament of Treitz to the rectum), effectively use REBOA during intraabdominal haemorrhage to control proximal aortic haemorrhage and perform a temporary abdominal closure.

The three remaining statements did not reach a consensus, as indicated in online supplemental appendix

C. There was disagreement regarding statements 1, 3 and 10.

Second-round consensus data (parts A and B)

Online supplemental appendix D indicates that eight statements that did not gain consensus in round 1 were revised, with statement 3 being split into four subsections. Statement 7 was revised to ensure consistent consensus that invasive interventions are necessary to sustain life in patients with NCAH despite damage control resuscitation (DCR). This resulted in the production of 11 new statements, which underwent consensus in part A. Out of the 11 revised statements, 5 gained consensus during the second round of surveys.

In part A, statement 1 establishes that NCAH is the leading cause of potentially preventable death in prehospital/battlefield settings. Statement 2 established that in austere environments with limited resources and no licensed surgical provider or team, there is insufficient evidence to guide medical/surgical intervention for patients with NCAH; furthermore, how to sustain their lives for more than 6 hours is unclear. Statement 6 establishes that in an austere environment without a trauma/general surgeon present, a patient with NCAH may undergo surgical intervention (limited exploratory laparotomy) if a trained and qualified general surgery physician assistant is available. However, this should only be done if adequate teams (anaesthesia providers, nurses and surgical technicians) and supplies to sustain the patient's physiology during the operation are present. According to statement 7, it has been concluded that DCR alone may not be enough to sustain the life of patients with NCAH in austere environments for a prolonged evacuation lasting 4 hours. To ensure the potential survival of a patient with NCAH in such conditions, it may be necessary to perform an invasive intervention. Statement 8 established consensus for the use of a focused assessment with sonography for trauma (FAST) examination or diagnostic peritoneal lavage use as a screening tool to assess the presence of significant intra-abdominal haemorrhage in patients with NCAH in austere environments. Statement 11 established consensus, noting that all expanding and leaking haematomas, including retrohepatic haematoma, should only be managed with packing by appropriately trained and qualified general surgery physician assistants in austere/remote environments where a trauma/general surgeon is not immediately available. Statement 10 established that during the first and second surveys, there was no consensus that an appropriately trained and qualified general surgery physician assistant with a qualified and trained anaesthesiology and surgical support team could successfully perform a limited laparotomy with abdominal haemorrhage control in hemodynamically unstable trauma patients that meet the indication for abdominal haemorrhage control in austere environments, as listed in the attached protocol (online supplemental file 1).

Statements 3–5 were revised from previous round 1, statement 3; in round 2, one of the four statements from this revised question gained consensus (statement 6), and the remaining three statements (statements 3–5) did not maintain consensus. Statement 9 did not gain consensus for placement of an ultrasound-guided REBOA catheter with the balloon up as a potential first step before surgically opening the abdomen in patients with NCAH in austere environments. Part B (online supplemental appendix E) contained three additional statements that did not gain consensus in round 1. After revision, statements 1 and 10 in round 2, part B did not gain consensus. Statement 3 gained consensus indicating a fellowship-trained licensed general surgery physician assistant or a general surgery physician assistant who is currently working in a trauma surgery department with at least 3–4 years of experience operating next to a trauma surgeon or general surgeon has the ability to perform limited exploratory laparotomy interventions in austere environments to control bleeding only with a team of qualified medical providers.

Final consensus results

Table 2 summarises the statements that received consensus during rounds 1 and 2 of the modified Delphi study. The study presents the results of a survey conducted in two rounds, where participants agreed on a set of statements. Table 2 summarises the findings, indicating that part A had a consensus on 10 out of 13 statements, while part B had a consensus on 9 out of 11 statements. Overall, 19 out of the 24 statements reached consensus across both parts.

Measures of success (part C)

Three measures of success were solicited from the participants in part C, who completed the first survey for the modified Delphi study. Success was defined as the patient surviving after undergoing surgery performed by a general surgery physician assistant for NCAH. The first measure of success was to assess what participants perceived as a successful outcome of a general surgery physician assistant performing a four-quadrant abdominal packing only in a patient with NCAH in austere environments. 19 (65.5%) indicated an expectation that greater than 50% survival would be acceptable (online supplemental appendix F). The second question queried what participants believed would be an acceptable level of success for general surgery physician assistants performing a four-quadrant abdominal packing and vascular shunting in a patient with NCAH in austere environments. 16 (57.1%) participants indicated that greater than 50% is a measure of success for a general surgery physician assistant to perform a four-quadrant abdominal packing and vascular shunting in a patient with NCAH in austere environments (online supplemental appendix F). The final measure of success queried what participants believed would be an acceptable measure of success for a general surgery physician assistant performing abdominal haemorrhage on a patient with NCAH in austere environments. 14 (50%) participants indicated that greater than 50% would be a measure of success (online supplemental appendix F).

Table 2 Summary of statements that have gained consensus

Combined statement from surveys 1 and 2 that made consensus	Degree of consensus	Strength of recommendation
Part A: protocol		
Non-compressible torso haemorrhage (NCTH) is the leading cause of potentially preventable death in the prehospital/battlefield environment.	Very good	Strong
In austere/remote environments that are resource limited and there is no licensed surgical provider or team; evidence is scarce to guide medical or surgical intervention to sustain life for greater than 6 hours in patients with NCTH of the abdomen.	Very good	Strong
In an austere environment lacking a trauma/general surgeon at the bedside, a patient who is suspected of having NCTH of the abdomen who meets the following criteria should have a surgical intervention (truncal haemorrhage control) performed to control bleeding by a qualified general surgery physician assistant: ► Adequate resources to sustain life during the operation to obtain truncal haemorrhage control	Good	Weak
4 units of whole blood are sufficient to assess if a patient is a transient or non-responder during damage control resuscitation.	Very good	Strong
In austere/remote environments where CT scan is not available, a focused assessment with sonography for trauma examination or diagnostic peritoneal lavage can be used as screening tools to assess for the presence of significant intra-abdominal haemorrhage in the hands of a qualified provider.	Very good	Strong
Most bleeding within the abdomen can be controlled with tight four-quadrant packing and/or direct pressure of bleeding vessels.	Good	Weak
In patients with severe haemorrhage that is not controlled with tight four-quadrant packing and or direct pressure. REBOA would serve as alternative to gain proximal aortic control over a left-sided thoracotomy and or supraceliac aortic control.	Good	Weak
All expanding and/or leaking haematomas, including retrohepatic haematoma, should only be managed with packing by non-surgeons (appropriately trained and qualified general surgery physician assistants) in austere/remote environments where a trauma/general surgeon is not immediately available.	Good	Weak
After all major bleeding is controlled, the abdominal cavity should be systematically explored for bleeding and intestinal leakage (from the ligament of Treitz to the rectum).	Very good	Strong
On managing intra-abdominal haemorrhage in austere/remote environments, the abdominal wall should be left open with the use of a temporary abdominal wall closure technique such as the use of a Bogota bag with a chest tube placed on low suction to remove intraperitoneal fluid.	Very good	Strong
Part B: potential role of general surgery physician assistants in truncal haemorrhage control		
A fellowship-trained licensed general surgery physician assistant, who has at least 3 years of experience working in an operative general surgery or trauma surgery environment is an asset to the general surgery and or trauma surgery disciplines.	Very good	Strong
A fellowship-trained licensed general surgery physician assistant or a general surgery physician assistant, who is currently working in a trauma surgery department with at least three to 4 years of experience operating next to a trauma surgeon or general surgeon has the ability to perform truncal haemorrhage control interventions in austere/remote environments to control bleeding only with a team of qualified medical providers.	Good	Weak
A fellowship-trained licensed general surgery physician assistant, who has at least 3 years of experience working in an operative general surgery or trauma surgery environment, can reference the indications for the initiation for truncal haemorrhage control in patients with NCTH of the abdomen in austere/remote environments to decide if truncal haemorrhage control is indicated.	Very good	Strong
A fellowship-trained licensed general surgery physician assistant, who has at least 3 years of experience working in an operative general surgery or trauma surgery environment can place an ultrasound-guided REBOA in zone III to gain proximal aortic control.	Good	Weak

Continued

Table 2 Continued

Combined statement from surveys 1 and 2 that made consensus	Degree of consensus	Strength of recommendation
A fellowship-trained licensed general surgery physician assistant, who has at least 3 years of experience working in an operative general surgery or trauma surgery environment, may be trained to perform a full midline laparotomy incision (from the xiphoid to the pubic symphysis) on patients with NCTH of the abdomen in austere/remote environments.	Good	Weak
A fellowship-trained licensed general surgery physician assistant, who has at least 3 years of experience working in an operative general surgery or trauma surgery environment may be trained to perform a tight four-quadrant abdominal packing on patients with NCTH of the abdomen in austere/remote environments.	Very good	Strong
A fellowship-trained licensed general surgery physician assistant, who has at least 3 years of experience working in an operative general surgery or trauma surgery environment, may be trained to systematically explore the abdominal cavity for bleeding and intestinal leakage (from the ligament of Treitz to the rectum).	Very good	Strong
A fellowship-trained licensed general surgery physician assistant, who has at least 3 years of experience working in an operative general surgery or trauma surgery environment, can be trained to effectively use REBOA during intra-abdominal haemorrhage to control proximal aortic haemorrhage.	Good	Weak
A fellowship-trained licensed general surgery physician assistant, who has at least 3 years of experience working in an operative general surgery or trauma surgery environment, can be trained to perform a temporary abdominal closure using a Bogota bag and using a chest tube at low suction to remove intraperitoneal fluid in patient with NCTH of the abdomen in austere/remote environments.	Very good	Strong

REBOA, resuscitative endovascular balloon occlusion of the aorta.

Revision of the protocol

The expert committee edited the protocol after an iterative review of the modified Delphi study final results and the original protocol. Major revisions were made in the initial indications to initiate limited exploratory laparotomy in patients with NCAH in austere/remote environments. The revised changes included attempting teleconsultation, if possible (trauma surgeon), patients with suspected abdominal or pelvic haemorrhage that cannot be stabilised before surgical team arrival, and having a high index of suspicion that continuous haemorrhage is coming from a source in the abdomen based on positive FAST or penetrating wound location (spleen, liver, retroperitoneum, complex vascular). The next minor revisions concerned the placement of REBOA during DCR with the balloon down versus the previous discussion of having the balloon up. The next minor revision comprised anaesthetising the patient with general anaesthesia (etomidate, propofol, ketamine). The addition of hemostatic agents in the temporary control of abdominal packing was also included in the final version.

DISCUSSION

This study gained consensus on 19 of 24 statements for general surgery physician assistants to perform limited exploratory laparotomy to manage non-compressible torso trauma in an austere environment. The consensus was used to develop an untested revised protocol. This protocol includes indications for controlling abdominal haemorrhage temporarily and addressing severe bleeding of the liver and spleen, abdominal aorta and visceral branches and the supramesocolic region.

The proposed revised protocol is untested and introduces a new approach to managing NCAH by general surgery physician assistants in austere environments. This protocol is intended for use by surgeons and trained general surgery physician assistants who are credentialed and supported by a team to manage the patient's physiology. According to experts, a properly trained physician assistant can manage operative haemorrhage control in an austere environment with direct or indirect physician oversight, but they should not perform vascular shunting. Only general surgery physician assistants credentialed by a certified credentialing body and operating under direct or indirect supervision should consider performing the interventions outlined in the revised protocol.

The use of REBOAs to support abdominal haemorrhage control during DCR and potentially during the truncal control intervention is an essential component of supporting the intervention of non-surgeons performing limited exploratory laparotomy. Early implementation of REBOAs for proximal abdominal haemorrhage control limits blood loss, while trauma surgeons and general surgery physician assistants intervene to temporise intra-abdominal haemorrhage.

Task shifting/sharing is a strategic method of assigning healthcare duties among teams within your medical discipline. The need for task shifting/sharing results

from the 'large and unmet burden of surgical disease' and the declining number of surgical professionals to meet this progressive challenge.[20] It involves delegating specific responsibilities from highly skilled professionals to those with less training and qualifications who work under the direct or indirect supervision of the delegating provider. The delegation occurs only after a comprehensive understanding of the specific medical discipline has been established to allow the healthcare professional to make appropriate decisions.[21] The task-shifting/sharing approach helps make the most of available human resources in healthcare. The WHO has discussed task shifting/sharing, currently used in 23 African countries.[22]

Moreover, task shifting/sharing has been implemented in 27 countries outside Africa, including Europe, America, Canada, New Zealand and Australia.[23] Healthcare providers who engage in task shifting/sharing have outcomes equivalent to those of their more educated mentors.[21] This Delphi study concludes that general surgery physician assistants are capable healthcare providers who, if given appropriate training and supervision, can manage a patient with NCAH in austere environments with direct and indirect supervision using a protocol.

Limitations

It is essential to acknowledge the limitations of this modified Delphi study. One significant limitation is the lack of registries for general surgery physician assistant participants. Additionally, it is assumed that all general surgery physician assistants have received similar training and worked in academic institutions with direct and indirect supervision. However, this assumption is only partially accurate as most general surgery physician assistants in the USA are trained on the job in non-academic institutions rather than completing a fellowship programme after their core physician assistant programme studies have been completed. This difference between the two categories of general surgery physician assistants is a limitation and a gap that needs to be addressed in future research.

Conclusion

The results of this Delphi study suggest that managing NCAH in challenging environments by general surgery physician assistants using limited exploratory laparotomy is a viable option following intensive and focused training and mentorship. The next important step is to test the revised protocol to evaluate its feasibility in clinical trials. Using the new protocol to treat NCAH is a reasonable goal for general surgery physician assistants to achieve under direct or potentially indirect supervision in the future.

Author affiliations
[1]Translational Health Science, The George Washington University School of Medicine and Health Sciences, Washington, District of Columbia, USA
[2]Department of Clinical Research and Leadership, The George Washington University School of Medicine and Health Sciences, Washington, District of Columbia, USA
[3]Research Services, VA South Texas Veterans Health Care System, San Antonio, Texas, USA
[4]United States Acute Care Solutions, New Braunfels, Texas, USA
[5]Trauma and Acute Care Surgery, San Antonio Military Medical Center, Fort Sam Houston, San Antonio, Texas, USA
[6]Department of Clinical Research and Leadership, PhD program in Translational Health Sciences, George Washington University, School of Medicine and Health Sciences, Washington, District of Columbia, USA

Acknowledgements The authors of this manuscript would like to thank Dr Babak Sarani, Dr Stacy A Shackelford, Dr Mark W Bowyer, and Dr Donald Jenkins for their mentorship and support throughout the completion of this manuscript. Additionally, I would like to thank Jasmine Adams for editing this manuscript.

Contributors DA, PLM and PvdW designed the study with input from all authors. DA and SH performed data collection and analysis. MM provided statistical data consultation and analysis. PLM, TN and PvdW reviewed all data for writing, acceptability and critical revisions. DA is responsible for the overall content and is the guarantor.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Disclaimer This material is supported by resources from the Audie L. Murphy VA Medical Center in San Antonio, Texas, USA. The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the Department of Veterans Affairs or the US Government, the Department of the Army, the Defense Health Agency or the Department of Defense.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants. This study was approved by the George Washington University institutional review board (NCR203117). All participants gave informed consent before participating in this study. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. Data are available on reasonable request. Interested parties can obtain the data from the corresponding author at dadams89@email.gwu.edu after consulting with the George Washington University institutional review board (GWU IRB). Individual participant data will be made available upon request one year after the study's publication. To access the data, requests must specify the intended use and receive approval from the research team and the GWU IRB before release.

ORCID iD
Donald Adams http://orcid.org/0000-0001-5394-1734

REFERENCES

1 Holcomb JB. Transport Time and Preoperating Room Hemostatic Interventions Are Important: Improving Outcomes After Severe Truncal Injury. *Crit Care Med* 2018;46:447–53.
2 Alarhayem AQ, Myers JG, Dent D, *et al*. Time is the enemy: Mortality in trauma patients with hemorrhage from torso injury occurs long before the "golden hour." *Am J Surg* 2016;212:1101–5.
3 Butler FK, Holcomb JB, Shackelford SA, *et al*. Advanced Resuscitative Care in Tactical Combat Casualty Care: TCCC Guidelines Change 18-01:14 October 2018. *J Spec Oper Med* 2018;18:37.
4 Global Data Plc. *The complexities of physician supply and demand: projections from 2021 to 2036*. Washington, DC: Association of American Medical Colleges, 2024.
5 Sternberg S. US News and World Report. 2019. Available: https://www.usnews.com/news/national-news/articles/2019-10-10/military-healthsystem-isnt-ready-for-battlefield-injuries
6 Adams D. Management of Non-Compressible Torso Hemorrhage of the Abdomen in Austere/Remote Environments by Non-Surgeon Using Truncal Hemorrhage Control. 2022.
7 Osborn LA, Brenner ML, Prater SJ, *et al*. Resuscitative endovascular balloon occlusion of the aorta: current evidence. *Open Access Emerg Med* 2019;11:29–38.
8 Freel D, Warr BJ. Surgical and Resuscitation Capabilities for the "Next War" Based on Lessons Learned From "This War." *US Army Med Dep J* 2016;188–91.
9 Holland SR. *Battlefield trauma physician assistant*. United States Army Medical Department Center and School Graduate Medical Education Department, 2016.
10 Baker JB, Northern DM, Frament C, *et al*. Austere Resuscitative and Surgical Care in Support of Forward Military Operations-Joint Trauma System Position Paper. *Mil Med* 2021;186:12–7.
11 Cantle PM, Hurley MJ, Swartz MD, *et al*. Methods for Early Control of Abdominal Hemorrhage: An Assessment of Potential Benefit. *J Spec Oper Med* 2018;18:98.
12 Gerhardt RT, Berry JA, Blackbourne LH. Analysis of Life-Saving Interventions Performed by Out-of-Hospital Combat Medical Personnel. *J Trauma* 2011;71:S109–13.
13 Berian JR, Baker TL, Rosenthal RA, *et al*. Application of the RAND-UCLA Appropriateness Methodology to a Large Multidisciplinary Stakeholder Group Evaluating the Validity and Feasibility of Patient-Centered Standards in Geriatric Surgery. *Health Serv Res* 2018;53:3350–72.
14 Jünger S, Payne SA, Brine J, *et al*. Guidance on Conducting and REporting DElphi Studies (CREDES) in palliative care: Recommendations based on a methodological systematic review. *Palliat Med* 2017;31:684–706.
15 Kumah EA, McSherry R, Bettany-Saltikov J, *et al*. PROTOCOL: Evidence-informed practice versus evidence-based practice educational interventions for improving knowledge, attitudes, understanding, and behavior toward the application of evidence into practice: A comprehensive systematic review of undergraduate students. *Campbell Syst Rev* 2019;15:e1015.
16 Diamond IR, Grant RC, Feldman BM, *et al*. Defining consensus: a systematic review recommends methodologic criteria for reporting of Delphi studies. *J Clin Epidemiol* 2014;67:401–9.
17 Fink A, Kosecoff J, Chassin M, *et al*. Consensus methods: characteristics and guidelines for use. *Am J Public Health* 1984;74:979–83.
18 Adams D, McDonald PL, Holland S, *et al*. Management of non-compressible torso hemorrhage of the abdomen in civilian and military austere environments: a scoping review. *Trauma Surg Acute Care Open* 2024;9:e001189.
19 Trappey AF, Thompson KM, Kuppermann N, *et al*. Development of transfusion guidelines for injured children using a Modified Delphi Consensus Process. *J Trauma Acute Care Surg* 2019;87:935–43.
20 Falk R, Taylor R, Kornelsen J, *et al*. Surgical Task-Sharing to Non-specialist Physicians in Low-Resource Settings Globally: A Systematic Review of the Literature. *World J Surg* 2020;44:1368–86.
21 Wren SM, Kushner AL. Task Shifting in Surgery-What US Health Care Can Learn From Ghana. *JAMA Surg* 2019;154:860.
22 Okoroafor SC, Christmals CD. Task Shifting and Task Sharing Implementation in Africa: A Scoping Review on Rationale and Scope. *Healthcare (Basel)* 2023;11:1200.
23 Maier CB, Aiken LH. Task shifting from physicians to nurses in primary care in 39 countries: a cross-country comparative study. *Eur J Public Health* 2016;26:927–34.