Additional File 1:

Supplementary Material

European Perspectives on Pre-hospital Interagency Collaboration During Terrorist Incidents: A Focus Group Study

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Table of Content

Supplementary Information: Methods

Recruitment Process

For recruitment purposes, a study information brochure providing detailed information about the project and data handling was distributed through multiple channels, including social media platforms and the authors' professional networks. Additional professionals in the domains of tactical, disaster, and pre-hospital emergency medicine were identified through an exploration of current literature. To ensure broad international representation, invitations were sent to emergency medical services (EMS) bases across Europe and distributed within professional medical and law enforcement associations, i.e., Europol and their ATLAS network for special intervention units.

After expressing interest through an online survey, each individual was then assigned to one interview group and informed by the principal investigator via a standardised e-mail, respectively. The comprehensive list of participants' names and provided personal information was only accessible to the principal investigator.

Along with the confirmed interview schedule, participants finally received a Participant Information Sheet outlining again the study's procedures and including a form for each participant's written informed consent.

Of 84 eligible individuals who had initially expressed their interest to participate through the online form, four withdrew – one due to lack of monetary compensation and three due to time constraints. Of 80 individuals who were then assigned to an interview group, 16 did not attend the final interview and could not be rescheduled – eight due to time constraints and

eight without any further information or correspondence with the principal investigator (Figure S1).

Interview Design and Process

All interview sessions were held via video conference (Zoom Workplace Pro, version 6.2.6 [41824]; Zoom Video Communications, Inc.) and conducted by the principal investigator (female physician, at the time of the interviews anaesthesiology/critical care resident with pre-hospital experience and MSc student for disaster medicine).

During a brief introduction, the timeline of the interview session was explained. Additionally, participants were given the opportunity to introduce themselves. Personal introduction was not compulsory, and every participant could choose to remain anonymous or use a pseudonym.

Embedded polls were anonymous, and poll results were shared with the interview group as part of the discussion.

Interviews were conducted in English, with a maximum duration of two hours. The full interview structure is presented in Appendix 1.

Data Handling and Analysis

Every interview session was audio-recorded. The recording was started only after participants had introduced themselves, and participants were notified. Immediately after the respective session, each audio recording was transcribed, and all potentially identifiable information regarding participants (e.g., names and cities/regions) was removed from transcripts.

Using the anonymised transcripts, content analysis was performed using deductive and inductive coding. Analysis was done using the MAXQDA software (Analytics Pro 24, Release 24.5.1, VERBI GmbH Berlin, Germany).

Deductive coding was applied for an a priori defined set of codes. These codes reflected challenges in interagency mass casualty incident (MCI) management as perceived in personal experience and reported in scientific literature.(1-5) The final list of codes was subject to coauthor consensus. Deductive codes included “Command”, “Communication”, “Critical Decisions Initial Phase”, “Hot Zone Care”, “Evacuation”, “Provider Safety”, “Spatial Planning”, “Interagency Understanding”, and “Most Urgent”.

Inductive codes were introduced for all additional content that arose from the dynamics of the interview whenever they were considered relevant for the scope of this study by the authors.

Supplementary Information: Results

Coding Process

In total, 749 interview sections were matched with deductive codes: 49 with “Command”, 133 with “Communication”, 106 with “Critical Decisions Initial Phase”, 160 with “Hot Zone Care”, 96 with “Evacuation”, 58 with “Provider Safety”, 45 with “Spatial Planning”, 57 with “Interagency Understanding”, and 45 with “Most Urgent”.

Assessing additional interview content, 210 interview segments were assigned inductive codes. The latter comprised “Training” (60), “Politics/Stakeholders” (33), “Additional Challenges” (23), “Uniformity” (22), “Learning Lessons” (19), “Resource Allocation” (18), “Triage” (17), “Interfacing with Hospitals” (13), and “Technical Solutions” (5).

During the coding process, subcategories were introduced for all codes with large volumes of matching instances.

In-Depth Examination: Interagency Collaboration Within Zones of Higher Risk

As outlined in the main manuscript, 64% of participants reported to primarily rely on law enforcement for casualty care inside the hot zone according to local protocols, with the majority relying specifically on special forces.

Personal preferences of participants mostly coincided with these findings favouring the police (59% [36/61]), although regular police officers were favoured over special forces in this subgroup (56% [20/36] vs. 25% [9/36], see Figure S2), and 19% (7/36) personally preferred police medical staff (e.g., special forces medics and embedded physicians) for casualty care. Overall, the number of participants preferring casualty care being provided by tactically trained non-police medical staff (21% [13/61]) and bystanders (13% [8/61]) was slightly higher than those relying on these entities in their protocols (15% [9/61] and 5% [3/61]), respectively.

Concepts involving specifically trained, non-police resources to enter zones of higher risk alongside law enforcement exist in multiple European countries, albeit some are limited to metropolitan areas, such as the Equipos Médicos de Apoyo a Entorno Táctico (EMAETs) in Spain.(6) Many deploy tactically trained fire services personnel, e.g. the Casualty Extraction Teams in Belgium, the Dutch Quick Response Teams, the Groupe d'Extraction in France, and the Danish Særlig Indsats I Kritiske Situationer (SIKS) teams.(7-10) Reasons for choosing fire services personnel may include those listed in the main discussion. Other concepts allow for tactically trained EMS personnel, e.g. the Tactical Emergency Medical Services (TEMS) teams that have long been an established component in tactical operations in Denmark and Finland.(11,12) In the United Kingdom, the Hazardous Area Response Teams (HART), the Special Operations Response Team (SORT), and the London-based Tactical Response Unit fulfil comparable roles.(13) Similar concepts have been introduced

after previous incidents in the United States of America.(14,15) As stated before, the main purpose of such teams is to evacuate casualties from zones of higher risk and provide stabilisation measures. For visualisation of European countries represented in this study that currently deploy specifically trained interagency teams in zones of higher risk, please refer to Figure 5 (main manuscript).

While interview participants were largely in favour of such interagency concepts, critical voices need to be recognised. Although absolute safety cannot be guaranteed even to teams in the supposedly safe perimeter and personal risk awareness should be promoted to all providers, members of interagency teams potentially carry higher risk when entering the warm zone. It has been underlined that tactically trained non-police providers typically don't hold the same tactical competencies as special forces medics.(16) They may thus be deployed exclusively to the warm zone for distinct tasks, as is currently standard practice in most countries with such concepts. Notably, interview participants averse to interagency teams exclusively worked in regions where such teams were non-existent. This coincides with an observation suggesting a lack of exposure to tactical training being associated with a lower readiness to enter zones of potentially higher risk.(17) Tactical training programmes led to medical providers being more comfortable with responding to a tactical incident. It is thus possible that critical voices stem from limited familiarity or experience with such scenarios.

Participants noted that shifting the responsibility for casualty care, at least within the warm zone, from police officers to non-police medical providers may allow these officers again to focus on their primary objective – threat elimination:

> "The problem we [police] experienced throughout the few years we have been training our people in TCCC [Tactical Combat Casualty Care] now is that the focus is

coming a lot on saving [providing medical care to] people by policemen, and that is not our primary objective."

Simultaneously, allowing trained medical personnel to provide earlier medical care to casualties, as opposed to restricting them to standby roles in the cold zone until the scene is fully secured or casualties are finally evacuated by other means, was seen as a potential method to reduce the risk of moral injury among medical providers. Allowing providers to focus on their trained role reportedly decreased the risk of psychological trauma.(18,19) This observation may also be applicable to concepts allowing police officers to focus on police tasks instead of casualty care. Moreover, tasking individuals with responsibilities traditionally handled by other entities increased the risk of feeling abandoned by their institution and thus developing a sense of hostility towards authorities.(18) This, in turn, heightened individuals' susceptibility to post-traumatic distress.(20) Similar observations have been made for feelings of guilt, e.g., due to not being able to fulfil one's professional role or task.(21)
Concurrently, previous research confirms the participants' notion that interagency teams to enter the warm zone should not be formed ad hoc, since operating in zones of higher risk demands specialised skills and expertise.(22,23)
It has been reported that specialised non-police tactical teams not only collaborated efficiently with law enforcement but raised the general awareness and preparedness for tactical incidents among regular providers as well.(12,23)

As an alternative to non-police medical providers entering the warm zone, some countries are currently deploying tactically trained physicians as part of police special forces units, such as the French unit "Recherche, Assistance, Intervention, Dissuasion" (RAID).(24) These specific resources are trained to enter and operate within the hot zone. They have repeatedly proven their operational efficiency and expertise, most notably in the Bataclan attack in Paris, France, when roughly 100 casualties were triaged and all live casualties were evacuated

within 30 minutes of entering, while the attack was still ongoing.(25) However, it needs to be highlighted that such highly specialised resources, like most special forces units, typically reside in centralised locations and may only arrive with significant delay.

As one participant summarised their thoughts:

> "Ideally, I think you'd have a system that had all of these things to try to shrink the hot zone, get people in, but if you can't do that, then get casualties out. And if you can't do that, then get appropriately trained specialist medical people who work within the police force under their command and to make the decisions."

Given that regular police officers are often the first on scene and to enter zones of higher risk, their level of medical training was briefly discussed in the interviews. Interviewees noted some variation in competencies across countries. Most reported police officers in their respective home countries to be trained in basic life-saving measures such as placing patients in recovery position, opening an airway, and applying tourniquets. Others described more advanced training programmes, including Tactical Combat Casualty Care (TCCC) or Tactical Emergency Casualty Care (TECC). A recurring concern among participants was the overall low frequency of medical training for regular police officers, particularly given their likely role as first responders in tactical incidents.

In contrast, special forces medics were reported to possess advanced-level medical skills, including the use of airway devices, performing thoracic decompression, and establishing intravenous or intraosseous access. However, as stated in the main discussion, special forces medics' roles were often misconceived, and it was reported that regular providers are usually not fully aware of their capabilities. Thus, it will be crucial for all responders to better

understand their interagency counterparts' level of training, in order to avoid a duplication of on-scene efforts.

In-Depth Examination: Zoning Concepts

Polled about current zoning protocols in their represented regions, 72% (44/61) of participants reported to work with a three-zone concept (red, yellow, green / hot, warm, cold). 10% (6/61) operated under a four-zone concept, allowing for further distinction of the warm zone into orange (allowing for medical interventions to be performed by police) and yellow (allowing for EMS personnel).(26) One interview participant elaborated on this concept:

> "The problem is […] that even police should not work [perform medical interventions] in a red zone but only do the basic measures. And so the area where police might work because it's already warm and it's no direct threat anymore, we call it orange, to clarify that's definitely still not a place for rescue services. And then yellow is the zone where, still, police is in control, but that's the area where we can discuss if it's reasonable, especially if we trained that in advance, to send in rescue personnel. The problem is that […] warm zones are usually kind of nebulous. So, you don't know what it is, and therefore we try to differentiate it with orange. […] Yellow, that's where EMS could work."

2% (1/61) stated that they used a different (unspecified) concept, while 8% (5/61) reportedly did not have a fixed zoning protocol, and 8% (5/61) were unsure about the protocol in use at the time of the interview (see Figure S3A).

Polled about their personal preference, 57% (35/61) of participants favoured a three-zone concept, while 30% (18/61) preferred a four-zone concept. However, some participants had not been familiar with the concept of four zones before the interviews, which could introduce bias. 10% (6/61) stated to prefer a different (unspecified) concept (see Figure S3B). Inquiring about the nature of their preference, the majority of these latter six participants described a two-zone concept (hot and cold zone only). Presuming body armour and adequate training of

providers to assess scene safety and inherent risk, they stated that a simplified zoning concept might allow for earlier evacuation of casualties from the hot zone and easing the burden of commanders. Concurrently, such an approach might also render zoning decisions more objective, and thus, decrease the risk of delays and misunderstandings among on-scene responders. However, it has been stressed repeatedly that adequate and regular training of specific medical providers, with a focus on behavioural competencies, would be a prerequisite if a two-zone concept was to be introduced. Such approaches may include the deployment of interagency teams with rigorous tactical training.

While the definition of a true hot zone demands a high level of expertise and repeated re-evaluation, data suggest that a direct threat to life often lasts no longer than 15 minutes.(27) The risk of secondary attacks necessitates careful attention, but the actual risk may be smaller than commonly perceived.(15,28)

If adequate training levels were not accomplished, interviewees feared a two zone-concept would bear the risk of further aggravating delays regarding casualty evacuation, since providers would likely wait for the hot zone to dissolve entirely:

> “I feel like if, at the moment [with the current state of training and risk decision modelling], we only had hot and cold, people would be delayed for longer going in. But ultimately, if a hot zone really is a hot zone, and that's only in case of a direct threat, and everyone is adequately trained to take their own risk benefit decisions as they arrive, then I think it would probably be easier than trying to dynamically change more layers of hot, warm, cold. I think no one's head is going to cope with that.”

> “My […] experience is mainly focused around high CBRN [chemical, biological, radiological, nuclear] threats. And we don't talk about warm zones anymore. They're cold or they're hot, and you're either in full protective equipment or you're not. And I think some of that thinking has to probably move into the tactical space because

> whenever you ask someone ‘is there a threat?’, it depends on them and their capabilities and where they are in the chain of command. And I think you'll always get a different answer. So, it's either you're safe or you are at risk. And as long as medical providers and people attending incidents understand that and train for it and are prepared to understand that […] risk is dynamic and can change, […] I think that would help.”

Ideally, participants stated that protected entry/exit points should be established between zones of different risk levels.

These observations suggest that the effectiveness of simplified zoning concepts is contingent upon adequate and routine training of providers. On the other hand, providers with less training or experience may benefit from more sophisticated zoning models. This, in turn, requires commanders to be sufficiently trained in establishing and complying with zoning models. Simultaneously, the success of zoning concepts relies on a timely flow of information between responding services. This could incorporate shared visual presentation of the respective areas via digital applications.

As highlighted above and in the main manuscript, a particularly considerable finding of this study was the discrepancy between the implicitness of threat zones during the interviews and the observed failure to implement and communicate zoning models on scene in past incidents:

> “It is a theoretical concept to say, ‘we have a hot zone, we have something called semi-secure zone, and we have a secure zone’. But this is usually not a reality. I've never found a police officer, in no training exercise and no real scenario, who had an answer when I asked where the zones were. No one could ever tell me. But what they can tell you is if […] it is secure right now, right here.”

240 Thus, it was stressed repeatedly that any model necessitates adequate training of all providers
241 designated to apply it. This was reportedly not standard practice in some regions across
242 Europe.

In-Depth Examination: The "Human Factor"

As highlighted in the main manuscript, discussions revolved around a complex of topics summarised here as "the human factor", i.e. behavioural competencies and interagency understanding.

Improved interagency understanding was identified as the most substantial factor in promoting provider safety on scene. Subsequently, discussions revealed multiple potential sources of error.

As discussed in the main manuscript, delayed flow of information between responding services may lead to compromised provider safety:

> "By the time they [police] have moved, we [EMS] have not worked out where they're going, and we're two or three steps behind their decision-making process all the time."

Participants also reported that misguided information was caused by differences in terminology between responders. Lack of uniformity of response protocols, including regional differences in some participating countries, further exacerbated this issue.

Moreover, participants observed that law enforcement officers and medical personnel responded to tactical incidents with thoroughly different perspectives and priorities of action. One paramedic stated:

> "It's really difficult for us to actually create an understanding that we need to attend to these patients. Our experience is that the police will be extremely focused on their job [neutralising a perpetrator] […]. So, it is a dilemma."

By contrast, a special forces operator described their perspective as follows:

> "I would just like to focus on finding the threat. And that's why I would never take care of organising something else if I know there is someone that is actively shooting

> […] because it's like a bleeding patient: If you don't stop the bleeding, it doesn't matter how much blood you put inside. […] You have to stop the bleeding. And the same thing works for us when we have a problem with an active shooter."

A different law enforcement officer highlighted that the presence of medical personnel could add another level of complexity to on-scene police work:

> "From the police perspective, you don't need any additional persons on site, including the emergency service. […] Sometimes the main problem is that you have to protect people from themselves."

Such perceptions may hold particularly true for medical providers without adequate training for situational awareness and risk assessment. While participants from countries deploying specialised interagency teams into zones of higher risk described situational awareness training for these providers, such trainings are largely uncommon in countries that exclusively stage medical personnel in the cold zone. Differences in risk assessment surfaced most prominently in the following statements of police officers:

> "If you are not in police training, that [identifying potential threats] is usually a problem. You don't know what to look for. Usually, you look at the face of people. We look at the hands of people. It's just a different way to approach the red zone."

> "Our point of view is pretty simple. Anyone who has not been identified as friendly is dangerous and will be treated as dangerous."

Discrepancies in risk awareness and the inherent necessity for additional security resources, i.e., to protect providers or prevent them from entering higher-risk zones, reportedly carried the risk of impeding the overall management of an incident.

Training providers in these competencies would likely help them adopt a more flexible mindset when dealing with dynamic situations. More importantly, it could enhance their

ability to recognise potential threats early, even in seemingly routine cases. The relevance of independent risk assessment competencies was further underscored by statements indicating that full provider safety cannot be expected at any stage of a tactical incident, even when the police are present.

Participants repeatedly described the urgent necessity to learn about other responding agencies' protocols and competencies. In fact, many participants described that this had been their motivating factor to sign up for the interview project.

When invited to pose questions to their interagency counterparts, participants raised the following themes:

- Which expectations do police commanders and officers have of medical personnel on scene, and vice versa?
- How do the police decide who will be in command?
- How do the police expect interagency communication to work?
- Where should medical personnel and equipment be positioned during different stages of the response?
- How do police officers define zones?
- What are the key factors that shape police decisions?
- What are the police's capabilities on scene, both tactically and medically?
- Do the police acknowledge the presence and task of medical personnel on scene?
- Is there more that the police should do in terms of medical interventions?
- Should the police assign more resources to casualty care during an ongoing threat?
- How much do regular medical providers know about medical competencies within the police and special forces, and how can both entities complement each other better?

At the time of the interviews, most participants reported a relative lack of opportunities for interagency education and training, leading to frustration about current response practices. The diversity of mindsets approaching a complex tactical incident was appreciated as a resource:

> "I think when pulling all of the agencies together to create something, everybody has a part in it. Everybody takes ownership and leadership."

However, many countries reportedly experience a void of standardised interagency concepts and education that may be needed to leverage the benefits. According to participants, this void extends beyond the immediate pre-hospital scene and includes the intersection with in-hospital management.

“It would be great to start working together before the problem arises,

as we do in the Emergency Department.

If a patient with a heart attack arrives,

you don’t just start training when he comes in.”

– Interview Participant from Italy –

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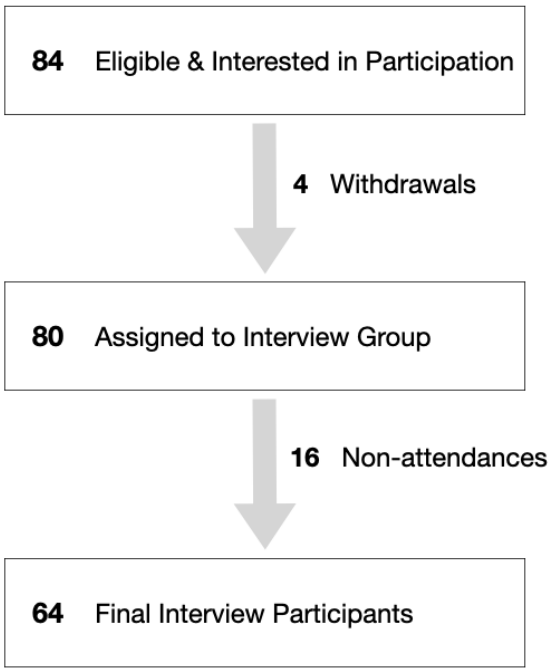
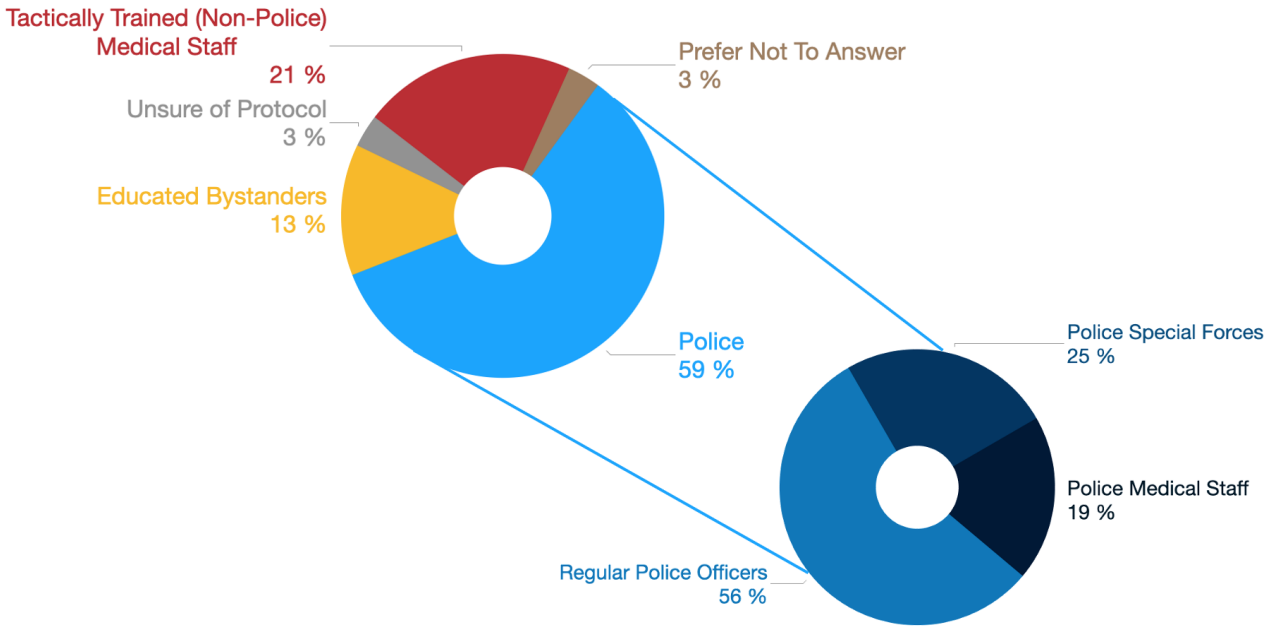
Supplementary Figures

Supplementary Figure S1. Study Flow.



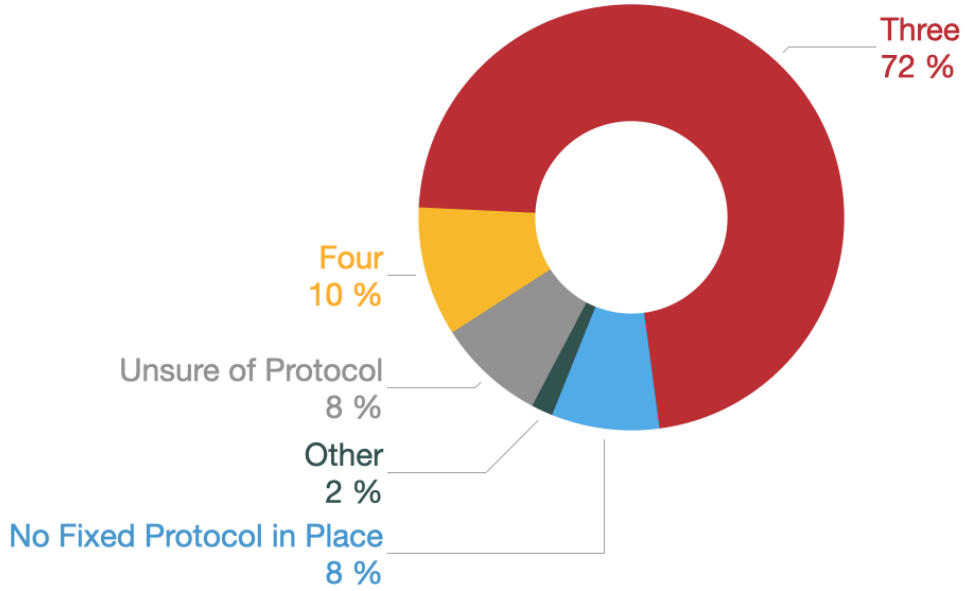
This figure shows the flow of potential and final participants throughout the recruitment process.

Supplementary Figure S2. Participants' Preferences Regarding Casualty Care Responsibilities Within the Hot Zone.



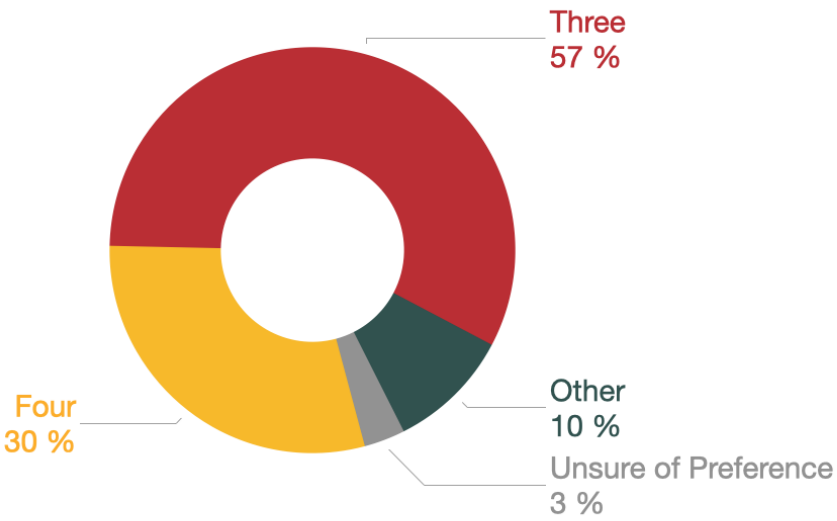
This figure depicts participants' responses to poll 3: "Which protocol would you prefer to take care of patients inside the red (hot) zone?", with the response options displayed in the figure. Poll response rate: 95% (61/64 participants).

Supplementary Figure S3A. Zoning Concepts According to Participants' Response Protocols.



This figure depicts participants' responses to poll 4: "How many threat zones does your local protocol for tactical/terrorist incidents include?", with the response options displayed in the figure. Poll response rate: 95% (61/64 participants).

Supplementary Figure S3B. Participants' Preferences Regarding Zoning Concepts.



This figure depicts participants' responses to poll 5: "How many threat zones do you wish your local protocol for tactical/terrorist incidents would include?", with the response options displayed in the figure. Poll response rate: 95% (61/64 participants).

APPENDIX:

Interview Protocol

Introduction of Principal Investigator & Interview Setting

Self-Introduction of Participants

- Start of Audio Recording -

Poll 1:
Do you feel adequately trained to collaborate with other responding agencies during a terrorist scenario?

- Yes
- No
- I don't know
- I prefer not to answer

Scenario:
Tuesday, 1.30 pm.
You have been dispatched to the following scenario:
A delivery van hit multiple people in the city centre, driver left the scene with a knife, driver now attacking pedestrians, unknown number of casualties, unknown location of attacker.
Dispatched to scene: 2 ambulances, 1 fast car incl. emergency physician, 3 police cars.

Question 1: Command
What are critical decisions to be made by commanders of responding agencies within the first 30 minutes of their arrival?

Question 2: Communication
What should be the protocol of communication among the different responding agencies?

Poll 2:
Do your local protocols for tactical/terrorist incidents focus on any of the following to take care of casualties inside the red (hot) zone?

- Medically trained regular police officers
- Medically trained police special forces
- Tactically trained non-police medical staff
- Tactically trained police medical staff

- Focus on educating bystanders (e.g., STOP THE BLEED®)
- None of the above
- I currently don't know
- I prefer not to answer

Question 3: Hot Zone Care

How can we minimise the therapeutic vacuum inside the red (hot) zone?

Poll 3:

Which protocol would you prefer to take care of patients inside the red (hot) zone?

- Medically trained regular police officers
- Medically trained police special forces
- Tactically trained non-police medical staff
- Tactically trained police medical staff
- Focus on educating bystanders (e.g., STOP THE BLEED®)
- None of the above
- I currently don't know
- I prefer not to answer

Question 4: Evacuation

How can we ensure the prioritised but safe evacuation of red-tagged patients from the red (hot) zone to a safer zone?

Poll 4:

How many threat zones does your local protocol for tactical/terrorist incidents include?

- Three
- Four
- Other
- No fixed protocol in place
- I currently don't know
- I prefer not to answer

Question 5: Spatial Planning
How can provider and patient safety be emphasised in terms of spatial planning?

Poll 5:
How many threat zones do you wish your local protocol for tactical/terrorist incidents would include?

- Three
- Four
- Other
- I currently don't know
- I prefer not to answer

Question 6: Interagency Understanding
Which thought process do you struggle the most to understand or would like to know more about in other agencies responding to a terrorist incident?

Question 7: Critical Improvements
Which area of interagency collaboration calls for the most urgent improvement?

Question 8:
Are there any topics we haven't covered that you consider a priority?

- End of Audio Recording -

Closing of Interview