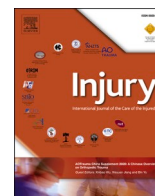


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## State of the art of trauma teams in Italy: A nationwide study

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### ABSTRACT

Trauma teams play a vital role in providing prompt and specialized care to trauma patients. This study aims to provide a comprehensive description of the presence and organization of trauma teams in Italy. A nationwide cross-sectional epidemiological study was conducted between July and October 2022, involving interviews with 137 designated trauma centers. Centers were stratified based on level: higher specialized trauma centers (CTS), intermediate level trauma centers (CTZ + N) and district general hospital with trauma capacity (CTZ). A standardized structured interview questionnaire was used to gather information on hospital characteristics, trauma team prevalence, activation pathways, structure, components, leadership, education, and governance. Descriptive statistics were used for analysis. Results showed that 53 % of the centers had a formally defined trauma team, with higher percentages in CTS (73 %) compared to CTZ + N (49 %) and CTZ (39 %). The trauma team activation pathway varied among centers, with pre-alerts predominantly received from emergency medical services. The study also highlighted the lack of formally defined massive transfusion protocols in many centers. The composition of trauma teams typically included airway and procedure doctors, nurses, and healthcare assistants. Trauma team leadership was predetermined in 59 % of the centers, with anesthesiologists/intensive care physicians often assuming this role. The study revealed gaps in trauma team education and governance, with a lack of specific training for trauma team leaders and low utilization of simulation-based training. These findings emphasize the need for improvements in trauma management education, governance, and the formalization of trauma teams. This study provides valuable insights that can guide discussions and interventions aimed at enhancing trauma care at both local and national levels in Italy.

### Background

Trauma teams are widely used worldwide as the standard of care in trauma reception and stabilization [1]. As traumatic injuries are a leading cause of death and disability worldwide, they require prompt and specialized care to maximize the chances of survival and recovery. A trauma team should be trained to work together seamlessly and efficiently to recognize and treat critical injuries and stabilize the patients

[2–4]. Trauma teams are assembled rapidly by people who might work together infrequently in a time-critical situation. A dedicated leader maintains a close awareness of the situation and plans the next steps [5]. Furthermore, the presence of trained practitioners used to adopt specific trauma management algorithms significantly decreases the time to life-saving procedures [6].

In Italy, trauma teams are recommended by national laws published in 2015 and 2017, which outline the organizational model and structure

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of local trauma networks known as SIAT Sistema Integrato per l'Assistenza al Trauma (Integrated Systems for Trauma Management) [7,8]. These laws classify hospitals based on their capacity to deliver integrated 24-hour trauma care, intermediate care, or primary stabilization with subsequent transfer to higher-level care centers. These three levels are Level 1 Centro Traumi ad Alta Specialità (CTS), Level 2 Centro Traumi di Zona which can be with (CTZ + N) or without (CTZ) neurosurgery, and Level 3 Pronto Soccorso Trauma (PST). To better understand each center capacity using the American College of Surgeons trauma centers classification: Centro Traumi Specialistico (CTS) offer round-the-clock availability of all specialties and are expected to provide clinical leadership in trauma care, and are similar to ACS Level 1. Centro Traumi di Zona con Neurochirurgia (CTZ + N), have in-house neurosurgery services available at all times, but other specialties may not be consistently present, they can be compared to ACS Level 2. Centro Traumi di Zona (CTZ), does not provide neurosurgical services, and certain other specialties may only be on-call during the night can be compared to ACS Level 3. Finally Pronto Soccorso Traumi (PST), are smaller hospitals where most services may be available on-call and can be compared to ACS Level 4 [9]. In 2019, the Italian National Institute of Health published comprehensive national guidelines for major trauma management [10,11]. A review of the preparatory scoping document for these guidelines reveals several critical issues. These include the absence of a national trauma registry, significant variation in mortality rates following major trauma across the country (ranging from 14 % to 42 %), lack of formally defined trauma centers in certain regions, limited integration between prehospital and in-hospital systems, and instances of major trauma patients being treated in hospitals lacking necessary trauma care capabilities [12].

Given the clinical evidence and limitations identified during the development of the Italian guidelines, a nationwide study on the presence and organization of trauma teams is warranted. The present study seeks to document the existence of trauma teams in Italian hospitals and to describe their activation criteria, team composition, leadership, and education and governance. Moreover, we aim at describing specific differences between hospital levels by comparing center and team characteristics.

## Methods

This is a nationwide cross-sectional epidemiological study of in-hospital trauma team prevalence, structure and organization run in Italy between July 1st and October 31st 2022.

A standardized structured interview was developed, reviewed and agreed upon by practicing clinicians with relevant national and international experience in trauma management. The interview questionnaire comprised the following content sections: hospital characteristics, the prevalence of a formally defined trauma team or reasons for its absence, trauma team activation pathways, trauma team structure and components, trauma team leadership, trauma education, and governance. If a trauma team was not formally defined at the responding institution, the same questionnaire was still administered to investigate the local management and practice of trauma care.

The selection of participating centers focused on CTS and CTZ with neurosurgery (CTZ + N) trauma centers aiming at a > 90 % response rate on a national basis as these are the centers that should see the majority of major trauma in the country. We also included as many CTZ without neurosurgery as possible but with no predetermined response threshold. We did not include PST in the study. We performed an online search on official national and regional government websites for all regional statutes on trauma systems or time-dependent pathology networks including trauma. Based on those, we drafted a list of hospitals participating in regional SIATs (local trauma systems) along with their designated classification. The list of sources can be found in the electronic supplement (ES1). Based on the aforementioned list we then searched for individual contacts either in the emergency department or

intensive care, or general/acute care/trauma surgery depending on the availability of contacts and local hospital organizations. Based on local organization we reached the most appropriate contact by either email or telephone. A single author conducted phone interviews with the clinical lead or an appropriate delegate to ensure consistency. Data were recorded in a computerized spreadsheet (Microsoft Excel 2016, Microsoft Corporation, Redmond, WA).

Participation in the study was voluntary, anonymous, and independent. Confidentiality of information was ensured and no financial incentive to participate in the study was offered. Verbal informed consent was obtained and the participants could withdraw from the study at any time. The study protocol was reviewed and acknowledged by the independent review board (IRB) of IRCCS Humanitas Research Hospital, Milano, Italy (protocol 36/2022) on June 28th, 2022.

## Statistical analysis

Due to the scope of the paper, only descriptive statistics were performed. Continuous variables were expressed as medians and interquartile ranges (IQR) or means and standard deviations based on their distribution evaluated with graphical methods (QQ plot). Comparisons between continuous variables were performed with the Kruskal-Wallis Rank Sum test or one-way analysis of variance, where appropriate. Categorical variables were expressed as numbers and percentages, and compared using the Chi-square test, or the Fisher's Exact test, when appropriate.

All the analyses were performed using the R software v. 4.3.0 (R Core Team 2023. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. <https://www.R-project.org/>), with the use of package "tableone" [13].

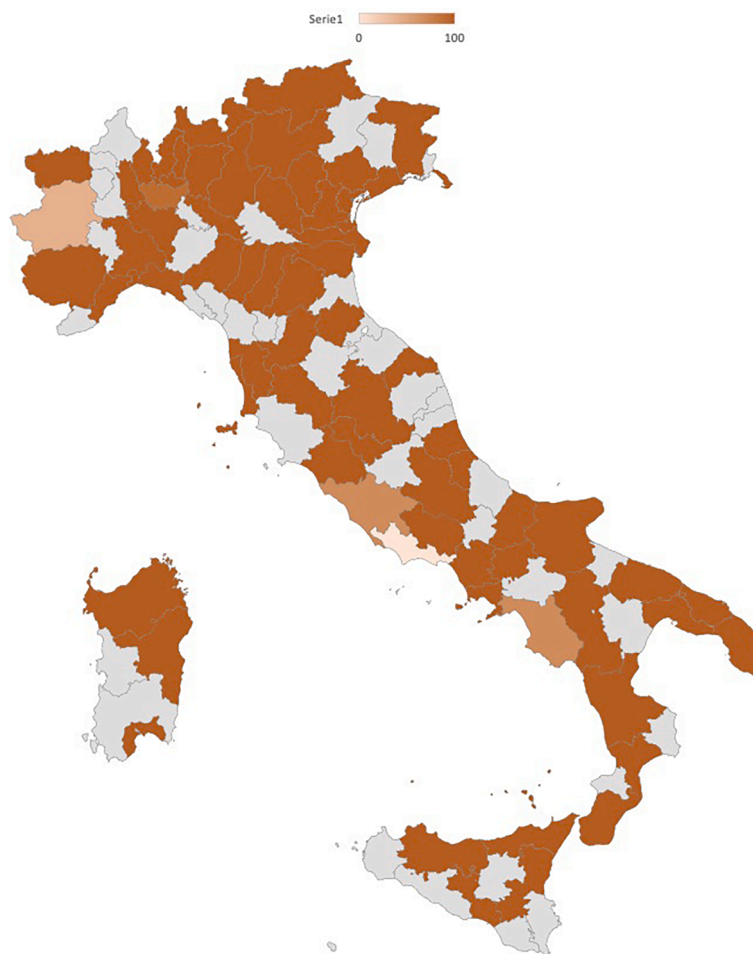
## Results

We interviewed a total of 137 centers, 44 CTS (44/45, 98 % of the national total), 47 CTZ + N (47/52, 90 % of the national total) and 46 CTZ. Data covers all 20 Italian regions. Nationwide coverage of this study is presented in Fig. 1. Hospital characteristics by designated level are shown in Table 1. A trauma team is formally defined by hospital protocols in 73/137 (53 %) of the centers; 32 (73 %), 23 (49 %) and 18 (39 %) in CTS, CTZ + N and CTZ respectively ( $p = 0.005$ ). Among those that reported having a trauma team, 14 (31 %) CTS, 9 (17 %) CTZ + N and 0 (0 %) CTZ reported having multiple trauma team levels (i.e. a basic trauma team vs. advanced trauma team) ( $p < 0.001$ ). Among those that reported not having a formal trauma team, the main obstacles to trauma team implementation reported are not enough trauma volume 28 (44 %), understaffing 20 (31 %) and internal political reasons 16 (25 %). Complete results stratified by center level are presented in the supplement (ES2).

## Trauma team activation pathways

All CTS and CTZ + N report receiving phone pre-alerts from the prehospital services, with only 3 CTZ reporting no pre-alert pathway in place. Most of the center report receiving the pre-alert by the Emergency Medical Services (EMS) dispatch center with a minority receiving it directly from the EMS personnel on the scene. Most of the centers report the pre-alert being received by the Emergency Department (ED) triage nurse (48 %, 61 % and 50 % for CTS, CTZ + N and CTZ respectively) ( $p = 0.482$ ), followed by the Emergency Department duty physician (32 %, 39 %, 50 %) ( $p = 0.214$ ). A significant number of centers also report the pre-alert being sent to the duty intensive care physician (25 %, 17 %, 17 %) ( $p = 0.563$ ). Other professional figures receiving direct pre-alert with a lesser proportion were general surgeons and designated trauma team leaders. Hospital activation criteria are presented in ES3.

In 18 (14 %) CTS, 8 (17 %) CTZ + N and 2 (4 %) CTZ the hospital team can activate the massive transfusion protocol (MTP) before patient



**Fig. 1.** Availability of data compared to the distribution of trauma centers at the national level, categorized by province. Provinces that do not have any hospitals meeting the study inclusion criteria are represented in gray. Shades of orange represent the percentages of hospitals that have provided data in relation to the total number of hospitals meeting the study inclusion criteria with lighter color approaching zero percent and stronger color approaching one hundred percent (as represented by the color bar on top).

arrival, solely based on the information from the EMS call ( $p < 0.001$ ). In two further cases, 1 CTS and 1 CTZ, the hospital MTP can be activated directly by the pre-hospital team. In thirteen (30 %) CTS, 18 (39 %) CTZ + N and 11 (24 %) CTZ the MTP can be activated only following patient arrival at the hospital ( $p < 0.001$ ). Lastly, 12 (27 %) CTS, 19 (41 %) CTZ + N and 33 (72 %) CTZ report not having a formally defined MTP ( $p < 0.001$ ). 8 (18 %) CTS, 5 (11 %) CTZ + N and 3 (7 %) CTZ report the ad-hoc possibility to skip the ED and meet the patient directly in the surgical theater (direct access) ( $p = 0.219$ ). Among these centers, this ad-hoc pathway for trauma patients is reported to be used in the case of positive free fluid at the prehospital FAST ultrasound (75 %, 100 %, 100 %) ( $p = 0.319$ ), incompressible hemorrhage (50 %, 100 %, 33 %) ( $p = 0.099$ ), and penetrating trauma (13 %, 0 %, 0 %) ( $p = 0.587$ ).

#### Trauma team structure and components

The most common composition is an airway doctor (from multiple specialties), a procedure doctor (from multiple specialties), two nurses and one health care assistant. Regarding the team composition of medical, nursing and allied health professionals involved in the initial assessment and resuscitation of trauma patients (in a multiple-answer question), detailed data stratified by center are presented in [Table 2](#). Details stratified by center and the presence or absence of a formal

trauma team are presented in the electronic supplement (ES5).

#### Trauma team leadership

Trauma team leadership is predetermined in 82/137 (59 %) of the centers. Of the 73 centers reporting a formal trauma team in place leadership is predetermined in 55 (75 %). The trauma team leader is from a fixed specialty in 100 (73 %) centers. The most common specialty for trauma team leaders (TTL) in hospitals with fixed leadership specialty is Intensive Care Medicine with 28/33 (85 %), 18/26 (56 %), 17/23 (49 %) in CTS, CTZ + N and CTZ, followed by Emergency Medicine with 4 (12 %), 11 (34 %), 18 (51 %) and Surgery 1 (3 %), 3 (9 %) and 0 (0 %) ( $p = 0.028$ ). In those centers with a variable TTL specialty, leadership is assigned based on team members' experience, or patient characteristics, most notably if the patient is mechanically ventilated. In those centers leadership can be from Intensive Care Medicine in 37/37 (100 %), Emergency Medicine 30/37 (81 %) or Surgery 10/37 (27 %). The trauma team leader is a dedicated role (hands off) in 11 (25 %), 2 (4 %) and 4 (9 %) of all CTS, CTZ + N and CTZ respectively ( $p = 0.007$ ).

#### Trauma team education and governance

Finally, data on training and clinical governance of teams are

**Table 1**  
Respondent characteristics by hospital level.

	CTS (n = 44)	CTZ + N (n = 47)	CTZ (n = 46)	p-value
<b>Hospital Characteristics</b>				
University Hospital, n (%)	20 (45)	11 (23)	3 (6)	<0.001
Public Hospital, n (%)	43 (97)	41 (87)	45 (97)	0.040
Hospital Beds (median [IQR])	725 [591, 1000]	450 [345, 690]	318 [200, 410]	<0.001
Emergency Department Visits, yearly (mean $\pm$ SD)	72,710 $\pm$ 42,805	52,182 $\pm$ 18,476	42,533 $\pm$ 16,771	0.022
Major Trauma (ISS > 15), yearly (median [IQR])	250 [120, 450]	65 [34, 185]	50 [35, 122]	<0.001
<b>Helipad, n(%)</b>				
No	6 (13)	10 (21)	8 (17)	0.585
Yes, direct shock room access	21 (47)	17 (36)	23 (51)	
Yes, with ambulance transfer from pad to shock room	17 (38)	20 (42)	14 (31)	
<b>Shock Room (Trauma Bay) Characteristics</b>				
E-FAST Capable, n (%)	44 (100)	47 (100)	46 (100)	1.000
CXR Capable, n (%)	38 (86)	40 (85)	39 (85)	0.975
Pelvic X-Ray Capable, n (%)	36 (82)	39 (83)	34 (74)	0.502
Resuscitative Thoracotomy, n (%)	28 (64)	23 (49)	12 (26)	0.005
Extraperitoneal Pelvic Packing, n (%)	25 (57)	21 (45)	9 (20)	0.001
Dedicated Rapid Infuser Available, n (%)	33 (75)	24 (51)	20 (44)	0.007

E-FAST: Extended Focused Assessment with Sonography for Trauma; CXR: Chest X-Ray.

\*E-FAST, CXR and Pelvic X-Ray refers to the ability to perform the exam directly in the shock room (trauma bay).

**Table 2**  
Composition of teams responding to major trauma in Italy.

	CTS (n = 44)	CTZ + N (n = 47)	CTZ (n = 46)	p-value
Anesthesiologist*	9 (21)	3 (6)	2 (4)	0.023
Intensive Care Physician*	41 (93)	40 (85)	35 (76)	0.079
Trauma/Acute Care Surgeon§	24 (55)	13 (28)	5 (11)	0.001
General Surgeon§	11 (25)	16 (34)	24 (52)	0.232
Neurosurgeon	7 (16)	2 (4)	1 (2)	0.005
Orthopedic	15 (34)	8 (17)	4 (9)	0.009
Emergency Physician	38 (86)	40 (85)	46 (100)	0.557
Radiologist	29 (66)	26 (55)	25 (54)	0.366
Emergency Department Nurse 1	43 (98)	47 (100)	45 (99)	0.334
Emergency Department Nurse 2	36 (82)	41 (87)	41 (89)	0.583
Trauma Team Nurse 1	8 (18)	0 (0)	1 (2)	0.001
Trauma Team Nurse 2	4 (9)	0 (0)	0 (0)	0.013
Critical Care Nurse 1	13 (30)	10 (21)	10 (22)	0.170
Critical Care Nurse 2	4 (9)	1 (2)	0 (0)	0.103
Radiographer	39 (89)	41 (87)	38 (83)	0.397
Laboratory Technician	8 (18)	4 (9)	2 (4)	0.085
Blood Bank Technician	11 (25)	2 (4)	1 (2)	0.001
Health Care Assistant 1	38 (86)	39 (8)	44 (96)	0.220
Health Care Assistant 2	7 (16)	2 (4)	1 (2)	0.350
Administrative/Scribe	1 (2)	0 (0)	0 (0)	0.345

\* In Italy Anaesthesia and Intensive Care Medicine are under the same specialty training program. They are presented separately as the questionnaire stratified whether the physician would be coming from the operating rooms or from the critical care team.

§ Both general surgeons and trauma/acute care surgeons in Italy are specialists in general surgery. Trauma/Acute Care surgery units are available only in selected hospitals, usually large academic or emergency centers. Where these units are not available the general surgery department covers for these pathologies.

presented in Table 3 and supplementary ES5.

## Discussion

In this survey of 137 designated trauma centers in Italy, 64 do not have a formally defined trauma team in place. Our findings (53 % of centers declaring a trauma team) are significantly lower than those reported in European surveys (88 % in the ETRAUSS Study) and worldwide (61 % in a survey by Bento et al.) [14,15]. Causes for not implementing a formal trauma team can be divided into two major components, clinical-organizational and political. In the former, both patient volume and understaffing can be included. Patient volume should not discourage a center from implementing a trauma team, especially in those areas where a receiving center can be the only facility covering an area. Political reasons can be trickier to tackle. They often include the fear of confrontation between specialists, or the belief that a single specialty owns the disease. The challenges associated with promoting early multidisciplinary response to severely injured patients and gaining recognition from the medical staff of different specialties have been acknowledged and addressed in many countries for over two decades [16]. This recognition stems from the understanding that a coordinated, multidisciplinary approach is essential for providing optimal care to trauma patients. Recognizing the value of an early multidisciplinary response means understanding that the expertise and contributions of various specialties, such as emergency medicine, surgery, anesthesiology, critical care, and trauma nursing, are crucial in delivering comprehensive trauma care. Each specialty brings unique skills and knowledge that, when combined, can significantly improve patient outcomes [2,17–21]. Furthermore, the implementation of the role of the resident within the trauma system should be encouraged to help normalize these concepts. A resident's presence can create a collaborative learning environment. Team members may be more inclined to share their knowledge and experiences, fostering a culture of continuous improvement. Residents may be more comfortable seeking input from various team members due to their learning mindset. This can lead to improved communication and information sharing among team members. This could have beneficial effects also on the long term

**Table 3**  
Training and Governance of teams responding to major trauma in Italy.

	CTS (n = 44)	CTZ + N (n = 47)	CTZ (n = 46)	p-value
<b>Specific training for trauma team members, n (%)</b>				
Standardized training (ATLS/ETC)	18 (41)	22 (47)	19 (41)	0.780
Hospital based training	18 (41)	20 (43)	22 (48)	
No training required	8 (18)	5 (11)	5 (11)	
Compulsory training	21 (48)	15 (32)	13 (28)	0.124
<b>Specific training for Trauma Team Leader, n(%)</b>				
Standardized training (ATLS/ETC)	7 (16)	9 (19)	7 (15)	0.399
Hospital based training	6 (14)	4 (9)	3 (7)	
No training required	29 (66)	34 (72)	36 (78)	
Hands on training (shadowing)	2 (5)	0 (0)	0 (0)	
Compulsory training	8 (18)	3 (6)	1 (2)	0.021
<b>High Fidelity Simulation use</b>				
Never	19 (43)	28 (60)	26 (57)	0.067
Sometimes	15 (34)	15 (32)	18 (39)	
Regular	10 (23)	4 (9)	2 (4)	
<b>Performance evaluation system in place, yes (%)</b>	18 (41)	9 (19)	4 (9)	0.001
<b>Morbidity and Mortality</b>				
Ad-hoc basis	20 (46)	27 (57)	24 (52)	0.009
Once every 6 months or more	11 (25)	5 (11)	0 (0)	
At least once every year	1 (2)	1 (2)	0 (0)	
Never	12 (27)	14 (30)	22 (48)	
<b>Trauma Registry, n(%)</b>				
Regional trauma registry	11 (25)	13 (28)	1 (2)	0.001
Local trauma registry	9 (21)	3 (6)	4 (9)	
No trauma registry	24 (55)	31 (66)	41 (89)	

organization of the multidisciplinary team promoting multidisciplinary and robust confrontation between specialists. Even though the leadership should remain in the hands of a consultant, the presence of trainees in the trauma team has been associated with similar crude outcomes [22].

Structural features of trauma management, such as the availability of surgical kits in the emergency department, are also conceptually linked with the multidisciplinary approach, especially when dealing with trauma-specific resuscitative maneuvers. Resuscitative Thoracotomy (RT) and extraperitoneal pelvic packing (EPP) are universally acknowledged life-saving procedures that patients in extremis should receive in the trauma bay of the emergency department, with no need to transfer the patient to the operating room [23–25]. However, only 57 % of CTS reported the capability to perform extraperitoneal pelvic packing (EPP) in the trauma bay, with the percentage slightly increasing to 64 % for RT. These percentages significantly decrease as the hospital level decreases, with Centro Traumi di Zona (CTZ) being the least likely to perform EPP. These procedures are fundamental and should be available in any hospital that provides organized trauma care.

Trauma team activation (TTA) plays a crucial role in providing advanced and specialized care to patients with severe injuries. Field triage enables pre-hospital emergency medical care providers to identify such patients and initiate TTA early, ensuring that the resuscitation room is prepared with personnel and equipment even before the patient arrives at the hospital. In our population, hospitals almost universally receive pre-alerts from emergency medical services. However, there is significant heterogeneity regarding the pathway and criteria for in-hospital TTA activation. Most centers reported utilizing a combination of anatomical, physiological, and mechanism-based criteria to activate the trauma team. The recently published Italian guidelines on trauma management recommend the use of the TRENAU system for field triage [26,27], which has demonstrated reasonable rates of overtriage and undertriage when retrospectively applied to real-world local data [28]. This system is currently implemented in the Lombardy region, and prospective data will be crucial in assessing its eventual clinical benefits for patients and centers.

A notable finding related to TTA activation is the absence of formally defined massive transfusion protocols (MTPs) in nearly half of the interviewed centers, including one-third of Centro Traumi Specialistico (CTS). MTPs are vital for managing major trauma as they ensure the efficient and rapid provision of optimal blood products while also off-loading cognitive demands from the team members who would otherwise have to make time-consuming requests and phone calls. The implementation of MTPs should be an integral part of an efficient trauma system [29]. In a study by Meyer et al. delays in MTP activation and product delivery were associated with prolonged time to hemostasis and 24-hour mortality [30]. However, only a minority of centers have worked on implementing early activation pathways for MTPs directly from emergency medical services personnel. A recent case series from Italy confirmed that more than two-thirds of prehospital activations of MTPs resulted in massive transfusions, highlighting the potential value of this pathway for more established trauma centers to explore [31]. It is also interesting to reflect upon the fact that a minority of centers have blood bank personnel as actual components of the TT. Direct access of trauma patients from emergency medical services straight to the operating room can be an efficient pathway, particularly for unstable trauma patients [32]. However, due to the organizational challenges involved, or local choices, it is not surprising that the overall prevalence of direct access is low and primarily limited to major trauma centers. The criteria for direct access in our study align with those reported in the published case series [33].

The most common specialties involved in trauma response in Italy are anesthesiologists/intensive care physicians, emergency physicians and general surgeons. Only a few centers reported the availability of dedicated trauma/acute care surgeons, and this figure is usually linked to more specialized centers such as CTS. There is neither optimal size nor

unique evidence on the optimal medical composition of trauma teams. The crucial factor in improving outcomes and reducing resuscitation times is the organization of the team members rather than the specific number of individuals present. The suggested number of members in a trauma team is typically between five to eight professionals. This range is recommended to ensure effective coordination, communication, and task completion during the resuscitation process. When the team consists of fewer than five members, there is a risk of individuals rushing to complete their tasks due to the increased workload. On the other hand, if the team exceeds eight professionals, it can lead to fragmentation and decreased effectiveness [19]. These numbers are in line with the Italian experience of centers that declare the presence of a trauma team. The composition of trauma teams in Italy may vary based on local preferences, available resources, and the specific characteristics of the injured population. The introduction of task allocation and horizontal organization in trauma teams has demonstrated significant reductions in resuscitation times, irrespective of the composition of the team. This finding highlights the importance of efficient teamwork and clear roles within the trauma response [34].

In many centers across Italy, it is observed that the anesthesiologist or the intensive care physician lead the initial management of trauma patients (88 % of all centers declaring a formal trauma team). The intensive care physician's expertise in critical care and their familiarity with managing complex medical conditions have historically made them suitable for providing immediate care to severely injured patients. Our findings differ from the ETRAUSS European trauma survey, where anesthesiologists/intensivists accounted for 32 % of trauma team leaders (TTLs), emergency physicians for 21 %, and surgeons for nearly 45 % of all TTLs. These differences can be attributed to the limited availability of trained trauma surgeons in Italy and the relative novelty of the specialty of emergency medicine. Comparative data between surgeons and other leaders of trauma teams, such as emergency physicians, indicate no notable disparities in the duration of emergency department stays or in the actual or predicted survival rates of patients [35,36]. It is known that the involvement of a trauma surgeon in the trauma team might reduce resuscitation time as well as time to definitive operative intervention [37].

It is worth noting that in those centers where leadership is not pre-assigned, the most common reason for leader selection is whether the patient is mechanically ventilated or not. This is a traditional approach linked to the anesthesiologist/intensivists expertise with airways but it is not in any way a certification of expertise in trauma management. Expertise in airways per se should not be sufficient to define a TTL. The role of a trauma team leader is to oversee and coordinate the efforts of the team during complex trauma cases, ensuring effective communication, assigning roles, making critical decisions, and providing situational awareness to optimize patient care and outcomes [38]. Therefore, centers adopting a flexible TTL approach should prioritize clinical expertise and training when selecting leaders.

The number of centers implementing a "hands-off" trauma team leader approach was very low and limited to the CTS. There is limited evidence regarding whether a hands-off or hands-on approach is superior for TTLs. However, some studies suggest that when leaders participate "hands-on," they are less likely to establish a structured team, resulting in less dynamic teamwork and less effective resuscitation tasks [39]. The scarcity of hands-off TTLs may derive from the limited availability of specialists in the field or a lack of crew resource management training.

Finally, our results emphasize the pressing need for improvements in trauma management education and governance. Currently, the most common educational opportunities for trauma team members are attending commercially available trauma courses or hospital-based training courses. However, these courses are rarely mandatory to join the trauma team. In terms of leadership, there is a near-universal lack of specific training for trauma team leaders. The correlation between effective team leadership and enhanced teamwork is widely

acknowledged as a significant factor contributing to improved patient care [40]. To address these gaps, dedicated training programs for trauma team leaders should be implemented as a mandatory requirement for professionals assuming leadership roles. Innovative educational programs like the Italian Resuscitation Council Trauma Bay Management Course (TBMC) aim to bridge this educational gap (full description of the course in the ES6). The utilization of high-fidelity simulation as a trauma team training technique, particularly in the form of in-situ drills, is alarmingly low, with regular drills being conducted in only slightly above 20 % of CTS and even lower percentages in other centers. Medical simulation, particularly when conducted "in situ" to replicate realistic and authentic environments and local protocols, is widely recognized as an effective educational method [41,42]. Regarding clinical governance, which serves as the framework for maintaining higher standards of safety and care in healthcare organizations, less than 50 % of CTS have a performance management system in place, though this figure is significantly higher than in other types of trauma centers (CTZ + N and CTZ). It is essential to emphasize that optimal care is not solely the result of direct patient contact and volume; it also stems from the implementation of a clinical governance process within the trauma network, hospital, and trauma team. Auditing, a fundamental component of governance, provides valuable information for educational purposes and service improvement [43]. As expected, the presence of governance programs such as Morbidity and Mortality case reviews and data collection through Trauma Registries is linked to the level of the center, with higher prevalence in CTS. The benefits of case-based education and revision, as described in a previous paper by the same author [44], can offer guidance to centers aiming to establish an auditing system.

### Limitations

Trauma systems are dynamic networks and the data provided are representative of a specific point in time. We used the best resources available (normative data published online on official government websites) to compile the list of theoretical hospitals to be interviewed by designated category. It is possible however that, due to the COVID-19 pandemic, some lower-level trauma centers have been adapted to be COVID-19-exclusive hospitals. Moreover the cutoff of 90 % for CTS and CTZ + N has been arbitrarily chosen, it would have been more informative if all existing centers were interviewed. A selection bias cannot be excluded, although interview subjects were carefully selected among trauma leaders and departmental leads in each hospital, the selection of participants is arbitrary and may not be fully representative of the whole country. Finally, while CTS and CTZ + N numbers are precisely known, the exact number of CTZ was not available to study investigators. As such the sample of CTZ might not be representative of the whole country.

### Conclusions

Only 53 % (73/137) of the interviewed centers had a formally defined trauma team. The distribution of formal trauma teams varied across different trauma center levels, with 73 % of CTS, 49 % of CTZ + N, and 39 % of CTZ reporting having a formal trauma team. These results suggest there is room for improvement in terms of formalizing trauma teams, enhancing MTP implementation, trauma team activation pathways, education and governance. The data presented in this study can serve as a foundation for further discussions and interventions to enhance local and national trauma care in Italy.

### CRedit authorship contribution statement

**Luca Carenzo:** Conceptualization, Data curation, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. **Cesare Mercalli:** Data curation, Investigation, Writing –

original draft, Writing – review & editing. **Elisa Reitano:** Data curation, Investigation, Methodology, Writing – review & editing. **Marco Tartaglione:** Investigation, Methodology, Supervision, Validation, Writing – review & editing. **Martina Ceolin:** Investigation, Methodology, Supervision, Writing – review & editing. **Stefania Cimbanassi:** Investigation, Methodology, Supervision, Writing – review & editing. **Daniele Del Fabbro:** Investigation, Methodology, Supervision, Writing – review & editing. **Fabrizio Sammartano:** Methodology, Supervision, Writing – review & editing. **Maurizio Cecconi:** Methodology, Supervision, Writing – review & editing. **Carlo Coniglio:** Methodology, Supervision, Writing – review & editing. **Osvaldo Chiara:** Methodology, Supervision, Writing – review & editing. **Lorenzo Gamberini:** Formal analysis, Methodology, Supervision, Writing – original draft, Writing – review & editing.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.injury.2024.111388](https://doi.org/10.1016/j.injury.2024.111388).

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