ORIGINAL ARTICLE

Practice Patterns and Management Protocols in Trauma across Indian Settings: A Nationwide Cross-sectional Survey

Kanwalpreet Sodhi[1], Ruchira Wasudeo Khasne[2], Gunjan Chanchalani[3], Ganshyam Jagathkar[4], Venkat Raman Kola[5], Mahesh Mishra[6], Shrikant Sahasrabudhe[7], Rajesh C Mishra[8], Amrish Patel[9], Ankur R Bhavsa[10], Haider Abbas[11], Pragyan Kumar Routray[12], Pramod Sood[13], Prasad Anant Rajhans[14], Reshu Gupta[15], Kapil Dev Soni[16], Manender Kumar[17]

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Abstract

Background: Trauma is the leading cause of death in India resulting in a significant public health burden. Indian Society of Critical Care Medicine (ISCCM) has established a trauma network committee to understand current practices and identify the gaps and challenges in trauma management in Indian settings.

Material and methods: An online survey-based, cross-sectional, descriptive study was conducted with high-priority research questions based on hospital profile, resource availability, and trauma management protocols.

Results: Data from 483 centers were analyzed. A significant difference was observed in infrastructure, resource utilization, and management protocols in different types of hospitals and between small and big size hospitals across different tier cities in India ($p < 0.05$). The advanced trauma life support (ATLS)-trained emergency room (ER) physician had a significant impact on infrastructure organization and trauma management protocols ($p < 0.05$). On multivariate analysis, the highest impact of ATLS-trained ER physicians was on the use of extended focused assessment with sonography in trauma (eFAST) (2.909 times), followed by hospital trauma code (2.778 times), dedicated trauma team (1.952 times), and following trauma scores (1.651 times).

Conclusion: We found that majority of the centers are well equipped with optimal infrastructure, ATLS-trained physician, and management protocols. Still many aspects of trauma management need to be prioritized. There should be proactive involvement at an organizational level to manage trauma patients with a multidisciplinary approach. This survey gives us a deep insight into the current scenario of trauma care and can guide to strengthen across the country.

Keywords: Advanced trauma life support-trained emergency room physician, e-FAST, Trauma, Trauma center, Trauma code, Trauma team.

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Highlights

- The-first-of-its-kind pan-India survey on trauma from around 500 centers in different cities across the country.
- The survey gives an insight into the current scenario of trauma care at the grassroots level and can serve as a guide to further strengthen trauma management across the country.
- There are certain infrastructure deficiencies and variations in trauma protocols in different types of setups.
- Most of the hospitals have good resources, emergencies managed by ATLS-trained physicians, and standard management protocols.

Introduction

Trauma is the leading cause of young deaths in India contributing significantly to the public health burden.[1,2] It is the responsibility and privilege of every critical care physician to take the challenge aiming for "zero preventable deaths and disability due to trauma." The ISCCM initiated a trauma network to conduct a survey with high-priority research questions on trauma management across the country. The objective of this survey was to understand the practice patterns and help identify the gaps and challenges in trauma management in the Indian scenario which could be the priority focus of the ISCCM.

[1]Department of Critical Care, Deep Hospital, Ludhiana, Punjab, India

[2]Department of Critical Care Medicine, SMBT Institute of Medical Sciences and Research Centre, Dhamangaon, Igatpuri, Nashik, Maharashtra, India

[3]Department of Critical Care, KJ Somaiya Hospital & Research Center, Mumbai, Maharashtra, India

[4]Department of Critical Care, Medicover Hospital, Hyderabad, Telangana, India

[5]Department of Critical Care, Yashoda Hospitals, Hyderabad, Telangana, India

[6]Department of Surgery, Mahatma Gandhi University of Medical Sciences & Technology, Jaipur, Rajasthan, India

[7]Department of Pulmonology and Critical Care Medicine, Medicover Hospitals, Aurangabad, Maharashtra, India

[8]Department of MICU, Shaibya Comprehensive Care Clinic, Ahmedabad, Gujarat, India

[9]Department of Pulmonary and Critical Care Medicine, Sterling Hospital, Ahmedabad, Gujarat, India

[10]Department of Critical Care, Spandan Multi Specialty Hospital, Vadodara, Gujarat, India

[11]Department of Emergency Medicine, King George's Medical University, Lucknow, Uttar Pradesh, India

Materials and Methods

In March 2022, a trauma network committee, consisting of critical care physicians, trauma experts, ER physicians, and senior ISCCM team leaders, was formed to collaborate, research, and improvise on trauma practices in the country. As an initial step, the committee decided to survey the current trends, awareness, and practices of trauma management in different hospitals across India. Thus, a survey was drafted after multiple inquiries, reviewed, and validated by the committee members. The final self-administrable, multiple-choice structured questionnaire (Appendix 1) comprised of the following:

- Information about the hospital infrastructure.
- The available resources in the setup including a dedicated trauma center, a trauma team, trauma code, the availability of ATLS-trained ER physician, and an in-house blood bank.
- The basic management protocols followed included the use of trauma score, imaging protocols, eFAST protocol, type of fluids, analgesia, antiedema measures, invasive and intracranial pressure (ICP) monitoring, the use of the cervical collar, spine boards, tranexamic acid (TXA), and centhaquine citrate.

The survey was rolled out through ISCCM mail to all its members and various city Indian Medical Association (IMA) groups *via* individual and social media communication, between 21 April to 1 May 2022. The purpose of the study was intimidated to the responder through an introductory message. Participation was voluntary.

Statistical Analysis

Data were described in terms of frequencies (number of cases) and relative frequencies (percentages) as appropriate. For comparing categorical data, Chi-squared (χ^2) test was performed, and Fisher's exact test was used when the expected frequency is less than 5. Covariates obtaining a $p < 0.05$ in the univariate analyses were included in the multivariate binary logistic regression analyses for ATLS-certified ER physicians for assessing the impact on trauma management. A probability value (p) less than 0.05 was considered statistically significant. All statistical calculations were done using statistical package for the social science (SPSS), version 21 (SPSS Inc., Chicago, IL, USA) statistical software program for Microsoft Windows.

Results

The response was obtained from 508 respondents across the country over 10 days. Of these, 3 respondents had given negative consent for participation and 22 forms were duplicated, from the same centers and were excluded. Eventually, 483 centers that filled the questionnaire relevantly were included.

Infrastructure

The profile of participating hospitals is shown in Figures 1 and 2. The city-wise distribution of hospitals into tier 1, that is, the metropolitan cities, tier 2, and tier 3 categories [as per the Government of India recommendations of the Seventh Central Pay Commission, house rent allowance (HRA) classification] is shown in Table 1.[3] Table 2 shows the available facilities in the hospitals.

Resource Utilization

The type of trauma being managed across hospitals is shown in Figure 3. A total of 33% of centers (158) performed whole-body computed tomography (CT) scan on a trauma victim at arrival,

[12]Department of Critical Care, CARE Hospitals, Bhubaneswar, Odisha, India
[13]Department of Critical Care Medicine, Dayanand Medical College & Hospital, Ludhiana, Punjab, India
[14]Department of Critical Care and Emergency Medicine, Deenanath Mangeshkar Hospital & Research Center, Pune, Maharashtra, India
[15]Department of Critical Care Medicine, Health City Hospital, Guwahati, Assam, India
[16]Department of Critical and Intensive Care, JPN Apex Trauma Center, All India Institute of Medical Sciences, New Delhi, India
[17]Department of Cardiac Anaesthesia, Fortis Hospital, Ludhiana, Punjab, India

Corresponding Author: Ruchira Wasudeo Khasne, Department of Critical Care Medicine, SMBT Institute of Medical Sciences and Research Centre, Dhamangaon, Igatpuri, Nashik, Maharashtra, India, Phone: +91 7020272240, e-mail: drruchirakhasne@gmail.com

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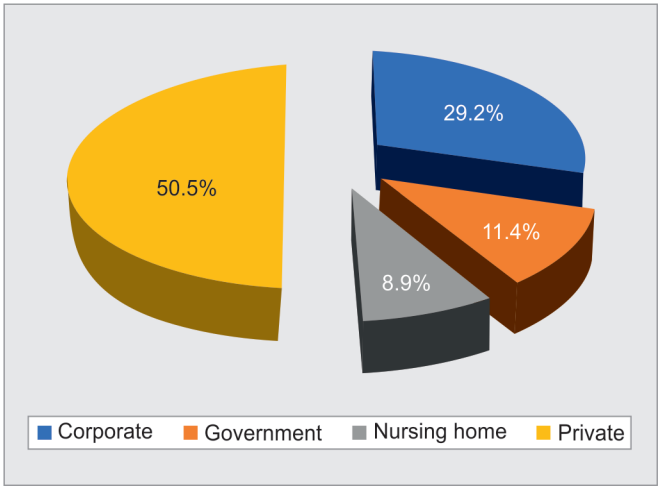

Fig. 1: Type of participating hospital

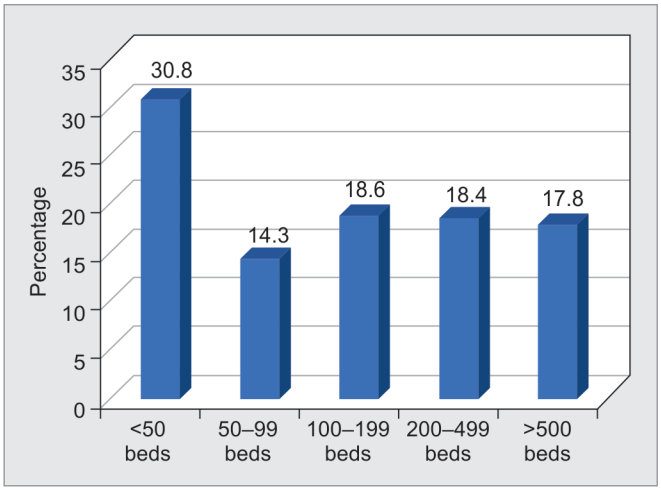

Fig. 2: Capacity of hospitals

Table 1: Distribution of hospitals in different tier cities

Types of cities	*Number of centers*	*%*
Tier 1	98	20.3
Tier 2	304	62.9
Tier 3	81	16.8

Table 2: Infrastructure and protocol details in centers surveyed

	Number of centers with facility (%)	
Parameter	*Yes*	*No*
Trauma center[a]	287 (59%)	196 (41%)
Trauma team[b]	213 (44%)	270 (56%)
Trauma code[c]	195 (40%)	288 (60%)
Trauma score[d]	261 (54%)	222 (46%)
Blood bank facility	315 (65%)	168 (35%)
ATLS-trained ER physician	296 (61%)	187 (39%)

[a]Trauma center: A hospital unit specializing in the treatment of patients with acute and especially life-threatening traumatic injuries. [b]Trauma team: A multidisciplinary group of individuals drawn from the specialties of emergency medicine, intensive care, surgery, orthopedics, neurosurgery, nursing, allied health and support staff, who work together as a team to assess and manage the trauma patient. [c]Trauma code: Defined highest level of activation of the trauma team, and the criteria should include physiologic criteria and some or several of the anatomic criteria. [d]Trauma score: Scoring system for severity based on anatomical descriptions of injuries, some on physiological parameters or combined data

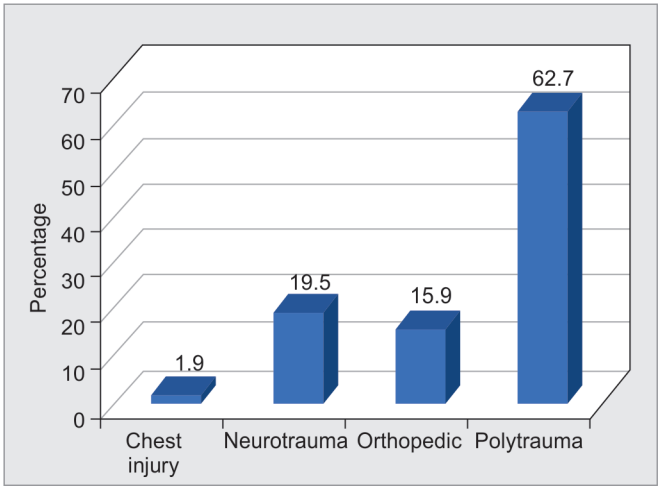

Fig. 3: Types of trauma being managed across centers

while the rest limited the scan to only the injured organ. A total of 271 centers (56%) followed the eFAST protocol for all trauma patients, among the rest, half never used eFAST and the other half used it from time to time. A total of 85% centers (408) were always using the cervical collar for cervical spine stabilization, 3% (15 centers) never used it and 12% (60 centers) used it occasionally. Spine board was routinely used for in-house shifting of trauma patients in 63% centers (302), 22% centers (106) never used while 15% (75%) centers used it sometimes.

Management Protocols

Fluid and analgesia preference for trauma resuscitation across centers is shown in Figure 4. A total of 64% centers (309) were routinely using TXA for trauma management while 8% (40) never

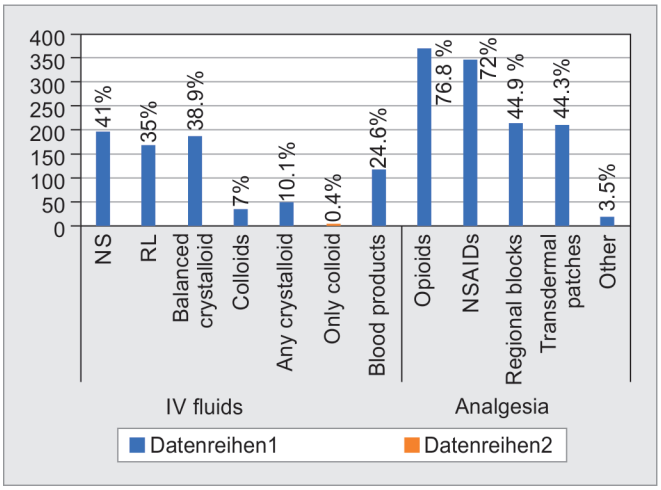

Fig. 4: Type of fluid and analgesia preferred for trauma management

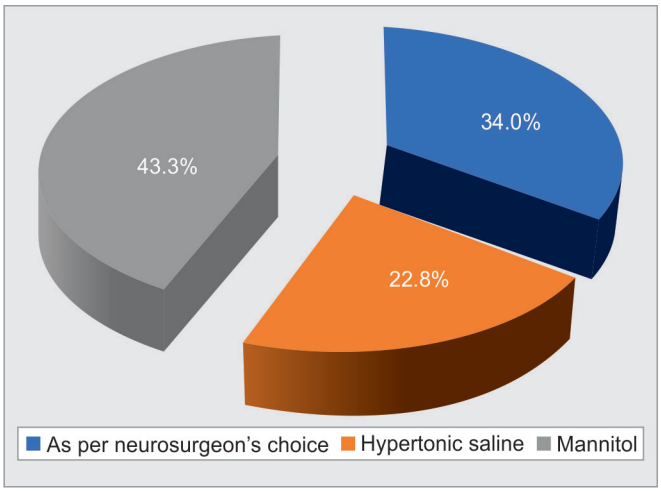

Fig. 5: Antiedema preference across centers

used and 28% (134) used the drug sometimes. Only 3% of centers (15) had ever used centhaquine citrate for trauma; 70% of the centers (335) started vasopressors early in ER after giving 2 L of intravenous (IV) fluids while 22% (104) started vasopressors in ICU if BP was not picking up, 3% (17) started late in ER after 4 hours, and 6% (27) had other reasons for starting vasopressors.

A total of 44% (211) centers used invasive monitoring routinely during trauma management while 29% (139) did not use and 27% (133) used sometimes. Only 10% of the centers (50) were using ICP monitoring, 17% (82) used it sometimes while 78% (351) did not use it. Moreover, 292 centers (61%) measured serial lactates during trauma management, 74 (15%) sometimes measured while 117 (24%) did not measure. Mannitol was the most preferred antiedema agent across 209 centers (43%) (Fig. 5).

Univariate analysis was done on the basis of the type of hospital setups, hospital size, the city tiers, and the ATLS-trained ER physician availability with interesting results.

Type and Size of Hospitals

See Table 3. Significant difference was seen in the type of hospital (private/corporate/government/nursing homes) with regard to the type of trauma managed, having a trauma center, dedicated trauma

Table 3: How do different hospital setups differ in trauma management?

	Type of hospital setup					
Parameters	*Corporate (n = 141)*	*Government (n = 55)*	*Nursing home (n = 43)*	*Private (n = 244)*	*Total*	*p-value*
City type						
Tier 1	47 (48%)	16 (16%)	2 (0.02%)	33 (34%)	98	0.001
Tier 2	87 (29%)	26 (8%)	32 (11%)	159 (52%)	304	
Tier 3	7 (9%)	13 (16%)	9 (11%)	52 (64%)	81	
Dedicated trauma center						
No	51 (36.2%)	19 (10%)	31 (16%)	95 (48%)	196	0.001
Yes	90 (63.8%)	36 (12%)	12 (4%)	149 (51%)	287	
Hospital beds						
<50 beds	10 (7.1%)	5 (3%)	34 (23%)	100 (67%)	149	0.001
50–499 beds	108 (43%)	26 (10%)	9 (4%)	105 (42%)	248	
>500 beds	23 (27%)	24 (28%)	0	39 (45%)	86	
Dedicated trauma team						
No	71 (26%)	25 (9%)	36 (13%)	138 (51%)	270	0.001
Yes	70 (33%)	30 (14%)	7 (3%)	106 (50%)	213	
ATLS-certified ER physician						
No	34 (18%)	22 (12%)	30 (16%)	101 (54%)	187	0.001
Yes	107 (36%)	33 (11%)	13 (4.3%)	143 (48%)	296	
Hospital trauma code						
No	66 (23%)	35 (12%)	37 (13%)	150 (52%)	288	0.001
Yes	75 (38%)	20 (10%)	6 (3%)	94 (48%)	195	
Any trauma score						
No	48 (22%)	24 (11%)	31 (14%)	119 (54%)	222	0.001
Yes	93 (36%)	31 (12%)	12 (4%)	125 (48%)	261	
Type of trauma managed						
Chest injury	1 (11%)	0	1 (11%)	7 (78%)	9	0.001
Neurotrauma	34 (36%)	6 (6%)	7 (7%)	47 (50%)	94	
Orthopedic	8 (10%)	5 (6%)	17 (22%)	47 (61%)	77	
Polytrauma	98 (32%)	44 (15%)	18 (6%)	143 (47%)	303	
Use of eFAST in trauma						
No	16 (15%)	19 (18%)	19 (18%)	52 (49%)	106	0.001
Sometimes	18 (17%)	14 (13%)	8 (7%)	66 (62%)	106	
Yes	107 (39%)	22 (8%)	16 (6%)	126 (46%)	271	
In-house blood–bank facility						
No	32 (19%)	0	19 (11%)	117 (69%)	168	0.001
Yes	109 (35%)	55 (17%)	24 (7%)	127 (40%)	315	
Trigger to start vasopressors in shock in trauma management						
Early in ER after giving 2 L IV fluids	111 (33%)	33 (10%)	27 (8%)	164 (49%)	335	0.001
In ICU if BP is not picking	16 (15%)	11 (10%)	13 (13%)	64 (62%)	104	
Late in ER after 4 hours or so	4 (23%)	7 (41%)	1 (6%)	5 (29%)	17	
Other reason	10 (37%)	4 (15%)	2 (7%)	11 (41%)	27	
Use of cervical collar						
No	2 (13%)	3 (20%)	2 (13%)	8 (53%)	15	0.004
Sometimes	5 (8%)	9 (15%)	9 (15%)	37 (62%)	60	
Yes	134 (33%)	43 (10%)	32 (8%)	199 (49%)	408	

(Contd...)

Table 3: *(Contd...)*

	Type of hospital setup					
Parameters	*Corporate (n = 141)*	*Government (n = 55)*	*Nursing home (n = 43)*	*Private (n = 244)*	*Total*	*p-value*
Use of spine board for shifting						
No	9 (8%)	13 (12%)	18 (17%)	66 (62%)	106	0.001
Sometimes	14 (19%)	16 (21%)	8 (11%)	37 (49%)	75	
Yes	118 (39%)	26 (9%)	17 (6%)	141 (47%)	302	
Opioids						
No	17 (15%)	16 (14%)	14 (12%)	65 (58%)	112	0.002
Yes	124 (33%)	39 (10%)	29 (8%)	179 (48%)	371	
Invasive monitoring for trauma						
No	14 (10%)	21 (15%)	19 (14%)	85 (61%)	139	0.001
Sometimes	38 (29%)	13 (10%)	15 (11%)	67 (50%)	133	
Yes	89 (42%)	21 (10%)	9 (4%)	92 (44%)	211	
Serial lactate measurement						
No	20 (17%)	21 (18%)	15 (13%)	61 (52%)	117	0.001
Sometimes	18 (24%)	10 (13%)	10 (13%)	36 (49%)	74	
Yes	103 (35%)	24 (8%)	18 (6%)	147 (50%)	292	
Preferred antiedema agent						
As per neurosurgeon's choice	30 (18%)	20 (12%)	20 (12%)	94 (57%)	164	0.001
Hypertonic saline	53 (48%)	10 (9%)	3 (3%)	44 (40%)	110	
Mannitol	58 (28%)	25 (12%)	20 (10%)	106 (51%)	209	
	Size of hospital					
	<50 beds (n = 149)	*50–499 beds (n = 248)*	*>500 beds (n = 86)*	*Total*	*χ^2-value*	*p-value*
Trauma center						
No	83 (42%)	94 (48%)	19 (10%)	196	27.062	0.001
Yes	66 (23%)	154 (54%)	67 (23%)	287		
Trauma team						
No	105 (39%)	130 (48%)	35 (13%)	270	22.112	0.001
Yes	44 (21%)	118 (55%)	51 (24%)	213		
ATLS-certified ER physician						
No	83 (44%)	84 (45%)	20 (11%)	187	29.242	0.001
Yes	66 (22%)	164 (55%)	66 (22%)	296		
Trauma code						
No	108 (37%)	141 (49%)	39 (13%)	288	18.305	0.001
Yes	41 (21%)	107 (55%)	47 (24%)	195		
Trauma score						
No	85 (38%)	111 (50%)	26 (12%)	222	16.083	0.001
Yes	64 (24%)	137 (52%)	60 (23%)	261		
Major trauma managed						
Chest injury	6 (67%)	3 (33%)	0	9	29.546	0.001
Neurotrauma	26 (28%)	52 (55%)	16 (17%)	94		
Orthopedic	41 (53%)	27 (35%)	9 (12%)	77		
Polytrauma	76 (25%)	166 (55%)	61 (20%)	303		
Radiological imaging protocol						
Organ specific CT	118 (36%)	155 (48%)	52 (16%)	325	13.998	0.001
Whole-body CT scan (Pan CT)	31 (20%)	93 (59%)	34 (21%)	158		

Use of eFAST						
No	51 (48%)	40 (38%)	15 (14%)	106	34.356	0.001
Sometimes	41 (39%)	55 (52%)	10 (9%)	106		
Yes	57 (21%)	153 (56%)	61 (22%)	271		
RL						
No	79 (25%)	177 (56%)	58 (18%)	314	14.052	0.001
Yes	70 (41%)	71 (42%)	28 (17%)	169		
Balanced crystalloid						
No	104 (35%)	143 (48%)	48 (16%)	295	6.987	0.030
Yes	45 (24%)	105 (56%)	38 (20%)	188		
Blood products						
No	103 (28%)	200 (55%)	61 (17%)	364	7.757	0.021
Yes	46 (39%)	48 (40%)	25 (21%)	119		
Blood-bank facility						
No	89 (53%)	76 (45%)	3 (2%)	168	79.885	0.001
Yes	60 (19%)	172 (24%)	83 (26%)	315		
Trigger to start vasopressors in trauma						
Early in ER after giving 2L IV fluids	95 (28%)	176 (52%)	64 (19%)	335	14.473	0.025
In ICU if BP is not picking	45 (43%)	49 (47%)	10 (10%)	104		
Late in ER after 4 hours or so	3 (18%)	9 (53%)	5 (29%)	17		
Other reason	6 (22%)	14 (52%)	7 (26%)	27		
Use of cervical collar						
No	7 (47%)	7 (47%)	1 (7%)	15	19.516	0.001
Sometimes	32 (53%)	20 (33%)	8 (13%)	60		
Yes	110 (27%)	221 (54%)	77 (19%)	408		
Use spine board for shifting						
No	44 (41%)	45 (42%)	17 (16%)	106	15.312	0.004
Sometimes	31 (41%)	33 (44%)	11 (15%)	75		
Yes	74 (25%)	170 (56%)	58 (19%)	302		
Opioids						
No	47 (42%)	46 (41%)	19 (17%)	112	8.896	0.012
Yes	102 (27%)	202 (54%)	67 (18%)	371		
NSAIDs						
No	28 (21%)	79 (58%)	28 (21%)	135	8.99	0.011
Yes	121 (35%)	169 (49%)	58 (17%)	348		
Use of invasive monitoring						
No	70 (50%)	50 (36%)	19 (14%)	139	46.969	0.001
Sometimes	42 (32%)	75 (56%)	16 (12%)	133		
Yes	37 (18%)	123 (58%)	51 (24%)	211		
Serial lactates in trauma management						
No	54 (46%)	49 (42%)	14 (12%)	117	20.151	0.001
Sometimes	25 (34%)	35 (47%)	14 (19%)	74		
Yes	70 (24%)	164 (56%)	58 (20%)	292		
Preferred antiedema measure						
As per neurosurgeon's choice	64 (39%)	71 (43%)	29 (18%)	164	10.251	0.036
Hypertonic saline	25 (23%)	62 (56%)	23 (21%)	110		
Mannitol	60 (29%)	115 (55%)	34 (16%)	209		

team, trauma code, following trauma score, in-house blood bank facility, having an ATLS-certified ER physician and management protocols including imaging, use of eFAST, cervical collar, spine boards, the trigger for vasopressor use, invasive monitoring, lactate monitoring, opioid use for analgesia and preferred antiedema agent. No significant difference was observed in the types of IV fluids or blood products for resuscitation, use of TXA, or ICP monitoring in different types of hospitals.

A significant difference was seen in the size of the hospital (small, <50; large, >500; and intermediate, 50–499 beds) with regard to type of trauma managed, having a trauma center, dedicated trauma team, trauma code, following trauma score, having an ATLS-trained ER physician, in-house blood bank facility and in management protocols including imaging protocols, use of eFAST, cervical collar, spine boards, the trigger for vasopressor use, invasive monitoring, lactates, opioid use, and preferred antiedema agent.

Type of Cities

See Table 4. There was a significant difference in the size of hospitals across different cities with half (48%) of hospitals in tier 3 cities being small (<50 beds) as compared to only 10% in tier 1 cities. The majority of larger hospitals (>500 beds) were in tier 1 and tier 2 cities (28% and 16%, respectively) as compared to tier 3 cities (12%). A significant difference was seen in the types of cities with regard to the type of trauma managed, having a trauma code, following trauma score, in-house blood bank facility, having an ATLS-certified ER physician, imaging protocols, use of eFAST, cervical collar and spine boards, type of fluid, the trigger for vasopressor use, use of invasive monitoring, lactate monitoring, analgesia, and antiedema agent preference. City-wise no difference was seen in the use of blood products, TXA, or ICP monitoring.

Advanced Trauma Life Support-trained ER Physician

Advanced trauma life support-trained ER physicians made a significant difference in trauma management by setting up dedicated trauma units, having a trauma team and trauma code, following trauma scores, and having a blood bank facility and in management protocols (Table 5) including the use of eFAST, more pan-organ CT scans (36.1% vs 27.3%, $p < 0.05$), higher use of balanced crystalloids (44.9% vs 29.4%, $p = 0.001$), centhaquine citrate (4.7% vs 0.5%, $p = 0.012$), opioids and regional blocks for analgesia, use of invasive monitoring, ICP monitoring and use of hypertonic saline (28% vs 14.4%) as compared to mannitol (39.2% vs 49.7%, $p = 0.002$).

Multivariate analysis (Table 6) showed a significant impact of ATLS-trained ER physicians on infrastructure organization and trauma management protocols ($p < 0.05$). The highest impact was on the use of eFAST (2.909 times), followed by hospital trauma code (2.778 times), dedicated trauma team (1.952 times), and following trauma scores (1.651 times). There was no strong association between trained ER physicians and radiological imaging protocol or use of TXA ($p > 0.05$).

Discussion

Multiple factors beyond the mode and severity of injury affect the outcomes of trauma patients including the hospital infrastructure, available resources, and management strategies. We comprehensively observed the practice patterns and trauma management strategies currently being followed from 483 centers varying from small nursing homes to large corporate hospitals and medical colleges in different cities of India through a national online survey.

Literature supports that hospitals with established trauma center show better outcomes. As per our survey, 59% of the hospitals had a dedicated trauma center and 44% had a dedicated trauma team. A study conducted in metropolitan areas found significantly lower mortality at hospitals with trauma centers (7.6% vs 9.5%).[4] A single-center Italian study by Magnone et al. showed that the introduction of trauma team had a positive impact on mortality in the first 24 hours.[5]

In our study, only 40% had in-place hospital trauma code. The literature does not show any major benefit of following the trauma code in patient outcomes. A study by Lo showed no significant differences in mortality or admission days with in-hospital trauma activation protocol.[6] Connolly, in 846 trauma patients, also showed no clear link between delayed trauma code activation to increased mortality.[7] A study has shown that 59% of the patients had normal radiological tests in trauma patients enrolled under trauma code activation and investigated as per the protocol.[8] With protocolized trauma code activation, there can be unnecessary investigations under the umbrella of fixed protocols, so more attention should be paid to the clinical condition rather than following fixed protocols.

To date, there is no universally acceptable trauma scoring system. In our survey, 56% of hospitals were following some trauma score although we did not enquire about which specific score was preferred. Most of the scoring systems have been devised in developed countries and might not be applicable to Indian settings. A systematic review of 336 studies revealed that implementing trauma scoring systems designed for high-income countries may not be relevant to low- and middle-income countries (LMICs).[9] Any major trauma needs a massive transfusion, although there is a lack of literature showing the impact of blood bank facilities on trauma outcomes. Our survey showed that 65% of the centers across the country had in-house blood bank facilities available.

Across the globe, the novel concept of emergency being managed by ATLS-trained physicians is in evolution. Trained ER physicians play a crucial role during the golden hour of trauma and are team leaders during the resuscitative phase of management.[10] In a 3-year pre and post-ATLS training study, Van Olden et al. showed that introduction of the ATLS program significantly improved trauma patient outcomes in the first hour after admission.[11] Study by Magnone et al. also showed that ATLS guidelines had a positive impact on mortality (14.1% vs 7.1%; $p = 0.033$).[5] In our survey, emergency of 61% of participating Indian hospitals are managed by ATLS-trained physicians, which is an optimistic number. The multivariate analysis of our study showed a strong correlation of ATLS-trained ER physicians with the highest impact on use of eFAST, followed by implementing trauma code, having a dedicated trauma team, and following trauma scores. Although we cannot comment upon the impact on outcomes from our data but the difference in management protocol should surely culminate in positive outcomes that might be explored in further studies. Recently a study evaluating the impact of emergency medicine training on mortality in a university teaching hospital showed a 43% reduction in mortality.[12] A literature review of 282 articles supports the efficacy of patient care delivered by trained ER physicians.[13]

Integration of eFAST has emerged as an essential point of care investigation in trauma management in recent years.[14] In our survey, a significant proportion of hospitals (56%) were implementing eFAST in trauma management. In a prospective interventional single-center study, conditions such as pneumothorax were identified with eFAST early than with serial X-rays (25 vs 38 minutes respectively; $p < 0.0001$), with less radiation exposure.[15] In a

Table 4: Analysis of trauma management in different types of cities

	Type of city				
	Tier 1 (n = 98)	*Tier 2 (n = 304)*	*Tier 3 (n = 81)*	*Total*	*p-value*
Hospital beds					
<50 beds	10 (7%)	100 (67%)	39 (26%)	149	0.001
50–499 beds	61 (25%)	155 (62%)	32 (13%)	248	
>500 beds	27 (31%)	49 (57%)	10 (12%)	86	
ATLS-certified ER physician					
No	21 (11%)	119 (64%)	47 (25%)	187	0.001
Yes	77 (26%)	185 (62%)	34 (11%)	296	
Trauma code					
No	50 (17%)	177 (61%)	61 (21%)	288	0.003
Yes	48 (25%)	127 (65%)	20 (10%)	195	
Trauma score					
No	36 (16%)	139 (63%)	47 (21%)	222	0.017
Yes	62 (24%)	165 (63%)	34 (13%)	261	
Major trauma managed					
Chest injury	0	3 (33%)	6 (67%)	9	0.001
Neurotrauma	20 (21%)	63 (67%)	11 (12%)	94	
Orthopedic	13 (17%)	44 (57%)	20 (26%)	77	
Polytrauma	65 (21%)	194 (64%)	44 (15%)	303	
Radiological imaging protocol					
Organ specific CT	62 (19%)	199 (61%)	64 (20%)	325	0.044
Whole-body CT scan	36 (23%)	105 (66%)	17 (11%)	158	
Use of eFAST					
No	10 (9%)	62 (58%)	34 (32%)	106	0.001
Sometimes	12 (11%)	71 (67%)	23 (22%)	106	
Yes	76 (28%)	171 (63%)	24 (9%)	271	
NS					
No	68 (28%)	177 (62%)	40 (14%)	285	0.023
Yes	30 (15%)	127 (64%)	41 (21%)	198	
RL					
No	76 (24%)	192 (61%)	46 (15%)	314	0.008
Yes	22 (13%)	112 (66%)	35 (21%)	169	
Balanced crystalloid					
No	44 (15%)	190 (64%)	61 (21%)	295	0.001
Yes	54 (29%)	114 (61%)	20 (11%)	188	
In-house Blood-bank facility					
No	16 (9%)	102 (61%)	50 (30%)	168	0.001
Yes	82 (26%)	202 (64%)	31 (10%)	315	
Use of cervical collar					
No	2 (13%)	8 (53%)	5 (33%)	15	0.023
Sometimes	6 (10%)	38 (63%)	16 (27%)	60	
Yes	90 (22%)	258 (63%)	60 (15%)	408	
Use of spine board for shifting					
No	8 (7%)	67 (63%)	31 (29%)	106	0.0001
Sometimes	11 (14%)	47 (63%)	17 (23%)	75	
Yes	79 (26%)	190 (63%)	33 (11%)	302	
Opioids					
No	9 (8%)	72 (64%)	31 (28%)	112	0.0001
Yes	89 (24%)	232 (63%)	50 (13%)	371	

(Contd...)

Table 4: *(Contd...)*

	Type of city				
	Tier 1 (n = 98)	*Tier 2 (n = 304)*	*Tier 3 (n = 81)*	*Total*	*p-value*
Regional blocks					
No	42 (16%)	167 (63%)	57 (21%)	266	0.001
Yes	56 (26%)	137 (63%)	24 (11%)	217	
Transdermal patches					
No	45 (17%)	167 (62%)	57 (21%)	269	0.004
Yes	53 (25%)	137 (64%)	24 (11%)	214	
Use of invasive monitoring					
No	9 (6%)	79 (57%)	51 (37%)	139	0.001
Sometimes	24 (18%)	93 (70%)	16 (12%)	133	
Yes	65 (31%)	132 (63%)	14 (7%)	211	
Serial lactates in trauma					
No	16 (14%)	59 (50%)	42 (36%)	117	0.001
Sometimes	9 (12%)	55 (74%)	10 (14%)	74	
Yes	73 (25%)	190 (65%)	29 (10%)	292	

Table 5: Analysis of infrastructure development and clinical trauma management based on presence or absence of ATLS trained physician

	ATLS-certified ER physician	*Non-ATLS-certified ER physician*	*Total*	*χ^2-value*	*p-value*
Dedicated trauma team					
No	125	145	270	57.962	0.001
Yes	171	42	213		
Hospital trauma code					
No	139	149	288	50.965	0.001
Yes	157	38	195		
Trauma score					
No	99	123	222	48.226	0.001
Yes	197	64	261		
Major trauma managed					
Chest injury	6	3	9	0.777	0.855
Neurotrauma	59	35	94		
Orthopedic	44	33	77		
Polytrauma	187	116	303		
Radiological imaging protocol for trauma					
Organ specific CT	189	136	325	4.102	0.047
Whole-body CT scan (Pan CT)	107	51	158		
Use of eFAST					
No	43	63	106	44.82	0.001
Inconsistent	52	54	106		
Yes	201	70	271		
NS					
No	176	109	285	0.065	0.799
Yes	120	78	198		
RL					
No	203	111	314	4.285	0.038
Yes	93	76	169		
Balanced crystalloid					
No	163	132	295	11.612	0.001
Yes	133	55	188		

Colloids					
No	283	166	449	8.189	0.006
Yes	13	21	34		
Any crystalloid					
No	269	165	434	0.878	0.357
Yes	27	22	49		
Only colloid					
No	294	187	481	1.269	0.524
Yes	2	0	2		
Blood products					
No	220	144	364	0.444	0.518
Yes	76	43	119		
Use of TXA					
No	18	22	40	5.038	0.081
Inconsistent	86	48	134		
Yes	192	117	309		
In-house blood–bank facility					
No	87	81	168	9.794	0.002
Yes	209	106	315		
Trigger to start vasopressors in shock in trauma management					
Early in ER after giving 2 L IV fluids	211	124	335	6.387	0.094
In ICU if BP is not picking	56	48	104		
Late in ER after 4 hours or so	14	3	17		
Other reason	15	12	27		
Ever used centhaquine citrate in trauma resuscitation?					
No	282	186	468	6.702	0.012
Yes	14	1	15		
Use of cervical collar					
No	2	13	15	26.017	0.001
Inconsistent	26	34	60		
Yes	268	140	408		
Use of spine board					
No	42	64	106	39.698	0.001
Inconsistent	37	38	75		
Yes	217	85	302		
Opioids					
No	51	61	112	15.240	0.001
Yes	245	126	371		
NSAIDs					
No	89	46	135	1.702	0.212
Yes	207	141	348		
Regional blocks					
No	149	117	266	6.927	0.009
Yes	147	70	217		
Transdermal patches					
No	155	114	269	3.433	0.074
Yes	141	73	214		
Use of invasive monitoring					
No	59	80	139	33.037	0.001
Inconsistent	83	50	133		
Yes	154	57	211		

(Contd...)

Table 5: *(Contd...)*

	ATLS-certified ER physician	*Non-ATLS-certified ER physician*	*Total*	*χ^2-value*	*p-value*
ICP Monitoring					
No	201	150	351	9.976	0.007
Inconsistent	56	26	82		
Yes	39	11	50		
Serial lactates					
No	50	67	117	23.386	0.001
Inconsistent	46	28	74		
Yes	200	92	292		
Preferred antiedema measure in neurotrauma					
As per neurosurgeon's choice	97	67	164	12.57	0.002
Hypertonic saline	83	27	110		
Mannitol	116	93	209		
Total		187	483		

Table 6: Multivariate analysis of ATLS-certified trained ER Physician

			95% CI for Ratio	
ATLS-certified trained ER Physician	*p-value*	*Odds ratio*	*Lower*	*Upper*
In-house Blood-bank facility	0.122	1.414	0.911	2.193
Dedicated trauma team	0.011	1.952	1.167	3.263
In-place hospital trauma code	<0.01	2.778	1.702	4.533
Follow any trauma score	0.035	1.651	1.035	2.633
Radiological imaging protocol for trauma	0.923	0.977	0.613	1.558
Use of eFAST in trauma management	<0.01	2.909	1.721	4.916
Use of TXA in trauma patients	0.886	1.056	0.503	2.216

systematic review of 75 studies (24,350 patients), eFAST was found to be a useful bedside ruling-in tool for pneumothorax or detecting free fluid in trauma settings but not as a rule-out tool.[16]

World Federation of Neurosurgical Societies (WFNS) Spine Committee and other guidelines recommend the use of special gear specifically based on the type and severity of the injury.[17,18] The majority of the centers were using a cervical collar (85%) and spine boards (63%) for in-house shifting of trauma patients, so there is a need to create awareness of when and in which type of trauma the cervical collar or spine boards should be used.

Crystalloids are the preferred fluid in initial trauma resuscitation. Our survey found that 0.9% normal saline (NS) was the preferred fluid (41%) for resuscitation, followed by balanced crystalloids (39%) and Ringer's lactate (RL) solution (35%), and 10% of the centers had no specific fluid preference. Evidence shows the preference for balanced crystalloids over NS with avoidance of hyperchloremic acidosis, but a recent meta-analysis of eight studies showed lower mortality in patients with traumatic brain injury (TBI) receiving NS [relative risk (RR): 1.25; 95% confidence interval (CI): 1.02–1.54].[19] RL being hypotonic in nature should be avoided in TBI. Secondary analysis of prospective, observational, multicenter, major trauma transfusion (PROMMTT) study showed that RL was associated with higher adjusted mortality compared with NS in TBI (HR 1.78; CI: 1.04–3.04; $p = 0.035$).[20] Ringer's lactate solution still being a preferred resuscitation fluid across 35% centers is worrisome.

The usual trigger to start vasopressors is after optimum fluid resuscitation with crystalloids.[13] In our survey, 70% centers were following this strategy. Early initiation of vasopressors during fluid resuscitation is associated with deleterious effects though the total amount of fluid needed for resuscitation was comparatively less.[21,22] Noradrenaline was the first choice of vasopressors in our study which is supported by the literature.[13,20] Serial lactate measurement is a sensitive test to estimate the extent of shock and is being done in the majority of the centers (61%).[23]

Multimodal analgesia is an integral part of trauma management based on the availability of the equipment and expertise, instead of favoring any particular analgesic agent.[24] We found opioids as the choice of analgesics for trauma patients at the majority of the centers (371 centers), followed by non-steroidal anti-inflammatory drugs (NSAIDs) (348 centers). Many centers were using USG-guided regional blocks (217 centers) and transdermal patches (214 centers).

Tranexamic acid use in trauma is strongly recommended after corticosteroid randomization after significant head injury (CRASH) II and CRASH III trials which showed that administration of TXA in less than 3 hours reduced the risk of death in bleeding trauma patients and was highly cost-effective.[25,26] The majority of centers (64%) were using TXA. The risks and benefits of a newer molecule, centhaquine citrate, are not thoroughly investigated. One prospective, multicentric, randomized phase III study in patients with hypovolemic shock showed its benefits in trauma resuscitation with lesser requirement of vasopressors, improvement in pulse pressure, and improved lactate clearance.[27] In our study, only 15 centers (3%) have ever used centhaquine. Hypertonic saline has advantages over mannitol in TBI in terms of fluid resuscitation and cerebral perfusion, but mannitol is also safe and effective option,

particularly with concomitant severe hypernatremia or volume overload.[28] Mannitol was used across 43% centers while 23% centers were using hypertonic saline.

Intracranial pressure monitoring should be a standard practice in severe TBI management as per brain trauma foundation guidelines.[29] We found very few hospitals in India using ICP monitoring in trauma management, with only 10% of centers using it in routine and 17% sometimes. A systematic review showed that ICP monitoring may not reduce the risk of hospital mortality but increases favorable functional outcomes.[30] Another study showed a clear survival benefit of using ICP monitors in patients with severe brain injury who survive the first 24 hours after injury ($p < 0.001$)[31] Our survey emphasizes the need to create awareness of ICP monitoring in severe brain trauma.

Significant differences in trauma management across different types and sizes of hospitals in different tier cities might be due to the difference in infrastructure, available resources, or logistics. Although in the current study we have not compared the outcomes in trauma patients with different settings, differences in outcomes are likely. The optimistic side was to observe that eFAST was being done regularly in 30% of tier 3 cities and another 30% using it sometimes in trauma management. Very few centers in tier 3 cities were using invasive monitoring, ICP monitoring, or measuring lactates.

Strengths

The survey is the largest and only study of its kind focusing on trauma management from different hospital setups across all tier cities in India. With a varied response from tier 3 to tier 1 cities, from small nursing homes to large medical colleges or corporate hospitals, the survey provides an insight into the infrastructure deficiencies and variations in trauma protocols which can help ISCCM leadership to focus on specific aspects of trauma management. Our work builds on prior literature and demonstrates the need for further experimental study designs to analyze practices regarding trauma management and determine trauma outcomes.

Limitations

There are a few limitations of our study. The survey was voluntarily filled out by a few hospitals in India and hence may not represent all the hospitals managing trauma across the country. Since this was a preliminary survey conducted with the intention to understand overall trauma practices followed and the availability of resources across the country, a few aspects such as damage control resuscitation, enquiring about BP targets, and massive transfusion protocols could not be evaluated in depth. The outcomes of trauma were not assessed and therefore it is difficult to understand the factors which affect the trauma outcomes. The actual practice of trauma management may not correlate with this self-answered knowledge evaluation and the practices might be different than those mentioned in the survey.

Conclusion

From the current survey of 483 centers across different cities in India with varying infrastructure, manpower and protocols, it was concluded that most of the centers had optimal infrastructure with ER being managed by ATLS-trained physicians, good resources, and were using the standard management protocols. The major areas of concern in trauma management across different hospitals in India are inappropriate radiological imaging, higher use of RL, and suboptimal use of ICP monitoring. The survey gives an insight into the current scenario of trauma care at the grassroots level and can serve to guide further to strengthen trauma management across the country.

Orcid

Ruchira Wasudeo Khasne https://orcid.org/0000-0002-2322-6569
Kanwalpreet Sodhi https://orcid.org/0000-0002-7377-9225
Gunjan Chanchalani https://orcid.org/0000-0001-8429-8526
Ganshyam Jagathkar https://orcid.org/0000-0001-9116-2096
Venkat Raman Kola https://orcid.org/0000-0002-6971-1236
Mahesh Mishra https://orcid.org/0000-0002-0868-9901
Shrikant Sahasrabudhe https://orcid.org/0000-0002-6074-8569
Rajesh C Mishra https://orcid.org/0000-0001-6305-5998
Amrish Patel https://orcid.org/0000-0003-3061-898X
Ankur R Bhavsa https://orcid.org/0000-0003-3047-666X
Haider Abbas https://orcid.org/0000-0001-9840-2988
Pragyan Kumar Routray https://orcid.org/0000-0001-7872-3370
Pramod Sood https://orcid.org/0000-0002-3432-9459
Prasad Anant Rajhans https://orcid.org/0000-0002-0111-6123
Reshu Gupta https://orcid.org/0000-0003-1570-4337
Kapil Dev Soni https://orcid.org/0000-0003-1214-4119
Manender Kumar https://orcid.org/0000-0002-2448-3057

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Appendix 1

Trauma Management Survey: An ISCCM Initiative

Trauma management survey is the first step to reach into the missing links of trauma management across the country.
**Required*

1. Are you willing to participate in the survey?*
   Yes
   No
2. Type of hospital setup?*
   Corporate
   Private
   Government
   Nursing home
3. Name of the hospital?*
4. City name?*
5. Do you have a trauma center?*
   Yes
   No
6. How many hospital beds?*
   <50 beds
   50-99 beds
   100-199 beds
   200-499 beds
   >500 beds
7. Do you have dedicated trauma team?*
   Yes
   No
8. Do you have a trained ER physician who is ATLS/CTLS certified?*
   Yes
   No
9. Do you have in-place hospital trauma code?*
   Yes
   No
10. Do you follow any trauma score?*
    Yes
    No
11. Which is the major trauma you manage?*
    Polytrauma
    Neurotrauma
    Orthopedic
    Chest injury
12. What is your radiological imaging protocol for trauma?*
    Whole-body CT scan (Pan CT)
    Organ specific CT
13. Do you routinely do eFAST in trauma management?*
    Yes
    No
    Sometimes
14. What is your fluid preference in trauma resuscitation?*
    Tick all that apply.
    NS
    RL
    Balanced crystalloid
    Colloids
    Any crystalloid
    Only colloid
    Blood products
15. Do you use TXA in trauma patients?
    Yes
    No
    Sometimes
16. Do you have in-house Blood-bank facility?*
    Yes
    No
17. What is your trigger to start vasopressors in case of shock in trauma management?*
    Early in ER after giving 2 L IV fluids
    Late in ER after 4 hours or so
    In ICU if BP is not picking
    Other reason
18. Have you ever used centhaquine citrate in trauma resuscitation?*
    Yes
    No
19. Do you use cervical collar in managing trauma patients?*
    Yes
    No
    Sometimes
20. Do you use spine board for shifting trauma patients?*
    Yes
    No
    Sometimes
21. What is your preferred analgesia in trauma management?*
    Tick all that apply.
    Opioids
    NSAIDs
    Regional blocks
    Transdermal patches
    All of these
    Other
22. Do you use invasive monitoring for trauma?*
    Yes
    No
    Sometimes
23. Do you routinely monitor ICP in managing neurotrauma patients?*
    Yes
    No
    Sometimes
24. Do you measure serial lactates in trauma management?*
    Yes
    No
    Sometimes
25. What do you prefer in neurotrauma?*
    Mannitol
    Hypertonic saline
    As per neurosurgeon's choice
26. Your e-mail id*