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ORIGINAL ARTICLE

Assessment of trauma care resources in medium- and low-complexity hospitals in Cali, Colombia: A multicenter observational study

Evaluación de los recursos para la atención del trauma en hospitales de mediana y baja complejidad de Cali, Colombia: Un estudio observacional multicéntrico

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Abstract

Introduction. Trauma is a major public health issue worldwide. In Colombia, Cali is the most violent city, contributing significantly to trauma-related mortality. The objective of this study was to evaluate the availability of emergency services' resources for managing trauma patients.

Methods. A cross-sectional, multi-center observational study was conducted across all nine medium- and low-complexity public hospitals in Cali, Colombia. The results were compared to the Panamerican Trauma Society (PTS) standards**.** Univariate analysis was utilized to examine the behavior and distribution of the data.

Results. Of the hospitals surveyed, 66.6% were level I, 33.3% were level II. Compliance with PTS guidelines was 73% for level I and 77.5% for level II. Among level I hospitals, 50% had cervical collars, 75% stocked basic airway supplies, but only one-third had rapid sequence induction medication. Two-thirds of level II hospitals had blood components. None of the hospitals were equipped with tourniquets, pelvic immobilizers, or immediate ultrasound availability. The mean transfer time to higher-complexity centers was 30.8 minutes from level I hospitals and 34.3 minutes from level II hospitals.

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Conclusions. Trauma management resources in medium and low-complexity hospitals did not meet PTS standards. This underscores the need for public health policies to improve trauma care through the provision of essential supplies, comprehensive training programs, and optimized prehospital care network.

Keywords: hospital equipment and supplies; hospital emergency service; emergency medicine; advanced trauma life support care; health services needs and demand; health services research.

Resumen

Introducción. El trauma es un problema de salud pública importante a nivel mundial. En Colombia, Cali es la ciudad más violenta, lo que contribuye significativamente a la mortalidad relacionada con el trauma. El objetivo de este estudio fue evaluar los servicios de emergencias para determinar las condiciones y recursos disponibles para el manejo del paciente politraumatizado.

Métodos. Se realizó un estudio observacional, transversal y multicéntrico en nueve hospitales públicos de mediana o baja complejidad en Cali, Colombia. Los resultados se compararon con los estándares de la Sociedad Panamericana de Trauma (SPT). Se utilizó un análisis univariado para examinar el comportamiento y la distribución de los datos.

Resultados. De los hospitales encuestados, 66,6 % eran nivel I y 33,3 % nivel II. El cumplimiento mínimo según la SPT fue del 73 % para nivel I y del 77,5 % para nivel II. El 50 % de los hospitales de nivel I contaba con collar cervical y el 75 % contaba con insumos para el manejo básico de la vía aérea, pero solo un tercio disponía de medicamentos para la secuencia de inducción rápida. Dos tercios de los hospitales de nivel II disponían de hemocomponentes. Ninguno de los hospitales estaba equipado con torniquetes, inmovilizadores pélvicos o disponibilidad inmediata de ultrasonografía. El tiempo promedio de traslado a centros de mayor complejidad fue de 30,8 minutos desde los hospitales de nivel I y de 34,3 minutos desde los de nivel II.

Conclusiones. Los recursos para el manejo del trauma en los hospitales de complejidad mediana y baja no cumplen con los estándares de la SPT. Esto resalta la necesidad de políticas de salud pública que mejoren la atención del trauma mediante la provisión de los suministros esenciales, programas de capacitación integral y una red de atención prehospitalaria optimizada.

Palabras clave: equipos y suministros de hospitales; servicio de urgencia en hospital; medicina de emergencia; atención de apoyo vital avanzado en trauma; necesidades y demandas de servicios de salud; investigación sobre servicios de salud.

Introduction

Trauma represents a major global public health challenge [1,2]. It is a leading cause of death among individuals under 45 years of age and ranks third in overall global mortality, resulting in an estimated 1.6 million deaths annually [3]. The incidence of trauma has notably increased over the past two decades and is significantly influenced by factors such as socioeconomic status, unemployment, and regional development [4-7].

In Colombia, violence stands out as the predominant etiology of trauma, characterized by a mortality rate of 5.8% between 2005 and 2010, imposing substantial socioeconomic burdens on the nation and its healthcare infrastructure [8]. By 2021, homicides had become the primary external cause of death in the country, closely followed by motor vehicles crashes [9]. Notably, despite the illegality of unauthorized firearm carrying in Colombia [10], the World Health Organization´s 2012

assessment revealed that 78% of homicides in the country involved firearms [11].

With a population exceeding 2.3 million, Cali stands as Colombia's third-largest city, while also having the most violent urban area [12]. As documented by the Citizen Council for Public Security, Cali ranked 32nd among the world's most violent cities by the end of 2022, exhibiting a homicide rate of 42.09 per 100,000 inhabitants, with a reported total of 1,007 homicides for that year [12].

Existing literature highlights numerous challenges hindering the delivery of high-quality trauma care in South and Central America. A systematic review identified nine key barriers that negatively impact trauma care provision, with deficiencies in training, and insufficient resources and equipment emerging as the most prevalent [13]. While some studies have assessed resource availability in emergency departments across South and Central America [14-16], only one has specifically focused on trauma care [16]; however, it is noteworthy that nearly half of the facilities evaluated in this study were large, high-complexity hospitals [16]. To our knowledge, no research in Latin America has specifically evaluated the resources available for managing polytrauma patients in medium- and low-complexity hospitals.

Given the alarming prevalence of violence and trauma in Cali, this study endeavors to undertake a comprehensive evaluation of the adequacy of emergency services supplies in this city's medium- and low-complexity hospitals. Specifically, assessing the resources available for management of polytrauma patients according to the guidelines established by the Panamerican Trauma Society (PTS) [17].

Methods

Study Design

We conducted a cross-sectional, multicenter observational study that involved a descriptive and comparative analysis.

Cali´s Healthcare Services

The emergency healthcare network in Cali comprises 46 facilities, 19 of which are under public administration. Among these, three are designated as level II and six as level I hospitals, totaling nine medium– and low-complexity institutions, while the remainder consists of smaller health centers [18]. This study encompasses all medium– and low-complexity hospitals within Cali, Colombia´s public emergency network, totaling nine facilities. These include Mario Correa Rengifo Hospital (MCR), San Juan de Dios Hospital (SJD), Isaías Duarte Cancino Hospital (IDC), Carlos Carmona Hospital (CC), Carlos Holmes Trujillo Hospital (CHT), Joaquín Paz Borrero Hospital (JPB), Primitivo Iglesias Hospital (PI), Siglo XXI Hospital (S21), and Terrón Colorado Health Center (TC), serving vast urban segments.

Hospital classification aligns with Colombia's Ministry of Health and Social Protection Resolution number 5261 of 1994, stratifying facilities into four complexity levels, each with defined capabilities [19]:

- **Level I:** These hospitals primarily employ general practitioners, auxiliary staff, paramedics, and other non-specialized healthcare professionals. They are equipped for minor surgical interventions.
- **Level II:** In addition to general practitioners, these hospitals offer basic specialties, such as internal medicine, obstetrics, pediatrics, general surgery, anesthesia, and orthopedics. They can conduct low- and medium-complexity surgical procedures.
- **Levels III and IV:** These are more advanced facilities, employing specialist physicians alongside general practitioners. They can perform medium- and high-complexity surgeries, with level IV hospitals even capable of transplant procedures.

Panamerican Trauma Society

The Panamerican Trauma Society (PTS) is an organization dedicated to optimizing trauma management across the Americas. It focuses on establishing structural foundations and guidelines for the efficient and timely care of trauma patients throughout Latin American countries. The PTS provides a comprehensive framework outlining care requirements for polytrauma patients,

categorized by the level of care provided. Within this framework, the PTS classifies necessary supplies as 'expected', 'desirable', or 'unnecessary', based on hospital capabilities and resources [17]. Our analysis specifically targets supplies designated as 'expected' by the PTS, as they form the essential foundation for delivering optimal care.

Data collection

Data collection took place from November 2022 to July 2023, encompassing all nine medium- and low-complexity public hospitals in Cali. Pre-scheduled site visits were carried out at each hospital, where direct inspections of physical supplies, infrastructure, and surveys to emergency service clinicians were performed. Pairs of investigators systematically collected and compiled data, documenting information using a standardized PTS-based checklist. Key variables examined include daily patient influx to the emergency department, patient stratification based on the triage system, response times, medication and supply availability, staffing levels, and facility infrastructure.

To evaluate patient transfer efficacy to higher complexity facilities, transfer times from the surveyed hospitals to primary level III and IV care centers in the city— Fundación Valle del Lili (FVL), Hospital Universitario del Valle (HUV), and Centro Médico Imbanaco (CMI)—were measured. A geolocation tool was employed for precise route calculation. Standardized measurements were uniformly conducted at 6:00 pm to mitigate temporal confounders, ensuring reliability and precision of findings.

Statistical analysis

Univariate analysis was performed to examine the distribution and behavior of the data. The Shapiro-Wilk test was utilized to assess the normality of quantitative variables. Variables demonstrating a normal distribution are reported with their respective mean and standard deviations. Conversely, non-normally distributed variables are presented using their median and interquartile ranges. Qualitative variables are expressed as percentages.

Results

Among the hospitals examined, 66.6% were categorized as level I complexity hospitals, while the remaining 33.3% were classified as level II. Each hospital surveyed was equipped with a resuscitation room. The capacity of observation units varied, accommodating between 10 and 45 cubicles.

Primarily, both levels of hospitals managed patients classified as triage 3 and 4 (Table 1). A comprehensive breakdown of daily admissions, stratified by triage level, is also provided in table 1. Daily admissions for polytrauma patients ranged from 7 to 10 individuals per day. Medical care time was evaluated according to triage classification. Both level I and level II hospitals provided immediate attention for triage I cases. Median patient care times for triage II patients were consistent at 28 minutes across both hospital levels, with minimal variation (Table 2).

All supplies assessed in our study were designated as 'expected' requirements according to the PTS criteria. We scrutinized 42 care resources for level I hospitals and 71 for level II. Compliance with PTS criteria stood at 73% for level I hospitals and 77.5% for level II institutions (Table 3). Notably, none of the nine hospitals achieved 100% compliance with the 'expected' supplies outlined by PTS.

Airway management supplies showed an adherence rate of 75% for level I hospitals and 74.6% for level II hospitals. Notably, the utilization of bag-valve-mask with reservoir and oropharyngeal cannula was widespread in both settings. Laryngeal masks were available in 83.3% of level I hospitals and in 100% of level II hospitals. However, it is concerning that only one-third of level I hospitals had the necessary medications for proper rapid sequence induction (RSI). Cervical collars were consistently accessible across level II hospitals, yet only 50% of level I facilities maintained stock of these devices.

In terms of circulation-related supplies, level I hospitals exhibited a compliance rate of 84.5%, while level II hospitals showed a rate of 77.8%. Items such as gauze, intravenous catheters, and cardiac monitors were universally available across all surveyed facilities. Despite this, critical equipment like tourniquets and commercial pelvic immobilizers were absent in both level I and level II hospitals.

Tranexamic acid was available in the inventory of 88.8% of all hospitals. While blood components were available in 66.6% of level II hospitals, none were present in level I facilities. Furthermore, none of the surveyed hospitals had immediate access to Focused Assessed Ultrasonography for Trauma (FAST). Approximately 66% of level II hospitals reported possessing emergency thoracostomy equipment.

Table 1. Daily patient volume per medical institution, along with their distribution based on triage level.

Level	Hospital	Patients per day	Triage I n (%)	Triage II n (%)	Triage III n (%)	Triage IV n (%)	Triage V n (%)
I	CC	66	1 (1.5)	5 (7.6)	30 (45.5)	30 (45.5)	ND
	CHT	285	10 (3.5)	40 (14)	150 (52.6)	70 (24.6)	15 (5.3)
	PI	37	2 (5.4)	7 (18.9)	28 (75.7)	N/A	N/A
	S21	81	6 (7.6)	15 (18)	60 (74)	N/A	N/A
	JPB	79	0.3	18 (23)	61 (77)	N/A	N/A
	TC	289	ND	18 (24)	ND	ND	ND
	MCR	119	20 (16.8)	17 (14)	67 (56)	13 (11)	2 (1.6)
II	IDC	20	ND	ND	ND	ND	ND
	SJD	15	3 (20)	10 (66.6)	2 (13.3)	N/A	N/A
Total		991	42 (6.2)	112 (16)	398 (58.3)	113 (16.5)	17 (2.5)

N/A: Hospitals refer these patients to outpatient care settings; ND: No data.

Source: Compiled by the author.

Table 2. Estimated waiting times for medical care, paraclinical reports, and medication administration, according to the hospital complexity level.

Patient care times	Complexity level	
	Level I, Median [RIQ]	Level II, Median [RIQ]
Triage I (mins)	0 [0.00, 0.00]	0 [0.00, 0.00]
Triage II (mins)	28 [20.00, 30.00]	28 [27.00, 29.00]
Triage III (mins)	64 [29.00, 120.00]	105 [97,5, 112.5]
Triage IV (mins)	51960 [26100.00, 7820.00	N/A
Triage V (mins)	7200 [7200.00, 7200.00]	N/A
Paraclinical test request until the report is issued (mins)	90.00 [90.00, 120.00]	120.00 [120.00, 120.00]
Prescription of medications to administration (mins)	60.00 [20.00, 120.00]	105.00 [67.50, 142.50]

N/A: Hospitals refer these patients to outpatient care settings.

Source: Compiled by the author.

Table 3. Resource availability for trauma management stratified by hospital complexity level.

Equipment/Supply	Total n=9 (%)	Level I hospitals n=6 (%)	Level II hospitals n=3 (%)
Airway (mean)	74.8%	75.0%	74.6%
Laryngeal mask	8 (88.8)	5 (83.3)	3 (100)
Bag-valve-mask with reservoir	9 (100)	6 (100)	3 (100)
Oropharyngeal cannula	9 (100)	6 (100)	3 (100)
Aluminum oxygen cylinder	0 (0)	0 (0)	0 (0)
Venturi masks with/without O2 reservoir	6 (66.6)	3(50)	3 (100)
Non-rebreather mask with reservoir	9 (100)	6 (100)	3 (100)
Nasogastric tube	8 (88.8)	5 (83.3)	3 (100)
Nasal cannula	9 (100)	6 (100)	3 (100)
Suction device		N/A	3 (100)
Yankauer or other stiff suction tip		N/A	1 (33.3)
Laryngoscope and endotracheal tubes		N/A	3 (100)
Breathing (mean)	84.7%	86.1%	83.3%
Stethoscope	9 (100)	6 (100)	3 (100)
Oxygen supply	9 (100)	6 (100)	3 (100)
Pulse oximetry	9 (100)	6 (100)	3 (100)
Heimlich valve	1 (11.1)	1 (16.67)	0 (0)
Circulation (mean)	81.2%	84.5%	77.8%
Gauze and bandages	9 (100)	6 (100)	3 (100)
Arterial tourniquet	0 (0)	0 (0)	0 (0)
Crystalloid	8 (88.8)	5 (83.3)	3 (100)
Intravenous catheters	9 (100)	6 (100)	3 (100)
Intraosseous needle	0 (0)	0 (0)	0 (0)
Electronic cardiac monitoring/ defibrillator	9 (100)	6 (100)	3 (100)
Urinary catheter	9 (100)	6 (100)	3 (100)
Abdominal trauma (mean)		N/A	88.9%
Laparotomy equipment		N/A	3 (100)
Negative pressure systems		N/A	2 (66.6)
Threads and sutures		N/A	3 (100)
Chest trauma (mean)		N/A	66.7%
Emergency thoracostomy equipment		N/A	2 (66.6)
Trauma to extremities / Pelvis (mean)	66.7%	50%	83.3%
Rigid board	9 (100)	6 (100)	3 (100)
Pelvic immobilizers	0 (0)	0 (0)	0 (0)
Spinal cord trauma (mean)		33.3%	66.7%
Cervical collar	6 (66.6)	3 (50)	3 (100)
Head immobilizer	3 (33.3)	1 (16.6)	2 (66.6)
Burns (mean)	82.5%	91.7%	73.3%
Sterile dressings	9 (100)	6 (100)	3 (100)
Tetanus prophylaxis	8 (88.8)	5 (83.3)	3 (100)
Others			
Rapid sequence intubation medication	5 (55.5)	2 (33.3)	3 (100)
Tranexamic acid	8 (88.8)	5 (83.3)	3 (100)
Blood components	2 (22.2)	0 (0)	2 (66.6)
FAST	0 (0)	0 (0)	0 (0)
TOTAL	75.2%	73.0%	77.5%

Note: certain data values have been omitted from the table to enhance readability. Consequently, calculated means may be inconsistent due to the incomplete dataset provided. N/A denotes that the specific supply is not considered an 'expected' requirement for the corresponding hospital level. Source: Compiled by the author.

An analysis was performed to assess the duration of patient transfers from each evaluated hospital to the primary level III and IV reference hospitals in the city, namely FVL, HUV and CMI. For level I hospitals, the mean transfer time to FVL was 34.8 minutes (± 6.8), 29.2 minutes (± 12.0) to HUV, and 28.5 minutes (± 9.5) to CMI. Conversely, for the level II hospitals, the mean transfer time was 43.3 minutes (± 4.5) to FVL, 29.1 minutes (± 12.4) to HUV, and 30.6 minutes (± 11.5) to CMI. Overall, the mean transfer times were 30.8 minutes (± 9.2) from level I hospitals and 34.3 minutes (± 11.0) from level II hospitals to the reference centers. Standardizing response times from the emergency ambulance request to their arrival and final transfer was not feasible.

Discussion

Significant deficiencies were identified in essential trauma care supplies, such as medications for RSI, tourniquets, commercial pelvic immobilizers, cervical collars, and blood components within level I and level II hospitals. Adherence rates to minimum recommendations, as per PTS guidelines, were notably suboptimal, with level I hospitals achieving 73% compliance and level II hospitals at 77.5%. These findings highlight substantial inadequacies in meeting standardized trauma care criteria across these facilities, necessitating comprehensive investigation and targeted interventions.

Despite most hospitals possessing basic airway management equipment, only one-third of level I hospitals are equipped with the necessary medications for conducting a proper RSI. It is well established that inadequate RSI is associated with an increased risk of intubation failure [20-24]. This heightened risk may contribute to the perceived high incidence of esophageal or failed intubations within the surveyed services; however, standardization of this data was not feasible. Nevertheless, it is noteworthy that failed intubations impose a significant burden of morbidity and mortality on trauma patients [22-24].

Laryngeal masks have emerged as valuable alternatives for airway management in complex cases [25-27], particularly where orotracheal intubation has not been successful or where physicians may lack sufficient training in this technique. It is encouraging to note that most level I hospitals and all level II facilities possessed laryngeal masks for utilization in such scenarios.

The absence of cervical collars in 50% of level I hospitals underscores a pivotal deficiency in trauma care. Despite its relatively low incidence of 6.7% in trauma cases [28,29], cervical trauma imposes a considerable disease burden [28-30]. Furthermore, it entails a substantial risk of secondary spinal cord injuries. Research suggests that a significant proportion of these injuries, ranging from 3% to 25%, occur during patient transit or early management [31]. Therefore, ensuring universal availability of cervical collars is paramount to attenuate the risk of spinal cord injuries.

Regarding bleeding control, level I hospitals exhibited an 84.5% compliance rate with recommended supplies, whereas level II hospitals demonstrated a slightly lower compliance rate of 77.8%. However, none of the surveyed hospitals were equipped with tourniquets or pelvic immobilizers, essential tools for managing trauma patients. Direct compression and tourniquets are widely recognized as the most effective methods for controlling external bleeding [32-34], underscoring the critical need for acquiring these devices. Despite the universal availability of chest X-rays across the surveyed hospitals, immediate access to ultrasound for conducting a FAST assessment —a crucial diagnostic tool in trauma management [35]—was lacking in all hospitals.

Although most hospitals stocked tranexamic acid, only two-thirds of level II hospitals had access to blood components, primarily due to the absence of blood banks or centers. Furthermore, only 66% of level II hospitals had chest tubes and pleural drainage systems available, which are essential for managing suspected cases of hemopneumothorax, a common issue in trauma contexts. On a positive note, all level II hospitals were equipped with operating rooms. However, the efficiency with which trauma patients can access surgical intervention remains an area requiring further evaluation.

Our findings are consistent with a systematic review in South and Central America, which similarly underscored widespread deficiencies in resources and equipment across both pre-hospital and hospital settings [13]. These emphasize the need for policymakers to implement a standardized procurement process ensuring that all level I and level II hospitals maintain consistent availability of essential trauma care supplies as outlined by the PTS guidelines. Such measures are crucial for enhancing the preparedness and efficacy of trauma care systems, potentially improving patient outcomes.

Patients categorized as triage I and II received care within the stipulated time frame specified by the Ministry of Health and Social Protection [36]. The average transfer time from the surveyed hospitals to mayor trauma centers across the city was approximately 30 minutes. Considering the well-established peaks in mortality linked to trauma, occurring both immediately after the event and within several minutes to hours thereafter [37], it is crucial for initial care settings to deliver prompt, life-saving interventions. This immediate intervention plays a pivotal role in preventing the loss of critical treatment opportunities during the transition to specialized facilities.

Understanding the prehospital trauma care framework in Cali is key in understanding why patients with severe trauma are not directly routed from the incident scene to specialized trauma facilities. While specific data for Cali is lacking, research conducted in Toronto, Canada, suggests that factors such as falls, female gender, and age over 65 are associated with a higher likelihood of being transported to non-specialized trauma centers. Additionally, when the distance to a specialized trauma center exceeds one mile, the probability of directing a patient there diminishes [38].

This study underscores the need for policy interventions aimed at strengthening the prehospital care network and enhancing access to trauma care. Policymakers should prioritize improving efficient coordination and transportation networks within emergency services, as these measures have been shown to markedly decrease trauma-related mortality [39]. Enhancing prehospital care should encompass initiatives such as refining training for emergency medical responders and advancing telemedicine capabilities to expedite and optimize trauma care delivery.

Although this study was unable to standardize ambulance response times, encompassing the period from the emergency call to the patient's ultimate transfer, it underscores a crucial variable warranting further investigation. Comprehensive understanding of this variable is essential for optimizing the city's healthcare network. This facilitates the establishment of a well-structured, efficient care network tailored to the specific requirements of trauma patients, ultimately aimed at mitigating care delays and decreasing associated morbidity and mortality rates.

Strengths and limitations

The primary strength of this study lies in its comprehensive data collection from all level I and level II public hospitals in Cali. This rich data set provides invaluable insights into the current conditions within these medical facilities, allowing for the identification of critical areas for improvement. Consequently, this data can serve as a guide for targeted interventions aimed at optimizing the management of trauma patients in limited resource settings.

However, it is important to acknowledge several limitations in our study. Firstly, due to the study´s design, there are gaps in the information collected from certain hospitals, which may compromise the accuracy of our findings. Moreover, our investigation did not assess the human resources or the competencies of clinicians, a critical aspect given that these hospitals predominantly employ general physicians or medical doctors fulfilling their mandatory social service (a required public service period following graduation from medical school). This factor may significantly impact the quality of trauma care provided. Therefore, this aspect warrants consideration for future investigations.

Furthermore, our analysis did not integrate the complete list of medications recommended by the PTS, including antibiotics and analgesics.

Nonetheless, our study provides valuable insights into the essential medications required for managing severe polytrauma, such as tranexamic acid, vasopressors, and medications for rapid sequence induction.

Moreover, it is important to note that the most recent PTS document dates to 2017, potentially missing out on the latest evidence. Additionally, as an international guideline, its applicability within the Colombian context requires careful consideration. Despite these limitations, the PTS guidelines provide a well-structured framework for centers handling trauma cases. Finally, our analysis did not investigate any correlation between our findings and patient outcomes. Future research should aim to analyze determinants of survival and outcomes to provide more comprehensive insights.

Conclusions

This study identified significant deficiencies in trauma management resources within medium and low complexity hospitals in Cali, failing to meet PTS standards. Shortages in essential resources such as RSI medication, hemorrhage control supplies, blood components, and cervical collars were evident. Moreover, the establishment of a well-organized and efficient healthcare network in the city is pivotal to mitigate care delays and optimize patient transfers. Given Cali´s pronounced violence burden, addressing these inadequacies is imperative to enhance trauma management and potentially improve patients' outcomes. The findings underscore the need for public health policies aimed at improving trauma care quality in Colombia and similar developing countries. These policies should encompass the provision of essential medical supplies, implementation of comprehensive training programs, investment in advanced telemedicine infrastructure, and optimization of emergency service transportation logistics. These measures are crucial for enhancing the overall effectiveness of trauma care systems and ultimately improving patient outcomes. This study lays the baseline for further investigations evaluating the outcomes associated with resource inadequacies in such settings, guiding future interventions to improve patient care.

Compliance with ethical standards

Informed consent: This study obtained ethical approval from the biomedical research ethics committee at Fundación Valle del Lili Hospital, documented in Approval Letter No. 686-2022, Act No. 25 of 2022. This study adheres to the principles of the Helsinki Declaration and complies with the STROBE guidelines for ethical and methodological rigor. Classified as "without risk" by the ethics committee, per Resolution 8430 of 1993 from the Colombian Ministry of Health, informed consent from participants was not required. Data management strictly adhered to confidentiality and data protection protocols.

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