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Development of a Minimum Dataset for a Prehospital Stroke Emergency Dashboard

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ABSTRACT

Objective: This study aimed to develop a Minimum Dataset (MDS) for a prehospital stroke emergency information dashboard in Iran.

Methods: This applied study was conducted in four phases. Phase 1 involved a scoping review (Arksey and O'Malley framework, PRISMA-ScR) of PubMed, Scopus, and Web of Science databases in August 2024. In phase 2, data items were extracted and refined from the included studies and aligned with key domestic and international clinical guidelines. Phase 3 consisted of element classification with expert input. In phase 4, content validity was assessed using the content validity ratio (CVR) and content validity index (CVI) among 10 experts, and elements were finalized based on necessity, clarity, and simplicity.

Results: Data elements were organized into two main categories: management data and clinical data. The validated MDS comprised 91 essential elements. Management data (41 elements) included identity and mission information (17 elements: mission identifier, patient information, incident location, dispatch team), key time indicators (11 elements: golden times, standard time intervals), and structural/logistical indicators (13 elements: equipment, human resources). Clinical data (50 elements) comprised initial assessment and stroke screening (5 elements: level of consciousness, Face-Arm-Speech-Time [FAST] test, symptom onset time), vital signs and clinical findings (18 elements: continuous monitoring, associated symptoms, medical history), prehospital interventions (10 elements: airway/ABC, specialized measures, pharmacotherapy), in-hospital interventions (2 elements: diagnostic and therapeutic measures), and outcome/final diagnosis (15 elements: dispatch, technician, in-hospital diagnoses; patient outcome; prehospital quality of care).

Conclusion: This standardized MDS integrated prehospital data, reduced documentation burden, and supported dashboards for performance monitoring, outcome feedback, benchmarking, delay reduction, and improved stroke outcomes.

Keywords: Emergency medical services; Dataset; Dashboard systems; Stroke; Development

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Introduction

Stroke is the second leading cause of death and the fifth leading cause of disability in adults worldwide [1, 2]. According to the Global Burden of Disease 2021 report, updated in 2024, more than 12.2 million new cases of stroke occurred worldwide in 2021, accounting for 6.55 million deaths and more than 143 million disability-adjusted life years (DALYs) [3]. More than 84% of this burden is in low- and middle-income countries [3, 4], and by 2050, upper-middle-income countries are projected to have the highest burden of stroke, followed by lower-middle-income countries, low-income countries, and high-income countries [5].

The clinical outcome of patients with acute ischemic stroke is directly related to "time." The famous phrase "Time is Brain," coined by Saver in 2006 [6], remains valid. For every minute of delay in restoring blood flow, approximately 1.9 million neurons and 14 billion synapses are lost [6]. Reperfusion therapies, including intravenous thrombolysis (IV alteplase) and mechanical thrombectomy, are effective only within a limited time window (4.5 hours for alteplase and up to 24 hours for elective thrombectomy) [7, 8]. Several studies indicated that a significant portion of the total delay in stroke treatment occurs in the prehospital phase [9, 10].

In the prehospital setting, three key factors are crucial: 1) rapid recognition of symptoms by the caller and dispatcher, 2) correct prioritization of the call and rapid dispatch of an ambulance, and 3) accurate on-scene diagnosis and direct transfer to a comprehensive stroke center or a center with thrombolysis capabilities [11, 12]. Recent studies suggested that the use of standardized prehospital diagnosis scales (such as Field Assessment Stroke Triage for Emergency Destination [FAST-ED], Rapid Arterial Occlusion Evaluation [RACE], or Gaze-Face-Arm-Speech-Time [G-FAST]) combined with telestroke and mobile stroke units could increase the rate of reperfusion therapy [13-16].

Despite this evidence, prehospital emergency systems in many countries, including Iran, still face serious challenges: lack of smart dashboards, lack of data integration between dispatch centers, ambulances, and hospitals, delays in identifying and prioritizing stroke patients, untargeted transfers to centers lacking advanced treatment capabilities, and lack of real-time performance monitoring tools [17-19]. In the data-driven era of health, health dashboards are recognized as one of the most effective business intelligence tools in the health field [20]. The World Health Organization (WHO) has identified real-time dashboards as essential components of rapid emergency response systems in its 2023 Health Information Systems Guide [21]. Recent studies have reported that the implementation of prehospital dashboards in the United States (Mission: Lifeline Stroke) and Europe (RESCUE-ESUS network) reduced the mean time from call to hospital by 11 to 19 minutes and increased the thrombolysis rate by 5.2 times [22, 23].

In general, information dashboards are vital tools in data management that facilitate rapid and effective decision-making by providing visualized and summarized information [24]. Within organizations, particularly in the healthcare sector, their importance lies in monitoring performance, identifying trends, and improving clinical processes. They are highly valuable because they transform complex data into charts, graphs, and key performance indicators, enabling users to gain valuable insights without requiring in-depth data analysis [24]. Types of dashboards include operational dashboards (for daily and real-time monitoring, such as tracking patients in the emergency department), strategic dashboards (for long-term goals, such as health resource planning), analytical dashboards (for exploring historical data and predicting trends, such as disease outbreaks), and tactical dashboards (for managing medium-term projects, such as optimizing ambulance routes) [25]. This diversity allows dashboards to be customized based on specific operational needs, thereby enhancing overall efficiency.

A minimum dataset (MDS), defined as a set of essential and standardized data elements for designing information dashboards, reduces the burden of data collection, ensures data quality, and enables inter-organizational comparison and analysis [26]. In complex systems such as healthcare, the MDS is essential for avoiding redundant data collection, minimizing errors, and focusing on key indicators, thereby conserving time and resources [27]. The goal of designing an MDS for prehospital stroke emergencies is to standardize the data collected by emergency medical service (EMS), such as response time, initial symptoms, initial diagnosis, and hospital transfer, to provide effective feedback based on definitive clinical outcomes (e.g., accurate diagnosis and treatment outcomes) [28]. Such standardization facilitates rapid diagnosis, reduces treatment delays, improves patient survival, and enhances the overall quality of prehospital care. In addition, providing this minimal dataset for analytical and operational dashboards enables emergency systems to continuously optimize their performance [29].

In Iran, despite the successful implementation of the "724" stroke code since 2018 and a significant reduction in door-to-needle times, a substantial performance gap remains among different centers [30]. Furthermore, the national 115 emergency medical information system currently lacks an integrated, intelligent dashboard for the real-time monitoring of key prehospital performance indicators. Therefore, designing a dedicated prehospital stroke emergency dashboard capable of integrating dispatch, ambulance, hospital, and clinical outcome data and presenting this information at both the clinical (for dispatchers and technicians) and managerial (for managers and policymakers) levels is both a scientific and practical necessity. Therefore, the present study aimed to identify the MDS required for designing a prehospital stroke emergency dashboard based on a real-world needs assessment, a systematic review of existing global dashboards, and subsequent localization for the Iranian healthcare system.

Materials and Methods

The present study was an applied study conducted in 2025 to determine the MDS of the prehospital stroke emergency dashboard in Iran, through a four-stage process.

To determine the MDS of the prehospital stroke emergency dashboard, a scoping review was conducted using the Arksey and O'Malley framework, which is based on a multi-stage approach for scoping studies. This framework has five key phases, including: 1) identifying the research question, 2) identifying relevant studies, 3) selecting studies, 4) charting data, and 5) collecting, summarizing, and reporting the results. In addition, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Review (PRISMA-ScR) guidelines were followed for this scoping review.

This scoping review was guided by the PCC framework (Population, Concept, Context), as recommended by the Joanna Briggs Institute (JBI) for structuring scoping review questions and defining inclusion criteria.

The primary research question was formulated as follows:

In patients with suspected acute stroke in the pre-hospital setting, what core data elements comprise an MDS for integration into an emergency dashboard?

The PCC elements are defined as:

Population (P): Patients with suspected acute stroke or stroke-like symptoms in the pre-hospital setting.

Concept (C): MDS, referring to the essential, standardized, and prioritized core data elements (e.g., clinical assessment findings, vital signs, stroke screening scales such as the Cincinnati Prehospital Stroke Scale or Los Angeles Motor Scale, time metrics, patient demographics, and communication/handover information) recommended or reported in the literature for effective pre-hospital stroke recognition, triage, decision-making, and data integration into real-time emergency dashboard tools.

Context (C): Pre-hospital emergency care settings, encompassing ambulance-based or field-based EMS responses and transport phases for acute stroke care. This excludes in-hospital phases (e.g., emergency department arrival or beyond) unless such sources explicitly inform or reference pre-hospital data requirements for dashboard design or use.

At this stage, a comprehensive literature search was performed in the PubMed, Scopus, and Web of Science databases from inception to August 31, 2024, without imposing any time restrictions. Keyword searches in these databases were performed using terms related to stroke ("stroke" OR "CVA") AND ("Minimum Data Set" OR "Dataset" OR "Common data elements" OR "Data elements" OR "Data recording" OR "Data usage" OR "Common data" OR "Data collection" OR "National data set" OR "Core data set") AND ("prehospital emergency"). In addition to keyword searches, Medical Subject Headings (MeSH) terms were also included to enhance the comprehensiveness of the search strategy. Gray literature was identified through searches conducted in Google Scholar. The keywords and search terms used for retrieving relevant studies are presented in Table 1.

To efficiently identify relevant evidence, minimize unnecessary full-text retrieval, and align with the exploratory goal of mapping the literature, retrieved articles underwent a single, combined phase of title and abstract screening against inclusion/exclusion criteria, followed by full-text review when needed. Two authors (M.H and Z.S) independently screened the titles and abstracts of all articles for relevance to the study objectives. Any disagreements were resolved through discussion or consultation with a third reviewer (H.S).

All English-language articles focusing on the MDS for a prehospital stroke emergency dashboard were included. Studies providing insufficient details regarding the MDS were excluded. Additionally, conference abstracts, letters to the editor, theses, dissertations, and articles without available full texts were excluded.

One reviewer (Z.S) manually extracted the data using Microsoft Excel (2019), and a second reviewer (M.H) validated the results. The extracted information included the first author's name, year of publication, study objective, country, and the MDS proposed for the development of the prehospital stroke emergency dashboard (Table S1).

In accordance with the fifth stage of the Arksey and O'Malley framework, the results of the scoping review were collated, summarized, and reported. The findings were mapped to inform subsequent phases of MDS development, including classification, refinement, and validation, while adhering to PRISMA-ScR reporting standards to ensure transparency and reproducibility.

In this step, the following guidelines were reviewed to identify potential data items for the prehospital stroke dashboard: the US Guidelines for the Early Management of Patients with Acute Ischemic Stroke [31], the 2020 Global Guidelines for Prehospital Management, Emergency Assessment, and Treatment of Patients with Acute Ischemic Stroke [32], and the Guidelines for the Care of Stroke Patients in the Prehospital Emergency Department, as approved by the Ministry of Health and Medical Education of Iran. Relevant data items were extracted, and duplicates were subsequently removed (Table S1).

Table 1. Search strategy for scientific databases.

Criteria		Description/Details
Articles	Time	The search was conducted up to 20 August 2024
	Language	English language only
	Databases and Fields	- PubMed: Title/Abstract or MeSH - Scopus: TITLE-ABS-KEY - Web of Science: Topic
	#1 (Concept: Minimum Data Set)	(“Minimum Data Set” OR Dataset OR “Common Data Elements” OR “Data Elements” OR “Data Recording” OR “Data Utilization” OR “Common Data” OR “Data Collection” OR “National Data Set” OR “Core Data Set”)
	#2 (Population: Stroke)	(Stroke OR “Cerebrovascular Accident” OR “Cerebrovascular Accidents” OR CVA OR CVAs OR “Brain Vascular Accident” OR “Brain Vascular Accidents” OR “Vascular Accident Brain” OR “Vascular Accidents Brain” OR Apoplexy OR “Acute Cerebrovascular Accident” OR “Acute Cerebrovascular Accidents” OR “Cerebrovascular Accident Acute” OR “Cerebrovascular Accidents Acute”)
	#3 (Context: Pre-hospital Emergency Care)	(“Emergency medical services” OR “pre-hospital emergency” OR “pre-hospital” OR emergency OR “emergency care” OR “emergency transfer”)
	Final Search String	#1 AND #2 AND #3
Gray search for guidelines	Search Terms Used	Combinations of: - “pre-hospital stroke” OR “prehospital stroke” OR “pre-hospital emergency stroke” OR “EMS stroke” AND - “guidelines” OR “management” OR “consensus” OR “recommendations” OR “position statement” OR “protocol” OR “minimum data set” OR “core data elements” OR “data elements” OR “dashboard” OR “prehospital data”

The MDS for the prehospital stroke emergency dashboard was identified and classified based on a comprehensive review of relevant scientific articles, international and national guidelines (e.g., American Heart Association/ASA prehospital stroke care recommendations), and official EMS resources/websites focused on stroke patient management.

Subsequently, two hybrid (in-person and virtual) expert panel meetings were held to refine and categorize the data elements. The panel comprised six specialists with extensive experience in stroke care: two emergency medicine specialists, two prehospital emergency medicine specialists, and two neurologists. All experts had more than 5 years of clinical and practical experience and were actively involved in stroke management or EMS operations within hospital emergency departments or prehospital services at five medical universities in Iran (Tehran, Birjand, Shiraz, Sistan and Baluchestan, and Mashhad).

To assess content validity, a questionnaire comprising the data elements identified in the previous step was distributed to a panel of 10 experts. This panel included emergency medicine specialists (n=3), emergency medical technicians (n=2), neurologists (n=3), and health information management specialists (n=2). The evaluation was conducted in two phases, including qualitative and quantitative sections, as detailed below:

• Qualitative Content Review

Experts were asked to review each item (data element) in terms of grammatical correctness, choice of specialized vocabulary, logical categorization, and clarity of scoring criteria, and to provide written suggestions for improvement. Following the collection of these comments, necessary revisions were made to the item wording.

• Quantitative Content Review

Two indices, the content validity ratio (CVR) and the content validity index (CVI), were used to measure content validity.

• Content Validity Ratio (CVR)

To determine the necessity of each item, Lawshe’s formula was used [33]. Experts rated the necessity of each item on a three-point scale (essential, useful but unnecessary, and unnecessary). Based on Lawshe’s table, given a panel of 10 experts, the minimum acceptable CVR value was determined to be 0.62 ($p<0.05$). Items scoring below this threshold were eliminated, while the remainder were retained. Finally, the average CVR for the entire instrument was calculated to ensure overall validity.

This index was used to examine the relevance, clarity, and simplicity of the items, based on the Waltz and Bausell methodology [34]. Experts rated each criterion on a four-point Likert scale (e.g., for relevance: from 1=irrelevant to 4=completely relevant). To calculate the CVI for each item (I-CVI), the number of experts assigning a score of 3 or 4 (the highest level) was divided by the total number of experts. The acceptance criterion for each item was a minimum score of 0.78.

Results

Phase 1 (Scoping Review) and Phase 2 (Identification of Data Items Based on Reference Guidelines)

The scoping review and clinical guideline evaluation yielded a total of 578 articles from three databases. After removing 236 duplicates and screening the titles and abstracts, 57 articles were selected for the final full-text review. After applying the study inclusion and exclusion criteria, a total of 21 studies and reference guidelines from 10 countries (including Iran, the United States, Taiwan, Germany, Spain, and South Africa) were included. The most frequently recurring prehospital data elements across these sources were: (1) time of symptom onset or last known well (LKW), (2) various time intervals (e.g., response time, time to scene arrival, on-scene time, time to hospital arrival, and total prehospital mission time); (3) performance and documentation of a validated stroke screening scale (e.g., FAST, Cincinnati Prehospital Stroke Scale [CPSS], Los Angeles Prehospital Stroke Screen [LAPSS]); (4) blood glucose measurement; (5) blood pressure measurement (often alongside vital signs); (6) hospital prenotification (or stroke code activation); and (7) presence of classic stroke symptoms (e.g., facial droop, arm weakness, speech impairment). A complete summary of all included references is provided in Supplementary Table S1.

Data extracted from the US Guidelines for the Early Management of Patients with Acute Ischemic Stroke [31] and the 2020 Global Guidelines for Prehospital Management, Emergency Evaluation, and Treatment of Patients with Acute Ischemic Stroke [32] were also incorporated into this study (Table S1). The flow of information through each phase of the review is presented in Figure 1.

Phase 3: Classification of Data Elements

As presented in Tables 2 and S2, the initial MDS of the prehospital stroke dashboard was classified into two main categories: management data and clinical data, a classification framework utilized in previous studies [35]. The management data category was divided into three subgroups: identity and mission information, key time indicators, and structural and logistical indicators.

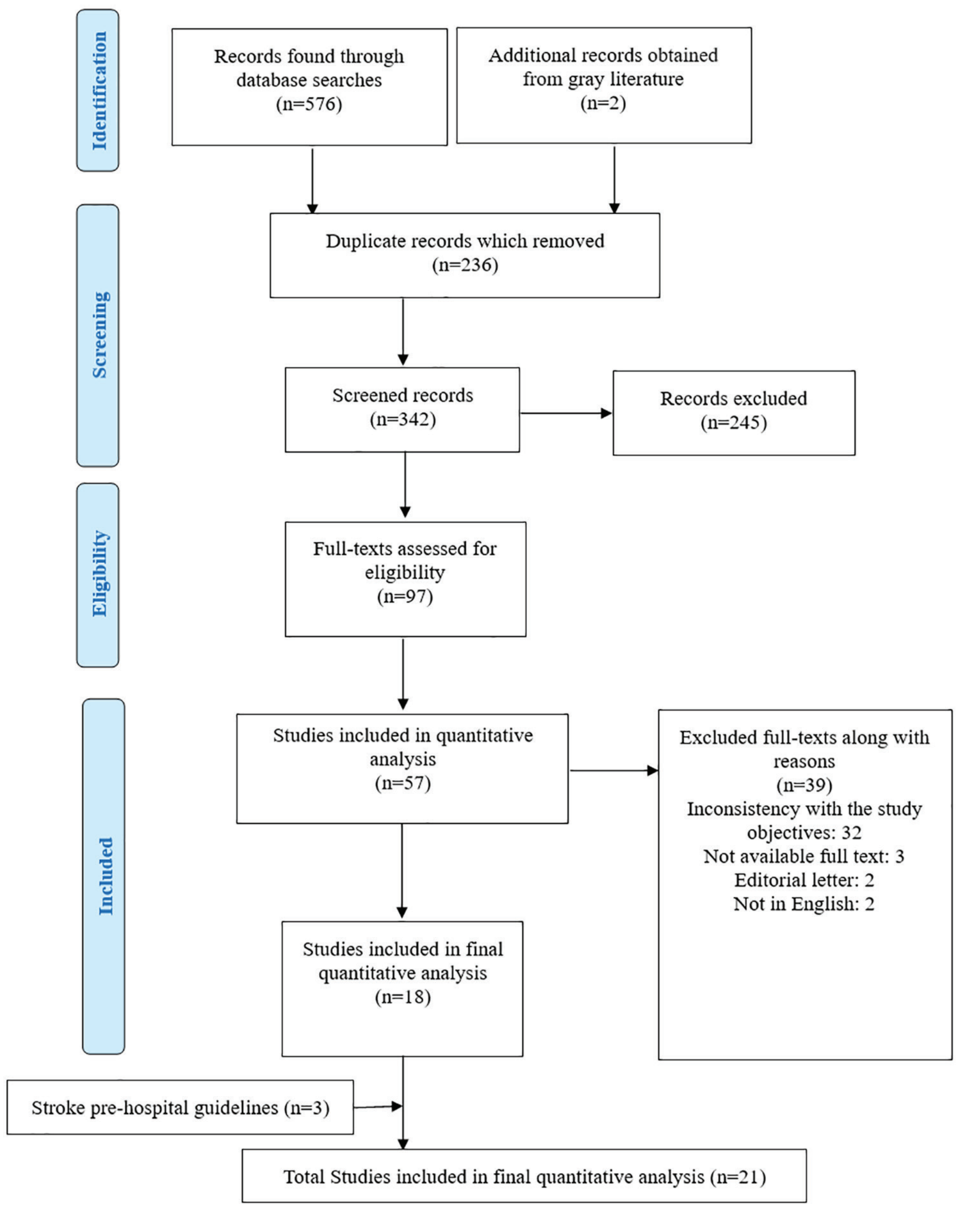

Figure 1. The PRISMA-ScR flow diagram

Table 2. Minimum dataset required to develop a prehospital stroke emergency dashboard and results of a validity study using CVR and I-CVI.

Category	Subcategory	Section	Data elements		CVR	I-CVI	Reference
Administrative Data	Identification and Mission	Mission ID	Unique Dispatch Code		0.85	1.00	Experts
		Patient Information	First and Last Name		0.82	1.00	[36-38]
			National Code		0.79	1.00	
			Date of Birth/Age		0.85	1.00	
			Gender		0.80	1.00	
			Marital Status		0.83	1.00	
			Mobile Contact Number		0.86	1.00	
		Site of Incident	Exact Address		0.80	1.00	
			Zip Code		0.83	1.00	
			Residence Type (Urban/Rural)		0.86	1.00	
			Distance to Base (Km)		0.85	1.00	
		Dispatch Team	Dispatch Operator Name		0.84	0.92	
			Personnel details of the expedition team	Identification Code	0.85	1.00	
				Educational Degree	0.80	0.89	
				Work Experience	0.83	0.91	
				Employment Type	0.86	0.95	
			Type of dispatch (land/air)		0.86	0.96	
	Key Time Metrics	Golden Times	Time to call 115		0.85	1.00	[36-38]
			Time to call (file sending)		0.81	1.00	
			Time to move code (response)		0.79	1.00	
			Time to arrive at the bedside (answer)		0.85	1.00	
			Time to start the transfer		0.80	1.00	
			Time to deliver to the hospital		0.83	1.00	
		Standard Intervals	Time to be present at the scene		0.86	1.00	
			Transfer time		0.80	1.00	
			Total mission time		0.83	1.00	
			Time to perform a CT scan		0.86	1.00	
			Time to inject TPA in the hospital		0.85	1.00	
	Structural and Logistics	Equipment	Number of active ambulances (Medical Services Control Unit)		0.82	1.00	[39-41]
			Number of helicopters		0.85	1.00	
			Portable CT scan		0.80	1.00	
			Thrombolytic drugs (such as tissue Plasminogen Activator)		0.83	1.00	
			Communication equipment (telephone, wireless)		0.86	1.00	
			Available medical equipment (electroshock, ventilator, glucometer, sphygmomanometer, pulse oximeter, flashlight)		0.86	1.00	
			Mechanical equipment (stretcher, scoop stretcher, stair chair, manual suction)		0.80	1.00	
		Human resource status	Number based on education		0.83	0.96	[36-38, 42]
			Field of study		0.83	1.00	
			Work experience		0.86	1.00	
			Type of employment		0.80	1.00	
		Human resource educational status	Passing the 724-code course		0.86	0.98	
			Passing 6-month supplementary courses for personnel		0.79	1.00	
Clinical Data	Initial Assessment and Stroke Screening	Having consciousness	Yes/No.		0.80	1.00	[39, 40, 43-48]
		FAST test	Facial numbness (unilateral/bilateral)		0.83	1.00	
			Hand movement disorder		0.86	1.00	
			Speech disorder		0.85	1.00	
		Time of onset of symptoms	Accurate recording of the moment of onset of the first symptom of the disease		0.79	1.00	

Category	Subcategory	Section	Data elements	CVR	I-CVI	Reference
	Vital Signs and Clinical Findings	Continuous monitoring	Blood pressure	0.86	1.00	
			Oxygen saturation	0.80	1.00	
			Respiratory rate	0.83	1.00	
			Heart rate	0.86	1.00	
			Blood sugar	0.80	1.00	
			Glasgow Consciousness Scale (	0.83	1.00	
		Accompanying symptoms	Dizziness	0.86	1.00	
			Visual disturbance	0.85	1.00	
			Fainting	0.82	1.00	
			Seizures	0.85	1.00	
			Hemiplegia	0.80	1.00	
			Paresthesia, eyelid or facial drooping	0.83	1.00	
		Medical history	History of previous transient ischemic attack (TIA) or cerebral vascular arrest (CVA)	0.86	1.00	
			Diabetes	0.86	1.00	
			High blood pressure	0.80	1.00	
			Atrial fibrillation	0.86	1.00	
			Drug/food allergies	0.88	1.00	
			Current medications	0.80	1.00	
	Pre-hospital Interventions	Airway Management (ABC)	Assessment and airway clearance (suction, intubation)	0.83	1.00	
			Oxygen therapy	0.86	1.00	
			Cardiac massage	0.85	1.00	
			Shock if needed	0.86	1.00	
		Specialized measures	Placement of an intravenous line (for TPA injection)	0.84	1.00	
			Cardiac monitoring	0.83	1.00	
			12-lead electrocardiogram	0.86	1.00	
			Capnography	0.79	1.00	
		Drug therapy	Name of medication administered at the scene	0.79	1.00	
			Administered dose	0.85	1.00	
	Hospital Interventions	Diagnostic measures	CT scan	0.80	1.00	
		Therapeutic measures	TPA injection (performed/not indicated/ contraindicated)	0.86	1.00	
	Outcome and Final Diagnosis	Dispatch operator detection	Did the dispatch operator suspect a stroke? (Yes/No)	0.80	1.00	
		Technician diagnosis	Did the technician suspect a stroke? (Yes/No)	0.83	1.00	
		Diagnosis in hospital (stroke center)	Was there a definitive diagnosis of stroke at the hospital? (Yes/No)	0.86	1.00	
			If yes, type of stroke (ischemic, hemorrhagic, TIA)	0.85	1.00	
		Patient fate	Discharge with recovery	0.82	1.00	
			Discharge with complications	0.85	1.00	
			Death (before arrival, in the presence of a technician, during transfer, in the hospital)	0.80	1.00	
		Quality of prehospital care	Number of successful/unsuccessful CPR	0.82	1.00	
			Medication errors	0.81	1.00	[40, 44, 49]
			Failed intubation	0.86	1.00	
			Percentage of transfer in golden time	0.84	1.00	
			Percentage of correct diagnosis by the 115-emergency service	0.83	1.00	
			Percentage of diagnosis agreement between the dispatch operator and the technician	0.86	1.00	
			Percentage of diagnosis agreement between the technician and the stroke center	0.78	1.00	
			Percentage of stroke coverage by the 115-emergency service (SAMA code 724)	0.83	1.00	

CVR: Content validity ratio, I-CVI: Item-level- Content validity index, TPA: 12-O-Tetradecanoylphorbol-13-acetate, CPR: Cardiopulmonary resuscitation.

The identity and mission information subgroup comprised 4 sections: mission identifier, patient information, incident location, and dispatch team, containing 1, 8, 4, and 7 information elements, respectively. The key time indicators subgroup was further divided into two sections: golden time metrics and standard time intervals, containing 6 and 5 information elements, respectively. The structural and logistical indicators subgroup was categorized into two sections: equipment and human resources, comprising 23 and 6 data elements, respectively.

The clinical data were categorized into 5 subgroups: Initial Assessment and Stroke Screening, Vital Signs and Clinical Findings, Pre-hospital Interventions, In-Hospital Interventions, and Outcome and Final Diagnosis.

The Initial Assessment and Stroke Screening subgroup included three sections: level of consciousness, FAST test, and time of symptom onset, comprising 1, 3, and 1 data elements, respectively. The Vital Signs and Clinical Findings subgroup had three sections: continuous monitoring, associated symptoms, and medical history, with 6, 15, and 16 data elements, respectively. The prehospital Interventions subgroup consisted of three sections: airway management (ABC), specialized interventions, and pharmacotherapy, containing 4, 4, and 2 data elements, respectively. The In-Hospital Interventions subgroup included two sections: diagnostic interventions and therapeutic interventions, each with 1 data element. Finally, the Outcome and Final Diagnosis subgroup comprised five sections: dispatch operator diagnosis, technician diagnosis, in-hospital (stroke center) diagnosis, patient outcome, and prehospital quality of care, each with 1, 1, 2, 7, and 8 data elements, respectively. Further details are provided in Tables 2 and S2.

Phase 4: Validation of Data Elements

The validity of the questionnaire and the MDS required for the prehospital ischemic stroke emergency dashboard was confirmed for all categories, subcategories, sections, and individual data elements based on the CVR and CVI values (Table 2).

Based on the results, none of the categories, subcategories, or sections were deleted. However, several individual data elements with insufficient content validity were removed. These included a limited number of demographic items, specific management and equipment-related elements (e.g., certain communication and medical devices), selected associated symptoms and medical history variables, as well as a few prehospital quality indicators. Full details of the deleted data elements are provided in Table S2.

Following the validation process, the final MDS was structured into two main categories: management data and clinical data. The management data category comprised three subgroups: identity and mission information, key time indicators, and structural and logistics indicators. The identity and mission information subgroup had four sections: mission identifier, patient information, incident location, and dispatch team, each containing 1, 6, 4, and 6 data elements, respectively. The key time indicators subgroup was further divided into two sections: golden times and standard time intervals, each containing 6 and 5 data elements, respectively. The structural and logistics indicators subgroup was further divided into three sections: equipment, human resources, and human resources education, each containing 7, 4, and 2 data elements, respectively.

The clinical data category was divided into five subgroups: Initial Assessment and Stroke Screening, Vital Signs and Clinical Findings, Pre-hospital Interventions, In-hospital Interventions, and Outcome and Final Diagnosis. The Initial Assessment and Stroke Screening subgroup had three sections: level of consciousness, FAST, and time of symptom onset, each with 1, 3, and 1 data element, respectively. The Vital Signs and Clinical Findings subgroup had three sections: continuous monitoring, associated symptoms, and medical history, each with 6 data elements. The Prehospital Interventions subgroup had three sections: airway management (ABC), specialized interventions, and pharmacotherapy, with 4, 4, and 2 data elements, respectively. The In-Hospital Interventions subgroup included two sections: diagnostic interventions and therapeutic interventions, each with 1 data element. The Outcome and Final diagnosis subgroup included five sections: dispatch operator diagnosis, technician diagnosis, in-hospital diagnosis (stroke center), patient outcome, and prehospital quality of care, containing 1, 1, 2, 3, and 8 data elements, respectively. Further details are provided in Table 2.

The initial candidate list, derived from the literature review, guidelines, and expert input, comprised 133 data elements across four main categories (Management, Clinical, Time Metrics, and Operational/Administrative). Following two rounds of expert validation using the CVR and item-level CVI (I-CVI), 42 elements were removed due to insufficient necessity, relevance, or redundancy (i.e., CVR below the threshold of 0.62 for the panel size, or low I-CVI). This resulted in a final validated MDS of 91 elements, as detailed in Table 2. The deleted elements and their corresponding validation scores are provided in Supplementary Table S2.

Discussion

This study identified an MDS for a prehospital stroke emergency dashboard tailored to the Iranian EMS (115) context, using expert consensus from neurologists, EMS managers, and health informatics specialists, informed by a scoping review and guideline synthesis. The resulting MDS comprised two core categories: management/administrative data (patient identity/mission information, key temporal indicators, structural-logistic parameters) and clinical data (initial assessment and stroke screening, vital signs and clinical findings, prehospital interventions, in-hospital interventions, and outcome and final diagnosis). This structure directly supports real-time aggregation of essential prehospital information, enabling standardized monitoring of time-sensitive processes (e.g., dispatch-to-scene, scene time, prenotification) and establishing feedback loops from hospital outcomes.

Expert consensus prioritized feasible high-priority data elements aligned with Iran's resource constraints and routine 115/ health information system (HIS) data flows. Retained items—such as precise symptom onset time, FAST/RACE/CPSS screening (supported by recent comparative evidence favoring MedPACS/sNIHSS-EMS/OPSS) [64], vital signs (blood pressure, O_2 saturation, Glasgow Coma Scale and blood sugar), key intervals (on-scene <5-minute target), intravenous (IV) line establishment for potential tissue plasminogen activator (tPA), and basic outcomes (final diagnosis type, mortality)—facilitate rapid diagnosis, safe transfer, and performance evaluation without overburdening field personnel. Exclusions (e.g., extensive medical history, insurance details, advanced imaging integration, 90-day modified Rankin Scale [mRS] follow-up) were deliberate to avoid redundancy, maintain minimalism, and ensure implementability given infrastructural limitations (e.g., the lack of a national outcome registry and variable provincial digital maturity).

Comparisons with existing literature revealed both alignment and intentional divergence to suit resource-constrained settings. Related studies, such as Rampishe *et al.,* focused on a standardized MDS for stroke health data management that addresses data inconsistencies and enhances interoperability [50]. Similar elements to our MDS include administrative data (e.g., patient identity information and EMS mission) and clinical data (initial assessment, such as stroke screening scales and vital signs). In particular, that study emphasized key time metrics (time of dispatch, arrival at scene, and transfer) that are directly aligned with our administrative MDS and are essential to reduce delays. However, Rampishe *et al.,* suggested broader insurance and medical history details that were omitted in our MDS, as our focus was strictly on minimal prehospital operational data, and insurance details create redundancy and are not compatible with Iran's limited EMS resources [51].

Similar patterns emerged across other systems (detailed in Supplementary Table S3, which synthesizes scope, purpose, and key elements against the proposed Iranian MDS). For instance, Le *et al.,* visualized data such as mortality rates by age, race/ethnicity, and sex at the county level in the Centers for Disease Control and Prevention's interactive dashboard for local trends in cardiovascular mortality and stroke [52]. Elements shared with our MDS include outcome indicators (such as mortality and disability) incorporated into our clinical MDS to provide feedback to EMS and monitor spatiotemporal patterns. However, this dashboard included broad epidemiological data, such as long-term geographic trends and racial disparities, which were absent from our MDS. The present study focused on immediate prehospital data rather than national epidemiological analysis; their inclusion would require a more advanced data infrastructure than is currently available in Iranian EMS and would compromise the minimalist nature of the MDS.

Matsumoto *et al.,* introduced the Task Calc. Stroke (TCS) app, which displayed the progress of tasks such as imaging, laboratory results, and thrombolysis in real time using a color-coded hexagonal dashboard, countdown timers, and history analysis [53]. Similar elements included key time indicators (e.g., task processing time) and basic treatment actions (e.g., alerts for thrombolysis), which were consistent with our administrative and clinical MDS and reduced communication burden. However, TCS included elements such as individual patient history analysis and integration with advanced imaging systems that are omitted in our MDS, as our focus was on field-based, rather than hospital-based and prehospital data. In Iran, EMS often lacks access to advanced digital tools, and their inclusion could reduce implementability.

Kitzman *et al.,* developed the Kentucky Appalachian Stroke Registry (KApSR), which collected demographic, clinical, and outcome data (e.g., mortality, IV-tPA administration, and length of stay) in rural areas [54]. Elements shared with our MDS included identity data, initial assessment (e.g., NIHSS), and outcome indicators used for quality assessment. Conversely, KApSR collects broader data such as patient volume, length of stay, and analysis of rural–urban disparities, which are excluded from our MDS. As our study focused on immediate prehospital data rather than a long-term registry, and given the infrastructural differences in Iran, their exclusion was necessary to avoid complexity and maintain a focus on operational key performance indicators (KPIs) such as time to scene and prenotification.

Dixon *et al.,* evaluated the performance of the Pulsara Stop Stroke© app, which reduced door-to-needle time by 40 minutes [55]. Shared elements include prenotification, stroke screening (e.g., FAST), and time indicators retained in our MDS. However, Pulsara has advanced digital coordination data, such as image sharing and real-time team communication, which are not included in our MDS. Iranian EMS often lacks access to advanced mobile technologies and focuses on basic data for standardization; including such features would require additional investment that is not a priority at the MDS development stage.

In addition, global registries such as Get with the Guidelines-Stroke (GWTG-Stroke) focus on 27 prehospital elements, including EMS times (dispatch, arrival, scene time, transport), prenotification, blood glucose check, vital signs (blood pressure, GCS, oxygenation), and stroke screening (e.g., FAST or CPSS). Elements shared with our MDS encompass all these time-based and clinical indicators, which are considered essential for reducing delays [29]. However, GWTG includes elements such as prehospital electrocardiogram, details of prior antiplatelet medications, and long-term follow-up data (e.g., mRS at 90 days) that are omitted in our MDS. This is because our focus is on minimal field data, and 90-day follow-up by Iranian EMS is highly challenging due to the lack of a national outcome registry. These were omitted to avoid redundancy and accommodate limited resources [56-58].

Collectively, these comparisons demonstrated that while international systems often incorporate broader or more advanced elements, the proposed Iranian MDS deliberately retains only high-priority, feasible items. It emphasizes time-critical metrics, simple screening scales (e.g., FAST/RACE/CPSS, informed by 2025 comparative evidence favoring MedPACS/sNIHSS-EMS/OPSS) [59], vital signs, and basic outcomes to ensure practicality, scalability, and absence of redundancy within Iran's infrastructural context. This structure was consistent with the aforementioned studies but maintains its minimalist nature. Excluded elements, such as insurance details, epidemiological analyses, and advanced digital tools, were discarded to prioritize feasibility within the Iranian EMS context (given its infrastructure and resource constraints), ensuring the MDS is practical, scalable, and non-redundant.

The incorporation of prerequisites—such as KPIs related to personnel training (correct diagnosis rate, false positives/negatives) [60-63], and structural/outcome indicators (scene time, positive FAST, mortality) [11, 64-68]—enables continuous feedback and aligns with collaborative models such as the sentinel stroke national audit programme (SSNAP) [57, 58].

In summary, this MDS represents the first integrated, localized minimal dataset for Iranian prehospital stroke dashboard development. It combines time-based (onset-to-door, door-to-needle), clinical, geographic, and logistical data in a modular, scalable format, leveraging existing 115/HIS infrastructure. It provides a foundation for real-time performance monitoring, inter-provincial benchmarking, and evidence-based improvements in rapid diagnosis, transfer efficiency, and care quality.

Despite its strengths, this study had several limitations. The MDS was developed through expert consensus informed by literature and guidelines, reflecting perceived needs rather than empirical testing in real-world Iranian EMS settings. Thus, its practical utility, acceptability to field personnel, and impact on clinical outcomes (e.g., reduced door-to-needle time, increased thrombolysis rates) or system efficiency remain untested. Although designed to be minimal, the feasibility of real-time collection of all elements—amid high workload, variable training, and acute mission pressures—poses a significant implementation challenge. This could inadvertently increase data entry burden on prehospital staff, potentially undermining the goal of streamlined data capture. Additional constraints include the lack of a national outcome registry (hindering long-term validation and 90-day follow-up), limited integration between the 115 dispatch, ambulance, and hospital systems, and substantial provincial differences in infrastructure and digital maturity, all of which may restrict short-term generalizability and rollout. Future research should prioritize pilot studies to evaluate feasibility, workload impact, user acceptance, and effects on key performance indicators, while refining mandatory versus optional elements for national scalability.

The design of an MDS for prehospital stroke emergency care in Iran, structured into two core categories—managerial (patient identity/mission information, key temporal indicators, structural-logistic parameters) and clinical (initial assessment/stroke screening, vital signs/clinical findings, prehospital interventions, hospital interventions, and outcome/final diagnosis)—establishes a standardized, expert-validated foundation for developing real-time information dashboards. By prioritizing essential, clear, and feasible elements, this MDS enables ongoing monitoring of EMS performance, outcome-based feedback, and inter-regional benchmarking, with the potential to reduce prehospital delays, enhance diagnostic accuracy, boost reperfusion therapy effectiveness, and elevate overall stroke care quality in the Iranian healthcare system. Future research should prioritize pilot implementation studies of the dashboard in selected provinces, incorporating usability testing with EMS personnel to assess acceptability and workflow integration. Rigorous evaluation of its effects on key performance indicators—such as onset-to-door time, door-to-needle time, on-scene time, percentage of appropriate stroke center referrals, thrombolysis rates, and diagnostic accuracy—is essential. Successful deployment could also generate high-quality, standardized prehospital data to support epidemiological surveillance, inter-provincial trend analysis, and evidence-based policy improvements at the national level.

Declaration

Ethics Approval and Consent to Participate: This study was approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences with the code of ethics IR.SBMU.RETECH.

REC.1403.636. During the research, efforts were made to observe the principle of trust in the use of resources and information and to present the results without any interference. The necessary consents were obtained from the participants at each phase of the research.

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Authors' Contribution: ZS: Conceptualization, methodology, software, validation, formal analysis, data curation, writing—original draft preparation, and project administration; ASH: Methodology, investigation, supervision, and project administration; SMRH: Software, formal analysis, data curation, and validation; HM: Investigation, supervision, writing-review and editing. All authors have read and agreed to the published version of the manuscript.

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