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A survey on the early management of spinal trauma in low and middle-income countries: From the scene of injury to the diagnostic phase (part II)

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1. Introduction

In the adult population, approximately 10% of major trauma victims are estimated to harbour a spinal fracture/dislocation, and 2% to suffer from a spinal cord injury, with or without a fracture/dislocation (Hasler et al., 2011). Such patients are in their majority (60%) young healthy males, in their most productive age, and the spinal injury can cause devastating social and economic impact due to impaired mobility and neurological deficits of varying severity (Ahsan et al., 2019; van Den Hauwe et al., 2020; Kumar et al., 2018; Sekhon and Fehlings, 2001).

Spinal trauma occurs when an external force is applied, directly or indirectly, to the spinal elements (Dowdell et al., 2018). Such force can compromise, with various grades of severity, the osteo-ligamentous structures responsible for vertebral stability and alignment, thus posing a concrete risk of neurological worsening to such patients during transportation (Liao et al., 2020; Todd et al., 2015).

The ATLS and PHTLS guidelines recommend considering all polytrauma patients as having a spinal injury until proven otherwise, bearing in mind that not all patients need immobilisation and that unnecessary restriction of spinal motion may cause complications in itself (ATLS Subcommittee et al., 2013; Wölfl et al., 2008). For this reason, most guidelines include recommendations about pre-hospital motion restrictions (Velopulos et al., 2018; Ahn et al., 2011; Mills et al., 2020; Maschmann et al., 2019; Hawkins et al., 2019; Kornhall et al., 2017; Theodore et al., 2013a; Zileli et al., 2020). Moreover, pre-hospital care providers should be specifically trained in the management of trauma patients and should be able to evaluate whether the benefits of spinal immobilisation overweight the risks (Thompson et al., 2021). However, in settings with limited resources, a professional pre-hospital system may be lacking while basic equipment may be considered a privilege, thus limiting the application of the above-mentioned recommendations.

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Abbreviations:

ASIA	American Spinal Injury Association
ATLS	Advanced Trauma Life Support
EA&P	East Asia and Pacific
E&CA	Europe and Central Asia
HICs	high-income countries
LA&C	Latin America and the Caribbean
LICs	low-income countries
LMICs	low- and middle-income countries
L-MICs	lower-middle-income countries
ME&NA	Middle East and North Africa
PHTLS	Pre-hospital Trauma Life Support
SA	South Asia
SLICS	subaxial cervical spine injury classification
SSA	Sub-Saharan Africa
TLICS	thoracolumbar spine injury classification
U-MICs	upper-middle income countries
WFNS	World Federation of Neurosurgical Societies

In cases of spinal cord injury, guidelines recommend a timely transfer to the definitive centre of specialist care so as to offer patients the highest possibilities of neurological recovery with a prompt adequate diagnosis and treatment (Zileli et al., 2020; Ahuja et al., 2020; Badhiwala et al., 2019; Parent et al., 2011; Ageron et al., 2020). However, this closely relies upon geographical and environmental factors, the availability of specific means of transport and generally the prehospital and healthcare system infrastructure. For this reason, it is conceivable that in some remote areas a transfer within the desirable timeframe may not be routine practice, with potential consequences on patient management and outcomes.

An accurate diagnosis is crucial in defining the best treatment strategy; whereas the availability and timing of obtaining a diagnosis will directly influence treatment options, outcomes, and prognosis (Ryken et al., 2013; Hadley et al., 2013; Fehlings et al., 2017). Again, the existing unequal distribution of resources across different realities may be responsible for heterogeneous clinical management (Calderón and Servén, 2014; WHO. World Health Statistics Organization, 2021).

The main objective of this study is to reveal the possible differences in the above-mentioned steps of management of spinal injury in LMICs and to explore whether or not the existing guidelines addressing these phases of care are being followed or not.

2. Methods

An electronic survey comprising 34 questions was designed and disseminated to physicians treating spinal trauma in LMICs (Appendix I). Methods of dissemination included email, social media and webinar presentations. Only partial aspects of the whole survey are dealt with and presented here. The questions relevant to this particular paper focus on the steps of acute management of patients with a spinal injury and include the specialisation of pre-hospital care providers (ranging from advanced, through basic, to no pre-hospital care); the available means of transportation (air or no air transportation available); the use of immobilisation devices (hard cervical collar and spinal backboard); the timing for transportation to the definitive centre of care (scene-to-door interval); the use of scales to assess the neurological status (ASIA) and to classify the fractures (TLICS/SLIC); the accessible diagnostic tools; and their timing and costs. For each question, the respondents were asked to give and estimation of the information/data about their current employment/institution.

Data are presented as per stratification of countries' income (LICs = low-income, L-MICs = lower-middle-income, U-MICs = upper-middle income); and geographical area (EA&P = East Asia and Pacific, E&CA=Europe and Central Asia, LA&C=Latin America and the Caribbean, ME&NA = Middle East and North Africa, SA=South Asia and SSA=Sub-Saharan Africa) according to the 2021 Word Bank Classification.

Data were prospectively collected and the results tabulated in a Microsoft Excel spreadsheet and statistical analysis was performed by the same software.

3. Results

Overall, the survey received responses from 1154 physicians who manage spinal trauma in 79 low- and middle-income countries (LMICs). All the included questionnaires were filled out completely and incomplete questionnaires were automatically excluded. Most answers came from L-MICs (48.4%, 558/1154) and the most represented geographic area was LA&C (26%, 300/1154). Most answers came from male physicians (90.2%, 1041/1154) and the most represented age group was 30–49 years (71.8%, 828/1154). Most respondents were consultants in Neurosurgery (48.9%, 564/1154) with an experience in managing spinal

Table 1
Main demographic information of the 1154 respondents to the questionnaire. (L-MICs = lower-middle-income countries, U-MICs = upper-middle-income countries, EA&P = East Asia and Pacific, E&CA=Europe and Central Asia, LA&C=Latin America and Caribbean, ME&NA = Middle East and North Africa, SA=South Asia, SSA=Sub-Saharan Africa).

Demographic	Total (%)
Total (%)	1154 (100)
Sex	
Male	1041 (90.2)
Female	113 (9.8)
Age (years)	
<25	3 (0.3)
25-29	67 (5.8)
30-49	828 (71.8)
50-69	246(21.3)
≥70	10 (0.9)
Current job title	
Consultant in Neurosurgery	564 (48.9)
Consultant in Orthopedics	361 (31.3)
Neurosurgery trainee	130 (11.3)
Orthopedic trainee	37 (3.2)
Other	62 (5.4)
Experience with spinal trauma (years)	
<5	393 (34.1)
5-10	307 (26.6)
>10	454 (39.3)
Level of resources of the Institution	
Low level	127 (11)
Medium level	594 (51.5)
High level	433 (37.5)
Population served	
<1 million	381 (33)
1–5 million	454 (39.3)
>5 million	319 (27.6)
Spinal cord injury cases treatment	
Yes, regularly	764 (66.2)
Yes, occasionally	375 (32.5)
No, never	15 (1.3)
Income area	
LIC	51 (4.4)
L-MIC	558 (48.4)
U-MIC	545 (47.2)
Geographic area	
EA&P	297 (25.7)
E&CA	98 (8.5)
LA&C	300 (26)
ME&NA	108 (9.4)
SA	223 (19.3)
SSA	128 (11.1)

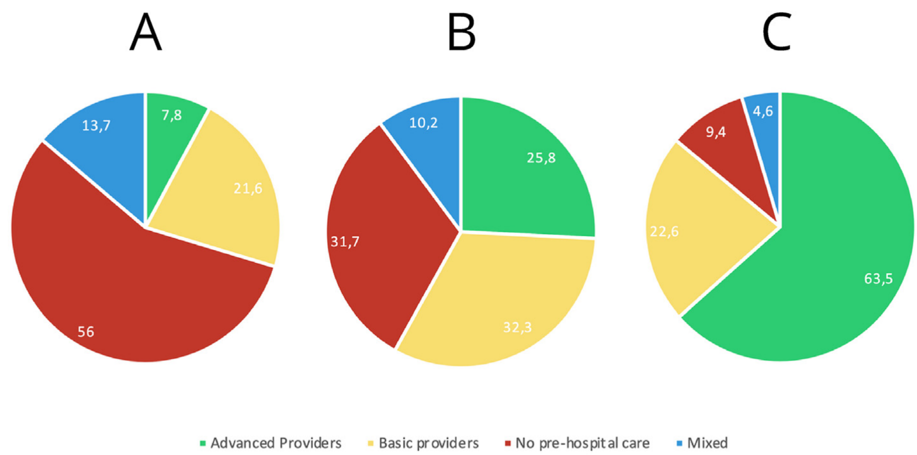

Fig. 1. Type and specialisation of pre-hospital care providers for the management of spinal trauma according to the different levels of resources: LICs (A), L-MICs (B) and U-MICs (C).

trauma longer than ten years (39.3%, 454/1154) (see Table 1). A complete list of the answers' distribution can be found in Appendix II while a tabular overview of the answers included in this article can be found in Appendix III.

3.1. Pre-hospital care

Overall, over a fifth and nearly a quarter of respondents (22.3%, 257/1154) reported having no access to any type of pre-hospital care. Only a minority of respondents (494/1154; 42,8%) reported working in environments with advanced pre-hospital care providers. The absence of any form of pre-hospital care was higher in LICs (29; 56%) when compared to L-MICs (177; 31.7%) and U-MICs (51; 9.4%) (see Fig. 1). The regions with the highest availability of advanced pre-hospital care providers were E&CA (68; 69.4%) and LA&C (189; 63%), while the highest lack of any form of pre-hospital care was stated by SSA (56; 43.8%) and SA (91; 40.8%) respondents.

Air transportation was available for only 29.4% (339) of the whole sample, with significant differences observed as per both economic (LICs 4 = 7.8%; L-MICs 115 = 20.6%; U-MICs 220 = 40.4%) and geographical (SA 43 = 19.3%; EA&P 75 = 25.3%; SSA 34 = 26.6%; LA&C 98 = 32.7%; ME&NA 37 = 34.4%; E&CA = 52 = 53.1%) area.

Regular use of a hard cervical collar and spinal backboard in cases of high risk of spinal cord injury was reported respectively by only 51% (589) and 42.2% (487) of the whole sample. Notably, 10.7% (124) and 18.9% (218) respectively stated to never use them. Differences in the regular use of a hard cervical collar and spinal backboard were correlated to the income region (hard collar: LICs 5.9%, L-MICs 26.5%, U-MICs 80.4%; spinal backboard: LICs 3.9%, L-MICs 18.3%, U-MICs 70.3%) and geographical area (see Fig. 2).

Transport timing from the scene of spinal cord injury to the definitive centre of care was achieved within 24 h by 81,7% (943/1154). However, significant differences were found stratifying the results according to income and geographic area, with 60.8% of LICs respondents receiving such patients >24 h after injury (see Fig. 3). The regions with the highest delays were SSA and SA with 40.6% (52) and 31% (69) respondents receiving such patients >24 h; while in ME&NA, E&CA, LA&C and EA&P such delays were reported less frequently. (0.9%, 6.2%, 6.4%, 16.8%).

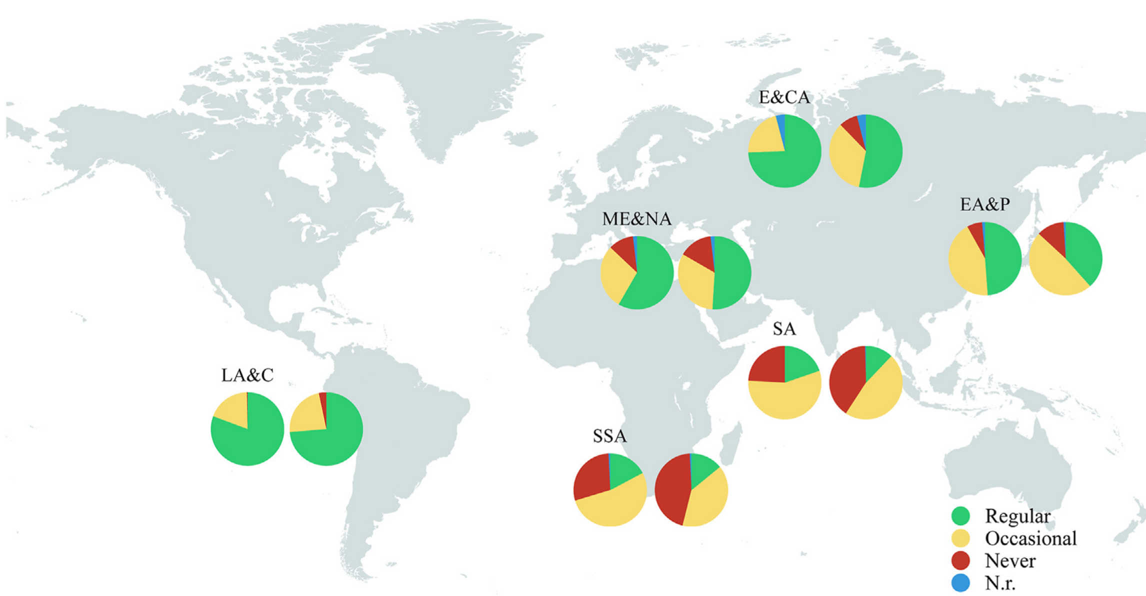

Fig. 2. Geographical differences in the reported rate of use of hard cervical collar (pie chart on the left of each couple) & spinal backboard (pie chart on the right) in cases at high risk of spinal cord injury, as reported by the 1154 respondents. EA&P = East Asia and Pacific, E&CA=Europe and Central Asia, LA&C=Latin America and the Caribbean, ME&NA = Middle East and North Africa, SA=South Asia and SSA=Sub-Saharan Africa.

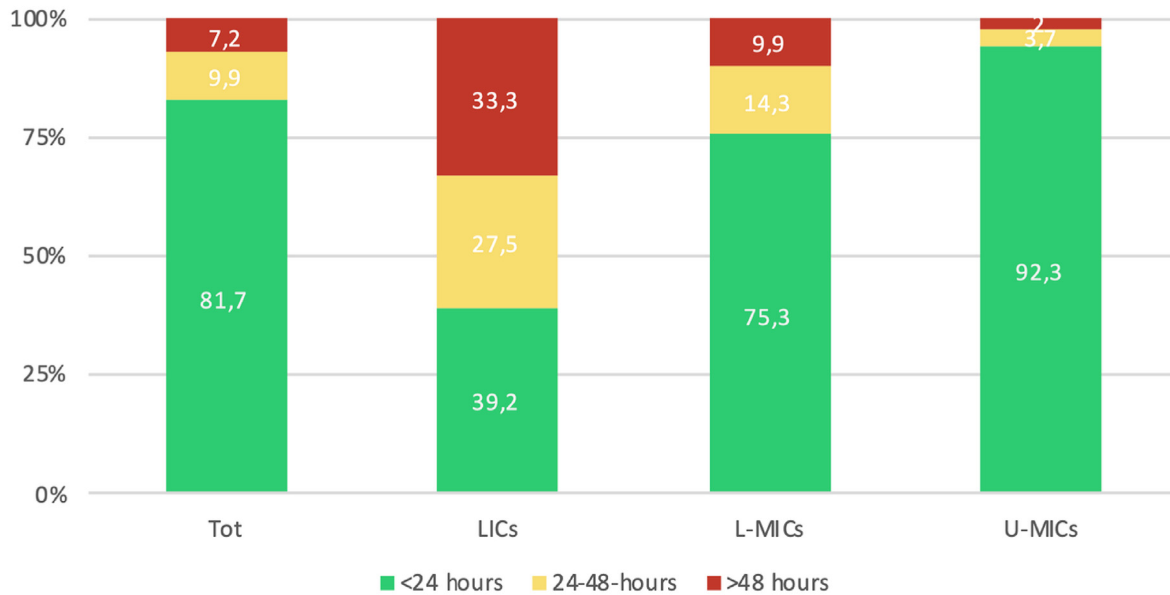

Fig. 3. Timing for transportation from the scene of injury to the centre of definitive care, in cases of spinal cord injury. Results are presented for the whole sample (first column) and stratified according to the economic macro-area (LICs second column, L-MICs third column and U-MICs last column).

3.2. Diagnosis

3.2.1. Scales and classifications

Overall, most respondents regularly use the ASIA scale to evaluate and report the neurologic status of patients with spinal cord injury (925/1154; 80.2%). No significant differences were found among the different economic areas (LICs 74.5%, L-MICs 80.8% and U-MICs 80%). The regions with the highest rate of declared regular use were EA&P (256; 86.2%) and SSA (108; 84.4%), while in ME&NA its use seems less frequent (62; 57.4%).

The AOSpine classification for spinal fractures was the most frequently used in the whole sample (884/1154; 76.6%). Increasing exclusive use of the AOSpine classification was found with an increase in the available resources (LICs 14 = 27.5%; L-MICs 216 = 38.7.5%; U-MICs 354 = 65.6%), while in LICs the TLICS/SLIC was the most frequently adopted (29 = 56.9.%). In SSA, 8.6% (11/128) stated not to use any classification system for spinal fractures.

3.2.2. Diagnostic imaging

Traditional x-rays were available by most respondents (1058/1154; 91.7%). The income region with the least availability was LICs (45/51; 88.2%). Amongst all respondents, 95.7% (1104) stated to have access to a regular computed-tomography (CT) scan while in LICs this was available for 72.5% (37) respondents. In all geographic regions, more than 90% reported having access to a regular CT scan. The availability of an angio-CT was reported by 48.3% (557) of the whole sample; in LICs it was 15.7% (8), in L-MICs 45.5% (254) and in U-MICs 54.1% (295). The highest access to an angio-CT was stated in ME&NA (65; 60.2%).

Magnetic resonance imaging (MRI) was declared available by 83.3% (961) of the whole sample, 64.7% (33) in LICs. The region with the least access to an MRI was SSA (98; 75.8%). The reported timing to obtain an MRI in cases of spinal cord injury was within 24 h for 67.4% (778) of the whole sample (22% immediately after entrance to the emergency room, 20.3% within 8 h, 25.1% between 8 and 24 h). Delays varied according to the income and geographic area, with the most significant delays found in LICs, EA&P and SSA (49%, 38% and 43% respectively stating to be able to obtain an MRI only 24 h after injury). In SSA, 22.7% (29) reported being able to obtain an MRI only after 48 h (see Table 2).

3.2.3. Costs of diagnostic imaging

Patients or their families did not incur any costs for diagnostics in 43.8% (505) of the whole sample. In contrast, 28.3% (327) of patients had to partially pay, while 27.6% (318) had to cover the total cost. Having to pay the full charge for diagnostics was inversely proportional to the available resources (LICs = 64.7%; L-MICs = 41.8%; U-MICs = 9.5%). Significant differences were also found amongst geographical areas (See Fig. 4).

Table 2
Reported timing to obtain an MRI in cases of spinal cord injury as stated by the whole sample (1154) and stratified according to the income and geographic area. (L-MICs = lower-middle-income countries, U-MICs = upper-middle-income countries, EA&P = East Asia and Pacific, E&CA=Europe and Central Asia, LA&C=Latin America and Caribbean, ME&NA = Middle East and North Africa, SA=South Asia, SSA=Sub-Saharan Africa).

	MRI timing for spinal cord injury cases									
	Total number (%)	LICs	L-MICs	U-MICs	EA&P	E&CA	LA&C	ME&NA	SA	SSA
Total (%)	1154(100)	51 (4.4)	558(48.4)	545(47.2)	297(25.7)	98(8.5)	300(26)	108(9.4)	223(19.3)	128(11.1)
Immediately	254(22)	3(5.9)	139(24.9)	112(20.6)	49(16.5)	21(21.4)	48(16)	39(36.1)	84(37.7)	13(10.2)
<8 h	234(20.3)	4(7.8)	95(17)	135(24.8)	48(16.2)	15(15.3)	82(27.3)	31(28.7)	44(19.7)	14(10.9)
8–24 h	290(25.1)	7(13.7)	137(24.6)	146(26.8)	81(27.3)	40(40.8)	77(25.7)	21(19.4)	48(21.5)	23(18)
24–48 h	187(16.2)	12(23.5)	93(16.7)	82(15)	72(24.2)	9(9.2)	39(13)	13(12)	27(12.1)	27(21.1)
>48 h	146(12.7)	13(25.5)	75(13.4)	58(10.6)	41(13.8)	11(11.2)	44(14.7)	4(3.7)	17(7.6)	29(22.7)
No MRI available	40(3.5)	12(23.5)	18(3.2)	10(1.8)	6(2)	0(0)	10(3.3)	0(0)	2(0.9)	22(17.1)
No SCI patients	3(0.3)	0(0)	1(0.2)	2(0.4)	0(0)	2(2)	0(0)	0(0)	1(0.4)	0(0)

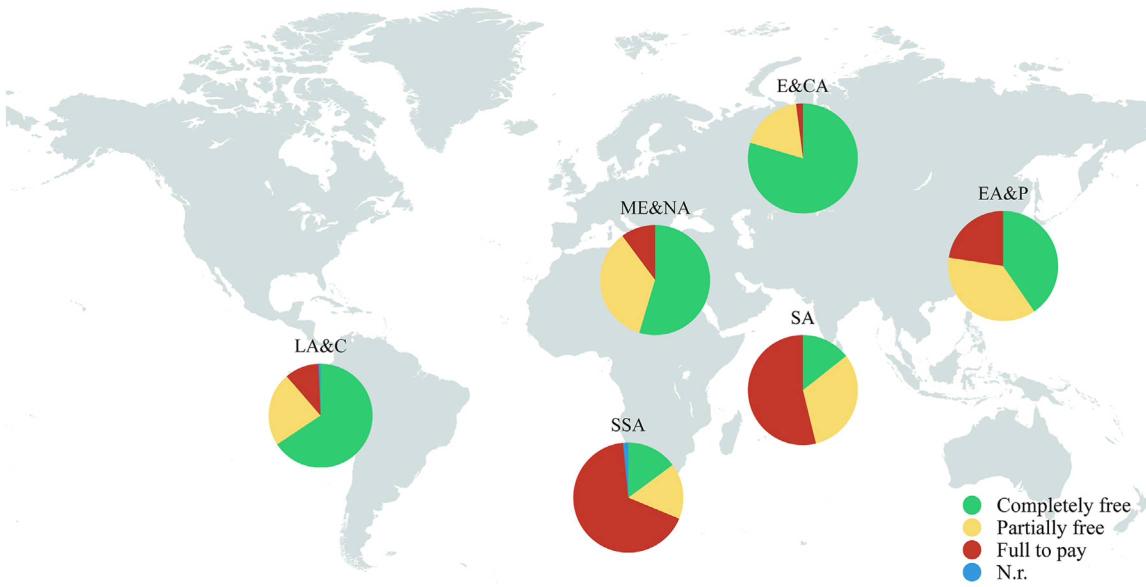

Fig. 4. Geographical differences in the costs for patients for diagnostic imaging, as reported by the 1154 respondents. EA&P = East Asia and Pacific, E&CA=Europe and Central Asia, LA&C=Latin America and the Caribbean, ME&NA = Middle East and North Africa, SA=South Asia and SSA=Sub-Saharan Africa.

4. Discussion

Our survey demonstrates significant variability in the adherence to the explored recommendations for spinal trauma. This was coupled to disparities of income and to locoregional/geographical variation. Previous studies also showed a lower rate of adherence in LMICs than in HICs to some guidelines for the management of spinal trauma, mainly in the pre-hospital phases of treatment (Lepard et al., 2022).

Indeed, it has been estimated that more than half of the world's population lives in regions where emergency services are not available, and in Africa this proportion can reach 90% (Eisner et al., 2021). Pre-hospital care has been recently described as one of the essential domains upon which policymakers should focus to develop effective and efficient health systems aiming at reducing deaths and disability secondary to neurotrauma (Reynolds et al., 2017; Jin et al., 2021). Specific instructions have been provided for this and they include frameworks of interventions like infrastructure, workforce, service delivery, financing, information management and governance. The development of a contextualized prehospital system in addition to emergency medical personnel training and timely transfer to neurotrauma facilities may be considered some of the most relevant of such measures (Corley et al., 2019). However, data show a significant deficit in training and available resources for managing spinal injuries in the pre-hospital setting in some LMICs and concrete solutions should be sought (Eisner et al., 2021).

The presence or not of trained pre-hospital care providers has a direct effect on the possibility to adhere to guidelines focused on spinal immobilisation and clearance (Ahn et al., 2011). Such training should include didactic, hands-on, practical and scenario-based activities and encompass all members of the interdisciplinary healthcare team (Mills et al., 2020).

As complications of improper spinal motion restriction go beyond pain and include potentially severe conditions like raised intracranial pressure, pressure ulcers, delays due to prolonged time on the scene, and difficulty in performing life-saving procedures like endotracheal intubation, the importance of training pre-hospital providers is clear (Velopulos et al., 2018; Kreinest et al., 2015). For this reason, existing guidelines recommend that cervical immobilisation should be performed by trained and experienced medical services (Theodore et al., 2013a).

Indeed, if it were true that improper immobilisation can put the patient at risk of the above-mentioned complications, the absence of spinal motion restriction when necessary can potentially cause devastating consequences, and guidelines do describe methods and criteria for immobilisation (Todd et al., 2015; Zileli et al., 2020; Toscano, 1988). Some authors described clever and low-cost alternatives to cervical immobilisation devices that could increase the rate of adherence to such guidelines, but large prospective trials ought to be conducted to evaluate the safety and feasibility of such techniques (Eisner et al., 2022).

The results of our survey confirm a significant difference amongst income and geographical region in the type of training and equipment of pre-hospital care providers, which may also affect the adherence to recommendations to other aspects of care like acute hemodynamic management (Sánchez et al., 2020; Nielsen et al., 2012).

An efficient trauma system includes appropriate means of transportation for the territory to allow trauma victims to reach in the shortest possible time the definitive centre of care (Reynolds et al., 2017). Air transportation increases the likelihood of survival when compared with ground transportation, but in our study its availability reached 50% in only one of the considered geographic regions and none of the income areas (Schneider et al., 2021).

The means of transportation is only one of the factors that can prolong delays. The importance of expeditious and safe transfer to the definitive centre of care with adequate resources and expertise is highlighted in most spinal cord injury guidelines, with a general timeframe that should not exceed 24 h from the time of the accident (Zileli et al., 2020; Theodore et al., 2013b). Ideally, such timing should be even shorter, as the possibilities of neurological recovery decrease if treatment occurs later than 24 h (Ahuja et al., 2020). Our results do seem to reveal the existence of significant delays for spinal cord injury transfers in some contexts and a consequent impossibility of following guidelines. However, the individualisation and description of such causes go beyond the scopes of our study.

The use of a precise, consistent and reproducible neurological evaluation tool for patient victims of acute spinal injuries is essential across all the phases of care. This facilitates communication between caregivers, directs the patient to the most appropriate treatment, and allows prognostication about potential outcomes. The AIS, as described by the ASIA, has all these characteristics and is recommended by current guidelines for acute neurological evaluation (Hadley et al., 2013; Sánchez et al., 2020). While in some regions the frequency of use of this scale could be considered satisfactory, the fact that in some areas this does not occur could affect patient management and it reveals the importance of improving basic training as mentioned above.

Another factor that may influence the decision-making process is the use of standardised scales to classify the morphology and stability of vertebral damage. The evolution of imaging techniques, mainly with the introduction of MRI, has allowed the development of sensitive and specific classification tools and current guidelines incorporate such advances, thus guiding treatment (Denis, 1983; Alves et al., 2020; Aarabi et al., 2013; Peev et al., 2021; Bajamal et al., 2021; Sharif et al., 2020).

For cervical injury, the SLIC classification combines fracture morphology, discoligamentous integrity and neurological status in order to predict stability and guide management (Vaccaro et al., 2007). The recent WFNS guidelines for subaxial spine injury state that the SLIC should be used as a standard of care and be preferred over other current classifications (Sharif et al., 2020). For thoracolumbar injuries, the last WFNS guidelines state that both the TLICS (the correlation of SLIC for the thoracolumbar segment) and the AOSpine classifications are valid tools, highlighting that the latter could be more useful in treating thoracolumbar injuries (Bajamal et al., 2021). Our results showed an unexpected direct correlation between income and an increase exclusive use of the AOSpine classification. It should not be ignored that a noticeable proportion of survey respondents (eg 8.6% (11/128) in sub-Saharan Africa) stated that they do not use any classification system in some situations.

Traditional radiography seems to be widespread in our sample. The same can be stated about regular CT when considering geographic stratification. However, a lower availability was found in low-resource areas when stratifying the results by income, with a possible effect on the timing, accuracy of diagnosis and consequent adherence to guidelines. The adherence to guidelines about a cervical vascular injury is probably heterogeneous but overall limited, as angio-CT was available in a minority of cases (Sharif et al., 2020).

Even if none of the current guidelines explicitly state that MRI is indispensable for decision making (except in specific cases like upper cervical injury), all underline its importance in formulating a better plan of management (Zileli et al., 2020; Alves et al., 2020; Aarabi et al., 2013; Bajamal et al., 2021; Sharif et al., 2020; Rozzelle et al., 2013). Additionally, MRI has an important role in outcomes prediction in spinal cord injury and can reveal potentially dangerous conditions not visible in traditional imaging, like discoligamentous ruptures or hematomas (Fehlings et al., 2017). MRI was overall stated available by a discrete proportion of our respondents. However, differences were found from one region to the other.

The availability of a technique, however, does not automatically translate into the ease of its use. Indeed, a significant proportion of respondents in areas with lower resources stated that diagnostic expenses must be covered by patients or their families. Although a detailed analysis of the causes of this phenomenon goes beyond the scope of this study, the consequences can be relevant, and one such consequence is timing. If the timing to obtain an MRI for a spinal cord injury is over 24 h, we suspect that treatment may occur even later, making it impossible to follow the current guidelines (Fehlings et al., 2017; Sánchez et al., 2020).

In general, we agree that guidelines are essential instruments which can help optimise the care offered to spinal trauma patients across all the phases of care, as their recommendations are based on the best available evidence. However, it may be valuable to consider, when guidelines are designed and formulated, existing and not easily modifiable regional differences that may affect the real-life application (Rubiano et al., 2020).

5. Limitations

The current study has several limitations, including those that are common to all surveys. The questionnaire was distributed by different means (social media, emails, presentation at webinars) and for this reason it was not possible to calculate response rate. English was the only language available to respond and this could have limited responses from non-English speakers. As participation was optional, respondents may have a higher interest in the examined topic when compared to non-responders. Our sample may be not exactly representative of all LMIC realities and scenarios, although our results include a noticeably high number of respondents. The likelihood of clustering of results with multiple respondents from the same institution is concrete. Even if our sample included both neurosurgeons and orthopaedic surgeons, in some regions of the world spinal trauma may be managed by only one or both. Finally, as our focus was LMIC practitioners, we do not have an explicit HIC group for comparison.

6. Conclusions

The management of the initial phases of care for spinal trauma in LMICs appears heterogeneous and parallels the challenges of adherence to current guidelines. An advanced pre-hospital care system is lacking in many realities, possibly directly influencing the rate of use of immobilisation devices, which appears insufficient in many areas. Transfer delays can be relevant in urgent cases like spinal cord injury, thereby influencing the timing of surgical treatment. Clinical and morphological classification tool usage differs from one region to another, and the diagnostic and consequent treatment process can be influenced by the availability of imaging techniques. Costs of diagnostics can also play a role. Guideline development processes should take into account such differences in order to ensure optimal management of spinal trauma all over the world.

Declaration of competing interest

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

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bas.2022.101185.

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