Spinal cord injury as a component of polytrauma in road accident victims

Abstract. Background. Road traffic injury remains one of the most serious and complex types of human injury both in Ukraine and around the world. The purpose of the research: to determine the location and extent of spinal cord injuries as a component of polytrauma as a result of a road accident. Materials and methods. We formed a study array of 298 victims with spinal cord injuries from the array of road accident victims (1,696 people) who were treated in the emergency medical care hospital of the city of Kyiv, the emergency medical care hospital of the city of Chernivtsi, and three central district hospitals of the Kyiv region in 2020–2021. Formation of the research array was carried out by the method of irreversible randomization using the technology of random numbers. The selection criterion for inclusion in the study was the presence of spinal cord injury in road accident victims. At the same time, verification of the nature of the damage was determined at this stage of the study only by clinical and anatomical features, namely, the cervical spine, the thoracic spine and the lumbar spine. Results. It was established that 87.25 % receive damage to one part of the spine. Damage to all parts of the spine in road accidents occurs in 1.68 %. Among the combination of injuries of the spine, the combination of injuries of the thoracic and lumbar parts has the largest specific weight. Spinal cord injury occurs most often in drivers 37.05 %, the least common in pedestrians 30.82 %. According to the NISS, 51.02 % of victims receive a mild spinal cord injury, 39.99 % of victims receive a severe spinal cord injury. In victims with a severity of 25 points, damage to the cervical spine has the largest specific weight of 40.29 %, the smallest is the thoracic section of 28.70 %. In drivers and passengers, the cervical spine is most often damaged, 53.85 and 48.91 %, respectively. In pedestrians, the lumbar spine is most often injured, 47.19 %. The coefficient of combination of damage to several sections of the spine at the same time for drivers and passengers is 1.14, and for pedestrians — 1.6. Conclusions. Spine injuries occur in 17.98 % of victims of traffic accidents. Most often, the cervical spine is damaged in 46.64 %, thoracic — in 32.55 %, and lumbar — in 35.23 % of those injured as a result of traffic accidents.

Keywords: traffic accident; traffic injury; vertebral injury; polytrauma; victims

Introduction

Road traffic injury remains one of the most serious and complex types of human injury both in Ukraine and around the world [1, 2]. Moreover, according to preliminary data, the results of the decade of combating road traffic injuries, which was carried out under the auspices of the UN in 2011–2020, did not lead to a significant reduction in the number of people injured in road traffic accidents (traffic accidents).

Previous studies have determined that road traffic injury (RTI) is a multicomponent injury, i.e. polytrauma [3]. The type of polytrauma as a result of a road accident with damage to the spine has already been studied quite thoroughly, including the combination of a spinal injury with damage to other organs and systems, but the clinical and anatomical characteristics of the vertebral injury in the structure of RTI and the dependence of clinical and anatomical characteristics on the sign of participation in movement remain insufficiently studied [4]. In this regard, the influence of the vertebral component on the outcome of the traumatic process remains insufficiently verified.

Spinal injuries are an important component of RTI with significant medical and social consequences [5, 6], in particular, disability of victims. At the same time, the location, volume and nature of spinal injuries due to road accidents require further study and verification. The above determined the expediency, necessity and relevance of this research.

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The **aim** of the research was to determine the location and extent of spinal injuries as a component of polytrauma as a result of a road accident.

**Materials and methods**

**Population**

On average, about 210,000 road accidents occur in Ukraine per year, as a result of which from 42,000 to 45,000 subjects are injured annually. Such a general set of phenomena is definitely unrealistic for study and analysis. Therefore, it was decided to conduct research in the order of an epidemiological experiment of a natural type, formed according to the law of large numbers. We formed a study array of 298 victims with spinal cord injuries from the array of road accident victims (1,696 subjects) who were treated in the emergency medical care hospital of the city of Kyiv, the emergency medical care hospital of the city of Chernivtsi and three central district hospitals of the Kyiv region in 2020–2021. The formation of the research array was carried out by the method of irreversible randomization using the technology of random numbers.

The selection criterion for inclusion in the study was the presence of spinal cord damage in road accident victims. At the same time, the nature of the damage was determined at this stage of the study only by clinical and anatomical features, namely, cervical spine (CS), thoracic spine (TS) and lumbar spine (LS).

The above made it possible to form a full-scale model according to the law of large numbers and conduct research in a mixed array. The above ensured the correct conduct of the research and the obtaining of reliable results: the scope of the research exceeds the necessary and sufficient scope, the research bases have typical features, the research methodology and methodology meet the requirements and criteria of evidence-based medicine.

The research was carried out within the scope of the dissertation research on the topic “Traffic injury (clinical-epidemiological, clinical-nosological characteristics, clinical features of the course of the traumatic process, principles of providing medical care)” approved by the Academic Council of the Ukrainian Scientific and Practical Center for Emergency Medical Care and Disaster Medicine of the Ministry of Health of Ukraine (protocol of the meeting of the Scientific Council No. 6 of December 15, 2020) in compliance with the terms of the Declaration of Helsinki and approved by the bioethics commission of the Ukrainian Scientific and Practical Center for Emergency Medical Care and Disaster Medicine of the Ministry of Health of Ukraine (protocol No. 10 dated December 8, 2020).

**Methods**

In this research, the methods of natural modeling, irreversible randomization, formal logic, and medical statistics were applied.

In this study, the volume of spinal injuries in the general mass of victims as a result of road accidents was studied, the structure of spinal trauma was determined and verified, depending on the spinal parts and the participation in the movement of the victims. The standardized clinical characteristics of victims with spinal cord injuries as a result of a traffic accident using the standardized NISS (New Injury Severity Score) assessment system were also studied and provided. Given the nature of this study, we determined only the severity of damage to the spine in the victims. In this study, a general assessment of the severity of the injury was chosen, rather than a specialized system for evaluating spinal injuries, as this injury was considered as a component of polytrauma. This study was conducted in controlled randomized groups that were formed based on the outcome of the traumatic process in the victims. This made it possible to determine and verify the influence of spinal injuries on the course of the traumatic process in road accident victims.

**Statistical analysis**

To fulfill the requirements of evidence, we used the methods of non-parametric analysis, namely the determination of the polychoric relationship indicator with the calculation of the coefficient of mutual connectivity (C), the indicator of mutual connectivity (\(\varphi^2\)) and the Pearson correspondence criterion \(\chi^2\), the probability was determined in comparison with the correspondence criterion of the Snedecor table, when determining the error rate of 5 %. Classical rank analysis and fractal analysis of the array with determination of distribution of dissipation using a simplified method were also carried out.

**Results**

In order to determine the location of spinal injuries, we conducted an analysis of the distribution by anatomic-functional area in the array of victims as a result of road accidents. The results are shown in Fig. 1.

As can be seen from the data in Fig. 1, damage to the spine occurs in 17.98 % of road traffic injury cases, which determines the fifth place in the distribution. At the same time, victims with the presence of a vertebral component of the damage make up 19.65 % of the mass of mortality due to road accidents, which determines the significant medical and social importance of the problem.

The distribution of the study array according to the participation in the traffic allows us to state that spinal injuries are most common among drivers. In the second place — passengers, in the third place — pedestrians. Moreover, the difference is quite significant, and the difference between drivers and pedestrians is 6.23 % in the absolute value of the intensive indicator.

![Figure 1. Distribution of the array of victims of a traffic accident according to the anatomical and functional area](image-url)
The above indicates a significant influence of participation in the traffic on the occurrence of spinal injuries in road accident victims.

The analysis of the distribution of the study array according to the spine part allowed us to conclude that the cervical spine is most often damaged — 46.64 %, the thoracic spine is the least common, 32.55 %. The difference between the minimum and maximum distribution rate is 14.09 % in absolute value of the intensive rate, or 43.29 % of the baseline rate.

In order to verify the connection between the sign of participation in movement and damage to a specific part of the spine, we made a distribution based on these signs. The data are given in Table 1.

Data in Table 1 indicate that there is a difference in the distribution based on participation in traffic and damage to a specific part of the spine and vice versa. Among drivers, the cervical spine is most often damaged — 53.85 %, the thoracic spine is the second most damaged, 33.33 %, the lumbar spine is the least damaged — 26.50 %. The combination factor of spine injuries is practically 1.14. The ratio of maximum to minimum indicators is 2.03, which suggests a moderate dissipation of the distribution.

Passengers also have the most damage to the cervical spine — 48.91 %, in the second place — the lumbar spine, 34.78 %, the lowest specific weight falls on damage to the thoracic spine — 30.43 %. The combination factor is also 1.14. The ratio of the maximum to the minimum indicators is 1.36, which suggests a slight dissipation of the distribution.

Among traffic participants “pedestrians”, the lumbar spine is most often injured — 47.19 %, the cervical spine is the second most injured, and the thoracic spine is the third most injured, 30.71 %. The combination factor is also 1.16. The ratio of maximum to minimum indicators is 1.40, which suggests a slight dissipation of the distribution.

On the other hand, among the victims, cervical spine injuries occur most often in drivers — 45.33 %, the least — in pedestrians, 22.30 %. The ratio of maximum to minimum indicators is 2.03, which suggests a moderate dissipation of the distribution.

Among victims with damage to the thoracic spine, drivers are also most often found — 40.21 %, and passengers have the lowest specific weight — 28.86 %. The ratio of maximum to minimum indicators is 1.39, which suggests a slight dissipation of the distribution.

The largest specific weight of victims with a lumbar spine injury is observed among pedestrians — 40.00 %, the smallest — among drivers — 29.52 %. The ratio of maximum to minimum indicators is 1.36, which suggests a slight dissipation of the distribution.

Summarizing the above, we can come to the conclusion that there is a high difference in the structure of spinal injuries based on participation in traffic. In general, it can be noted that road users who are in a vehicle are characterized by damage to the cervical spine, and pedestrians are characterized by damage to the lumbar spine. Damage to the thoracic spine is to a small extent inherent in active traffic participants.

The analysis of injury cases proved that this distribution is related both to the specificity of the injuring agent and to the neglect of safety rules.

A polychoric analysis of the Table 1 was carried out, which made it possible to establish that there is a positive ($\chi^2 = 0.18$), pronounced ($C = 0.39$) and highly probable relationship ($\chi^2 = 61.11$) between the sign of participation in traffic and a damaged spine, and above the specified positions are within the field of probability.

Considering that, on average, each victim with vertebral injuries receives 1.14 spinal injuries, we considered it appropriate to divide the study array according to the characteristic of the spinal part, taking into account the combination of injuries of the spinal parts. The data are shown in Fig. 2.

The data of Fig. 2 testify in favor of the fact that 87.25 % of victims with vertebral damage as a result of a road accident

![Figure 2. Distribution of the array of damage to the spine taking into account the combination of parts](http://pjs.zaslavsky.com.ua)

**Table 1. Analysis of the distribution of the study array according to the participation in the traffic and the damaged part of the spine**

<table>
<thead>
<tr>
<th>Part of the spine</th>
<th>Drivers</th>
<th>Passengers</th>
<th>Pedestrians</th>
<th>General array</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%*</td>
<td>%**</td>
<td>rank</td>
<td>%*</td>
</tr>
<tr>
<td>CS</td>
<td>45.33</td>
<td>53.85</td>
<td>1</td>
<td>32.37</td>
</tr>
<tr>
<td>TS</td>
<td>40.21</td>
<td>33.33</td>
<td>2</td>
<td>28.86</td>
</tr>
<tr>
<td>LS</td>
<td>29.52</td>
<td>26.50</td>
<td>3</td>
<td>30.48</td>
</tr>
<tr>
<td>The combination factor</td>
<td>1.14</td>
<td></td>
<td></td>
<td>1.14</td>
</tr>
</tbody>
</table>

Notes: here and in Table 2: * — number of victims in the group based on damaged parts of the spine; ** — number of victims in the group based on traffic participation.
receive damage of the first part. Among the combinations of injuries to the spine, the combination of injuries to the thoracic and lumbar parts has the highest specific weight. Damage to the cervical and lumbar parts has the lowest specific gravity. Damage to all parts of the spine occurs in 1.68%.

In order to verify the influence of the sign of participation in traffic on the occurrence of spinal injuries, we conducted an analysis of the distribution of the study array by the sign of the damaged spine in groups formed by the sign of participation in traffic. The analysis data are given in Table 2.

The analysis of the data from Table 2 revealed that the highest specific weight among drivers, i.e., the first ranking place is occupied by damage to the cervical spine — 41.31%. In the second place are victims with damage to the lumbar spine (27.17%). In the last ranking place — victims with simultaneous damage to the cervical and lumbar spine and cervical, thoracic, lumbar spine, 1.09% each. The ratio of the maximum to the minimum indicator is 37.89, which suggests a very high dissipation of the distribution of the array of drivers.

Among traffic participants “passengers” the largest percentage has damage to the lumbar spine — 40.45%. Damage to the cervical spine ranks second — 25.84%. The lowest specific weight among pedestrians is a combination of damage to the thoracic and lumbar spine and a combination of cervical, thoracic, lumbar spine — 3.37% each. The combination of damage to the cervical and lumbar parts of the spine in a reliably significant amount was not detected in the passengers. The ratio of the maximum to the minimum indicator is 12.0, which suggests a high dissipation of the distribution of the array of passengers.

Damage to the cervical spine has the highest specific weight in injured pedestrians — 48.73%, in the second place — damage to the chest, 22.22%. Pedestrians with a combination of damage to three parts of the spine have the lowest specific gravity — 0.85%. The ratio of the maximum to the minimum indicator is 57.33, which suggests a very high dissipation of the distribution of the array of pedestrians.

On the other hand, damage only to the cervical spine among road users occurs most often in pedestrians — 48.31%, the least — in passengers, 19.49%. The ratio is 2.48.

Pedestrians also have the highest specific weight — 41.93%, drivers have the lowest specific weight — 27.42%. The ratio is 2.53.

Among the victims with damage to the lumbar spine only, passengers have the highest specific weight — 45.00%, the lowest — pedestrians, 23.75%. The ratio is 1.89.

Drivers and passengers have the highest percentage of combined injuries in victims of both the cervical and thoracic spine — 38.46% each, and pedestrians — 23.08%. The ratio is 1.67.

In the distribution of the specific weight of victims with damage to the cervical and lumbar spine, pedestrians are in the first place — 66.67%, drivers are in the second place, 33.33%, and among passengers, simultaneous damage to these parts was not observed. The ratio is 2.0.

The highest specific weight of the simultaneous combination of damage to the thoracic and lumbar spine is observed in pedestrians — 52.94%, the smallest — in passengers, 17.65%. The ratio is 3.0.

Damage to three parts of the spine at the same time is most often observed in passengers — 60.00%. Drivers and pedestrians account for 20.00% of such damages. The ratio is 3.0.

Summarizing the above, we can conclude that the sign of participation in traffic has a significant impact on the occurrence of damage to a specific section of the spine and a combination of sections, especially this effect is expressed in active traffic participants.

A polychoric analysis of the Table 2 was carried out, which made it possible to establish that there is a positive (\( \phi^2 = 0.08 \), pronounced (\( C = 0.28 \)) and highly probable relationship (\( \chi^2 = 24.95 \)) between the sign of participation in movement and the damaged part of the spine, and the above positions are within the field of probability.

To determine the severity of spinal cord injury, as indicated above, we used the standardized NISS scoring system, assessing the severity of spinal cord injury only. The data of the analysis of the distribution of the study array according to the severity of the damage in the groups by parts of the spine are given in Table 3.

Analysis of the data in the Table 3 indicates that most often victims of road accidents receive a light injury, which is estimated at 1 point (41.45%), in the second place — injuries with a severity of 16 points (26.66%), the lowest specific weight is given to victims with the severity of spinal cord injuries at 9 points — 8.99%. The ratio of the maximum

### Table 2. Analysis of the distribution of the study array according to the characteristic of the damaged spine in groups of traffic participants

<table>
<thead>
<tr>
<th>Part of the spine</th>
<th>Participation in Traffic</th>
<th>General array</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Drivers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Passengers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pedestrians</td>
<td></td>
</tr>
<tr>
<td><strong>%</strong></td>
<td><strong>%</strong></td>
<td><strong>%</strong></td>
</tr>
<tr>
<td><strong>%</strong></td>
<td>rank</td>
<td><strong>%</strong></td>
</tr>
<tr>
<td><strong>%</strong></td>
<td></td>
<td><strong>%</strong></td>
</tr>
<tr>
<td><strong>%</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS</td>
<td>32.20</td>
<td>41.31</td>
</tr>
<tr>
<td></td>
<td>19.49</td>
<td>25.84</td>
</tr>
<tr>
<td></td>
<td>48.31</td>
<td>48.73</td>
</tr>
<tr>
<td>TS</td>
<td>27.42</td>
<td>18.48</td>
</tr>
<tr>
<td></td>
<td>30.65</td>
<td>21.35</td>
</tr>
<tr>
<td></td>
<td>41.93</td>
<td>22.22</td>
</tr>
<tr>
<td></td>
<td>20.81</td>
<td>3</td>
</tr>
<tr>
<td>LS</td>
<td>31.25</td>
<td>27.17</td>
</tr>
<tr>
<td></td>
<td>45.00</td>
<td>40.45</td>
</tr>
<tr>
<td></td>
<td>23.75</td>
<td>16.24</td>
</tr>
<tr>
<td></td>
<td>26.84</td>
<td>2</td>
</tr>
<tr>
<td>CS + TS</td>
<td>38.46</td>
<td>5.43</td>
</tr>
<tr>
<td></td>
<td>38.46</td>
<td>5.62</td>
</tr>
<tr>
<td></td>
<td>23.08</td>
<td>2.56</td>
</tr>
<tr>
<td></td>
<td>4.36</td>
<td>5</td>
</tr>
<tr>
<td>CS + LS</td>
<td>33.33</td>
<td>1.09</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>66.67</td>
<td>1.71</td>
</tr>
<tr>
<td></td>
<td>1.01</td>
<td>7</td>
</tr>
<tr>
<td>TS + LS</td>
<td>29.41</td>
<td>5.43</td>
</tr>
<tr>
<td></td>
<td>17.65</td>
<td>3.37</td>
</tr>
<tr>
<td></td>
<td>52.94</td>
<td>7.69</td>
</tr>
<tr>
<td></td>
<td>5.70</td>
<td>4</td>
</tr>
<tr>
<td>CS + TS + LS</td>
<td>20.00</td>
<td>1.09</td>
</tr>
<tr>
<td></td>
<td>60.00</td>
<td>3.37</td>
</tr>
<tr>
<td></td>
<td>20.00</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>1.68</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>
The cervical spine has the greatest influence on the severity of injuries, the lumbar spine has a slightly smaller effect, and the thoracic spine has the least influence.

A polychoric analysis of the Table 3 was carried out, which made it possible to establish that there is a positive ($\chi^2 = 0.13$), pronounced ($C = 0.34$) and highly probable relationship ($\chi^2 = 45.18$) between the sign of participation in traffic and a damaged spine, and the above positions are within the field of probability.

In order to complement the results of the analysis presented above, we considered it expedient and necessary to conduct an analysis of the impact of damage to a specific part of the spine as a component of polytrauma on the outcome of the traumatic process in road accident victims. For this, the distribution of the study array was carried out according to the characteristic of the damaged spine in effective groups. The results of the analysis are given in Table 4.

Data in the Table 4 indicate that there is a fairly significant difference in the indicators of the outcome of the traumatic process in road accident victims.

Among the survivors, the highest specific weight is given to victims with cervical spine injuries — 39.03 %, and the lowest — with thoracic spine injuries, 29.03 %. The ratio of the maximum to the minimum indicator is 1.34, which suggests a low dissipation of the distribution.

Among the victims with a negative course of the traumatic process, the largest specific weight has victims with

### Table 3. Analysis of the distribution of the study array according to the severity of damage in groups by spine parts

<table>
<thead>
<tr>
<th>Parts of the spine</th>
<th>Cervical spine</th>
<th>Thoracic spine</th>
<th>Lumbar spine</th>
<th>General array</th>
</tr>
</thead>
<tbody>
<tr>
<td>NISS score</td>
<td>%*</td>
<td>%**</td>
<td>rank</td>
<td>%*</td>
</tr>
<tr>
<td>1</td>
<td>52.45</td>
<td>53.96</td>
<td>1</td>
<td>18.18</td>
</tr>
<tr>
<td>4</td>
<td>54.55</td>
<td>12.95</td>
<td>4</td>
<td>33.33</td>
</tr>
<tr>
<td>9</td>
<td>12.90</td>
<td>2.88</td>
<td>5</td>
<td>35.48</td>
</tr>
<tr>
<td>16</td>
<td>20.65</td>
<td>13.67</td>
<td>3</td>
<td>40.22</td>
</tr>
<tr>
<td>25</td>
<td>50.00</td>
<td>16.56</td>
<td>2</td>
<td>30.43</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Notes: * — number of victims in a group based on the damaged part; ** — number of victims in the group by severity of damage.
damage to the cervical spine, the smallest — with damage to the lumbar spine, 19.35 %. The ratio of the maximum to the minimum indicator is 3.0, which suggests moderate dissipation of the distribution.

The highest mortality rate occurs with damage to the cervical spine — 12.95 %, the lowest mortality — in victims with damage to the lumbar spine, 5.71 %. Attention is drawn to the tendency of the mortality rate to decrease in the causal direction of the anatomical sign of damage.

Thus, the vertebral component of polytrauma has a significant impact on the outcome of the traumatic process. Damage to the cervical spine is especially dangerous for the occurrence of a negative result of the traumatic process.

A polychoric analysis of the Table 4 was carried out, which made it possible to establish that there is a positive ($\chi^2 = 0.0128$), moderate ($C = 0.1124$) relationship between the sign of participation in traffic and the damaged part of the spine. But the value of the probability indicator ($\chi^2 = 4.37$) suggests a significant influence of other factors, which is quite natural in this case, since spinal damage is only one of the components of polytrauma as a result of a road accident, and the above-mentioned positions are within the field of probability, taking into account the influence of other factors.

**Discussion**

The data of our study on the importance of spinal injuries due to road accidents are in the general trend of global research on spinal injuries, in particular due to road accidents [7–9]. It is worth noting that, according to research, in the countries of the European Union, in particular in the Netherlands, road accidents are the second most common cause of spine injuries [10]. Such data at the appropriate level of probability do not exist in Ukraine yet and require further research.

The analysis of the clinical and nosological structure of the spine in road accident victims deserves special attention. In contrast to developed countries, where damage to the lumbar spine prevails — 64.8 % [10], in our country, damage to the cervical spine is in the first place, 46.64 %, which on average, according to the specific gravity, is 20.25 % more than in developed countries. A careful analysis of cases proved that such a high specific weight of cervical spine injuries in the clinical and nosological structure of spine injuries in road accident victims is due to non-compliance with safety rules, primarily — non-use of seat belts by drivers and passengers, and is confirmed by a high specific weight of cervical spine injuries in road traffic participants (53.58 and 48.91 %, respectively). Thus, in order to prevent damage to the cervical spine (which is the most dangerous for the victim’s life), it is necessary to strengthen preventive work in the direction of proving the strict necessity of using seat belts [11, 12].

Particular attention should be paid to multiple injuries of the spine in victims of road accidents, the specific weight of which, according to our research, is 12.75 %, which is more than twice the rate in developed countries [13–15]. An unconditional original feature of this study is a thorough analysis of the clinical and anatomical structure of spine damage due to road accidents in groups of traffic participants, including pedestrians, and in open and accessible sources of scientific and special information, we did not find data on multiple spinal damage depending on the sign of participation in traffic.

It is worth noting that the largest specific weight of multiple spine injuries is found in drivers and pedestrians (13.04 and 12.81 %, respectively), which indicates to some extent the peculiarities of the mechanism of spine injury by active road users. This issue requires further research using technical modeling tools.

A separate issue is the severity of spinal injuries in road accident victims. According to standardized assessment systems, such injuries in Ukraine are more severe. As mentioned above, we used the standardized New Injury Severity Score evaluation system. According to the assessment, most injuries are relatively mild (up to 4 points on the scale) and do not pose a direct threat to the victim’s life (51.09 %), which is significantly lower than the rate in developed countries [16–20]. As determined by the analysis, this is due to the high specific weight of victims with a severe — 16 points (26.66 %) and extremely severe — 25 points (13.33 %) injury, which is a direct threat to the victim’s life.

An integral analysis of the severity of spinal damage depending on its clinical and anatomical department is unprecedented. According to these data, it was established that the severity of the damage probably correlates with the substrate of the damage. Light injuries, which do not pose a direct threat to the life of the victims, are more typical for the cervical spine — up to 55 % of the group according to the severity of the injury. Severe injuries (16 points) are most characteristic of the thoracic spine — up to 40 %. An extremely severe injury (25 points) is characteristic of the cervical spine — up to 50 %. The results of this study require further verification in order to determine and establish the strength and intensity of the impact of the traumatic agent.

**Table 4. Analysis of the distribution of victims according to the characteristic of the damaged spine in the effective groups**

<table>
<thead>
<tr>
<th>Parts of the spine</th>
<th>Groups</th>
<th>Survivors</th>
<th>The dead</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%*</td>
<td>%**</td>
<td>rank</td>
</tr>
<tr>
<td>CS</td>
<td>87.05</td>
<td>39.03</td>
<td>1</td>
</tr>
<tr>
<td>TS</td>
<td>92.78</td>
<td>29.03</td>
<td>3</td>
</tr>
<tr>
<td>LS</td>
<td>94.29</td>
<td>31.94</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Notes: * — number of victims in the group based on the injured part of the spine; ** — number of victims in the effective group.
The results of the study of the severity of damage to the spine as a result of road accidents have not only medical, but also medical and social significance, as they determine the volume and severity of the medical and social consequences of traffic accidents as man-made emergencies. This is also a fundamental basis for the formation of programs for the prevention of damage caused by road accidents and the minimization of the consequences of an emergency situation, primarily the death and disability of victims, which were cited in previous studies [21].

The advantage of our study and, at the same time, a promising direction for the continuation of the research on traffic injuries is the analysis of injuries in groups that are formed based on participation in traffic.

We considered it expedient to divide the affected road users into active road users who can influence the occurrence of a road accident, its nature, and to some extent the volume — drivers and pedestrians — and passive participants who cannot affect the road accident in any way (passengers). From our point of view, this approach is promising in both scientific and practical aspects and needs further development.

Summarizing the above research results, it can be determined that spinal damage is an important component of polytrauma as a result of road accidents, which have quite specific clinical and anatomical features, including a combination of damage to two or more parts of the spine. A significant and probable influence of the sign of participation of victims in road traffic on the clinical and anatomical structure of vertebral road traffic injury and indirectly — on the severity of the damage and the outcome of the course of the traumatic process in the victims was also established.

The results of our research make a certain contribution to solving the problem of road traffic injuries and should be the basis for further research in this direction, primarily the prevention of serious consequences.

**Limitations of the study.** The exclusion criterion was injuries due to rail injuries and injuries due to road accidents involving two-wheeled vehicles for the following reasons: the special nature and genesis of the damage (this requires separate studies) and the small amount of such injuries in the total array — up to 2%. Certain shortcomings of our study are the limited nature of the model and the limited features and criteria of analysis. This is due to objective factors, the elimination of which is beyond the competence of the authors, but it does not affect the completeness and reliability of the results of our research.

**Conclusions**

Spinal cord injury is an essential component of polytrauma and occurs in 17.98% of traffic accident victims. In the structure of injured road users with a vertebral component of polytrauma as a result of a road accident, drivers have the highest specific weight — 37.05%, passengers — 32.13%, and pedestrians — 30.82%, that is, the distribution is conditionally uniform, with a slight dissipation of the distribution. The cervical spine is most often damaged — 46.64% of cases, thoracic — 32.55%, lumbar — 35.23%, while the probable influence of the sign of participation in road traffic on the occurrence of damage to a specific part of the spine has been established. The dependence of the severity of damage on the anatomical feature (department of the spine) was established. The most severe injuries occur with injuries to the thoracic spine — 62.63%. The significant influence of the anatomical sign of damage on the outcome of the traumatic process has been established, the most negative effect is caused by damage to the cervical spine (lethality rate 12.95%). However, mortality is influenced by other factors.

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