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FORENSIC-MEDICAL EVALUATION OF INJURIES RECEIVED DURING OPERATION OF PERSONAL MOBILITY DEVICES: THE STATE OF THE PROBLEM (REVIEW)

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Abstract. The article analyzes literature data on modern aspects of traffic injury. Some factor criteria for traffic injury are singled out and identified how they have changed with the modernization of modern vehicles. The data concerning injuries associated with the use of modern personal mobility devices, such as kick-scooters, electric scooters, electric unicycles, electric hover boards, skateboards, roller skates and similar devices were analyzed. Prospects for studying this problem and its value for modern forensic traumatology are outlined. Traffic injury is one of the most common problems today, as it is one of the main causes of death of the young population and ranks first among the causes of death due to injury. In particular, on the territory of Ukraine, the number of killed in car accidents each year reaches 400,000. This scientific research was carried out with the aim of conducting an analysis of literary assets on the problem of studying car injuries associated with the operation of modern electric means of personal mobility. Due to new technological features of modern vehicles, the appearance of new types of transportation facilities, such as kick-scooters, electric scooters, electric unicycles, electric hover boards, skateboards, roller skates and similar devices, except for traditional issues, answers to which are widely covered in the fundamental works of the last century, new questions are posed to the experts, conditioned new, previously undescribed signs of traffic injury the requirements to the level of the scientific validity of the expert's conclusions are growing, which require appropriate methods of expert research. However, despite the full range of data provided, the problem associated with the study of injuries received on kick-scooters, electric scooters, electric unicycles, electric hover boards, skateboards, roller skates and similar devices is little studied. This type of vehicle was first introduced in November 2017 and become quite common today. The main task of this type of vehicle is to facilitate travel in large cities. Despite the ease and accessibility of operation, this type of transport is quite fast and can pose a danger to drivers and other road users. Therefore, forensic experts received new challenges today related to the study of the complex of injuries in drivers and pedestrians resulting from the operation of electric scooters, the mechanism of their formation, the study of signs of characteristic injuries to the driver and pedestrians' data. However, despite all the work done, its results in most cases are statistical in nature and do not provide a comprehensive picture of the mechanism of injury and forensic-medical evaluation of the consequences of injury. There is also an open question related to the study of the characteristic's injuries of drivers and pedestrians, the establishment of differential traumatic criteria specific to the driver and pedestrians. There is also an open question related to the study of the feature of injuries and establishment of differential traumatic criteria specific to drivers and pedestrians. Despite the availability of literature on this issue, the rapid spread of personal mobility devices on the roads, as well as the increasing number of related injuries, initiates the arising of new expert tasks that arise during forensic-medical examinations of this injury and outlines new prospects for studying this problem in the context of forensic medicine.

Keywords: traffic accident, a complex of injuries, forensic medicine.

Introduction. Traffic injury is one of the most common problems today, as it is one of the main causes of death of the young able-bodied population and ranks first among the causes of death due to injury. In particular, on the territory of Ukraine, the number of dead in traffic accidents each year ranged from 4,000 people. Due to new technological features of modern vehicles, the appearance of new types of transportation facilities, such as kick-scooters, electric scooters, electric unicycles, electric hover boards, skateboards, roller skates and similar devices, except for traditional issues, answers to which are widely covered in the fundamental works of the last

century, new questions are posed to the experts, conditioned new, previously undescribed signs of traffic injury the requirements to the level of the scientific validity of the expert's conclusions are growing, which require appropriate methods of expert research [1].

Purpose: this scientific research was carried out with the aim of conducting an analysis of literary assets, on the problem of studying car injuries associated with the operation of modern electric means of personal mobility.

Accordingly, the number of criminal proceedings to investigate traffic accidents is growing. At the same time, the requirements for the quality of investigations in

this category of cases have also increased, in particular to forensic examination (forensic-medical, as well as complex forensic-medical and transport-traffic types of examination). As practice shows, except for traditional issues, answers to which are widely covered in the fundamental works of the last century ([2-10], new questions are posed to the experts, due in particular to the technological features of modern vehicles and appearance of new type of transport [11-13].

However, despite the full range of data provided, the problem associated with the study of injuries received on kick-scooters, electric scooters, electric unicycles, electric hover boards, skateboards, roller skates and similar devices is little studied. This type of vehicle was first introduced in November 2017 and become quite common today. The main task of this type of vehicle is to facilitate travel in large cities. Despite the ease and accessibility of operation, this type of transport is quite fast and can pose a danger to drivers and other road users [14-15]. Therefore, forensic experts received new challenges today related to the study of the complex of injuries in drivers and pedestrians resulting from the operation of electric scooters, the mechanism of their formation, the study of signs of characteristic injuries to the driver and pedestrians [16-21].

This problem is partially studied in the works of foreign scientists [22-28]. Swiss researchers Papoutsi S, Martinolli L, Braun C, Exadaktylos A, based on a retrospective study of injuries caused by electric bicycles during 2012-2013, provided statistics on the incidence of injuries to different parts of the body, namely: head/neck injuries were the most common and amounted to 27.4%; injuries of the upper extremities - 22.6%, face - 19.3%, injuries of the chest - 11.3%, abdomen - 9.7%, lower extremities - 6.4%. In particular, the most common head/neck injuries were simple traumatic brain injury (14.9%) and subarachnoid hemorrhage (7.4%). As for facial injuries, the most common were tears lacerations (10.4%) and fractures of the facial skull (4.5%). Clavicle fractures (11.9%) and rib fractures (6.0%) were also common.

However, the obtained data are statistical in nature and do not create a holistic view of the mechanism of this injury, the phase of injury, they can not establish identification criteria specific to the driver and pedestrian [29].

It is also worth noting a group of Chinese scientists Feng Z., Raghuvanshi RP, Huang Z. Xu. D., Zhang C., Jin T. (2010), who retrospectively studied injuries, including fatalities, during 2004-2008 related to the use of electric bicycles. The authors found an annual increase in the number of victims of the use of electric bicycles by 2.7 per 100 thousand populations and noted a lower risk of injury when using passive protective equipment [30].

Another group of American researchers Ashurst J, Wagner B. (2015), studied injuries related to the use of a personal vehicle Segway® Personal and found that 81% of patients had fractures of the lower extremities. The authors also noted that such injuries are classically different from injuries received during the operation of electric scooters, in the case of which the injury of the upper extremities was more common [31].

The study of the injury received as a result of operation of the electric scooter was engaged Tarak K., Trivedi M., Charles L., Antonio A.L.M. (2019). In their study, the researchers retrospectively examined cohort the medical records of 249 patients from Southern California

who applied to the emergency department with injuries related to the use of electric scooters in the period from September 1, 2017 to August 31, 2018. It was found that the most common injuries were fractures (31.7%), traumatic brain injuries (40.2%) and soft tissue injuries (27.7%) [32].

Worth noting is a scientific study conducted by American researchers Nikan K. Namiri, Hansen Lui, Thomas Tangney, et al. The authors investigated the data of the National Electronic Trauma Monitoring System (NEISS) for the United States of America (<https://www.cpsc.gov/Research--Statistics/NEISS-Injury-Datay>) in the period from 2014 to 2018. There has been a sharp increase in injuries and hospitalizations associated with the use of electric scooters between 2017 and 2018. Almost one third of patients received a head injury (32%). Injuries to the upper and lower extremities were also common (32%). The most common injuries in this group were fractures (27%), bruises, abrasions (23%) and lacerations (14%) [33].

However, despite all the work done, its results in most cases are statistical character and do not provide a comprehensive picture of the mechanism of injury and forensic-medical evaluation of the consequences of injury. The related question to the study of the specific injuries of drivers and pedestrians, the establishment of differential traumatic criteria specific to the driver and pedestrians.

The studies of the feature of injuries and establishment of differential traumatic criteria specific to drivers and pedestrians are sensitive.

Due to increase the number of personal mobility devices for movement, their users frequently violate traffic rules and receive different types of injuries. The results of these events cause the problem of determining the administrative and legal status of road users [34-36] and accordingly appear a problem of classification of traffic injuries in connection with the personal mobility devices.

Another poorly studied problem for the forensic society is the qualification of injuries received during the operation of electric self-balancing scooters (gyroboards) [38-43]. A group of scientists Xu J., Shang S., Qid H., Yue G., Wange Y. are studying this problem [38]. The authors found that drivers of self-balanced scooters can receive serious brain injuries in possible accidents in collisions with vehicles, not only from throwing on the car hood and hitting the windshield, but also from falling and secondary contact with the ground. At this article, by simulating the collision of a virtual vehicle and a self-balancing scooter partially covers the mechanism of injury. It was analyzed kinematic models of scooter drivers' injuries under different contact conditions, such as different speeds of the vehicle at the time of collision, collisions at different angles and different anthropometric parameters of the scooter driver. In addition, were reconstructed processes using proven models and important contusion parameters (such as coup or counter-pressure, von Mises stress, and maximum shear stress) are isolated and analyzed to assess the gravity of a regional contusion. The results show that the risk of traumatic brain injury increases with the speed of the vehicle and the speed of the self-balancing scooter.

The study of the mechanism of infliction of cranio-cerebral injuries in drivers of self-balancing scooters in a frontal collision with a car also engaged Shang S., Zheng Ya., Shen M., Yang Xi., Xu J. [43]. The results of the study show a positive correlation between the speed of the car

and the speed of impact on the windshield (linear and angular) and accordingly, the gravity of traumatic brain injury.

Conclusions. Despite the availability of literature on this issue [44-49], the rapid spread of personal mobility devices on the roads, as well as the increasing number of related injuries, initiates the arising of new expert tasks that arise during forensic-medical examinations of this injury and outlines new prospects for studying this problem in the context of forensic medicine.

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**СУДОВО-МЕДИЧНА ОЦІНКА ТРАВМ,
ОТРИМАНИХ НА ЕЛЕКТРИЧНИХ
САМОКАТАХ, ВЕЛОСИПЕДАХ,
ПЕРСОНАЛЬНИХ ЕЛЕКТРОННИХ
ТРАНСПОРТЕРАХ: СТАН ПРОБЛЕМИ
(ОГЛЯД ЛІТЕРАТУРИ)**

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Резюме. У статті наведено аналіз літературних даних стосовно сучасних аспектів транспортної травми. Виділено окремі факторні критерії та визначено, як вони змінилися у зв'язку з модернізацією сучасних транспортних засобів. Проаналізовано сучасні дані стосовно травми, пов'язаної з використанням електричних засобів персональної мобільності, таких як електричні скутери, електричні велосипеди та персональні електронні транспортери та інші. Визначені перспективи вивчення даної проблеми у зв'язку з появою новітніх видів транспортних засобів на автодорогах. Виділені проблемні судово-медичні питання, пов'язані з вивченням механізму утворення даної травми та експертної оцінки її наслідків. Окреслені перспективи вивчення даної проблеми та її цінність для сучасної судово-медичної травматології.

Дорожньо-транспортний травматизм – одна з найактуальніших проблем сьогодення, оскільки є однією з основних причин смертності молодого працездатного населення та займає перше місце серед причин смертності внаслідок травм. У зв'язку з новими технологічними особливостями сучасних транспортних засобів, появою нових видів електричних засобів персональної мобільності, крім традиційних питань, відповіді на які широко висвітлені у фундаментальних працях минулого століття, перед фахівцями ставляться нові питання, обумовлені появою раніше неописаних ознак дорожньо-транспортної травми; зростають вимоги до рівня наукової обґрунтованості експертних висновків. Незважаючи на наявність літературних даних з цього питання, стрімке розповсюдження електричних засобів персональної мобільності на дорогах, а також збільшення кількості травм, пов'язаних з їхньою експлуатацією, ініціює появу нових експертних завдань, які постають під час виконання судово-медичних експертиз, та відкриває нові перспективи для вивчення.

Ключові слова: транспортний травматизм, комплекс травм, судова медицина.

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