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Telerehabilitation model in operated individuals with upper limb and chest trauma due to road traffic accidents

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Abstract. Implementing telerehabilitation methods for individuals injured in road traffic accidents with upper limb and chest trauma is critically essential for improving patients' functional recovery, ensuring effective interaction between the patient and the rehabilitation specialist, and reducing overall time and costs associated with rehabilitation. The purpose of the study is to assess the effectiveness of applying telemedicine monitoring tools and the developed rehabilitation model in the functional recovery of operated patients with upper limb and chest trauma. The study included patients who underwent surgery due to upper limb and chest trauma resulting from road traffic accidents. Patients were divided into two groups: retrospective (186 patients) underwent standard rehabilitation, while the main group (62 patients) was involved in the developed telerehabilitation model programme. Functional outcomes were analysed using the qDASH scale, including the average time spent by patients on rehabilitation per day, the number of patient visits to the medical facility within 3 weeks, and the total time spent by the rehabilitation specialist per patient over 3 weeks. After rehabilitation, over 80% of patients in both groups demonstrated positive and satisfactory results, with a slight advantage of excellent results in the main group (12.90% versus 9.14%). Patients in the main group spent more time on their rehabilitation (41+3 minutes per day) and had access to progress monitoring functions and communication with the doctor, which increased their motivation and involvement. Telerehabilitation remarkably reduced the number of required doctor visits (5±2 versus 11±3 visits) and the time spent by the rehabilitation specialist on each patient over 3 weeks (132±12 minutes versus 243±17 minutes). The average time per day spent by the injured individuals on rehabilitation exercises in the main group was 41±3 minutes, while in the retrospective group, it was 31±7 minutes. The telerehabilitation model is an equivalent alternative and complement to standard rehabilitation methods. Its advantages include increased motivation for performing rehabilitation exercises and the ability to conduct training in a distance-controlled environment

Keywords: polytrauma surgery; telemedicine; rank analysis; retrospective study

INTRODUCTION

According to recent studies, road traffic accidents are a key cause of mortality from trauma [1, 2]. In Ukraine, the percentage of fatalities among all injured in road traffic accidents (RTAs) varies between 15-17%, while in European countries, this figure is 3-4%, and in the United States, it is 2-3% [3].

The majority of research on polytrauma resulting from road traffic accidents focuses on the principles of emergency care for the injured to reduce the mortality rate. However, a retrospective analysis of 9012 RTA victims by E. Berkeveld *et al.* [4] concluded that achieving optimal outcomes for this group of patients does not depend on the time of prehospital transport but requires timely implementation of individualised treatment, adherence to clinical protocols, careful dynamic observation, and professional rehabilitation after discharge. A study conducted in Croatia by J. Kovačević *et al.* [5] observed a decrease in self-care and employment opportunities among 200 out of 640 RTA victims, leading to a lower quality of life. It also caused a significant economic burden for their families.

With the development of information technologies, telemedicine can address these issues by improving access to healthcare professionals and communication in the medical field and reducing logistical costs. A study by

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K. Moulaei *et al.* [6] demonstrated that using a portable device can provide continuous monitoring of patient's physiological parameters and detect real-time changes that can be automated and less noticeable to medical personnel.

In the clinical study "MERLIN" by S.G. Rozevink *et al.* [7], the effectiveness of using portable devices for home-based rehabilitation to address economic issues, particularly by reducing costs and travel time for patients, was analysed. It also allowed rehabilitation specialists to conduct classes more effectively simultaneously with several patients since each could interact with their own device and be in a convenient place. It was noted that the effectiveness of remote rehabilitation was not inferior to conventional methods. However, such scientific observations mainly relate to the telerehabilitation of patients after strokes and do not fully reveal the importance of using portable devices for the remote rehabilitation of RTA victims [8, 9].

According to A.I. Tsvyakh *et al.* [10], one of the main advantages of using portable telerehabilitation systems is the improvement of musculoskeletal functions. In addition, it increases patients' interest and motivation for performing rehabilitation exercises. It also leads to greater commitment to rehabilitation procedures and more active participation in treatment procedures. This is particularly relevant for caring for patients with polytrauma associated with upper limb and chest injuries [11].

The main focus of most studies on RTA victims is on immediate medical care, while long-term rehabilitation remains less explored. It is important to pay attention to the quality of life issues faced by surviving victims after RTAs and their families, especially in the context of inadequate rehabilitation. In this case, telemedicine can play a key role in improving care for this category of patients. Modern research highlights the substantial potential of telerehabilitation in the treatment and recovery of patients after various types of injuries. Numerous publications demonstrate that these approaches not only improve the functional status of survivors but also provide greater accessibility and effectiveness of rehabilitation services, patient engagement in the recovery process, while reducing economic and time costs. However, the effectiveness of telerehabilitation in RTA survivors with upper limb and chest injuries is not sufficiently highlighted. The purpose of this study is to evaluate the effectiveness of telemedicine monitoring tools and the developed rehabilitation model in the functional recovery of patients with upper limb and chest injuries.

MATERIALS AND METHODS

The medical records of hospitalised patients who underwent treatment at the municipal non-profit enterprise "Ternopil City Emergency Hospital" from 2015 to 2020 were analysed, following a protocol approved by the hospital's ethics committee. The study materials included 186 medical records of patients with upper limb and chest injuries, forming the retrospective group. In the main group, 62 patients with upper limb and chest injuries were sequentially enrolled in the study over two years at the same hospital – from September 2020 to November 2022. The study included survivors aged 18 and older who were admitted to the emergency department of the hospital after road traffic accidents. Patients with injuries not related to a motor vehicle were excluded. Both groups were compared by age, gender, occupation, nature of injuries, injury severity score, and evaluated the functional status of the limb, the average duration of rehabilitation per day, number of patient visits to the medical facility over 3 weeks, and the total time spent by the rehabilitation specialist on one patient over 3 weeks.

To analyse the effectiveness of rehabilitation in both groups, the QuickDASH questionnaire [12], which is a universal tool for diagnosing functional limitations of the arm, shoulder, and hand, was used. This method includes 11 criteria that allow assessing the physical abilities and symptoms in patients with single or combined upper limb and shoulder girdle injuries. Each question has 5 possible answers, reflecting the degree of difficulty in performing tasks (1 – I can perform the task easily; 2 – I have slight difficulty; 3 – I have moderate difficulty; 4 – I have a lot of difficulty; 5 – I am unable to perform the task). The overall score of the answers is converted into points using the following formula:

$$QuickDASH = 25 * (\frac{(sum\ of\ n\ responses)}{n} - 1), \qquad (1)$$

where n – number of responses. It should be noted that the QuickDASH score cannot be calculated if more than 1 item is missing. Thus, 0 points correspond to full function recovery, while 100 points indicate severe disability.

All 186 patients from the retrospective group underwent conventional rehabilitation procedures for 3 weeks after the trauma. This group received standard methods of rehabilitation therapy. A total of 62 patients from the main group were involved in telerehabilitation for a 3-week period after the trauma and were taught a set of exercises with a developed portable device for home use. In the main group, the QuickDASH score was assessed at discharge from the hospital and after 3 weeks of telerehabilitation. In the retrospective group, the QuickDASH score was also assessed on the day of discharge from the hospital according to records in the patient's medical records. After 3 weeks, this indicator was determined based on patient surveys during visits to the doctor and using a developed Google Forms survey. All participants followed an approved rehabilitation protocol (massage, exercises, therapeutic exercises). The exercise program, which included passive and active movements – flexion, extension, and strengthening of the upper limb and chest muscles, was conducted three times a day for three weeks and aimed to improve flexibility, strength, proprioception, and neuromuscular coordination.

The conventional rehabilitation group performed the exercise program for 15 minutes, three times a day, independently at home, and visited a medical facility as needed. The exercise programme was prescribed by the same physiotherapists as in the main group, and the intensity of the exercises was determined by the physiotherapists based on the patient's symptoms. A prototype for monitoring patients with musculoskeletal disorders, developed and tested during a research project funded by the Ministry of Health of Ukraine (registration number 0119U000608, 2019-2021), was used for the study.

For the main group, a telerehabilitation model was created, which included using this prototype with sensors to track the limb's position in space and sensors to measure the angle of flexion, temperature, volume, and pulse (Fig. 1). During the study, the sensors were integrated into an orthosis fixed on the injured limb of the patients. A specially developed software complex allowed for remote monitoring of biomechanical parameters of movement, local temperature, frequency of active movements, and volume of the injured limb. During the performance of rehabilitation exercises at home, data from the patients' portable sensors were collected and transmitted to a cloud server via mobile internet and then displayed on personal smartphones or doctors' computers in digital and graphical formats. The telerehabilitation protocol included: 1) training on the use of the prototype and attachment of the portable device to the affected limb, as well as the use of special software; 2) performing home exercises, including passive flexion and extension of the upper limb; 3) active flexion and extension of the upper limb. In addition, all study participants underwent training on determining pain intensity using a 10-point visual analogue scale.

Figure 1. Developed prototype with sensors
Source: photographed by the author

In the telerehabilitation group, patients were provided with instructions for using the prototype and performing the exercise program three times a day for 15 minutes under remote monitoring. Qualified physiotherapists provided patients with consultations and recommendations regarding their progress in performing exercises, maintaining an active daily routine, and alleviating symptoms using text messages and phone calls. Rehabilitologists also monitored patients' performance of home exercises and, if necessary, adapted the load programme according to their condition and needs.

The study was conducted in accordance with the principles of good clinical practice and ethical principles as required by the Helsinki Declaration [13]. To maintain confidentiality and protect patients' personal data, information about their identity was excluded from the analysis and stored in a secure electronic format with limited access. For statistical processing and comparison of the study results between groups of patients depending on the type of data and distribution law, Student's t-test, Mann-Whitney U test, and one-way analysis of variance (ANOVA) were used.

RESULTS

In the retrospective group, there were 135 (72.58%) males and 51 (27.42%) females. In the main group, there were 44 (71.97%) males and 18 (29.03%) females. The nature of the injuries was diverse in both sexes but similar in rank in both groups. Thus, among all patients, the majority of injuries were sustained by cyclists and pedestrians, regardless of gender (Table 1).

Table 1. Distribution of victims by the type of injury and gender

No.	Type of the injury	Retrospective group						Main group					
		Men			Women			Men			Women		
		Number	%	Rank	Number	%	Rank	Number	%	Rank	Number	%	Rank
1.	Cyclists	48	35.56	1	7	13.73	3	24	38.71	1	1	1.61	2
2.	Car driver	24	17.78	3	2	3.92	-	5	8.04	3	0	0	-
3.	Motorcycle driver	15	11.11	5	0	0	-	4	6.45	4	0	0	-
4.	Animal-drawn transport	3	2.22	-	0	0	-	4	6.45	4	0	0	-
5.	Passenger of the bus	1	0.74	-	2	3.92	-	0	0	-	1	1.61	4
6.	Passenger of the car	17	12.59	4	11	21.57	2	1	1.61		4	6.45	3
7.	Pedestrian	27	20.00	2	29	56.86	1	6	9.68	2	12	19.35	1
8.	Total	135			51			44			18		

Source: compiled by the author

However, it is necessary to note the pronounced risk of injury among men in both the retrospective and main groups, both as cyclists (first rank) and pedestrians (second rank). Although women in both groups also faced risks of injury as pedestrians and cyclists, their overall frequency is lower compared to all groups where the injured individuals used transportation. Both groups show a similar percentage distribution between men and women: 72.58% in the retrospective group and 70.97% in the main group (Table 2).

Table 2. Characteristics of research groups on differences in the compared indicators

	Retrospective group	Main group	p-value
Men	135 (72.58%)	44 (70.97%)	
Women	51 (27.42%)	18 (29.03%)	

Table 2. Continued

	Retrospective group	Main group	p-value
Age 18-24 25-44 45-60 >60	 40 (21.51%) 79 (42.47%) 38 (20.43%) 29 (15.59%)	 7 (11.29%) 34 (54.84%) 13 (20.97%) 8 (12.90 %)	0.225829
Employment student works does not work pensioner	 7 (3.76%) 74 (39.78%) 81 (43.55%) 24 (12.90%)	 2 (3.23%) 27 (43.55%) 25 (40.32%) 8 (12.90%)	0.957764
ISS	21.66	21.12	

Notes: the p-value is obtained using the chi-square test for categorical variables and the analysis of variance (ANOVA test) for continuous variables
Source: compiled by the author

In terms of age distribution, the most common among patients are individuals of working age from 25 to 44 years old, comprising over 40% in both groups. Meanwhile, the smallest group consists of individuals aged 18-24 years in the retrospective group and individuals over 60 years old in the main group. When comparing the distribution by employment categories between the two groups, minor differences can be observed, but the number of injured individuals among those employed and unemployed is approximately the same and approaches 40%. Other categories, such as students and retirees, are represented in smaller numbers, with their percentage not exceeding 13% in any group. Comparing both groups by Injury Severity Score (ISS), they are practically identical. Thus, it can be argued that the retrospective and main groups were identical in such parameters as age, gender, employment, and injury severity index.

In the retrospective group, the rehabilitation programme was based on early implementation of controlled functional mobilisation, overcoming swelling using medication therapy, and prescribing physical therapy at the place of residence for three weeks. In the main group, the standard rehabilitation programme was supplemented by the use of the developed telemedicine model. Due to the remote monitoring capabilities, the physician could control the correctness of each stage of rehabilitation tasks in real time and, considering the functional state of the limb, make adjustments to the loads during exercises. At the beginning of the rehabilitation process for patients with hand injuries, a key step was the implementation of controlled functional mobilisation under telemedicine control. This played a crucial role in the remote control of the range of motion, reflected in the graph, where restrictions in bending angles up to 31 degrees and a gradual increase in local temperature to 26-27 degrees during exercises were visualised. This indicates a tendency to improve local blood circulation and enhance metabolic processes (Fig. 2).

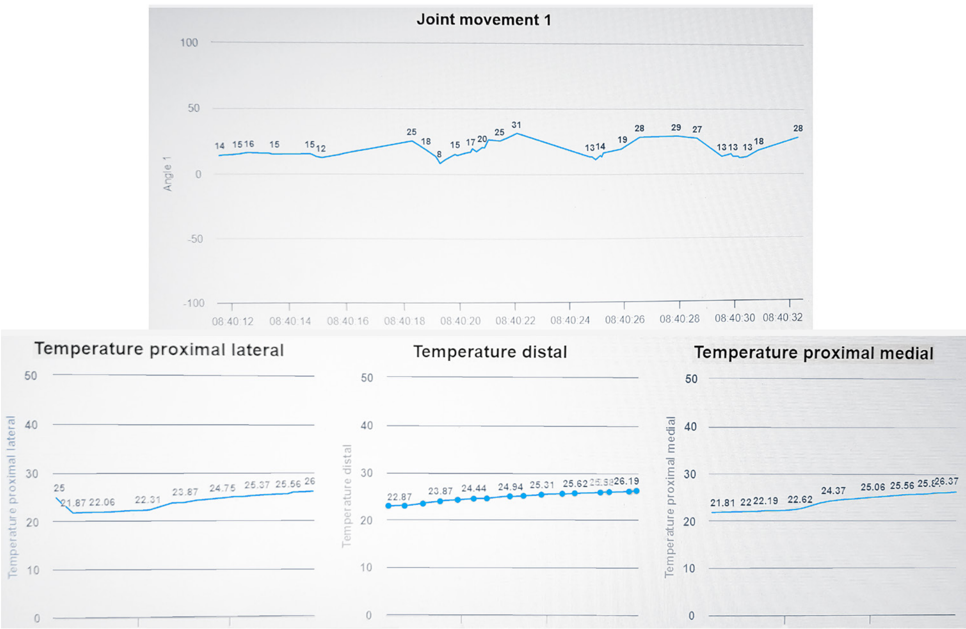

Figure 2. The first day of TV rehabilitation. Visualisation of the rehabilitation method, which makes it possible to evaluate the patient's physiological indicators using graphs
Source: photographed by the author

However, the graph clearly shows that with the increasing load during exercises on the injured arm, the local temperature does not reach the norm, and at this moment, the range of motion stops increasing. If movements are not stopped, an inflammatory process may begin. The peculiarity of the telerehabilitation programme lies in the methods of dealing with such complications, particularly with swelling due to excessive load on the limb.

On the 21st day of the telerehabilitation process, patients in the main group achieved bending angles of up to 90 degrees (Fig. 3). The graph shows the normal range of motion of the arm. It should be noted that a stable local temperature of about 31 degrees Celsius was recorded during intensive muscle work. This indicated the effectiveness of muscle work and an optimal load level, which is critically essential for restoring hand functions. Such visual data helped doctors understand the dynamics of recovery and adapt rehabilitation programmes according to each patient's individual needs. They also became a valuable tool for demonstrating patient's progress, motivating them to further active participation in rehabilitation measures.

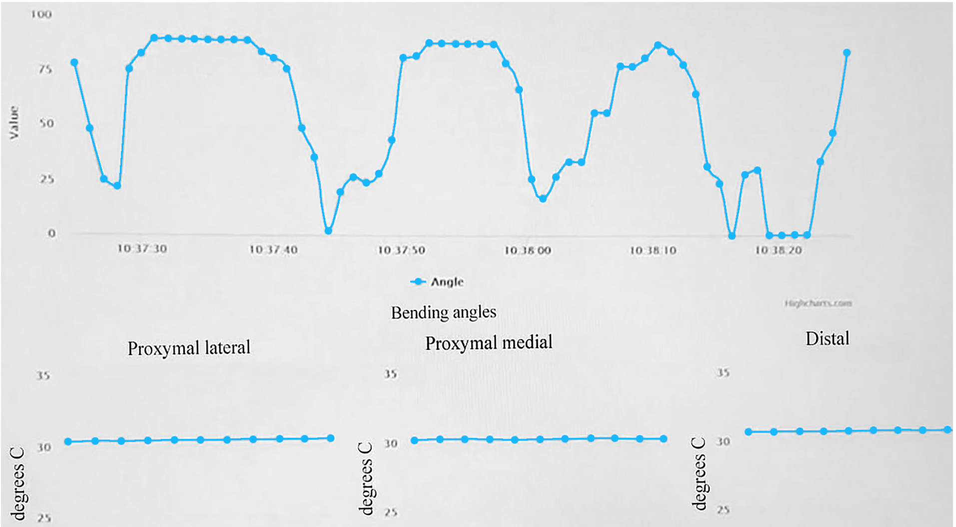

Figure 3. Changes in the range of motion and temperature on the 21st day of telerehabilitation
Source: photographed by the author

Participants in the main group also independently recorded changes in pain levels after performing exercises using a gadget. In case of increasing pain, they indicated its intensity, choosing one of three levels: mild increase in pain (1-4 points), moderate increase (5-7 points), significant increase (8-10 points). The software allowed increasing the daily load in case the pain intensity after exercises did not exceed 7 points, and there was no progressive swelling of the limb. In case of persistent increase in pain and presence of swelling, the doctor made adjustments to the rehabilitation algorithm. In the retrospective group, the patient visited a medical institution for consultation with a rehabilitation specialist in case of severe pain.

Notably, in the main group, the rehabilitation specialist systematically monitored the dynamics of the patient's clinical condition, analysing the range of motion, pain reduction, and improvement of limb function. If necessary, corrections were remotely made to the telerehabilitation protocol for optimal effectiveness. Based on the observation results of the patient's dynamics, the medical specialist could modify the rehabilitation plan, adjusting the intensity and duration of procedures, as well as integrating additional exercises to achieve progress. Functional outcomes in the retrospective and main groups were analysed using the QuickDASH scale. The average time in minutes spent by patients for rehabilitation per day, the number of patient visits to the medical facility within 3 weeks, and the total time spent by the rehabilitation specialist on one patient within 3 weeks were also evaluated (Table 3).

Table 3. Functional results in the retrospective and main groups

	Retrospective group	Main group	p-value
qDISH start of rehabilitation			
Excellent (0-25 points)	-	-	p=0.70
Good (26-50 points)	71 (38.17%)	21 (33.87%)	
Satisfactory (51-84 points)	107 (57.53%)	37 (59.68%)	
Unsatisfactory (85-100 points)	8 (4.30%)	4 (6.45%)	
qDISH 21st day of rehabilitation			
Excellent (0-25 points)	17 (9.14%)	8 (12.90%)	p=0.14
Good (26-50 points)	115 (61.83%)	45 (72.58%)	
Satisfactory (51-84 points)	46 (24.73%)	7 (11.29%)	
Unsatisfactory (85-100 points)	8 (4.30%)	2 (3.23%)	

Table 3. Continued

	Retrospective group	Main group	p-value
Average duration of rehabilitation per day	31 ± 7 min	41 ± 3 min	p < 0.005
Number of patient visits to a medical facility in 3 weeks	11 ± 3	5 ± 2	p < 0.005
The total time spent by the rehabilitator on one patient during 3 weeks	243 ± 17 min	132 ± 12 min	p < 0.005

Notes: the p-value is obtained using the chi-square test for categorical variables and the analysis of variance (ANOVA test) for continuous variables
Source: compiled by the author

The obtained data show that at the end of the rehabilitation course (after 3 weeks), in both study groups, over 80% of the injured individuals noted positive and satisfactory (26-84 points) indicators. It should be noted that about 10% of patients successfully underwent rehabilitation and achieved excellent qDASH scores (<25 points). Although these data do not differ particularly, it is necessary to note a slightly higher percentage of excellent functional outcomes in the main group – 12.90% compared to 9.14% in the retrospective group. This can be explained by the greater motivation of patients in the telerehabilitation group. It is also important to note that about 8 (4.3%) injured individuals with extremely poor functional outcomes (85-100 points) did not improve their condition in the retrospective group. In the main group, there was a slight decrease in the cohort of such injured individuals – from 4 (6.45%) at the beginning of rehabilitation to 2 (3.23%) after three weeks.

The study revealed a statistically significant difference between the two groups in the average time in minutes spent by patients on rehabilitation per day – 31±7 min in the retrospective group and 41±3 min in the main group (p<0.005). Clearly, the developed portable device has functions that allow patients to track their rehabilitation progress, set reminders for exercises, and access a rehabilitation specialist in case of complications or adverse events in real time. The feeling of constant control by the doctor helps better engage patients and motivates them. Substantial differences were also found in the number of patient visits to the medical facility within 3 weeks, which decreased by almost half in the telerehabilitation group (p<0.005). Furthermore, in the main group, there was a threefold reduction in the total time spent by the rehabilitation specialist on one patient within 3 weeks (p<0.005). Therefore, after three weeks of rehabilitation, over 80% of the injured individuals in both groups achieved positive results, with the main group showing a slightly higher percentage of excellent results, which may be due to greater motivation and continuous monitoring of patients using the developed telerehabilitation model.

DISCUSSION

Patients who have experienced road traffic accidents often face a range of health consequences that can manifest both in the short and long term. These consequences can lead to varying degrees of impairment and disability, which in turn can result in substantial economic costs. These costs not only impact the quality of life of survivors but also have substantial implications for their families.

According to a study by F. Cunha-Diniz *et al.* [14], the treatment outcomes of individuals injured in road traffic accidents vary widely and depend on several factors. The nature of the accident plays a crucial role – for example, pedestrians, cyclists, and motorcyclists are often more susceptible to serious injuries. In addition, victim characteristics such as age, gender, and health status also greatly influence outcomes. Among these factors, the type and severity of injuries sustained during the accident are considered the main prognostic factors for injury outcomes and future quality of life.

According to many researchers, after upper limb injuries in road traffic accidents, there is a noticeable decrease in quality of life during the initial acute phase, usually within 1-2 weeks after the injury, with gradual improvement over the first year of recovery [15-17]. Previous studies have highlighted the disabling nature of upper limb and chest injuries. Interestingly, patients with upper limb injuries showed significant improvement within the first three months but did not reach their pre-injury levels of quality of life until 12 months post-injury. In a study by B. Gopinath *et al.* [17] on quality of life after such injuries, it was discovered that most patients who were not hospitalised recovered within two months, except for patients with spinal injuries. These groups showed a recovery pattern similar to hospitalised patients, with progress noted up to five months but at suboptimal levels of quality of life.

R. Rissanen *et al.* [18] observed that non-hospitalised patients with upper limb injuries experienced a significant loss of quality of life at 2.5 months, which improved to general population norms at nine months post-injury. In contrast, hospitalised patients with similar injuries remained significantly below these norms even at 24 months. Their study underscored the overall impact of upper limb injuries on health, particularly noting that proximal injuries, such as shoulder fractures, demonstrate slower recovery compared to distal injuries.

The difference in the results of these studies may be related to differences in the duration of observation, data collection methodologies, diagnostic categories, severity of injuries, and cultural factors. However, they all did not consider the importance of the individual choice of limb rehabilitation method. Despite the complexity and importance of these studies, there is a lack of rehabilitation protocols that use a holistic and individual approach to analysing the severity of injuries in road traffic accidents. Most of these studies typically focus on specific aspects of injury, whereas the development of individual treatment and rehabilitation programmes should include a broader spectrum, covering not only injuries sustained in road traffic accidents but also the economic consequences and individual characteristics of the injured. This comprehensive perspective is crucial for understanding the impact of road traffic accidents on individuals and developing more effective rehabilitation techniques, including the use of modern technologies, exoskeletons, and telemedicine.

Since 2000, many research groups have also been developing complex robotic devices for rehabilitation that can be controlled remotely and worn by the injured [12, 19]. T. Ahmed *et al*. [20] developed a telerehabilitation system based on an exoskeleton device that allows the rehabilitation specialist to remotely control it as a subordinate device through the main apparatus. However, the doctor can only monitor the patient's condition visually or through a webcam. N. Singh *et al*. [21] proposed a telerehabilitation system based on an end-effector device for passive and assistive wrist and finger training. The system includes a data collection and communication module for remote monitoring, visual biological feedback.

The current landscape of rehabilitation robotics is characterised by devices that are primarily autonomous mechanical systems with limited networking capabilities. This poses a substantial problem as it restricts interaction between the rehabilitation specialist and the system, which may be located at a considerable distance. Effective rehabilitation requires the healthcare provider to carefully monitor the patient's progress and appropriately adapt exercises when needed. The advanced innovation in the developed prototype lies in its system for tracking the spatial position of the limb, autonomy, and small size. This system, in conjunction with specialised software, transmits detailed information about the hand's kinematics and performed exercises to the rehabilitation specialist via the internet, allowing for adjustments and changes in the load regime as needed. In addition, the developed prototype includes additional sensors for measuring temperature, pulse, and volume, providing essential data that the doctor can assess dynamically to prevent complications. This allows for a more qualitative assessment of whether the patient has achieved specific rehabilitation goals. From the patient's perspective, such a highly adaptive portable telerehabilitation device that can be comfortably used at home can significantly increase motivation for regular physical exercises. This is a substantial step forward in home rehabilitation, combining advanced technology with user-oriented design to improve treatment outcomes.

The proposed telerehabilitation model also allows patients and doctors to be less bound by strict work schedules. Patients can perform rehabilitation exercises at a time convenient for them, while doctors can provide services from anywhere, both online and by analysing previous records of recovery progress. The applied telemedicine system is equipped with advanced data management tools. They can be integrated with electronic medical records, stored in cloud servers, ensuring that the patient's rehabilitation history is always up-to-date, accessible, and securely protected. These data confirm the high effectiveness of the proposed telerehabilitation model for this category of patients.

CONCLUSIONS

The study highlights the variety of consequences faced by individuals who have experienced road traffic accidents, including short-term and long-term health impacts that can lead to reduced quality of life and disability. In addition to the direct health damage, substantial economic costs for rehabilitation are also important.

The use of advanced technologies, such as telerehabilitation devices that allow remote control and adaptation of the rehabilitation process, plays a key role in improving the accessibility and effectiveness of rehabilitation. These devices provide detailed monitoring of patients' physical condition, enabling doctors to promptly adjust treatment and exercises according to the patient's needs. The created telemedicine model can be used in comprehensive rehabilitation of patients with upper limb injuries, especially those associated with shoulder or chest injuries.

The study results demonstrate the advantage of telerehabilitation over conventional physiotherapy, and the proposed telemedicine model can be a viable alternative or addition to standard rehabilitation methods for individuals with upper limb and shoulder injuries. The main advantages include increased motivation for performing rehabilitation exercises and the ability to train in a remotely controlled environment and at home with greater intensity than conventional rehabilitation.

In particular, the average duration of daily rehabilitation sessions in the main group was 10 minutes longer (41±3 minutes), and the number of visits to medical facilities was almost halved. As a result, in the main group, excellent rehabilitation results (qDASH <25 points) were achieved in 12.90% of patients, compared to 9.14% in the retrospective group, demonstrating the increased effectiveness and convenience of the proposed telerehabilitation model.

In general, this study indicates the need for the development of integrated, individually adapted approaches to rehabilitating individuals injured in road traffic accidents, emphasising innovative technologies and telemedicine, which can remarkably improve the quality and accessibility of rehabilitation services. This will help improve the quality of life of injured patients and particularly reduce the costs of the rehabilitation period. Further research in this area should focus on assessing the long-term effects of telerehabilitation, developing individually adapted protocols, and integrating new technologies to ensure effective and accessible recovery for the injured.

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CONFLICT OF INTEREST

The author declares no conflict of interest.

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Телереабілітаційна модель в оперованих постраждалих в дорожно-транспортних пригодах з травмою верхньої кінцівки та грудної клітки

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Анотація. Впровадження методів телереабілітації для постраждалих у дорожньо-транспортних пригодах з травмами верхньої кінцівки та грудної клітки є критично важливим для покращення функціонального відновлення пацієнтів, забезпечуючи ефективну взаємодію між пацієнтом та реабілітологом, та сприяє зменшенню загального часу і витрат, пов'язаних з реабілітацією. Мета дослідження полягала в оцінці ефективності застосування засобів телемедичного контролю та розробленої теререабілітаційної моделі при функціональному відновленні прооперованих пацієнтів з травмами верхньої кінцівки та грудної клітки. У дослідженні взяли участь пацієнти, які були прооперовані з приводу травми верхніх кінцівок та грудної клітки в результаті дорожньо-транспортних пригод. Пацієнти були розподілені на дві групи: ретроспективна (186 пацієнтів) проходила стандартну реабілітацію, тоді як основна група (62 пацієнти) була залучена до програми розробленої телереабілітаційної моделі. Функціональні результати були проаналізовані за допомогою шкали qDASH, а також оцінювалися: середній час, затрачений пацієнтами для реабілітації в день, кількість візитів пацієнта до медичного закладу за 3 тижні та загальний час, затрачений реабілітологом на одного пацієнта протягом 3 тижнів. Після реабілітації понад 80 % пацієнтів в обох групах продемонстрували позитивні та задовільні результати, з незначною перевагою відмінних результатів у основній групі (12,90 % проти 9,14 %). Пацієнти основної групи витрачали більше часу на свою реабілітацію (41+3 хвилини щодня) та мали доступ до функцій моніторингу прогресу і зв'язку з лікарем, що підвищувало їх мотивацію та залученість. Телереабілітація значно зменшила кількість необхідних візитів до лікаря (5±2 проти 11±3 візити) та час, витрачений реабілітологом на кожного пацієнта за 3 тижні (132±12 хв проти 243±17 хв). Середній час на день, витрачений постраждалими на реабілітаційні вправи в основній групі був 41±3 хв, у той час як в ретроспективній – 31± 7 хв. Телереабілітаційна модель є рівноцінною альтернативою та доповненням до стандартних методик реабілітації. Її переваги полягають у підвищенні мотивації до виконання реабілітаційних вправ та можливості проведення тренувань у дистанційному контрольованому середовищі

Ключові слова: хірургія політравми; телемедицина; ранговий аналіз; ретроспективне дослідження