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Please cite this article EVALUATION OF HAND INJURY MANAGEMENT AT THE EMERGENCY DEPARTMENT - ARE WE GETTING BETTER?

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UDC:

DOI: https://doi.org/10.2298/VSP200308035N

When the final article is assigned to volumes/issues of the Journal, the Article in Press version will be removed and the final version appear in the associated published volumes/issues of the Journal. The date the article was made available online first will be carried over.
EVALUATION OF HAND INJURY MANAGEMENT AT THE EMERGENCY DEPARTMENT - ARE WE GETTING BETTER?

PROCENA LEČENJA POVREDA ŠAKE U URGENTNOM CENTRU - DA LI NAPREDUJEMO?

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Abstract

Introduction. Hand injuries are one of the most common injuries seen in emergency departments. Inadequate treatment can lead to prolonged healing, complications, significant morbidity and serious disability. The aim of this study was to evaluate epidemiology, risk factors and treatment of hand injuries in one tertiary care level clinical center in order to be able to suggest targeted strategies for better management of injuries. Methods. This study was designed as a descriptive retrospective epidemiological study that involved all patients with hand injuries that were treated in Clinical center of Vojvodina in a seven year period. Authors collected sociodemographic and clinical data such as age, gender, mechanism of injury, type of injury, days of hospitalization, type of defect reconstruction, time of injury, timing of surgery and reasons for operative treatment delay. For every hospitalized patient modified hand injury severity score (MHISS) was calculated. All data was analyzed using SPSS IBM 21.0 software. Results. There were 34796 patients from 2012. to 2018. treated for hand injury at the Clinical Center of Vojvodina, with 554 (1,6%) being hospitalized. Mean age of patients was 43.2, majority (87.55%) were men and most of them were injured at home (47.2%). Most injuries occurred during knife handling. Average length of stay for hospitalized patients was 4 days. MHISS score for most patients was over 50 and was classified as severe. Waiting time for operation was observed to get shorter throughout selected years. Conclusion. Hand injuries present a complex problem that can be sometimes underestimated by patients. Requirement of highly specialized hand surgeons, sometimes special equipment (e.g. microscope), multiple operations, prolonged rehabilitation, possible invalidity and high cost of treatment calls for careful evaluation of problem and development of proper strategies in order to be able to lower the costs and obtain better medical care for all people with higher injury risk.

Key words: hand injury, occupational hand injury, modified hand injury severity score, emergency department, upper extremity

Apstrakt

Uvod. Povrede šake spadaju među najčešće povrede koje se sreću u urgentnim centrima širom sveta. Neadekvatno lečenje može dovesti do produženog zarastanja, komplikacija,
značajnog morbiditeta i invaliditeta. Cilj ove studije je bio da sagleda epidemiologiju, faktore rizika i tretman povreda šake u jednom terciijarnom kliničkom centru sa ciljem da se omogući kreiranje bolje strategije za tretman ovih povreda. **Metode.** Ova studija je dizajnirana kao deskriptivna retorspektivna epidemiološka studija koja je obuhvatila sve pacijente sa povredama šake koji su lečeni u Kliničkom centru Vojvodine u sedemogodišnjem periodu. Analizirani su opšti sociodemografski i klinički podaci: starost, pol, mehanizam povrede, tip povrede, dužina hospitalizacije, način rekonstrukcije defekta, vreme povrede, dužinu čekanja na operativno zbrinjavanje, razlozi za odlaganje operativne intervencije. Za svaku povredu lečenu u hospitalnim uslovima izračunat je modifikovan skor za procenu težine povrede šake (MHISS). Softverski paket SPSS IBM 21.0 je korišćen u obradi podataka. **Rezultati.** U analiziranom periodu (2012-2018. godine) tretirano je 34796 pacijenata sa povredam šake, od čega je hospitalizovano 554 (1,6%). Prosečna starost hospitalizovanog povređenog pacijenta bila je 43.2 godine, 87.55% uzorka su činili muškarci, a povrede su većinom nastale u kućnim uslovima (47.2%). Najčešći uzrok povreda je bilo rukovanje oštricom noža. Prosečna dužina hospitalizacije je iznosila 4 dana. MHISS vrednost je kod većine iznosila preko 50, što se klasifikuje kao teška povređa. Uočen je trend smanjenja dužine čekanja na operativno lečenje kroz posmatrane godine. **Zaključak.** Povrede šake predstavljaju kompleksan problem koji pacijenti nekada potcenjuju. Potreba za visoko specijalizovanim hirurzima za šaku, nekada specifičnom opremom (npr. mikroskop), višestruke operativne intervencije, dugotrajna rehabilitacija, potencijalan invaliditet i visoki troškovi lečenja ukazuju na potrebu da se ovaj problem pažljivo evaluira, te kreira adekvatna strategija kako bi se smanjili ukupni troškovi i pružio bolji tretman osobama izloženim većim rizikom za povređivanje. **Ključne reči:** povrede šake, povrede šake na radnom mestu, urgentni centar, gornji ekstremiteti
Introduction

Hand injuries are one of the most common injuries seen in emergency departments (ED). As almost every human activity involves hands they are the most exposed part of body and thus are often prone to different kind of injuries such as lacerations, cuts, crush injuries, amputations, sprains, infections, fractures, burns etc. Most hand injuries are minor and usually heal without problems. People are used to getting small burns while cooking, cuts while working or being scratched while playing with animals, so one may often underestimate level of injury and try to solve problem with inadequate home remedies or improvised treatment in non-sterile environment. Postponed or inadequate treatment can lead to prolonged healing, complications, long term morbidity and even serious disability. As in leisure and home activities, occupational hand injuries contribute significantly to total count of injuries.\(^1\)

It is estimated that between 16 to 30 percent of all emergency visits occur due to hand injuries in USA. The United States Bureau of Labor Statistics reported that hand injuries are the second most common injury resulting in days away from work (DAFW). Incidence rates for non-fatal hand injuries involving DAFW per 10000 full time workers for 2018 in USA report highest rates for upper arm in total (28.6 /10 000 workers) and 12.3/10 000 workers just for hand. In the national statistical analysis for occupational injuries in the Republic of Serbia upper arm was most often affected part of body (46.64%), with fingers being injured in 18.41% of all cases. Finger injuries were also most often injuries of upper extremities (38.4%) observed in EDs in USA which was published by Ootes et al. in a broad epidemiological study which involved 92.601 patients. Same study estimated that average USA resident had 1 in 88 chance of presenting in ED with upper arm injury during their lifetime.

Among many hazardous occupations, according to statistics from USA, crop harvesting with machinery (106.4/10000 workers) and working with narrow fabric mills (112.9/10000 workers) are considered as most dangerous jobs. This is taken as a very important risk factor at work, as the region of Vojvodina is a typical agricultural area with many workers being employed in such a risky occupational environment. These injuries are often highly mutilating, involve multiple finger amputations and defects of vital neurovascular structures leaving limited surgical options for reconstruction (Figure 1 and 2).
The aim of this study was to get a closer insight in treatment of hand injuries at the Clinical Center of Vojvodina, a tertiary care level center, and to present epidemiological data of hand injuries in previous years in order to analyze potential risk factors that could lead to injury. Another aim was to evaluate medical treatment strategies that patient received upon ED admission so that targeted strategies for prevention, risk management and better medical treatment can be suggested. Creating public health initiatives based on national injury registry could allow professionals to target current problems and thus better allocate limited resources.

Methods

This study was designed as a descriptive retrospective epidemiological study that included patients which were treated for hand injury at the ED of the Clinical Center of Vojvodina in a seven year period (2012-2018.). All data was obtained from medical documentation and local electronic database. Authors collected sociodemographic and clinical data such as age, gender, education level, qualification for job that led to injury, mechanism of injury, type of injury, days of hospitalization, type of defect reconstruction/treatment, timing of injury, waiting time in ER, timing of operation, then for
occupational injury perceived cause of injury and reasons for operative treatment delay. As the reasons for operative treatment delay following factors were noted: alcohol abuse, time elapsed from last food intake, preoperative evaluation of patient (diagnostic procedures and therapy), bad general health condition or other injuries that postponed operation, operating theatre (OR) availability, disposal of specialist medical staff. For every patient modified hand injury severity score (mHISS) was calculated. All data was analyzed using SPSS 21.0 (IBM Corp. Armonk, NY, USA). For numerical and categorical variables mean and standard variation were calculated with descriptive analysis and was displayed as such in various graphical manners.

**Results**

This study included 34796 patients with hand injuries treated in the Clinical Center of Vojvodina during 2012-2018. time period, with 554 (1.6%) of them being hospitalized for treatment. Average mean age of hospitalized cluster was 43.2 (SD±15.58) years. Most of the patients were men 485 (87.55%), while there were just 69 women (12.45%). Figure 3. shows distribution of patients according to place of injury.

![Fig. 3- Distribution of patients according to place of injury](image)

Injuries that occurred as work-occupational hand injuries (77; 13.9%) were also independently analyzed. Mean age of patient injured while working was 40.92 (SD±15.03) years. Trend of incidence of such injuries is shown in Figure 4.
Fig. 4- Yearly incidence of work-occupational injuries

As a perceived cause of injury that occurred at work patients specified following causes: not being well (6; 7.7%), working faster than usual due to time restraints (29; 37.67%), not being experienced (first time doing something) (6; 7.8%), working overtime (12; 15.6%), not being familiar with equipment (11; 14.29%), faulty equipment (6; 7.8%), injury caused by other person’s actions (4; 5.2%), being distracted (3; 3.9%).

Most of the patients required to wear safety gloves at work according to safety standards did wear protective gloves during injury (40/61, 65.57%).

Most injuries occurred while handling sharp items such as knife blade. Distribution of mechanisms of hand injuries/tools is shown in Figure 5.

![Distribution of injury mechanisms/tools](image)

**Fig. 5-** Distribution of injury mechanisms/tools

Average length of stay in hospital after hand injury in hospitalized group of patients was 4.07 days. Figure 6. presents length of stay for various mechanisms/tools of injury.
Fig. 6. Length of hospitalization for every mechanism/tool of injury
For all patients MHISS was calculated and compared it with mechanism/tool of injury as presented in Figure 7. All patients according to MHISS had severe hand injury but for groups with glass ad blunt injuries which were categorized as moderate.

Fig. 7- Modified hand injury severity score in correlation with mechanism/tool of injury
Amputation of one or more fingers was seen in every mechanism/tool of injury group but blunt, glass and firearm groups with injuries with circular saw and agricultural machinery having highest percentages of amputation risk (Figure 8.).
Fig. 8- Presence of amputation of one or more digits in different mechanism/tool of injury

All reconstructive techniques were used in closure of defects after hand injury: direct suture (347, 81%), skin graft (32,7%), skin flaps (8, 2%), amputation (26, 6%), amputation and skin graft (13,3%), amputation and skin flap (4,1%).

Average time from injury to arrival to the Clinical Center of Vojvodina was 2,5 hours. This was data obtained from patients recalling time of injury so it has to be taken with caution. Most often as a reason for the delay of arrival to the Clinical Center of Vojvodina patients reported: initial referral to secondary level hospital, waiting for transportation, underestimating the need for surgical treatment, being injured far away from referral center. As reasons for delay of surgical treatment after arrival to the ED two group related causes were identified: patient related (consumption of alcohol, prior food intake, arrival after midnight, comorbidities, need for additional diagnostic procedures, associated injuries that required delay of surgical treatment) and hospital related (occupancy of OR or surgeon). Yearly distribution of cause related delay by groups is shown in Figure 9.
Fig. 9- Reasons for the delay of operative treatment

A yearly decreasing trend in waiting time between arrival to ED and operative treatment was observed (Figure 10.).

Fig. 10- Yearly trend of waiting time between ED arrival and operative treatment

In general cluster most of the patients were injured during day shifts; 6-12h (180; 32.49%), 12-18h (184; 33.21%), 18-24h (131; 23.65%), 24-06h (59; 10.65%).

Reason for patient related operative treatment delay such as alcohol abuse, as one of preventable factors, had special attention paid to. It was present in 11% of entire cluster and 40% of patients who abused alcohol had arrived after midnight. Figure 11. shows daily quartered distribution of patients who abused alcohol upon admission.

Fig. 11- Abuse of alcohol as a reason for operative treatment delay in comparison with time of the day

Average time elapsed while waiting from arrival to operative intervention in 2018. was 5 hours. Factors that emerged as risk factor for longer waiting were time of arrival, age of patient, need for more than one specialist, occupancy of ORs, need for additional diagnostic procedures.
Discussion

Hand injuries often present multilevel impact on society in general. Costs of medical treatment, rehabilitation, absence from work, health insurance reimbursements and costs of prequalification are just some of the problems that have to be taken in consideration.

Our study reveals that just 1.6% of all patients who suffered hand injury that were referred to ED, required hospitalization. One must acknowledge that this does not mean that injuries that were managed under local or regional anesthesia in outpatient department didn’t result in invalidity or produce considerable final costs. In our study we focused on patients whose injuries required hospitalization. All of them according to MHISS score were classified as severe (MHISS > 50) or moderate (MHISS 21-50) as represented in Figure 7. Most of injured patients were men (70-92% depending on calendar year examined) fully working capable, around 40 years old (43.20;SD±15.58). Larsen et al. presented results that are similar to ours where most of injured were males with females being dominant just in group of assault victims who were older than 65. They also found that 1 out of every 55 Dutch and 1 out of every 28 Danish people presented to ED with hand injuries, thus confirming importance of adequate management and good primary surgical treatment of these injuries. In our study, men were dominant in all age groups. In group of patients older than 65, women presented just 9.2% of entire cluster.

It is also interesting to analyze occupational hand injuries presented in different studies. Occupational acute hand injuries were responsible for 13.9% of all hand injuries in our sample of patients. Average age of those patients was 40.92 years old (SD±15.03) which is significantly higher than data presented in Sorock et al. review article where young workers under 24 years of age were at highest risk of hand trauma. This significantly younger age of injured compared with other groups of patients with hand injuries could be attributed to lack of experience in work or underestimation of importance of safety measures. This was confirmed in Wu et al. multicenter study on occupational hand injuries in Foshan, PR China, that included 2186 patients, in which cluster most of the injuries due to occupational hazards injuries included young men that lacked safety training. This makes young men especially vulnerable group that has to be addressed in security briefings and education plans made by occupational management. Our study showed no significant age difference between injured at work and injured at home or at
other activities, but most of our patients with occupational hand injuries also confirmed not having any special safety training. One can safely assume that working population in Serbia is exposed to more difficult working conditions than in USA, meaning that risk factors should differ. Authors can’t overrate working conditions in Serbia, where older machinery, sometimes outdated technology and economic situation pushes people to work longer hours or more jobs simultaneously. When asked about circumstances that lead to injury it was interesting to see perceived reasons that patients mentioned as the most important for injury occurring. Most of them, 37.67%, sad that they were in a hurry to finish job or that they were working overtime (15.6%). In Wu et al. study distraction was most often seen as patients’ idea of the injury cause. Authors can no claim that it was lack of experience in our sample, as most of the injured were over 40 years old, but it looks like people in Vojvodina underestimate importance of safety measures and standards which in combination with outdated machinery, puts them at higher risk for accidents. Close studies of these patients and analysis of circumstances before the moment of injury could provide useful information for National Health Service and labor departments and consecutively lead to creation of targeted strategies that would make safer working environment.

Usually, in the region of Vojvodina, most severe injuries were hand or finger conquassation, which occurred in agricultural industry while working with heavy machinery such as corn snappers or harvesters (Figure 1 and 2). Those injuries are characterized by “T triad” as in: excess TIME until treatment, TRESH/wound contamination and big TRAUMA and often require more operative procedures, have more complications and longer hospitalization in general8,9. In this study, patients injured by agricultural machinery had the longest hospitalization of average 11.9 days, which is significantly longer that average 4 days for all injury mechanisms in general.

As this survey reveals, men are often injured while working at home with circular saw and table saw as part of their DIY activity (Figure 3). Women are also more likely to suffer injury at home, but usually suffer minor cuts, small burns and lacerations that can be treated without hospital admission. Working during off hours is also category presented as a place/circumstance of injury (15.7%). As seen in previous studies, illegal or off-license work often puts workers in position to work without proper protection, in unsafe conditions, with prolonged working hours, without adequate training and education for that particular job. All of these factors are known to facilitate injuries.
Wide palette of reconstructive procedures (skin graft, local flaps, direct sutures, amputations) is being done in order to adequately treat hand injuries. Most of the hospitalized patients had good skin coverage that didn’t require skin grafts or skin flaps in order to close the wound, but despite that had to be hospitalized as complex reconstructions of tendons, nerves and bone fractures are usually done in general anesthesia.

Golden standard/window for wound closure is within 6 hours from the moment injury. This means that best results and lowest risk of infection can be expected if primary wound care is being done in above-mentioned time-window. In practice, it is very difficult to arrange all the necessary stages of treatment in such a short period of time, especially if large area of one medical center is the referral hospital for vast area of region. There are many factors that contribute to operative treatment delay. In our study patients needed an average of 2.5 hours just to arrive to ED. This data is uncertain as patients were recalling time of injury and sometimes were not sure about it. Average waiting time in ED for operative treatment in these seven years was 6 hours and 39 minutes, but this time is getting significantly shorter throughout years which suggest that changes that made in organizational structure have been giving good results. Shorter time from admission to definite treatment and thus improved medical care was achieved by better organization of triage system, employment of more specialists in ED, implementation of new information system that covers all patient steps through ED service, and for sure by continuous struggle to continuously educate doctors and nurses. In 2018., last year analyzed, time to definite treatment was around 5 hours which is considered very good compared with more developed countries. This is common problem seen in all ED worldwide. ED setting is specific and complex. Numerous attempts have been made to improve ED care services in the world\textsuperscript{10,11,12}. Reviewing literature addressing this issue authors came across many models that have been proposed in different ED settings: various systems of patient grouping (Emergency severity index triage system- ESI, tree-level triage evaluation system, etc.), “fast track” models, senior doctor assessment at triage instead of nurse triage model, are just being some of the possible solutions to a problem in which one may achieve better results within available resources\textsuperscript{10,13}. Ajami et al. presented results that demonstrate that in recent years patient waiting time in the ED has increased in many countries due to, mostly, rising number of patient referrals to EDs\textsuperscript{14}. Same study found that in England waiting time for medical examination in ED was increased to 4 hours, and in Canada to 2
hours. We have to keep in mind that this is just waiting time for medical examination with more time elapsed when adding time from arrival to ED to surgical intervention. Horwitz et al. revealed that fewer than half of hospital centers in their study, that included 364 non-federal U.S. hospital EDs, admitted their ED patients within 6 hours\textsuperscript{15}. Besides higher inflow of patients there is also a problem of inexperienced interns, residents and young specialists that have multi-tasks in several places, different wards, operation theaters, triage rooms, etc. Treating more than one patient at the same time is difficult and requires more experience. Lack of experience in decision making process can lead to requesting more investigations and tests in order to make decision and prolonging waiting time before operative treatment. Clinical Center of Vojvodina is the only tertiary health center and University hospital for whole province of Vojvodina. This means that 1.5 million people are on daily basis oriented to Clinical Center of Vojvodina in case of complex hand injuries as most of the hospitals in the region do not have plastic/reconstructive surgeon available on call. Complex hand injuries sometimes require teamwork of more surgeons like neurosurgeons, orthopedic and vascular surgeons and others that have to be available at the same time for the same surgical procedure. Authors noted reasons for the late onset of surgical interventions following: time of arrival, severe comorbidities usually associated with aging population, need for more than one specialist, consumption of alcohol or food before arrival to hospital, occupancy of ORs or surgeons, need for additional diagnostic procedures and other associated injuries that required delay. In most cases (78.84\%), occupancy of OR or surgeon was the reason for intervention delay. In the previous years higher road traffic accidents count, more powerful machinery in use, industrial environment, easy access to alcohol, increasing violence on the street, immense workload on trauma centers both locally and worldwide all lead to prolonged waiting time. Despite all these common problems and new challenges that we face every day, waiting time for operative procedure in the Clinical Center of Vojvodina is being shortened in last two years. It is most important to shorten the time from injury to arrival in ED, as upon arrival primary wound care is being done, with wound being temporary dressed in sterile conditions. While waiting for intervention, preoperative antibiotics, pain therapy and, if needed, blood transfusion is administered. This means that patient is under constant medical supervision. As it was already underlined, loss of time before surgery is a big problem in cases such as injuries in agriculture, which are unfortunately often most violent
ones, as injured patient is somewhere in the field, far from nearest local ambulance, usually alone. It takes more for them to reach the hospital and medical help than for people working near regional health center or being at home. Besides direct costs of medical treatment and time of work absence one has to keep in mind that permanent disability often requires prequalification or even early retirement, so that these injuries may impose significant burden for society as presented in de Putters et al. study\textsuperscript{16}. Economic impact of hand injuries is substantial, and so prevention strategies should be created and targeted at most expensive injuries in order to control and lower the resource spending. Proper epidemiological analysis of injuries in ED should provide directions for training priorities for medical crew.

Limitation of this study is certainly inclusion of patients from a single center. Even though Clinical Center of Vojvodina is the largest hospital in the region and is only tertiary level center in Vojvodina, hand injuries are also being treated in local hospitals within 100 kilometers reach. Problems that are dominant in those health centers could be different and at the same time interesting for evaluation. Another limitation is patient-related: false data recalling, like eg. time of injury or concealing the truth (usually concerning place and circumstances of injury, use of protective gloves, etc.). Occupational injuries are usually followed by insurance company compensations, employment problems, so injured employee tends to be under pressure not to mention circumstances of injury and thus give false information to medical stuff.

\textbf{Conclusion}

Hand injuries present a complex problem that is sometimes underestimated by both patients and general practitioners, usually as something that is regarded unimportant and easily treatable. Need for highly specialized surgeons (plastic, orthopedic, vascular or hand surgeons where available), sometimes special equipment (e.g. microscopes), multiple operations, prolonged rehabilitation, possible invalidity and high costs of treatment are putting this medical problem at the pinnacle of our attention. More comprehensive and detailed study could give us better insight in this problem and allow us to draw more relevant conclusions. One can argue that different medical care levels (primary/secondary/tertiary) have different dominant problems and thus require individual approaches and special logistic plans for health care improvement. Also, closer insight in
circumstances of occupational hand injuries can result in better approach to safety management and furthermore safety training for specific work-related risks.

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Fig 1. Hand injury caused by corn harvester
Fig. 2. Hand injury in agriculture
Fig 3. Distribution of patients according to place of injury
Fig 4. Yearly incidence of work-occupational injuries
Fig 5. Distribution of injury mechanisms/tools
Fig 6. Length of hospitalization for every mechanism/tool of injury
Fig 7. Modified hand injury severity score in correlation with mechanism/tool of injury
Fig 8. Presence of amputation of one or more digits in different mechanism/tool of injury
Fig 9. Reasons for the delay of operative treatment
Fig 10. Yearly trend of waiting time between ED arrival and operative treatment
Fig 11. Abuse of alcohol as a reason for operative treatment delay in comparison with time of the day

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Fig 1
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Fig 11

Received on March 8, 2020.
Revised on February 13, 2021.
Accepted March 29, 2021.
Online First April, 2021.