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Type of manuscript	Word limit	Abstract word limit	Reference limit	Table limit	Figure limit
Original Article	5000 (Structured)	200	50	6	7 or total of 15 images
Review Article	5000	200	50	6	10 or total of 20 images
Case Report	1500	200	10	No tables	10 or total of 20 images
Letter to the Editor	500	N/A	5	No tables	No media
Scientific letter	900	N/A	10	No tables	2 or total of 4 images
Clinical Imaging/ Visual Diagnosis	400	N/A	5	No tables	3 or total of 6 images
History	900	N/A	10	No tables	3 or total of 6 images
Publication ethics	900	N/A	10	No tables	No media

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Book Section: Sherry S. Detection of thrombi. In: Strauss HE, Pitt B, James AE, editors. Cardiovascular Medicine. St Louis: Mosby; 1974.p.273-85.

Books with Single Author: Cohn PF. Silent myocardial ischemia and infarction. 3rd ed. New York: Marcel Dekker; 1993.

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Contents

Technological Innovations in Emergency Department Services

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Abstract

Technology has brought various innovations on how healthcare providers acquire information, work, and communicate. These innovations are most common in the emergency department. Among the important innovations in the emergency department, imaging methods and diagnostic tests are now performed at the bedside. The main purpose of bedside imaging methods and diagnostic tests is to achieve rapid results and initiate appropriate treatment in a short time. Technological development provides fast access to diagnostic tests and rapid results as well as facilitates access to specialist physicians. Patients' data can be transmitted to advanced centers by telemedicine application, and consultation services can be obtained. Bedside consultation is also possible, thanks to the telemedicine application supported by robotic technology. Biosensors, mobile applications, technological products used in patient registration and follow-up process, and voice response systems used in patient monitoring after discharge are among other technological innovations used in emergency departments. All these tools and systems provide many facilities for emergency service delivery. However, reasons such as being expensive, not supervised by medical professionals, and time-consuming limit their use. While technological developments are increasing continuously, to ensure the same development in emergency departments, scientific studies with a high value of evidence are needed in this field.

Keywords: Digitalization, emergency department, innovation, technology

Introduction

Information and communication technology have advanced rapidly in the last two decades; Many new ways and tools have been developed in which information can be processed, stored and transmitted. The cloud-based data storage areas, wireless broadband networks, mobile computing systems and comprehensive data analysis methods affect the production and service industry fundamentally (1). The health sector is one of the areas that are influenced most by these rapid advances in information and communication technology. Advances in medical devices, equipment and diagnostic methods, as well as advances in information communication technology, bring important innovations to the functioning of the health system (2).

Emergency departments (EDs) have a special and important place in the health system. Scaling epidemics, disasters, accidents, and injuries in recent years increases the importance of EDs in the health system (3). On the other hand, the need for emergency EDs can reach a level that exceeds department resources. Technological advances provide important opportunities to meet the need for EDs by keeping service quality at the highest level. It is necessary to review ED services, redesign and strengthen them by making use of developing technological opportunities in order for the EDs to develop in parallel with the technological developments, and thus to provide the best service for the applications (2).

In this article, it is aimed to present information about technological innovations used in EDs. For this purpose, PubMed, Medline, Cochrane, and Google Scholar databases were searched using the keywords "emergency department", "digitalization", "technology" and "innovation". Literature research was expanded by examining the obtained publications and using the keywords "robotic technology", "mobile application", "wearable biosensor"

and "artificial intelligence". Technological innovations used in EDs can be listed as; bedside imaging methods and diagnostic tests, decision support systems, artificial intelligence technology, telemedicine applications, robotic technology, wearable biosensors, mobile applications, technological innovations used in patient registration and follow-up, and voice response systems used in patient monitoring after discharge.

Bedside Imaging Methods and Diagnostic Tests

Bedside Ultrasonography

The fact that ultrasonography (USG) can be applied at the bedside is an important technological development that enables fast diagnosis of life-threatening conditions. Bedside ultrasound brings convenience such as making or excluding key diagnoses, directing resuscitation noninvasively, reducing ionizing radiation, and ensuring safe implementation of invasive procedures (4). With the production of palm USG devices, these conveniences have been taken one step further. These devices, which are almost pocket sized, have the advantages of being both easy to use and cheap (5). In a systematic review, it was found that palm USG devices showed strong correlation with high-level ultrasound devices in the diagnosis of intra-abdominal free fluid and hydronephrosis, assessment of the pleural cavity, detection of abdominal aortic aneurysms, obstetric and gynecological examinations; however, it is stated that high evidence studies are needed to demonstrate its effectiveness in abdominal examinations (6). Despite its listed advantages and many conveniences, USG that can be applied at the bedside with today's technology cannot provide a complete radiological evaluation. Therefore, the need for conventional ultrasound devices continues when more extensive scanning is required (5).

Portable Computer Tomography Devices

Computed tomography (CT) is a powerful diagnostic method in detecting the presence of intracranial damage (7). However, during the transfer of patients who are sent to the imaging unit for brain CT procedure, problems such as failure to continue monitoring, interruption of intravenous therapy and inadequate ventilation may be encountered. These problems can cause many complications such as hypotension, hypoxia and increased intracranial pressure (8). Portable CT scanners, which have become widespread in recent years, have a capacity of taking about 32 images per second and can be brought directly to the patient's bed (9). This technology reduces the time required for imaging in the evaluation of patients suspected of stroke or head injury in EDs and can be effective in preventing complications that may arise during patient transfer (7).

With the developing technology, portable CT scanners have been produced that can display not only cranial imaging but also the whole body. Portable whole-body CT scanners, which can be readily carried from room to room, have proficiency to produce high standard CT imagery, and improve the diagnosis and treatment of a broad variety of emergency health problems. The whole-body CT scanners can give high-resolution bone, spine, thorax and soft tissue imaging of diagnostic value. However, abdominal images obtained by portable whole-body CT scanners are reported to be of lower quality than conventional CT imaging (7). Simultaneous display of multiple body areas with the portable whole body CT scanner both saves time and significantly reduces the dose of radiation exposure. In addition, the fact that these devices can be carried easily allows them to be taken to another unit and used for different clinical applications, when they are not needed in the ED (7,9).

Bedside Tests

Bedside tests are defined as any analytical test performed by a healthcare professional, outside the traditional laboratory setting for a patient. Terms such as near-patient testing, point of care testing, non-laboratory tests, decentralized laboratory tests are also used for bedside tests (10).

With the advances in microchip and miniaturization technology and developments in production processes in the last 10 years, fast, low cost, robust and reliable bedside measuring devices can be produced. With these devices, laboratory quality results can be obtained (11). It is also possible to transmit the results obtained from bedside testers wirelessly to the medical record system. Cartridges containing sensitive chemical biosensors are configured on the silicon chip to perform specific analyses for these devices. Thus, it is possible to carry out tests such as blood gas, biochemical, hematological, coagulation tests and β-HCG at the bedside. In addition, there are special tests to determine the basic metabolic status and serum lactate level, as well as special tests that can be used for the diagnosis of acute coronary syndrome and congestive heart failure (10,12).

With bedside tests, necessary samples are taken for measurement in the patient's environment and test results can be obtained in a short time at the same place or near. Thus, the necessary treatment can be planned in a short time and near the patient (11). These tests allow rapid response to many emergency cases, such as immediate initiation of targeted therapy for patients with sepsis (13), cases of poisoning and overdose (14), and acute coronary syndrome (15).

Decision Support Systems

Tools that provide clinical decision support have a wide variety of computer-based systems, clinical guides, various algorithms, and digital resources that facilitate access to current information.

Along with technological innovations, computer-based systems called advanced clinical decision support systems (CDSS) that can offer patient-specific recommendations have been developed (16). Advanced CDSS is an important innovation for EDs that require quick decision making in high-risk situations. These systems are used for various purposes in EDs (17).

With the development of clinical decision support systems, it was determined that better clinical management was provided in the EDs and better patient results were achieved. In the study of Niemi et al. (18), It has been shown that improvement has been achieved in the diagnosis and treatment of pneumonia and heart failure patients with the use of CDSS. Drescer et al. (19) determined that CDSS contributed significantly to the accuracy of the decision to have CT angiography in patients who were suspected of pulmonary embolism, but CDSS was considered to be less accepted by emergency physicians because it was time-consuming. It has also been determined that with improved CDSS, there is a significant benefit in the management of sepsis cases (20), and in making the right triage decision (21).

Although clinical decision support systems have benefits and usefulness mentioned, they have some limitations and negative aspects. In a systematic analysis on this issue, the negative aspects are listed as follows. Clinical decision support systems can be installed as independent systems or integrated into the electronic health record (EHR) software of hospitals. In the case of the CDSS systems are a stand-alone system, it may disrupt the workflow of clinicians, as it requires clinicians to perform recording outside of routine computer work. If it is integrated into the system, it can create a substantial strain for the EHR system. In addition, clinical decision support systems can provide meaningless and unnecessary suggestions and warnings, and this can cause alert fatigue in healthcare professionals. Another limitation of decision support system is the difficulty in keeping the information bases of decision support systems up to date as clinical information changes. Moreover, the successful use of decision support systems requires proficiency in using advanced technology and these systems have a negative impact on user skill (16).

Artificial Intelligence

The usage area of artificial intelligence technology in health sector is getting wider. The first use of this technology in EDs is to provide decision support in triage (21). Today, artificial intelligence technology can be used in the EDs for patient monitoring and early detection of clinical complications (22).

Successful results are obtained in the evaluation of diagnostic imaging results such as computed tomography and USG with artificial intelligence technology in EDs (23). This technology has the potential to reduce the waiting time for radiology consultations in large centers and to enable rapid and accurate interpretation of imaging results in rural EDs where radiologists do not work (22).

Another usage area of artificial intelligence in EDs is natural language processing systems. These systems have the ability to interpret free texts, extract and classify certain words from these texts. Electronic clinical notes kept in the EDs can be analyzed with natural language processing systems and probability estimations can be made for various clinical situations (24).

Telemedicine

Telemedicine, which is defined as the remote provision of health services by using information and communication technology, enables healthcare professionals in hospitals with limited resources for acute developing serious health problems to connect to centers that are advanced in terms of expert and technical equipment and to receive consultancy services. Telemedicine applications in EDs are the best example of this (25).

Telemedicine is used to facilitate the management of different cases in EDs. In the EDs where emergency medicine specialists do not work, consultation can be provided with specialists for stroke cases by using telemedicine application (TeleStroke). Thus, the appropriateness of tissue plasminogen activator (tPA) treatment for cases can be determined and applied without delay (26). Telemedicine consultations were also found to contribute to accurate and rapid ECG assessment and initiation of appropriate therapy in cases followed up with suspicion of acute myocardial infarction (27).

Telemedicine technology is used in the management of psychiatric cases in EDs. With the service, also known as telepsychiatry, expert support on emergency psychiatric intervention can be provided (28). It has been found that management of sepsis cases with telemedicine is improved, especially in rural areas (29). Another area in which telemedicine technology is used is the maintenance of trauma cases care. In cases of trauma in rural areas, the frequency of mortality and morbidity is higher than in urban areas. With telemedicine, it is possible to consult the experts in developed centers about the cases of trauma in rural areas. Thus, access to definitive treatment can be shortened and early trauma case management can be improved (30).

Robotic Technology

In EDs, robotic technology can be used in the implementation of various tests that can assist in clinical risk classification. Concussion syndrome (CS) is a complication that can often be

encountered after mild traumatic brain injury. Subbian et al. (31) developed a robot-supported objective neurological test that can guide clinical classification for CS and predict the probability of CS by evaluating neurological functions in EDs. However, in the study, it has been reported that difficulties such as creating a suitable area for the robotic device in the ED, requiring trained personnel to use the robot and providing special technical support for the maintenance of the device limit the use of the device in the EDs (31).

Another application area of robotic technology in EDs is telemedicine applications. While fixed monitors can be used for telemedicine, monitors can be taken to the patient by using mobile and remote-controlled robots. In the evaluation of stroke patients, O'Caroll et al. (32) found that the stroke team at the hospital was faster than the robotic telemedicine application. In the same study, it was reported that the results of robotic telemedicine applications were excellent and this method could be used safely for EDs that do not have a stroke team to intervene at the bedside.

Mobile Applications

Emergency physicians use many scoring systems and algorithms in their daily work. Mobile applications have been developed to provide easy access at the bedside to algorithms, checklists, clinical calculators and risk grading systems frequently used by physicians in EDs (33). Mobile applications used in EDs can be listed as providing decision support, accessing and evaluating patient data, and those that provide fast communication with other healthcare professionals or patients (34).

Mobile applications provide many conveniences to its users. Unlike other service tools used in EDs, it is abundant and much cheaper. However, those who develop these applications are not subject to quality standards and controls like other medical product developers. For this reason, mobile applications to be used must be carefully selected (34,35).

Wireless "Wearable" Biosensors

Recent technological innovations show that wireless "wearable" biosensors can be used to catch the deterioration in the condition of patients at an early stage (36). In their study with sepsis patients, Garbern et al. (37) Determined that wireless "wearable" biosensors are a reliable way for continuous monitoring of heart rate and breathing. Another new use of wearable biosensors in EDs is to prevent deaths from overdose opioid intake, which is an increasing threat to the whole world. For this purpose, the drug dose used by patients who are prescribed opioids in EDs can be monitored with wearable biosensors. Thus, compliance of the patients with the treatment plan can be evaluated (38).

Technological Innovations Used in Patient Registration and Follow-Up

Online Registration

In traditional EDs, every patient other than those coming to the ED by ambulance registers at the patient registry and the treatment priority is determined after the first assessment by the triage officer. With the developing technology, it is possible for the patients to make their own records for their ED visit from their homes and cars via their mobile phones. Thus, the workload of the employees in the triage and patient registration unit is reduced and it is possible to perform the admission processes in a shorter time (39).

Today, another innovation used for patient registration in EDs is kiosk devices. In addition to obtaining a queue number for examination, these patients can enter their medical history, background, pain level, and major complaints data into the system from the kiosk screen (40). Although a limited number of studies have been done on this new practice, the data obtained show that reduced workload helps triage nurses to focus more on patients' medical condition (41), and reduce the waiting time of patients in the ED (42).

Patient Flow Software and Real-Time Location Systems

The focus of ED service delivery shifts from expertise-based care to system-based key performance indicators such as "National Emergency Access Target (NEAT)" and "four-hour rule". This makes the patient transfer process and information transfer between emergency EDs and inpatient units more and more important (43).

Patient tracking systems and patient flow software are technology-based solutions developed to improve the transfer of patients from the emergency room to other service and diagnostic units in the hospital (44). Patient flow software used in the EDs enables patients' locations to be seen in the hospital. They can define the empty beds in the hospital according to their specialty. Thus, it contributes to the reduction of the waiting time of the patients who will be admitted from the ED, to facilitate the communication between the ED and other services, and to speed up the patient admission and discharge processes (45).

Patient tracking systems are based on infrared lights, radio waves and ultrasound technology. Patients are generally followed up with position transmission wristbands, and sensors and radios are used as tracking tools (45,46). In some of these systems, by manually entering and updating data, patient information can be transferred and tracked from the ED to the inpatient units to which the patient is transferred. Some other systems provide tracking the location of patients in real time. Thus, it is possible

to follow the units in which the patient in the ED is sent during the whole treatment process in real time (45).

With real-time follow-up, it is possible to monitor how long patients wait in the diagnosis and treatment units that they are sent to. In the system, it is also possible for healthcare professionals in the units where the patients go to share the information and notes they consider important to the patient. Along with the patient's location, important warnings such as "ready for discharge" or "waiting for the queue for X-ray" and "risk of falling" can be transferred to the system and monitored (44,45). All this information can be seen on a digital screen called "electronic whiteboard" in the ED. Location transmission labels can also be applied to beds, staff and equipment, and allow tracking of all movements in the hospital (46).

Patient tracking systems and patient flow software provide ease of use of time more efficiently and increase safety on patient care (44). It is reported that the system facilitates the registration of the procedures performed on the patients, reduces the waiting time, and increases patient satisfaction (47). In addition, it provides hospital managers with important data to analyze the workflow. However, since patient tracking systems are very new, their effects and success outputs have not been fully documented (46).

Voice Response Systems

The follow-up of patients after discharge from the ED and the care requirements in the early discharge period are among the issues that draw attention in recent years. The most important problems related to patient safety in early discharge are not knowing what to do in case of symptoms restarting or progressing, and patients do not have their recommended controls (48). Depending on such problems, approximately 8% of the patients who are discharged from the ED may develop various complications after discharge (49). Telephone monitoring is carried out for the early detection of possible complications. This practice is reported to increase patient safety and satisfaction (48,50). However, it is almost impossible to make phone calls with any patient who is discharged in the intensive working conditions of the EDs. Voice response systems have been used to overcome this limitation.

Interactive Voice Response System is an interactive system that enables the exchange of information by accessing information systems remotely by telephone, directing them with keys or voice. Thus, financial problems, personnel and time shortages can be overcome for the follow-up of patients discharged over the phone. The software owned by these systems also enables people to connect to a computer via the phone and transfer the data entered by the patients to the digital environment through the established connection (49,50).

Conclusion

Technological innovations have provided significant benefits to the treatment and care process in EDs from patient admission to discharge. These benefits include reduced patient stay in the EDs, rapid diagnosis, real-time follow-up of patients in the EDs and hospital so that patient information can be shared with the entire care team, and medical errors due to causes such as memory factor and time pressure are avoided. The expeditious advances in technology have the potential to offer innovative solutions for predicting epidemics, avoiding preventable deaths, reducing healthcare waste, and improving efficiency and quality of care in ED services. However, in general, the use of technological developments in healthcare services brings along problems such as the safety and non-protection of patient data, weakening of caregiver-patient interaction, problems of integration and cost-effectiveness, and the inability of health professionals to adapt adequately to new technological changes. In conclusion, further studies with a high level of evidence regarding the effects of technological innovations on patient safety, care cost, and practitioner satisfaction are needed in order to overcome these problems and provide ED services with the highest quality using technological developments.

Ethics

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: P.Ş., A.G., M.İ., Design: P.Ş., A.G., Literature Search: P.Ş., Writing: P.Ş., A.G., M.İ.

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References

1. Arugu LO, Chigozie CF. Information and communication technology (ICT) application in social and political system. European Journal of Research in Social Sciences. 2016;4:51-63.

2. Figueiredo J, Eiriz V. Analysis of the impact of technological innovation on healthcare services. International Journal of Behavioural and Healthcare Research. 2009;1:234-46.

3. Powell MP, Yu X, Isehunwa O, Chang CF. Trends in urgency of emergency department visits among those with and without multiple chronic conditions, 2007-2012. J Hosp Med Manage. 2016;2:1-9.

4. Chacko J, Brar G. Bedside ultrasonography: Applications in critical care: Part I. Indian J Crit Care Med. 2014;18:301-9.

5. Ali F, Ali E, Ali U, Hussain A. A narrative review on the advantages of portable ultrasound machines in the emergency department. Emergency Medicine and Critical Care. 2018;2:43-7.

6. Rykkje A, Carlsen JF, Nielsen MB. Hand-Held Ultrasound Devices Compared with High-End Ultrasound Systems: A Systematic Review. Diagnostics (Basel). 2019;9:61.

7. Rumboldt Z, Huda W, All JW. Review of portable CT with assessment of a dedicated head CT scanner. AJNR Am J Neuroradiol. 2009;30:1630-6.

8. Knight PH, Maheshwari N, Hussain J, Scholl M, Hughes M, Papadimos TJ, et al. Complications during intrahospital transport of critically ill patients: Focus on risk identification and prevention. Int J Crit Iln Inj Sci. 2015;5:256-64.

9. Sempeles S. New Portable CT System Can Scan Entire Body. Journal of Clinical Engineering. 2011;36:86-7.

10. Patil S. POCTED: Use of point of care test devices in the emergency department. ICU Management & Practice. 2016;16:154-6.

11. St John A, Price CP. Benefits of point-of-care testing in the Emergency Department, 2018. (cited 2019 April 9). Available at: https://acutecaretesting.org/-/media/acutecaretesting/files/pdf/benefits-of-pointofcare-testing-in-the-emergency-department

12. Hildyard C, Curry N. Point-of-care testing: a standard of care? Anaesthesia. 2015;70:1113-8.

13. Shim BS, Yoon YH, Kim JY, Cho YD, Park SJ, Lee ES, et al. Clinical Value of Whole Blood Procalcitonin Using Point of Care Testing, Quick Sequential Organ Failure Assessment Score, C-Reactive Protein and Lactate in Emergency Department Patients with Suspected Infection. J Clin Med. 2019;8:833.

14. Lager PS, Attema-de Jonge ME, Gorzeman MP, Kerkvliet LE, Franssen EJF. Clinical value of drugs of abuse point of care testing in an emergency department setting. Toxicol Rep. 2017;5:12-7.

15. Ahmed S, Jafri L, Raheem A, Shakeel S, Siddiqui I. Performance Evaluation of Cardiac Troponin I Assay: A Comparison Between the Point-of-care Testing Radiometer AQT90 FLEX and the Central Laboratory Siemens Advia Centaur Analyzer. Cureus. 2019;11:e4231.

16. Sutton RT, Pincock D, Baumgart DC, Sadowski DC, Fedorak RN, Kroeker KI. An overview of clinical decision support systems: benefits, risks, and strategies for success. NPJ Digit Med. 2020;3:17.

17. Bennett P, Hardiker NR. The use of computerized clinical decision support systems in emergency care: a substantive review of the literature. J Am Med Inform Assoc. 2017;24:655-8.

18. Niemi K, Geary S, Quinn B, Larrabee M, Brown K. Implementation and evaluation of electronic clinical decision support for compliance with pneumonia and heart failure quality indicators. Am J Health Syst Pharm. 2009;66:389-97.

19. Drescher FS, Chandrika S, Weir ID, Weintraub JT, Berman L, Lee R, et al. Effectiveness and acceptability of a computerized decision support system using modified Wells criteria for evaluation of suspected pulmonary embolism. Ann Emerg Med. 2011;57:613-21.

20. Bond CM, Djogovic D, Villa-Roel C, Bullard MJ, Meurer DP, Rowe BH. Pilot study comparing sepsis management with and without electronic clinical practice guidelines in an academic emergency department. J Emerg Med. 2013;44:698-708.

21. Fernandes M, Vieira SM, Leite F, Palos C, Finkelstein S, Sousa JMC. Clinical Decision Support Systems for Triage in the Emergency Department using Intelligent Systems: a Review. Artif Intel Med. 2020;102:101762.

22. Grant K, McParland A. Applications of artificial intelligence in emergency medicine. Univ Toronto Med J. 2019;96:37-9.

23. Jalal S, Parker W, Ferguson D, Nicolaou S. Exploring the Role of Artificial Intelligence in an Emergency and Trauma Radiology Department. Can Assoc Radiol J. 2021;72:167-74.

24. Ye Y, Tsui F, Wagner M, Espino JU, Li Q. Influenza detection from emergency department reports using natural language processing and Bayesian network classifiers. JAMIA. 2014;21:815-23.

25. Ward MM, Jaana M, Natafgi N. Systematic review of telemedicine applications in emergency rooms. Int J Med Inform. 2015;84:601-16.

26. Shea CM, Tabriz AA, Turner K, North S, Reiter KL. Telestroke Adoption Among Community Hospitals in North Carolina: A Cross-Sectional Study. J Stroke Cerebrovasc Dis. 2018;27:2411-7.

27. Miller AC, Ward MM, Ullrich F, Merchant KAS, Swanson MB, Mohr NM. Emergency Department Telemedicine Consults are Associated with Faster Time-to-Electrocardiogram and Time-to-Fibrinolysis for Myocardial Infarction Patients. Telemed J E Health. 2020;26:1440-8.

28. Freeman RE, Boggs KM, Zachrison KS, Freid RD, Sullivan AF, Espinola JA,et al. National Study of Telepsychiatry Use in U.S. Emergency Departments. Psychiatr Serv. 2020;71:540-6.

29. Mohr NM, Campbell KD, Swanson MB, Ullrich F, Merchant KA, Ward MM. Provider-to-provider telemedicine improves adherence to sepsis bundle care in community emergency departments. J Telemed Telecare. 2020:1357633X19896667.

30. Lapointe L, Lavallee-Bourget MH, Pichard-Jolicoeur A, Turgeon-Pelchat C, Fleet R. Impact of telemedicine on diagnosis, clinical management and outcomes in rural trauma patients: A rapid review. Can J Rural Med. 2020;25:31-40.

31. Subbian V, Ratcliff JJ, Meunier JM, Korfhagen JJ, Beyette FR Jr, Shaw GJ. Integration of New Technology for Research in the Emergency Department: Feasibility of Deploying a Robotic Assessment Tool for Mild Traumatic Brain Injury Evaluation. IEEE J Transl Eng Health Med. 2015;3:3200109.

32. O'Carroll CB, Hentz JG, Aguilar MI, Demaerschalk BM. Robotic telepresence versus standardly supervised stroke alert team assessments. Telemed J E Health. 2015;21:151-6.

33. Lin M, Rezaie S, Husain I. Top 10 mobile apps in emergency medicine. Emerg Med J. 2014;31:432-3.

34. Genes N. mHealth in emergency medicine [special report]. Emerg Med Pract. 2017;(Suppl 2017A):1-11.

35. Yablowitz MG, Schwartz DG. A Review and Assessment Framework for Mobile-Based Emergency Intervention Apps. ACM Computing Surveys. 2018;51:1-32.

36. Breteler MJM MSc, Huizinga E, van Loon K, Leenen LPH, Dohmen DAJ, Kalkman CJ, et al. Reliability of wireless monitoring using a wearable patch sensor in high-risk surgical patients at a step-down unit in the Netherlands: a clinical validation study. BMJ Open. 2018;8:e020162.

37. Garbern SC, Mbanjumucyo G, Umuhoza C, Sharma VK, Mackey J, Tang O, et al. Validation of a wearable biosensor device for vital sign monitoring in septic emergency department patients in Rwanda. Digit Health. 2019;5:2055207619879349.

38. Carreiro S, Wittbold K, Indic P, Fang H, Zhang J, Boyer EW. Wearable Biosensors to Detect Physiologic Change During Opioid Use. J Med Toxicol. 2016;12:255-62.

39. Thomas MC, Atrubin D, Hamilton JJ. Impact of Patient Self-Registration in Emergency Departments on Syndromic Surveillance Data. Online J Public Health Inform. 2015;7:e93.

40. Rhoads J, Drazen E. Touchscreen check-in: kiosks speed hospital registration. Oakland, CA: California HealthCare Foundation (online), 2009. (cited 2020 April 10): Available at: https://www.chcf.org/wp-content/uploads/2017/12/PDF-TouchscreenCheckInKiosks.pdf

41. Coyle N, Kennedy A, Schull MJ, Kiss A, Hefferon D, Sinclair P, et al. The use of a self-check-in kiosk for early patient identification and queuing in the emergency department. Can J Emerg Med. 2019;21:789-92.

42. Mahmood A, Wyant DK, Kedia S, Ahn S, Powell MP, Jiang Y, et al. Self-Check-In Kiosks Utilization and Their Association With Wait Times in Emergency Departments in the United States. J Emerg Med. 2020;58:829-40.

43. Staib A, Sullivan C, Cabilan CJ, Cattell R, Eley R. Digital transformation of the emergency department-inpatient interface (EDii): integration for future innovation. Aust Health Rev. 2020;44:666-71.

44. Pennathur PR, Cao D, Bisantz AM, Lin L, Fairbanks RJ, Wears RL, et al. Emergency department patient-tracking system evaluation. Int J Ind Ergon. 2011;41:360-9.

45. Gholamhosseini L, Sadoughi F, Safaei A. Hospital Real-Time Location System (A Practical Approach in Healthcare): A Narrative Review Article. Iran J Public Health. 2019;48:593-602.

46. Bacheldor B. Philly Hospital Uses RTLS to Track Patient Flow, Care and Training. RFID Journal. 2009;1-3.

47. Deryahanoglu O, Kocaoglu B. Applications of RFID Systems in Healthcare Management: A Simulation for Emergency Department. IJITEE. 2019;10:786-92.

48. Dhalla IA, O'Brien T, Ko F, Laupacis A. Toward safer transitions: how can we reduce post-discharge adverse events? Healthc Q. 2012;15:63-7.

49. Calder LA, Cwinn AA, Gatien M, Gee A, Larocque N, Calder-Sprackman S, et al. The feasibility of an interactive voice response system (IVRS) for monitoring patient safety after discharge from the ED. Emerg Med J. 2018;35:180-5.

50. Chern CH, How CK, Wang LM, Lee CH, Graff L. Decreasing clinically significant adverse events using feedback to emergency physicians of telephone follow-up outcomes. Ann Emerg Med. 2005;45:15-23.

Original Article

Knowledge Level of Healthcare Professionals on Basic and Advanced Life Support in Children

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Abstract

Aim: This study aimed to determine the knowledge level of nurses, emergency medical technicians, and paramedics about the basic and advanced life support guidelines in children.

Materials and Methods: The study was conducted between July 2018 and August 2018, with 602 volunteer healthcare professionals, in Gaziantep of Turkey province of Turkey where the pediatric population is high. Following the 2015 guidelines of the American Heart Association, a questionnaire about basic and advanced life support in children and demographic data was administered. Statistical comparisons were made between the groups.

Results: Of the 602 participants, 62% were male. The average age of the participants was 28.4 (minimum-maximum, 18-50) years. The basic and advanced knowledge scores of the nurses were lower than those of the emergency medical technicians and paramedics. Those who work in pediatric emergency departments and pediatric intensive care units, with 5-8 years of experience, and paramedics had high advanced life support scores and total knowledge scores. The basic life support knowledge scores and total knowledge scores of those with certification were good, but the advanced life support knowledge score was inadequate.

Conclusion: The basic and advanced life support knowledge scores of the professionals were moderate, and the total knowledge scores of the nurses working in pediatric services were low. While basic life support knowledge scores of the paramedics and professionals working in emergency departments and child intensive care units were low, their advanced life support knowledge scores were high.

Keywords: Basic life support in children, advanced life support in children, nurse, emergency medical technician, paramedics

Introduction

Cardiac arrest; It is the cessation of respiratory and cardiac activity for many reasons, especially respiratory problems in children. Cardiopulmonary resuscitation (CPR); defined as life-saving procedures for airway safety and respiratory and circulatory support following cardiac arrest (1).

According to the American Heart Association (AHA) guidelines-Basic Life Support (BLS) guideline, children (between 28 days and 18 years old) who do not respond to environmental stimuli, are not breathing or breathing poorly, have no central pulse, or have a central pulse ≤ 60/minute should be evaluated within a maximum of 10 seconds; help should be called, respiratory and compression support should be started and applied synchronously (1-3). When there is a rescuer, 30 chest compressions, and in case of double rescuer, 15 chest compressions followed by 2 breaths should be applied. During each compression, the rib cage should be collapsed at 1/3 depth and allowed to stand back to create an effective pulse in the patient. Chest compression should be 100-120/min for patients with advanced airway support. Patients should be ventilated asynchronously for 10 sec/min for each ventilation (1,4).

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The goal of performing CPR is to reach the patient's previous quality of life (1,4,5). With the developments in emergency care and first aid methods in children; It was reported that discharge after CPR reached from 24% to 43% (1,4-6). Early detection of the life-threatening situation in the child services and early warning of the emergency team, and the correct implementation of the first and emergency aid can increase the success of CPR and decrease mortality and sequela rates (2,3,5). In some studies, it is stated that even if only effective compression is performed, success has increased by 10%, and good neurological results can reach 60% with high quality CPR application (1,5,7).

Survival and neurological good results; the patient's age, comorbidity, time of arrest, time to first aid, adequacy of medical team and equipment, high quality CPR application and post-resuscitative care are directly related (1,8-10). Turkey in practice in order to increase the success rate of CPR according to AHA guidelines, the children basic and advanced life support courses are organized and maintained the certification.

In this study, in Gaziantep province in Turkey where child population is high, it was aimed to determine the level of knowledge in nurses, emergency medicine technicians and paramedics who is dealing with pediatric patients according to the basic and advanced life support guide AHA-2015 Guide in children with the latest updates.

Materials and Methods

This study planned as a cross-sectional descriptor; Between July 2018 and August 2018, it was conducted in three big hospitals of Gaziantep Turkey (Gaziantep Cengiz Gökçek Gynecology and Pediatrics Hospital, Dr. Ersin Arslan Training and Research Hospital and 25 Aralık State Hospital). One of the study centers; the children's hospital accepts about 250,000 children patient per year; on the other hand, Dr. Ersin Arslan Training and Research Hospital and 25 Aralık State Hospital accept an average of 50,000-75,000 children patient per year. Nurses, emergency medical technicians and paramedics; who works in the child emergency departments, child intensive care units and child services of these hospitals and who works in the ambulance service and emergency health department operations and coordination center of the province were included in the study. Those who did not give care about pediatric patients and those who were temporarily assigned to these units from other centers were excluded from the study. Health workers other than nurses, emergency medical technicians and paramedics were excluded. The data were collected through a 16-question survey form. Descriptive features such as age, gender, occupational title, year of employment in the profession, the department they worked in and basic and advanced life support certification status; asked

as multiple choice or open-ended questions. In the second part of the survey, the participants were asked ten multiple choice questions to measure their level of knowledge about basic and advanced life support in children. By giving "one point" to each information question that is answered correctly; basic life support evaluated by 5 points over 5 questions; advanced life support was evaluated 5 points over 5 questions and life support total knowledge level score was evaluated finally over 10 points. Based on the total score; It was evaluated as "0-2 points: bad, 3 points: medium, 4 points: good, 5 points: very good". Knowledge level questions were prepared by the researchers with reference to the AHA 2015 guidelines-BLS (1). Permission was obtained from the institutions where the study was conducted in order to conduct the research. Ethics committee approval was obtained from the Local Non-Interventional Clinical Research Ethics Committee of Gaziantep University (no: 2019/148, date: 03.04.2019). The participants were informed about the study, their verbal and written consent was obtained and the study was completed on a voluntary basis.

Statistical Analysis

SPSS 23.0 package program was used for statistical analysis of the data. Categorical measurements were given as numbers and percentages, while continuous measurements were given as mean, deviation and minimum-maximum. The suitability of variables to normal distribution was evaluated using visual (histogram and probability plots) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk tests). Mann-Whitney U test was used in binary variables and Kruskall-Wallis test was used in more than two variables. Bonferroni analysis was used in Post-Hoc analysis to determine the source of the difference between the groups. Spearman correlation analyzes were applied for correlation analysis between the scales. In all tests, p<0.05 was considered statistically significant in all tests.

Results

Seven hundred fifty healthcare professionals (HPs) who met the criteria of the study were reached, 602 of them voluntarily participated in the study. In the study, 378 (62%) of the participants were male and the average age of all participants was 28.4 years (min-max: 18-50 years). On the other hand, nurses with 414 participants were 68.8% of whole group. Four hundred and thirty-three (73%) of the participants had less than 8 years of experience in their fields. One hundred and fifty-two (25.2%) of the participants had a basic and advanced life support certificate. Demographic characteristics of HPs are given in Table 1. The answers to basic and advanced life support questions and the evaluation of the scale scores used are given (Figure 1).

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Table 1. Demographic features of healthcare professionals			
		n	%
Gender	Female	224	37.2
	Male	378	62.8
Age (years)	≤23	94	15.6
	24-27	212	35.2
	28-32	180	29.9
	≥33	116	19.3
Professional experiences	≤4	261	43.4
	5-8	172	28.6
	9-12	89	14.8
	≥13	80	13.3
Professional title	Nurse/health officer	414	68.8
	Emergency medical technician	89	14.8
	Paramedic	99	16.4
Have a basic and advanced life support certificate	Yes	152	25.2
	No	450	74.8
Department	Emergency department-child intensive care unit	223	37.0
	General pediatric service	214	35.5
	112 operator service	35	5.8
	Ambulance service	130	21.7
		mean ± SD	min-max
Age (years)		28.39±5.49	18-50
min: Minimum, max: Maximum, SD: Standard deviation, n: Number			
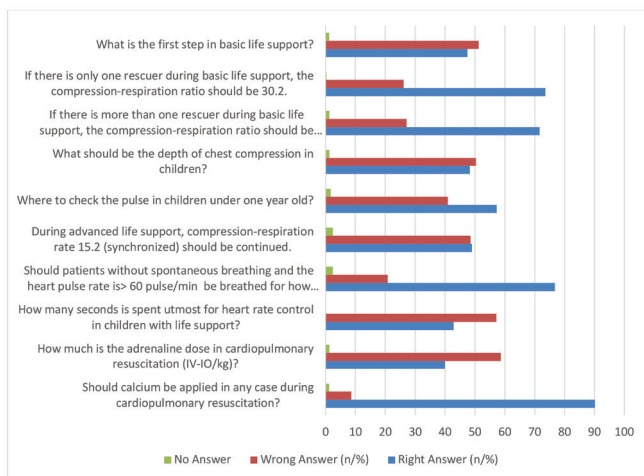
Figure 1. Distribution of knowledge questions by percentage of answers

A weak positive correlation was found between basic life support knowledge scores (BLSKS) and advanced life support knowledge scores (ALSKS) subscale dimensions (r=0.256). It was determined that there was a strong positive correlation between BLSKS and the total knowledge scores (TKS) (r=0.811) (p=0.001). There was also a strong positive correlation between the ALSKS subscale size and the TKS (r=0.773) (p=0.001). Average values of scale scores are given in Table 2.

Gender and scale scores of health professionals and their differences were not statistically significant (p>0.05). The ALSKS [mean ± standard deviation (SD)=3.24±1.04] and TKS (mean ± SD=6.27±1.81) of the HPs who aged 28-32 years, were higher than the other groups, and these scores were found to be statistically significantly higher compared to other age groups (p=0.001, p=0.022, respectively). The ALSKS (mean ± SD=3.20±0.96) and TKS (mean ± SD=6.33±1.71) of those who have worked and experienced in their fields for 5-8 years are higher than the other groups, and the statistically significant difference is due to this group (p=0.017, p=0.027, respectively). It was found that paramedics' BLSKS (mean ± SD=3.33±0.97), ALSKS (mean ± SD=3.10±1.10) and TKS (mean ± SD=6.43±1.64) of paramedics were higher than all other groups, and this difference was statistically was found to be significantly higher

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Table 2. Examining the scale scores used in the study		
	Mean ± SD	Min-max
Basic life support knowledge scores (BLSKS)	2.98±1.18	0-5
Advanced life support knowledge scores (ALSKS)	2.98±1.09	0-5
Total knowledge scores (TKS)	5.97±1.80	1-10
min: Minimum, max: Maximum, SD: Standard deviation, n: Number		

(p=0.000, p=0.049, p=0.009, respectively). When the HPs with basic and advanced life support certificates are compared; It was observed that BLSKS was higher in those with certification, but ALSKS was not different between groups (p=0.008, p=0.725, respectively). While the BLSKS of those working in the ambulance service was higher, the ALSKS of those working in the emergency department-child intensive care units was higher. In Table 3, all the relationship between the demographic characteristics of HP and their scale scores is given. Eighty-three (54.6%) of 152 healthcare workers with certificates were employed in the ambulance service; 194 (43.1%) of 450 healthcare workers without certification were found to be working in the general services. Certification information is given in Table 4 according to the units in which HPs work.

Discussion

Our study is the first study which covers hospitals in a large city where have many of the child population. Also, our study included the largest participants in Turkey. Our results shows that the participants' who are young group with moderate experiences BLSKS and ALSKS are moderate. On the other hand, paramedics' ALSKS and TKS were "good" in terms of level. While the ALSKS of the HP working in the emergency departments and child intensive care units were good, thoughtfully, their BLSKS were insufficient. It was also determined that the HPs working in the general service had low TKS and the certification contributed positively to BLSKS and TKS, but had no effect on the ALSKS.

Nurses spend more time with the patient in the hospital services due to their duties. Paramedics and emergency medical technicians greet the patient first on the field. Therefore, they can only take part in the starting minutes of the CPR, which is directly related to the prognosis (3,6). In the literature, it has been reported that the basic knowledge of CPR of nurses is low-medium in general even in developed societies. Frequently CPR trainings have been pointed out (11-19).

The HPs between 28-32 ages are good at advanced knowledge score (AKS) and TKS. It can be explained by the fact that they were mostly working in the emergency departments and child intensive care units, and also have moderate (5-8 years) professional experience. It suggests that the hospitals' management may have made their plans especially in this direction in departments with dynamic functioning.

In this high-participation study shows that the professional experience has not made a difference in BLSKS. The professionals with moderate experience were better in ALSKS and TKS. This could be explained by the fact that the information has been obtained through more practice. It is found that the ALSKS of the HP working in the emergency departments and child intensive care units, which frequently encounter critical pediatric patients, is good and the BLSKS is insufficient. It can be explained by the fact that there are always doctors in these departments, airway safety is provided early and more advanced life support is provided. This also supports that information may have been acquired through practice. Unlike in the literature, Örsal et al. (20) study with the participation of 78 nurses stated that nurses have >10 years of experiences have higher BLSKS and ALSKS. Aygin et al. (21), study with the participation of 97 nurses stated that the knowledge level of nurses working in education and research hospitals was higher.

In our study, at all levels of knowledge of young and less experienced (<4 years) HP does not make any difference, suggests that the information learned in schools may be forgotten in a short time. In the literature regarding CPR trainings, It was stated that the trainings contributed the knowledge of HP but the information gained was forgotten in a short time such as 3-6 months and it could not be reflected in the skill completely (2,11,22-24). Similarly, Şener et al. (25) stated that school knowledge continued in the first years of graduation, but experience was at the forefront in the coming years.

Our study is composed of interested participants with pediatric patients only, it is the first study to compare different occupational groups on that issue in Turkey. The lower BLSKS of nurses than emergency medical technicians and paramedics suggests that they may not have updated critical patient management information in routine working conditions. Paramedics have higher advanced knowledge than other groups, it can be explained by their education is more focused on critical patients and they are more active in the critical field due to working conditions. Therefore, it may be beneficial to review the sections on critical child patient management in nursing education program.

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Table 3. Comparison of demographic features and scale scores of healthcare professionals				
	n	Basic life support knowledge scores	Advanced life support knowledge scores	Total scores
		Med (min-max)	Med (min-max)	Med (min-max)
Gender (u)				
Female	224	3 (0-5)	3 (0-5)	6 (2-10)
Male	378	3 (0-5)	3 (0-5)	6 (1-10)
p		0.750	0.979	0.918
Age (years) (x2)				
≤23	94	3 (1-5)	3 (0-5)	6 (1-10)
24-27	212	3 (0-5)	3 (0-5)	6 (2-10)
28-32	180	3 (0-5)	3 (0-5)	6 (2-10)
≥33	116	3 (0-5)	3 (1-5)	6 (2-10)
p		0.575	0.001	0.022
Professional experiences (x2)				
≤4	261	3 (0-5)	3 (0-5)	6 (1-10)
5-8	172	3 (0-5)	3 (1-5)	6 (3-10)
9-12	89	3 (0-5)	3 (1-5)	6 (2-10)
≥13	80	3 (0-5)	3 (0-5)	6 (2-10)
p		0.318	0.017	0.027
Professional title (x2)				
Nurse/health officer	414	3 (0-5)	3 (0-5)	6 (1-10)
Emergency medical technician	89	3 (0-5)	3 (0-5)	6 (2-10)
Paramedic	99	3 (1-5)	3 (0-5)	6 (2-10)
p		0.000	0.049	0.009
Have a basic and advanced life support certificate (u)				
Yes	152	3 (0-5)	3 (0-5)	6 (2-10)
No	450	3 (0-5)	3 (0-5)	6 (1-10)
p		0.008	0.725	0.029
Department (x2)				
Emergency department-child intensive care unit	223	3 (0-5)	3 (1-5)	6 (2-10)
General pediatric service	214	3 (0-5)	3 (0-5)	6 (1-10)
112 operator service	35	3 (0-5)	3 (1-5)	6 (2-9)
Ambulance service	130	3.5 (0-5)	3 (0-5)	6 (2-10)
p		0.001	0.000	0.001
Med: Median, min: Minimum, max: Maximum, n: Number				

Table 4. Certification information according to the units where healthcare professionals work					
Certification	Emergency department-child intensive care unit n (%)	General service n (%)	112 operator service n (%)	Ambulance service n (%)	Total n (%)
Yes	33 (21.7)	20 (13.2)	16 (10.6)	83 (54.6)	152 (25.2)
No	190 (42.2)	194 (43.1)	19 (3.2)	47 (10.4)	450 (74.8)
Total	223	214	35	130	602
n: Number					

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In Turkey, in order to increase the success rate of CPR practices, basic and advanced life support in children courses are organized and certification of health workers is done. According to our study, the certification programs have contributed positively to BLSKS and TKS. Therefore, repeated training activities can be more beneficial. On the other hand, the fact that having a certificate did not make a difference in ALSKS. It also suggests that educational activities are more focused on basic life support issues. It may be beneficial to expand the programs by including the evaluation of the course achievements with detailed feedback. On the other hand, facilitation of the transfer of information and the learning of team members could be done by planning of simulation-based trainings (26). Increasing the number of courses, updating the training program and holding case meetings involving the whole team can contribute to the improvement. These meetings could be a step in increasing the quality by strengthening team dynamics.

When the departments are analyzed, HPs (mostly nurses) working in the general pediatric service have a poor TKS compared to others. It is noticed that the renewal of knowledge during routine work is insufficient and they continue to their work with the former knowledge. We think that nurses should be more involved in training on critical patients and their motivation in this regard should be increased.

Study Limitations

The study reflects the knowledge level of HPs but does not include skills and self-assessments. The study shows only the results of HPs who work in those three large hospitals with high patient populations and working in the city's emergency health services of Gaziantep which is the one of major cities of Turkey. In addition, it does not reflect the knowledge levels of other HPs who do not care for pediatric patients and who do not work as nurses, emergency medical technicians and paramedics. It is also among the other limitations of the study that the HP who have a certificate could not learn the certificate update dates.

Conclusion

This study; It has shown that HPs' basic and advanced life support knowledge levels are not at the desired level. Also; It has shown that the knowledge levels of HPs working in different fields of hospitals are different from each other and that staffs do not follow up-to-date information about that. We think that the scope of trainings in both universities and hospitals should be revised and their frequency should be increased.

References

1. de Caen AR, Berg MD, Chameides L, Gooden CK, Hickey RW, Scott HF, et al. Part 12: Pediatric Advanced Life Support: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2015;132(18 Suppl 2):S526-42.

2. Girotra S, Spertus JA, Li Y, Berg RA, Nadkarni VM, Chan PS; American Heart Association Get With the Guidelines–Resuscitation Investigators. Survival trends in pediatric in-hospital cardiac arrests: an analysis from Get With the Guidelines-Resuscitation. Circ Cardiovasc Qual Outcomes. 2013;6:42-9.

3. Matos RI, Watson RS, Nadkarni VM, Huang HH, Berg RA, Meaney PA, et al. Duration of cardiopulmonary resuscitation and illness category impact survival and neurologic outcomes for in-hospital pediatric cardiac arrests. Circulation. 2013;127:442-51.

4. Yılmaz HL, Karaböcüoğlu M. Çocuk Acil Tıp: Kapsamlı ve Kolay Yaklaşım. Editörler: Karaböcüoğlu M, Yılmaz HL, Duman M. Cilt II, İstanbul Tıp Kitapevi; İstanbul: 2012: p. 83-105.

5. Vural M, Koşar MF, Kerimoğlu O, Kızkapan F, Kahyaoğlu S, Tuğrul S, et al. Cardiopulmonary resuscitation knowledge among nursing students: a questionnaire study. Anatol J Cardiol. 2017;17:140-5.

6. Güven DY, Karabulut N. Kardiyopulmoner resusitasyon eğitiminin Hemşirelerin bilgi düzeyine etkisi. Arch Health Sci Res. 2018;5:161-8.

7. Atkins DL, de Caen AR, Berger S, Samson RA, Schexnayder SM, Joyner BL Jr, et al. 2017 American Heart Association Focused Update on Pediatric Basic Life Support and Cardiopulmonary Resuscitation Quality: An Update to the American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2018;137:e1-6.

8. Lee J, Yang WC, Lee EP, Huang JL, Hsiao HJ, Lin MJ, et al. Clinical Survey and Predictors of Outcomes of Pediatric Out-of-Hospital Cardiac Arrest Admitted to the Emergency Department. Sci Rep. 2019;9:7032.

9. Atkins DL, Everson-Stewart S, Sears GK, Daya M, Osmond MH, Warden CR, et al. Epidemiology and outcomes from out-of-hospital cardiac arrest in

Eurasian J Emerg Med.
2021;20(3): 135-42

Tolu Kendir et al. Knowledge Level of HPS

children: the Resuscitation Outcomes Consortium Epistry-Cardiac Arrest. Circulation. 2009;119:1484-91.

10. Gök F, Kılıçaslan A, Topal A, Yavşan DM, Yosunkaya A. An assessment of the Current Knowledge of Nurses, Staffed in Intensive Care Units, About Airway Management and Basic Life Support. J Chest Dis Crit Care Med. 2014;1:56-60.

11. Bukiran A, Erdur B, Ozen M, Bozkurt AI. Retention of nurses' knowledge after basic life support and advanced cardiac life support training at immediate, 6-month, and 12-month post-training intervals: a longitudinal study of nurses in Turkey. J Emerg Nurs. 2014;40:146-52.

12. Josipovic P, Webb M, Grath IM. Basic life support knowledge of undergraduate nursing and chiropractic students. J Adv Nurs. 2008;26:58-63.

13. De Regge M, Calle PA, De Paepe P, Monsieurs KG. Basic life support refresher training of nurses: individual training and group training are equally effective. Resuscitation. 2008;79:283-7.

14. Smith KK, Gilcreast D, Pierce K. Evaluation of staff's retention of ACLS and BLS skills. Resuscitation. 2008;78:59-65.

15. Boonmak P, Boonmak S, Srichaipanha S, Poomsawat S. Knowledge and skill after brief ACLS training. J Med Assoc Thai. 2004;87:1311-4.

16. Shahrakivahed A, Masinaienezhad N, Shahdadi H, Arbabisarjou A, Asadibidmeshki E, Heydari M. The Effect of CPR Workshop on the Nurses' Level of Knowledge and Skill. Int Arc Med. 2015;8.

17. Hopstock LA. Cardiopulmonary resuscitation; use, training and self-confidence in skills. A self-report study among hospital personnel. Scand J Trauma Resusc Emerg Med. 2008;16:18.

18. Einspruch EL, Lynch B, Aufderheide TP, Nichol G, Becker L. Retention of CPR skills learned in a traditional AHA Heartsaver course versus 30-min video self-training: a controlled randomized study. Resuscitation. 2007;74:476-86.

19. Munezero JBT, Atuhaire C, Groves S, Cumber SN. Assessment of nurses knowledge and skills following cardiopulmonary resuscitation training at Mbarara Regional Referral Hospital, Uganda. Pan Afr Med J. 2018;30:108.

20. Örsal Ö, Boğa SM, Kersu Ö. Acil ve Yoğun Bakım Servislerinde Çalışan Hemşirelerin Temel ve İleri Kardiyak Yaşam Desteğine İlişkin Bilgi Düzeylerinin Değerlendirilmesi. IGUSABDER. 2017;3;203-20.

21. Aygin D, Açıl HC, Yaman Ö, Çelik M, Danç E. Hemşirelerin Kardiyopulmoner Resüsitasyon ve Güncel 2015 Kılavuz Bilgilerinin Değerlendirilmesi. Turk J Card Nur. 2018;9:7-12.

22. Brião Rda C, de Souza EN, de Castro RA, Rabelo ER. Cohort study to evaluate nursing team performance in a theoretical test after training in cardiopulmonary arrest. Rev Lat Am Enfermagem. 2009;17:40-5.

23. Papadimitriou L, Xanthos T, Bassiakou E, Stroumpoulis K, Barouxis D, Iacovidou N. Distribution of pre-course BLS/AED manuals does not influence skill acquisition and retention in lay rescuers: a randomised study. Resuscitation. 2010;81:348-52.

24. Karahan A, Cerit B, Ak B, Çıtak N, Şahin S, Ayhan F. Hemşirelik öğrencilerinin temel yaşam desteği eğitiminden hemen ve üç ay sonra bilgi ve beceri düzeylerinin değerlendirilmesi. Türkiye Acil Tıp Dergisi. 2005;5:22-7.

25. Şener S, Güler V, Türkan H. Eğitim hastanesinde görev yapan hemşirelerin erişkin/pediatrik temel ve ileri yaşam desteği bilgi düzeyleri. Türkiye Acil Tıp Dergisi. 2004;4:155-9.

26. Twigg S. Clinical event debriefing: a review of approaches and objectives. Curr Opin Pediatr. 2020;32:337-42.

Appendix 1. Knowledge Level of Healthcare Professionals on Basic and Advanced Life Support in Children

1. I participate in the survey on a voluntary basis.

A. Yes   B. No

2. Gender:

A. Female   B. Male

3. Your Professional Title:

A. Nurses/Health officer

B. Emergency Medical Technician

C. Paramedic

4. Your Age: …………

5. How many years have you been working in your profession?

………………

6. Do you have a basic and advanced life support certificate for children?

A. Yes   B. No

7. In which unit are you working?

A. Hospital emergency-child intensive care unit

B. Hospital general pediatric service

C.112 operation service

D. Ambulance service

8. What is the first step in basic life support?

A. Look, listen, feel method

B. Calling for help, checking pulse and starting compression

9. Where is the pulse checked in children under one year old?

A. Carotid artery

B. Femoral-Brachial arteries

C. Dorsalis pedis artery

D. All

10. If there is only one rescuer during basic life support, the compression-respiration ratio should be 30: 2.

A. Right   B. Wrong

11. If there is more than one rescuer during basic life support, the compression-respiration ratio should be 15:2.

A. Right   B. Wrong

12. What should be the depth of chest compressions in infants, except for children and infants?

A. Chest anterior posterior diameter should be 1/4 deep, 3 cm, speed should be 100-120/min.

B. Front anterior posterior diameter should be 1/3 deep, 4-5 cm, speed should be > 100-120/min

C. Chest anterior posterior diameter should be 1/3 deep, 3 cm, speed should be 100-120/min

D. Chest anterior posterior diameter should be 1/2 in deep, 4-5 cm, speed should be 100-120/min

13. How many seconds can be spent for heart rate control in children who need life support?

A.5 sec   B.10 sec   C.15 sec

14. How many seconds should patients be breathed with a heart rate> 60/min and no spontaneous breathing?

A. 3-5 sec   B> 5 sec

15. During advanced life support, compression-respiration ratio should be continued at 15: 2 (synchronous).

A. Right   B. Wrong

16. How much is the dose of Adrenaline in cardiopulmonary resuscitation (IV-IO/kg)?

A-) 1 mg/kg (1/10000> 0.1ml/kg=1dzm/kg IV-IO)

B-) 0.1 mg/kg (1/10000> 0.1ml/kg=1dzm/kg IV-IO)

C-) 0.01 mg/kg (1/10000> 0.1ml/kg=1dzm/kg IV-IO)

17. Should calcium be applied in any case during cardiopulmonary resuscitation?

A. Yes   B. No

Thank you for your participation in the survey.

Original Article

Short-Term Results of Combined Open Reduction and Internal Fixation in the Treatment of Trans-Scaphoid Perilunate Fracture-Dislocation

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Abstract

Aim: This study aimed to evaluate the short-term clinical and radiographic results of combined open reduction and internal fixation in the treatment of trans-scaphoid perilunate fracture-dislocation (TSPLFD).

Materials and Methods: Data of eight patients diagnosed with TSPLFD who underwent combined open reduction and internal fixation and followed for a minimum of 8 months were retrospectively analyzed. All patients underwent surgical treatment with an Acutrak® screw, ligament repair using suture anchors, and Kirschner wire. The functional outcomes were evaluated using the modified Mayo Wrist Scores and total active range of motion scale. Radiographic outcomes were assessed based on standard X-ray images of the wrist.

Results: Of the patients, seven were male and one was female, and the median age was 32 years (range: 20-44). The median follow-up duration was 12 months (range: 8-16). According to the TAROM scores, the outcomes were excellent and good in one and seven patients, respectively. The median Mayo Wrist Scores were 84 (range: 80-95). Good radiographic results were achieved in all patients. No surgery-related complications such as infection, loss of reduction, and Sudeck's atrophy were observed.

Conclusion: Although TSPLFD is a rare condition, early diagnosis and surgical treatment yield favorable functional and radiographic results. However, post-traumatic arthritis and functional dissatisfaction may occur in the long term.

Keywords: Trans-scaphoid perilunate fracture-dislocation, dorsal approach, Acutrak screw, suture anchor, Kirschner wire

Introduction

Trans-scaphoid perilunate fracture-dislocation (TSPLFD) is an uncommon injury of the wrist, usually caused by high-energy trauma (1,2). It is more frequent in adult males and up to 25% of cases are missed in the initial presentation (3,4). Dorsal perilunate fracture-dislocation is the most common type of TSPLFD characterized by the dorsal dislocation of the capitate head from the distal lunate joint (3,5). Treatment options of TSPLFD include closed reduction, open reduction with a dorsal approach, volar approach, or combined (dorsal + volar) approach, and arthroscopy-assisted reduction (6-9).

In the present study, we aimed to evaluate short-term clinical and radiographic results of combined open reduction and internal fixation in the treatment of TSPLFD.

Materials and Methods

This single-center, retrospective study was conducted between January 2019 and July 2020. A total of eight patients who were admitted to the emergency unit with high-energy injuries and underwent combined open reduction and internal fixation with the diagnosis of TSPLFD and who were followed for minimum eight months were included. The study period encompassed the entire duration of surgery, follow-up, and data collection and

analysis. All patients were surgically treated with an Acutrak® screw, ligament repair using suture anchors, and Kirschner wire (K-wire). A written informed consent was obtained from each patient for all diagnostic and therapeutic procedures. The study protocol was approved by the Local Ethics Committee of Ankara City Hospital (no: E1-20-1230, date: 28.10.2020). The study was conducted in accordance with the principles of the Declaration of Helsinki.

All patients underwent a detailed medical history interview, physical, local, and systemic examinations. Bilateral wrist radiographs were obtained (Figures 1 and 2) and computed tomography was performed. Based on the results, surgery was decided. All operations were carried out by two hand surgeons under general anesthesia. A 4-cm longitudinal skin incision ulnar to the Lister's tubercle was made. The extensor pollicis longus tendon was released distally and retrieved from the third extensor compartment. The joint capsule was reached through the second and fourth compartments. The capsule was opened using a T-shaped incision. The K-wires were placed into

the scaphoid fracture line and used as joysticks for reduction. Then, two thin K-wires were placed dorsally to fix the scaphoid. Following drilling of the most central K-wire under the guidance of fluoroscopy, compression was applied using an Acutrak® (Acumed Inc., OR, USA) screw. The dorsal lunotriquetral ligament was ruptured with joint instability. The ligament was reduced using surgical instruments and the lunotriquetral joint was stabilized via two percutaneous K-wires through the triquetrum. A mini-anchor (2.0 mm) was threaded on the lunate and the lunotriquetral ligament was repaired with reinforced suture anchors. The joint capsule was repaired via 3-0 polydioxanone (PDS) suture (Ethicon Inc., NY, USA) and the extensor retinaculum was approximated via 4-0 PDS suture. The skin was closed with 4-0 prolene sutures.

Following the wound dressing, the wrist through the volar capsule was casted in neutral alignment using short-arm casts. The absence of postoperative neurovascular deficit was confirmed, and control X-ray was performed (Figures 3 and 4). Wound dressing was advised to the patients and/or their caregivers every three days. The patients were scheduled for

Figure 1. Anteroposterior X-ray of trans-scaphoid perilunate fracture-dislocation

Figure 2. Lateral X-ray of trans-scaphoid perilunate fracture-dislocation

Figure 3. Postoperative anteroposterior X-ray of a 32-year-old male patient

Figure 4. Postoperative lateral X-ray of a 32-year-old male patient

follow-up on postoperative day 7th and the absence of loss of reduction was confirmed by radiographs. The sutures were removed at week 2nd and a circular short-arm plaster cast was placed. At week 6th, the K-wires were retrieved from all patients under local anesthesia. The patients and/or caregivers were instructed to do wrist exercises at home and were referred to the hand rehabilitation unit. The rehabilitation program was applied both under the supervision of physiotherapists and as a self-supervised program. At three months following surgery, the range of motion (ROM) measurements were performed. The patients in whom the ROM was normal were scheduled for follow-up at 6th and 12th months (Figures 5 and 6).

Figure 5. Postoperative anteroposterior X-ray of a 32-year-old male patient at one-year follow-up

Figure 6. Postoperative lateral X-ray of a 32-year-old male patient at one-year follow-up

The functional outcomes were evaluated using the modified Mayo wrist scores and total active range of motion (TAROM) scale as excellent (90-100), good (80-90), fair (65-80), and poor (<65). Flexion and extension were measured and the discrepancy between the operated and non-operated wrists was examined. Radiographic outcomes were assessed based on standard X-ray images of the wrist and were classified using the Herzberg classification (Table 1, Table 2) (3,10).

Statistical Analysis

Statistical analysis was performed using the SPSS for Windows version 17.0 (SPSS Inc., Chicago, IL, USA). Descriptive data were expressed in median (minimum-maximum) or number and frequency, where applicable. The Student t-test was used to compare the ROM of the joint between the operated and non-operated wrists. A p-value of <0.05 was considered statistically significant.

Results

Of the patients, seven were males and one was female with a median age of 32 (range: 20 to 44) years. The etiology of TSPLFD was a high-energy injury, including fall from a height in six patients, motorcycle accident in one patient, and in-vehicle accident in one patient. The patient with a history of fall from a height had an additional intra-articular distal tibial fracture

Table 1. Radiological and functional outcomes of the patients	
	Herzberg's classification
Stage I	Lunate remained in place under the radius
Stage IIa	Lunate was palmarly dislocated but rotated by less than 900
Stage IIb	Lunate was palmarly dislocated and rotated more less than 900

Table 2. Herzberg's radiological score	
A	Normal carpal alignment and morphology of carpal bones
B	Abnormal carpal alignment or morphology of carpal bones; 1 or more of the following: Static scapholunate dissociation Static lunotriquetral dissociation Ulnar translation of the carpus Nonunion of scaphoid or other carpal bone Malunion of scaphoid or other carpal bone (more than 1 mm step-off on articular surfaces) Collapse of lunate and or proximal pole of scaphoid, suggesting avascularity Carpal collapse pattern (dorsal intercalated segment instability or volar intercalated segment instability) without 1 of the above causes
C	X-ray film modified by the treatment (proximal row carpectomy, wrist arthrodesis, etc.)

of the contralateral limb. At the time of admission, physical examination findings of the patients included tenderness over the radiocarpal joint and fovea radialis of the scaphoid bone with limited flexion, extension, supination, and pronation of the wrist. Posteroanterior X-ray revealed the interrupted lines of the Gilula (Figure 7), while lateral X-ray showed malalignment in the radius lunate and capitatum (Figure 8) (11). All patients, except

Figure 7. Irregular the interrupted lines of the Gilula

Figure 8. Malalignment in the radius, lunate and capitatum

for one, underwent closed reduction in the emergency room. Following reduction, no neurological deficit was observed. The median time from the onset of injury to surgery was 1.5 days (range: 1 to 3), depending on the wrist edema. No postoperative neurovascular deficit was observed in any of the patients. The median time to discharge was 1.5 days (range: 1 to 3). The median follow-up was 12 months (range: 8 to 16).

The median time to K-wire removal was 6 weeks (range: 5 to 7). According to the TAROM scores, the results were excellent in one patient and good in seven patients. The median Mayo Wrist scores was 84 (range: 80 to 95). Good radiographic results were achieved in all patients. The median flexion was 50º (range: 30º to 85º) in the operated side and 70º (range: 35º to 90º) in the non-operated side (p<0.05). The median extension was 30º (range: 20º to 60º) in the operated side and 50º (range: 25º to 65º) in the non-operated side (p<0.05). According to Herzberg's classification, seven of the patients had Stage I and one had Stage IIb disease. No surgery-related complications such as infection, loss of reduction, or Sudeck's atrophy were observed during follow-up.

Radiological and functional outcomes of the patients are given in Table 3.

Discussion

Perilunate fracture-dislocations account for 2% to 3% of all carpal injuries (12). It is rarely reported in children (13), and frequently affects young male adults with an average age of 30 years (14). The most common causes are motorcycle accidents and fall from a height. Consistent with the literature, seven patients were male adults with a median age of 32 years (range: 20 to 44) in our study. The etiology of TSPLFD was a high-energy injury, including fall from a height in six patients, motorcycle accident in one patient, and in-vehicle accident in one patient. In addition, the patient with a history of fall from a height had an additional intra-articular distal tibial fracture of the contralateral limb.

Table 3. Radiological and functional outcomes of the patients					
Case	Age/Sex	Follow-up (m)	Quality of reduction	Mayo wrist score	Radiological herzberg score
1	44/M	8	Good	80	A
2	41/M	10	Good	82	A
3	35/M	10	Good	82	A
4	32/M	12	Good	84	A
5	32/F	12	Poor	84	A
6	30/M	14	Good	86	A
7	25/M	15	Good	86	A
8	20/M	16	Good	95	A
M: Male, F: Female					

Perilunate fracture-dislocations are primarily evaluated based on the locations of the capitate and lunate. If the capitate is located in the dorsal lunate, it is classified as dorsal dislocation and if it is located in the volar lunate, it is classified as volar dislocation. The incidence of dorsal dislocations is higher than the volar type and, in the majority of cases, scaphoid fractures are accompanied, known as TSPLFD (14). In our study, all patients had dorsal dislocations presenting with scaphoid fractures.

Review of the literature reveals that time from injury to surgery and open fractures are the main prognostic factors of dorsal perilunate fracture-dislocations (15). In a study, Komurcu et al. (16) reported that early treatment of TSPLFD with open reduction and internal fixation yielded favorable results. In our study, the median time from the onset of injury to surgery was 1.5 days (range: 1 to 3), depending on the wrist edema. Of note, all of our patients had closed injuries.

Although rare, surgical treatment of acute perilunate dislocations with proximal row carpectomy and three-corner fusion has been described in the literature (17,18). However, open reduction combined with a volar, dorsal or combined (dorsal + volar) approach is more frequently used in the daily practice (19,20). The K-wire with and/without headless cannulated screws is widely applied to those presenting with additional scaphoid fractures. In the present study, all patients were treated through a dorsal approach and a headless cannulated screw was used for the treatment of scaphoid fractures. Ligament repair was performed using suture anchors and K-wire. These wires were buried beneath the skin and left *in situ* for about six weeks. In a previous study, the lunotriquetral ligament was repaired using the K-wire which was left *in situ* for minimum eight weeks (21).

Furthermore, there are several studies reporting median and ulnar nerve injuries following perilunate fracture-dislocations (22,23). In our study, one patient had numbness in the first three fingers after surgery which resolved spontaneously at the end of six weeks. Neuropraxia was suspected in this patient and no additional treatment was given.

Study Limitations

The single-center, retrospective nature of the study with relatively small sample and short follow-up size are the main limitations of this study.

Conclusion

In conclusion, although TSPLFDs are rare entities, early diagnosis and surgical treatment yield favorable functional and radiographic results. However, post-traumatic arthritis and functional dissatisfaction may occur in the long-term.

Ethics

Authorship Contributions

Surgical and Medical Practice: E.A., U.B., Concept: E.A., Design: E.A., Data Collection and Processing: E.A., Analysis of Interpretation: E.A, U.B., Literature Search: E.A., Writing: E.A.

References

1. Rockwood CA, Jr, Green DP, Bucholz RW. Fractures and dislocations of the wrist, in Rockwood CA, Jr, Green DP (eds): Fractures in Adults, Vol 1.NewYork: Lippincott Williams&Wilkins Publishers; 201. p. 857-908.

2. Najarian R, Nourbakhsh A, Capo J, Tan V. Perilunate injuries. Hand (NY). 2011;6:1-7.

3. Herzberg G, Comtet JJ, Linscheid RL, Amadio PC, Cooney WP, Stalder J. Perilunate dislocations and fracture-dislocations: a multicenter study. J Hand Surg Am. 1993;18:768-79.

4. Grabow RJ, Catalano L 3 Carpal dislocations. Hand Clin. 2006;22:485-500.

5. Wingelaar M, Newbury P, Adams NS, Livingston AJ. Lunate Dislocation and Basic Wrist Kinematics. Eplasty. 2016;16:ic37.

6. Bagheri F, Taraz-Jamshidi MH, Birjandinejad A, Sharifi-Daloei SR, Mirkazemi M, Choghadeh MF, et al. Trans-scaphoid perilunate fracture-dislocation and isolated perilunate dislocations; surgical versus non surgical treatment. Arch Bone Jt Surg. 2013;1:74-7.

7. Murakawa D, Makino T, Kishimoto S, Hamamoto H. Volar perilunate trans-scaphoid dislocation: a case. Hand Surg. 2014;19:419-21.

8. Meszaros T, Vögelin E, Mathys L, Leclère FM. Perilunate fracture-dislocations: clinical and radiological results of 21 cases. Arch Orthop Trauma Surg. 2018;138:287-97.

9. Jeon IH, Kim HJ, Min WK, Cho HS, Kim PT. Arthroscopically assisted percutaneous fixation for trans-scaphoid perilunate fracture dislocation. J Hand Surg Eur Vol. 2010;35:664-8.

10. Forli A, Courvoisier A, Wimsey S, Corcella D, Moutet F. Perilunate dislocations and transscaphoid perilunate fracture-dislocations: a retrospective study with minimum ten-year follow-up. J Hand Surg Am. 2010;35:62-8.

11. Sochart DH, Birdsall PD, Paul AS. Perilunate fracture-dislocation: a continually missed injury. J Accid Emerg Med. 1996;13:213-6.

12. Ada S, Özerkan F, Bora A, Ademoğlu Y, Kaplan İ. Perilunat kırıklı-çıkıkların cerrahi tedavi sonuçları. Acta Orthop Traumatol Turc. 1995;29:263-7.

13. Massicot R, Uzel AP, Céolin JL, Brouard P. Dorsal trans-scaphoid perilunate dislocation in a 9-year-old child. Eur J Pediatr Surg. 2005;15:140-3.

14. Hildebrand KA, Ross DC, Patterson SD, Roth JH, MacDermid JC, King GJ. Dorsal perilunate dislocations and fracture-dislocations: questionnaire, clinical, and radiographic evaluation. J Hand Surg Am. 2000;25:1069-79.

15. Kara A, Celik H, Seker A, Kilinc E, Camur S, Uzun M. Surgical treatment of dorsal perilunate fracture-dislocations and prognostic factors. Int J Surg. 2015;24:57-63.

16. Komurcu M, Kürklü M, Ozturan KE, Mahirogullari M, Basbozkurt M. Early and delayed treatment of dorsal transscaphoid perilunate fracture-dislocations. J Orthop Trauma. 2008;22:535-40.

17. Muller T, Hidalgo Diaz JJ, Pire E, Prunières G, Facca S, Liverneaux P. Treatment of acute perilunate dislocations: ORIF versus proximal row carpectomy. Orthop Traumatol Surg Res. 2017;103:95-9.

18. Matthewson G, Larrivee S, Clark T. Case Report of an Acute Complex Perilunate Fracture Dislocation Treated with a Three-Corner Fusion. Case Rep Orthop. 2018;2018:8397638.

19. Sotereanos DG, Mitsionis GJ, Giannakopoulos PN, Tomaino MM, Herndon JH. Perilunate dislocation and fracture dislocation: a critical analysis of the volar-dorsal approach. J Hand Surg Am. 1997;22:49-56.

20. Trumble T, Verheyden J. Treatment of isolated perilunate and lunate dislocations with combined dorsal and volar approach and intraosseous cerclage wire. J Hand Surg Am. 2004;29:412-7.

21. Laporte M, Michot A, Choughri H, Abi-Chahla ML, Pelissier P. Luxations et fractures-luxations périlunaires du carpe, étude rétrospective d'une série de 17 cas [Perilunate dislocations and fracture-dislocations of the wrist, a review of 17 cases]. Chir Main. 2012;31:62-70.

22. Mühldorfer-Fodor M, Hohendorff B, Saalabian AA, Hahne M, van Schoonhoven J, Prommersberger KJ. Neuropathie des N. medianus nach perilunären Luxationsverletzungen [Median nerve neuropathy after perilunate dislocation injuries]. Handchir Mikrochir Plast Chir. 2014;46:163-8.

23. Imao K, Tsubokawa N, Maki Y. Trans-scaphoid-perilunate dislocation with an ulnar nerve injury. J Hand Surg Eur Vol. 2016;41:111-2.

Original Article

Determining the Anxiety Levels of Emergency Health Workers in the COVID-19 Pandemic

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Abstract

Aim: This study aimed to determine the anxiety levels of emergency healthcare workers during the coronavirus disease-2019 (COVID-19) pandemic.

Materials and Methods: This descriptive and cross-sectional study was conducted using face-to-face interviews with 153 healthcare workers in emergency service clinics who cared for patients suspected of COVID-19. Study data were obtained using a descriptive characteristics questionnaire and the State-Trait Anxiety Inventory (STAI).

Results: The mean state anxiety score of emergency healthcare workers was 42.76±10.06, the mean trait anxiety score was 42.11±8.22, and the total scale mean score was 84.88±15.11. No significant relationships were found between STAI scores and participants' descriptive characteristics (i.e., workplace, gender, marital status, age, profession, years of experience, and satisfaction with work conditions).

Conclusion: This study revealed that emergency healthcare workers experienced anxiety at the panic level.

Keywords: Anxiety, emergency, COVID-19

Introduction

Humanity has faced disasters throughout history. One type of disaster is epidemic disease, which deeply affect humanity and lead to death and devastating effects. They also disrupt social life and the commercial activities of communities (1). Today's disaster is the novel coronavirus disease-2019 (COVID-19), which emerged in December 2019 in the Wuhan Province of China and went on to affect the entire world. It was determined that this disease is caused by a new type of coronavirus (CoV) that has not been detected before, and it was named SARS-CoV-2 due to its similarity to the Severe Acute Respiratory Syndrome (SARS) virus (2,3). While SARS-CoV-2, a member of the CoV family, is causing a pandemic, the Middle East Respiratory Syndrome (MERS) and SARS have also caused serious infection rates and deaths in the

world. In addition, this family has many subtypes (HCoV-229E, HCoV-OC43, HCoV-NL63 and HKU1-CoV), which can be found in people, but are characterized by milder infections (2,4).

As in all epidemics, people's lives have also been turned upside down, and an atmosphere of panic has been created in societies. Despite all protective and isolation measures taken by governments, social psychological trauma could not be prevented. Health workers have found themselves in a more peculiar position in terms of psychological trauma. They not only face normal risks like other people, but also professional risks (5,6). Those who perform invasive procedures such as intubation and resuscitation, bronchoscopy and catheter insertion, and laboratory workers and healthcare workers who are in direct contact with patients constitute the high-risk group. Emergency health workers are thus

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part of the high-risk group for COVID-19. In addition, healthcare workers face problems such as discrimination, exclusion and pressure in society, working above capacity, separation from their families and burnout syndrome. These have led to stress, anxiety and depression (7).

Without doubt, the emergency service workers who first encounter COVID-19 patients are among the groups that have experienced these feelings most intensely during the pandemic. Determining the anxiety levels of the emergency service workers who faithfully struggle with the pandemic, and planning appropriate measures is extremely important both for emergency service workers and for the quality and reliability of the services they provide to the public. Before effective approaches are developed to support health professionals, it is important to determine their anxiety and fear levels (8).

This study aims to determine the anxiety levels of emergency health workers during the COVID-19 pandemic.

Materials and Methods

Type of Study

This is a descriptive and cross-sectional study.

Study Population and Sample

This study was conducted from June 1st to June 30th, 2020 by face-to-face interviews with 153 health professionals who deals with suspected COVID-19 patients at the emergency service clinics of Erzurum Atatürk University and Erzurum District Training and Research Hospital. The study population consisted of 184 people who worked in these hospitals during the study period, and the study sample consisted of 153 voluntary participants who agreed to participate in the study. The population representation power of the sample was 83.2%.

Data Collection

The study data were obtained using a descriptive characteristics questionnaire and the State-Trait Anxiety Inventory (STAI). The participants filled out the forms individually in approximately five minutes.

The Descriptive Characteristics Questionnaire consists of 14 questions regarding the health professionals' age, gender and professional information.

The State-Trait Anxiety Inventory (STAI) was developed by Spielberg et al. (9) in the USA in 1970 and its Turkish form's validity and reliability were performed by Öner and Le Compte (10). This form includes two scales consisting of a total of 40 questions. The first 20 questions measure the state anxiety level of the patient, while the remaining questions measure the trait anxiety levels.

The state anxiety scale requires individuals to determine how they feel at a certain time and under certain conditions and answer the questions considering their feelings under these conditions. The trait anxiety scale requires individuals to determine how they generally feel. While reading the state anxiety scale, in accordance with the strength of the current feelings, patients answered each question with one of the following responses: (1) Never, (2) Some, (3) Much or (4) Completely. They answered each question of the trait anxiety scale with one of these responses: (1) Rarely, (2) Sometimes, (3) Mostly or (4) Almost every time. There are two types of statements on the scales that are either direct or reverse statements. Both the state anxiety and the trait anxiety scales include 10 questions with direct statements and 10 with reverse statements. Direct statements indicate negative feelings, while reverse statements represent positive feelings. When scoring the reverse statements, statements that have a weighted value of 1 become a 4, and a weighted value of 4 becomes a 1. Furthermore, answers with a value of 4 indicate a high level of anxiety in direct statements, however, in reverse statements, answers with a value of 1 indicate a high level of anxiety. According to Oner's suggestion, on Speilberg's state trait anxiety scale, scores are assessed as follows: 0-19 points indicate "no anxiety", 20-39 points indicate "slight anxiety", 40-59 points indicate "moderate anxiety", 60-79 points indicate "severe anxiety" and scores of 80 and higher represent "panic" (9,10). In this study the Cronbach's alpha internal consistency coefficient was 0.71.

Statistical Analysis

All data were analyzed with SPSS (Statistical Package for the Social Sciences) software for Windows (v18.0; IBM, Armonk, NY, USA). Individual and aggregate data were summarized using descriptive statistics including mean, standard deviation, medians (minimum-maximum), frequency distributions and percentages. Initial evaluations and comparison of the data for normal distribution was made via Kolmogorov-Smirnov and Shapiro-Wilk tests. Comparison of the dependent variables with normal distribution was made with Student's t-test and ANOVA. For the continuous variables that were not normally distributed, the Kruskall-Wallis and Mann-Whitney U tests were conducted to compare the groups. The results were evaluated at a 95% confidence interval, and $p<0.05$ was the threshold for statistical significance.

Ethical Aspects of the Study

The principles of the Declaration of Helsinki were followed during the study. Approval was obtained from Atatürk University Faculty of Medicine Ethics Committee (no:15, date: 28.05.2020). Information was given to the participants about the purpose of

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the study, its methods and the time they were asked to allocate for the study. Their verbal consent was obtained, after explaining that the data collected would only be used within the scope of the study, and that confidentiality would be strictly ensured.

Results

The biggest group of the participants (64.7%) had been working at the district training and research hospital; 57.5% of the participants were men, and 51.6% were married. The biggest education group was formed by high school graduates (35.9%); 39.2% had worked at the hospital for 1-5 years, and 28.8% were nurses. Finally, 82.4% liked their profession, and 57.5% were satisfied with their work conditions (Table 1).

The participants' mean state anxiety score was 42.76±10.06, and their mean trait anxiety score was 42.11±8.22. Their mean score on the entire STAI was 84.88±15.11 (Table 2).

Table 3 shows a comparison of STAI mean scores and the participants' descriptive characteristics. No statistically significant relationships were found between the participants' STAI mean scores and their descriptive characteristics (workplace, gender, marital status, age, profession, years in the profession, satisfaction with work conditions).

Discussion

During epidemics, healthcare workers are in closest contact with infected patients. Healthcare professionals at the forefront of combating the disease in this difficult time have been confronted with a deadly virus with an extremely high rate of contagiousness which has never been seen before. The mental health of healthcare professionals in emergency departments has been significantly affected, and they experience serious difficulties dealing with this complex situation (11,12). The results of the current study are discussed here along with those in the literature.

This study determined that the participants' mean score on the entire STAI was 84.88, which corresponds to panic. Studies have reported that the COVID-19 pandemic has had more psychological effects on healthcare personnel than injuries (11,12). Cheung et al. (13) conducted a study in Hong Kong and found that medical and nursing personnel experienced high levels of burnout, mental fatigue and anxiety due to the COVID-19 pandemic. Bohlken et al. (14) determined that doctors in Germany experienced high levels of anxiety and show depressive symptoms. Unfortunately, previous studies have reported that severe psychological pressure and intense fear of death have even led healthcare personnel to attempt suicide (15,16). Healthcare workers on the frontline in Wuhan were under moderate to severe stress during the peak periods of the epidemic, and many reported high anxiety levels and depression (17). Regarding this subject, another study conducted in Wuhan, the main center of the epidemic, reported that a large proportion of healthcare workers experienced severe anxiety and most of them received psychological help (18). Chew et al. (19) conducted a multi-center study and found that 8.7% of healthcare personnel experienced anxiety on levels from moderate to panic. The results of this

Table 1. Distribution of the emergency health professionals' descriptive characteristics

Characteristics	Number	Percentage
Hospital		
District Research Hospital	99	64.7
Atatürk University Research Hospital	54	35.3
Gender		
Female	65	42.5
Male	88	57.5
Marital status		
Married	79	51.6
Single	74	48.4
Education		
Primary school graduate	6	3.9
High school graduate	55	35.9
Associate's degree	25	16.4
Bachelor's degree	32	20.9
Master's degree	35	22.9
Years of work experience		
1-5 years	60	39.2
6-10 years	53	34.6
11 years and more	40	26.1
Profession		
Physician	39	25.5
Nurse	44	28.8
Emergency medical technician	13	8.5
Triage staff	6	3.9
Personnel (cleaning and transport)	21	13.7
Other (medical secretary, X-ray technician, etc.)	30	19.6
Are you happy with your job?		
Yes	126	82.4
No	27	17.6
Are you satisfied with your work conditions?		
Yes	65	42.5
No	88	57.5
Age [Mean (SD)]	30.96±7.13	
SD: Standard deviation		

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Table 2. Minimum and maximum scores on the State-Trait Anxiety Inventory (STAI) and the distribution of mean scores

Subdimension	Min-max scores	Mean scores $\overline{X} \pm SD$
State Anxiety Scale	20-65	42.76±10.06
Trait Anxiety Scale	21-72	42.11±8.22
STAI Score	41-125	84.88±15.11
SD: Standard deviation		

Table 3. Comparison of the mean scale scores and the descriptive characteristics of the emergency healthcare workers

Scale		X ± SD	Test and significance value
STAI	**Place of employment**		
	District training hospital	83.31±13.81	t=-0.412 p=0.58
	Research hospital	84.31±16.05	
	Gender		
	Female	84.31±13.81	t=-0.412 p=0.60
	Male	85.31±16.05	
	Marital status		
	Married	83.70±14.95	t=-1.002 p=0.30
	Single	86.14±15.30	
	Profession		
	Physician	84.05±16.78	F=1.239 p=0.29
	Nurse	85.61±15.27	
	Emergency medical technician	78.00±16.49	
	Personnel (cleaning and transport)	82.23±15.31	
	Triage	88.00±10.03	
	Other	89.10±11.97	
	Total	84.88±15.11	
	Years of work experience		
	1-5 years	85.06±16.72	F=0.127 p=0.88
	6-10 years	85.43±14.69	
	11 years or more	83.87±13.35	
	Total	84.88±15.11	
	Satisfaction with work conditions		
	Yes	83.83±15.92	t=-0.728 p=0.46
	No	85.65±14.54	
	Age	r=-0,033 p=0.68	
STAI: State-Trait Anxiety Inventory, SD: Standard deviation			

study are consistent with the international literature. Emergency departments are first groups to come into contact with people infected with COVID-19, and many aspects of the disease that are not yet fully understood, the fear of death and intense work conditions cause them to experience panic level anxiety. At the same time, the fear of transmitting the virus to their families and necessity of staying away from their families during this time is thought to be another reason for intense stress. News about healthcare workers in other countries going through very difficult times due to severe work conditions, also increased the anxiety levels of emergency health personnel.The anxiety levels of this study's participants did not vary with sociodemographic

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variables such as age, gender, marital status or profession. Huang and Zhao reported that young people in China experienced more fear of catching the disease, and that their anxiety levels were higher (20). The first scientific study of the anxiety levels of healthcare professionals in Wuhan reported that female healthcare professionals experienced more fear than their male counterparts (17). A study conducted in Turkey found that nurses experienced more anxiety than other healthcare personnel, and that female healthcare workers experienced more anxiety than males (21). Another study determined that approximately one-third to half of nurses had symptoms of anxiety, depression and insomnia. It also reported that, like nurses, physicians experienced great levels of stress, and that nearly half of them experienced anxiety and depression (22). This study's results differ from those in the literature. This may be due to the panic level anxiety of this study's participants. Because all groups had high levels of anxiety, mean score of the whole population was found at panic level. In addition, this result may be due to the fact that the study was conducted when the pandemic reached high levels and awareness of all groups increased as the epidemic had spread and become a more severe pandemic. The literature describes four levels of anxiety: mild, moderate, severe and panic. At the panic level, responsiveness to external stimuli decreases, motor coordination weakens, and communication problems occur. In addition, problems such as dyspnea, dizziness and fear of death may occur (23). Panic level anxiety negatively affects all personnel, regardless of age, gender, marital status or profession. This study shows how seriously this epidemic has affected emergency healthcare professionals who are in constant contact with infected patients, who are the first group to interact with them and who are at risk of being infected.

Study Limitations

The study was conducted in the center, and the study sample reflects only one area of Turkey. The results of this study can be generalized to the study group.

Conclusion

The results of the study indicate that the emergency healthcare workers experienced anxiety at the panic level. Anxiety affects mental status and can cause serious problems for the short- and long-term psychological well-being of emergency health care personnel. It is extremely important to evaluate anxiety levels in order to provide an effective support system for emergency health personnel, to begin their psychological recovery process as soon as possible and to meet their psychological care needs.

In order to protect the mental health of emergency medical personnel, psychological counseling and group meetings should be provided to address and manage methods of coping with the anxiety caused by this pandemic.

Ethics

Authorship Contributions

Conception and Design: İ.Ö., M.K., Z.K.Ö., Data Analysis and/or Interpretation: İ.Ö., E.T., Z.K.Ö., M.K., Statistical Analysis: İ.Ö., Writing: İ.Ö., Z.K.Ö., E.T., M.B., N.O.C.

References

1. Rawls CG, Turnquist MA. Pre-positioning of emergency supplies for disaster response. Transportation Research Part B: Methodological. 2010;44:521-34.

2. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A Novel Coronavirus from Patients with Pneumonia in China, 2019. N Engl J Med. 2020;382:727-33.

3. TR Ministry of Health, General Directorate of Public Health. COVID-19 guide. Ankara: Ministry of Health, General Directorate of Public Health. 2020.

4. Mousavizadeh L, Ghasemi S. Genotype and phenotype of COVID-19: Their roles in pathogenesis. J Microbiol Immunol Infect. 2021;54:159-63.

5. Rajkumar RP. COVID-19 and mental health: A review of the existing literature. Asian J Psychiatr. 2020;52:102066.

6. Ekiz T, Ilıman E, Donmez E. Comparison of health anxiety level and control perception of COVID-19 Int J Healthc Manag and Strategies Research. 2020;6:139-54.

7. Kang L, Li Y, Hu S, Chen M, Yang C, Yang BX, et al. The mental health of medical workers in Wuhan, China dealing with the 2019 novel coronavirus. Lancet Psychiatry. 2020;7:e14.

8. White DB, Lo B. A Framework for Rationing Ventilators and Critical Care Beds During the COVID-19 Pandemic. JAMA. 2020;323:1773-4.

9. Spielberger CD, Gorsuch RL, Lushene RE. Test manual for the State Trait Anxiety Inventory. 1st ed. California: Consulting Psychologists Press, 1970.

10. Öner N, Le Compte A. Discontinuous (state) trait anxiety inventory handbook, 2nd Edition, Istanbul, Boğaziçi University Publications. 1983;1-26.

Özlü et al. Emergency Health Workers in COVID-19

Eurasian J Emerg Med.
2021;20(3): 149-54

11. Pappa S, Ntella V, Giannakas T, Giannakoulis VG, Papoutsi E, Katsaounou P. Prevalence of depression, anxiety, and insomnia among healthcare workers during the COVID-19 pandemic: A systematic review and meta-analysis. Brain Behav Immun. 2020;88:901-7.

12. Zhang WR, Wang K, Yin L, Zhao WF, Xue Q, Peng M, et al. Mental Health and Psychosocial Problems of Medical Health Workers during the COVID-19 Epidemic in China. Psychother Psychosom. 2020;89:242-50.

13. Cheung T, Fong TKH, Bressington D. COVID-19 under the SARS Cloud: Mental Health Nursing during the Pandemic in Hong Kong. J Psychiatr Ment Health Nurs. 2021;28:115-7.

14. Bohlken J, Schömig F, Lemke MR, Pumberger M, Riedel-Heller SG. COVID-19-Pandemie: Belastungen des medizinischen Personals [COVID-19 Pandemic: Stress Experience of Healthcare Workers - A Short Current Review]. Psychiatr Prax. 2020;47:190-7.

15. Papoutsi E, Giannakoulis VG, Ntella V, Pappa S, Katsaounou P. Global burden of COVID-19 pandemic on healthcare workers. ERJ Open Res. 2020;6:00195-2020.

16. Montemurro N. The emotional impact of COVID-19: From medical staff to common people. Brain Behav Immun. 2020;87:23-4.

17. Du J, Dong L, Wang T, Yuan C, Fu R, Zhang L, et al. Psychological symptoms among frontline healthcare workers during COVID-19 outbreak in Wuhan. Gen Hosp Psychiatry. 2020;67:144-5.

18. Kang L, Ma S, Chen M, Yang J, Wang Y, Li R, et al. Impact on mental health and perceptions of psychological care among medical and nursing staff in Wuhan during the 2019 novel coronavirus disease outbreak: A cross-sectional study. Brain Behav Immun. 2020;87:11-7.

19. Chew NWS, Lee GKH, Tan BYQ, Jing M, Goh Y, Ngiam NJH, et al. A multinational, multicentre study on the psychological outcomes and associated physical symptoms amongst healthcare workers during COVID-19 outbreak. Brain Behav Immun. 2020;88:559-65.

20. Huang Y, Zhao N. Generalized anxiety disorder, depressive symptoms and sleep quality during COVID-19 outbreak in China: a web-based cross-sectional survey. Psychiatry Res. 2020;288:112954.

21. Hacimusalar Y, Kahve AC, Yasar AB, Aydin MS. Anxiety and hopelessness levels in COVID-19 pandemic: A comparative study of healthcare professionals and other community sample in Turkey. J Psychiatr Res. 2020;129:181-8.

22. Que J, Shi L, Deng J, Liu J, Zhang L, Wu S, et al. Psychological impact of the COVID-19 pandemic on healthcare workers: a cross-sectional study in China. Gen Psychiatr. 2020;33:e100259.

23. Öz F. Basic Concepts in Health. 2nd Edition. Ankara: Mattek Printing House; 2010. p. 130-5.

Original Article

Primary Care Patients Who Prefer Emergency Department Instead of Family Physician; How Do They Use Their Family Physician?

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Abstract

Aim: Patients with non-urgent (NU) issues go to the emergency department (ED) rather than to primary care providers, and this has become a worldwide problem. Thus, this study aimed to determine the characteristics of NU patients and to compare the use of EDs and family physicians (FPs).

Materials and Methods: This cross-sectional study was conducted in the ED of a tertiary hospital. A questionnaire was administered to NU (level 5) patients (aged ≥18 years) defined using the five-level triage system.

Results: Upper respiratory tract infection symptoms (19.6%) and gastrointestinal system problems (18.6%) were the most common complaints. FP contact was made before the ED visit by 13.3% of the patients. Most of them (79.6%) stated that they were satisfied with their FP and 6.1% never went to the FP. As regards health problems, 39.5% and 29.3% reported that they preferred the FP and ED, respectively. The visiting frequency of ≥3 times per year was 30.1% for the ED and was 42.9% for the FPs. The frequency of ED visits of those who were not satisfied with their FP was significantly higher than those of other participants (p=0.025). A significant relationship was found between the frequency of ED visits and FP visits.

Conclusion: Less than half of the patients preferred FPs when they had health problems. Those who visited the ED also frequently visited FPs. Dissatisfaction with the FP is associated with the frequency of visits in the ED.

Keywords: Emergency department, non-urgent use, family physician, primary care

Introduction

Using primary healthcare system effectively results in increased patient satisfaction, improved health status of patients, reduced use of hospital resources and reduced health costs (1). Despite the expansion of primary healthcare services around the world, the first choice of many people in the healthcare system remains the emergency departments (EDs) (2). It has been reported that the rate of non-urgent (NU) patient visits to EDs varies between 12% and 56% in different countries (3).

EDs are designed to provide continuous, rapid, qualified and accessible healthcare for injuries and acute diseases that require urgent intervention (4). However, NU use of EDs is common in many countries and is an important factor in overcrowding (5). The increasing number of patients leads to problems such as increased waiting time of patients, insufficient health care, and increased morbidity and mortality rates (6). NU visits may lead to problems like unnecessary examinations, wrong treatments, excessive health expenditures and the loss of comprehensive care services that can be provided by primary care physicians (7).

It is difficult to evaluate and define patient visits that are NU or inappropriate for EDs. It is generally defined as visits that do not increase the probability of a negative risk in health conditions with a delay of a few hours (8). These patients are generally

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primary care patients and can be given appropriate care by the general practitioner or family physician (FP) without the need for fast and special services of the ED (9).

The perceived severity of the disease, the desire for a quick recovery, the efficiency of primary health care services, and the lack of access to primary care and other alternative health services are important factors in NU patients visiting EDs (10-12).

Although there is no clear data on the number of NU visit rate in Turkey, it is known that the number of ED visits increase gradually. ED visits per capita were 1.11 in 2009 and increased to 1.12 in 2013 (13). It was reported that approximately 290 million people applied to hospitals affiliated to the Ministry of Health between January and October 2017, and 28.5% of them were ED admissions (14).

Primary healthcare services are provided by FPs in Turkey since last 10 years. Each person has a registered FP. When a person is not satisfied, he/she has right to choose different FP. FPs generally serve within office hours (8.00 am to 17.00 pm). Patients can apply EDs or hospitals directly instead of their FP during office hours. In Turkey, there are a limited number of studies researching the reasons of NU patients preferring EDs instead of FP. This study was conducted to determine the characteristics of NU patients who applied to the ED of a university hospital located in the southern Turkey, their reasons for admission and to compare the features of use FPs.

Materials and Methods

This cross-sectional study was conducted between April 2019 and June 2019 during office hours (between 9:00 a.m. and 5:00 p.m. on weekdays). It was carried out in the ED of Gaziantep University Faculty of Medicine, Training and Research Hospital. Gaziantep is one of the largest cities in southern Turkey with a population of 2.7 million. The hospital's ED is the largest ED in the region by serving approximately 255,000 patients per year. The hospital is located in a central area where patients can easily arrive from all regions of the city.

According to the triage operation procedure of the ED, in which the study was conducted about, patients are evaluated by the nurses and doctors in charge of triage in accordance with the 5-level triage system by the priority of injury. The patients are classified as follows: Severely injured patients are classified with code red (level 1-2), middle injured patients are classified with code yellow (level 3-4), patients with good general condition, stable vital signs and health problems that do not require urgent intervention are classified as NU (triage level-5) with code green.

Inclusion criteria in the study were being 18 years of age or older, being Turkish speaker and classification with triage level 5. The

patients with this feature were informed about the study by the triage doctors. Questionnaires were handed out to the patients who agreed to participate in the study. Patients completed the questionnaires after the consultation at the ED. The patients who gave incomplete answers to the questions in the patient survey, cases for examinations that cannot be performed under family healthcare center's conditions (such as radiography, ultrasonography), forensic cases and mentally disabled patients were excluded from the study.

The questionnaire, which was prepared by scanning the literature (15-17), contained 15 questions divided into two sections. In the first part of the patient survey, the sociodemographic characteristics of the patients (age, gender, education level, income status, marital status, place of residence) were questioned. In the second part of the questionnaire, there were nine questions about the patients' use of EDs and FPs.

Ethics

Ethical approval was obtained from the Ethics Committee of Gaziantep University Medical Faculty (decision number: 2019/103, date: 06.03.2019). Informed consent was obtained from the patients who participated in the study.

Statistical Analysis

SPSS (Statistical Package of Social Sciences) version 23.0 software was used for statistical analysis and $p<0.05$ was considered statistically significant. Number and percentage values were used for descriptive statistics, and categorical variables were evaluated by the chi-square test.

Results

We enrolled 402 patients during the study period. Ten people were excluded due to missing data. Thus, a total of 392 people were included in the study. The average age of the patients was 40.3±13.8 (minimum: 18 - maximum: 81) years, and 47.2% in the 30-50 age range. 50.8% (n=199) of the participants were male, 33.4% (n=131) were high school graduates, 50.5% (n=198) were middle level incomed and 76.3% (n=299) were married. The socio-demographic characteristics of the patients are shown in Table 1.

It was found out that 19.6% (n=77) of the complaints at ED admissions had problems related to the upper respiratory system, 18.6% (n=73) had complaints about the gastrointestinal system, 13.3% (n=52) had musculo-skeletal system (Table 2).

It was found that 13.3% (n=52) of the patients who applied to FP before applying to the ED. The majority of the participants (79.6% n=312) stated that they were satisfied with the FP, 10.5% (n=41)

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did not know their FP. Six percent of the participants stated that they never went to the family doctor. Twenty-four (6.1%) patients stated that they never went to the family physician. In case of any health problem, the 39.5% (n=155) chose FPs and 29.3% (n=115) chose EDs as their first prefer. The most common reason for applying to the FP was for prescribing medication with the rate of 59.8% (n=220) and after that, for being examined for health problems with the rate of 40.2% (n=148). The decision between the ED and FP of the patients are shown in Table 3.

42.9% (n=168) of the patients stated that they visited their FP and 30.1% (n=118) visited the ED three or more times in a year. A significant correlation was found between the frequency of ED visits and the frequency of FP visits. It was found that more than

half (55.9%) of those who visited the ED three or more in a year also visited the FP three or more in a year (Table 4).

The frequency of ED visits was found to be significantly higher (p=0.025) of those who were not satisfied with their FP compared to other participants (those who did not know the FP and were satisfied with the FP) (p=0.025). In the Table 5 the comparison of the participants' dissatisfaction with their FP and the visit frequency of ED were shown in.

Discussion

The first contact point between general practitioner and FP is providing personalized healthcare and this is important for directing individuals with serious injuries or diseases to

Table 1. Demographic characteristics of the patients

		n	%
Gender	Male	199	50.8
	Female	193	49.2
Age category	Under 30	108	27.6
	30-50 years	185	47.2
	Over 50 years old	99	25.3
Marital status	Married	299	76.3
	Not married	93	23.7
Income level	Low	54	13.8
	Medium	198	50.5
	Good	140	35.7
Educational level	Primary school	99	25.3
	Secondary school	102	26.0
	High school	131	33.4
	University	60	15.3
Place of residence	Province	328	83.7
	County/village	64	16.3

Table 2. Complaints of patients while emergency service applications

	n	%
Complaints about the upper respiratory tract	77	19.6
Complaints about the gastrointestinal system	73	18.6
Muscle-joint complaints	52	13.3
Complaints about genital and urinary tract	48	12.2
Dizziness, headache, and confusion	48	12.2
Minor traumas (fall-hit)	43	11.0
Skin related complaints	25	6.4
Psychological issues	11	2.8
Other	15	3.8
Total	392	100.0

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Table 3. Features of patients using emergency department and family physician

		n	%
Primary healthcare centers before the emergency service	Yes	52	13.3
	No	340	86.7
Visited primary healthcare center	Yes	368	93.9
	No	24	6.1
Satisfaction with the family physician	Do not know	41	10.5
	Satisfied	312	79.6
	Unsatisfied	39	9.9
The most preferred application institutions for health problems	Family physician	155	39.5
	Hospitals	122	31.1
	Emergency department	115	29.3
Visit frequency of family physician	One or less in a year	49	12.5
	1 or 2 times a year	175	44.6
	3 and more in a year	168	42.9
Visit frequency of emergency department	1-2 times in my life	69	17.6
	1 or 2 times a year	205	52.3
	3 and more in a year	118	30.1
The most common reasons for using family physician*	Being examined for health problems	148	40.2
	Prescribing medicine	220	59.8
	Blood pressure measurement/ examination/medication injection	90	24.5
	Getting a medical report	42	11.4
	Other reasons	29	7.9

*Participants gave more than one answer, n: Number

Table 4. Comparison of emergency department and family physician use frequency

Frequency of family physician use

			Less than 1 in a year	1-2 times per year	3 and more in a year	p-value x^2 test
Frequency of emergency department use	Less than 1 in a year	n	17	40	12	0.001
		%	24.6	58	17.4	
	Once or twice a year	n	20	95	90	
		%	9.8	46.3	43.9	
	3 and more in a year	n	12	40	66	
		%	10.2	33.9	55.9	

appropriate healthcare services (18). In a study conducted with patients with low level emergency in Canada, it was reported that approximately half of the patients sought alternative care before applying to the ED, and the rate of those who applied to the FP was 25.9% (19). A study done by Unwin et al. (20) reported that approximately 40% of the participants contacted a healthcare provider before applying to the ED. In a study conducted in Italy, it was reported that 84.1% of the participants applied to the ED at their own request or on the advice of their relatives without being referred by a physician (21). Akpinar et al. (16) from Turkey,

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Table 5. Comparison of dissatisfaction with the family physician and the frequency of emergency department use			Not satisfied with the family physician	Does not know the family physician or is satisfied	p-value x² test
Frequency of emergency department use	Less than 1 in a year	n	4	65	0.025
		%	10.3	18.4	
	Once or twice a year	n	16	189	
		%	41.0	53.5	
	3 and more in a year	n	19	99	
		%	48.7	28.0	

the rate of those who applied to another physician before applying to the ED was reported with the rate of 12.2%. In our study, it was found that only 13.3% of the patients went to their FP before applying to the ED. These findings show that a large proportion of patients in Turkey, where there is no obligatory referral system, use the ED as the first place of application.

In this study, it was found that complaints about the upper respiratory system, gastrointestinal and musculo-skeletal system were the leading complaints of ED admissions. Similarly, in other studies, complaints related to the upper respiratory tract, gastrointestinal system and conditions that cause pain were reported to be common (11,12,16,17,22).

The results of our study revealed that most of the NU patients who applied to the ED prefer hospitals and EDs more for their health problems. In the other studies, it has been shown that a significant portion of NU patients consider the ED as the place where they want their health problems to be solved (19,20). In a study conducted in England, it was reported that 29% of the patients who applied to the ED for NU situations thought that general practitioners could not help (23). In the study conducted by Idil et al. (17), it was stated that approximately one third of the patients (28.7%) did not prefer their FP when they had health problems.

In a study conducted in the United States, it was reported that patients' communication satisfaction with primary healthcare providers was not associated with NU ED choices. However, in the same study, it was found that patients with poor to moderate quality perceptions for primary healthcare were more likely to choose EDs (24). Akpinar et al. (16), reported that NU patients had an average of 68.1% satisfaction rate with their FPs and that there was no correlation between dissatisfaction and frequent use of the ED. Similarly, in this study, it was found that most of the patients were satisfied with their FPs. However, differently, in this study, a significant relationship was found between dissatisfaction with the FP and the frequency of ED visits (p=0.025).

It has been reported in the literature that people who prefer EDs frequently also prefer primary healthcare services and health services extensively (25-27). Similarly, in this study, it was shown that those who prefer the ED frequently also prefer primary healthcare centers frequently. Oh et al. (28) reported that those who had a history of frequent ED visits within one year had higher rates of inappropriate emergency use the following year. In a recent study conducted in Saudi Arabia, it was reported that approximately one third (32.5%) of NU patients visited the ED three or more times in the last year (15). Idil et al. (17) reported that 17.1% of the patients visited the ED with similar complaints in the previous two weeks. Similar to other studies, this study found that approximately one third of the participants visited the ED or more times in a year.

Study Limitations

The limitation of our study is that the study was conducted in a single center within a limited time. The results of the study cannot be generalized. The data in the study are based on the statements of the participants. In the study, the survey form was kept short in order not to interfere with the functioning of the ED, and the detailed reasons why the patients preferred ED and/or FP were not questioned. Therefore, investigating the reasons why prefer ED and FP in future studies will provide a better enlightenment on the subject.

Conclusion

As a result, it has been found that approximately two-thirds of NU patients do not prefer FPs when they have health problems. It has been found that users who frequently use the ED also frequently use FP. Dissatisfaction with the FP is associated with the frequent visits of the EDs. More studies should be conducted to increase the satisfaction of the patients with their FPs and to make them prefer FPs more.

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Ethics

Ethics Committee Approval: Ethical approval was obtained from the Ethics Committee of Gaziantep University Medical Faculty (decision number: 2019/103, date: 06.03.2019).

Informed Consent: Informed consent was obtained from the patients who participated in the study.

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References

1. Tiagi R, Chechulin Y. The effect of rostering with a patient enrolment model on emergency department utilization. Healthc Policy. 2014;9:105-21.

2. Pacheco J, Cuadrado C, Martínez-Gutiérrez MS. Urgent care centres reduce emergency department and primary care same-day visits: a natural experiment. Health Policy Plan. 2019;34:170-7.

3. Seeger I, Kreienmeyer L, Hoffmann F, Freitag MH. Cross-sectional study in an out-of-hours primary care centre in northwestern Germany - patient characteristics and the urgency of their treatment. BMC Fam Pract. 2019;20:41.

4. Khangura JK, Flodgren G, Perera R, Rowe BH, Shepperd S. Primary care professionals providing non-urgent care in hospital emergency departments. Cochrane Database Syst Rev. 2012;11:CD002097.

5. Pines JM, Hilton JA, Weber EJ, Alkemade AJ, Al Shabanah H, Anderson PD, et al. International perspectives on emergency department crowding. Acad Emerg Med. 2011;18:1358-70.

6. Di Somma S, Paladino L, Vaughan L, Lalle I, Magrini L, Magnanti M. Overcrowding in emergency department: an international issue. Intern Emerg Med. 2015;10:171-5.

7. Huang LC, Chung WF, Liu SW, Wu JC, Chen LF, Chen YC. Characteristics of Non-Emergent Visits in Emergency Departments: Profiles and Longitudinal Pattern Changes in Taiwan, 2000-2010. Int J Environ Res Public Health. 2019;16:1999.

8. Uscher-Pines L, Pines J, Kellermann A, Gillen E, Mehrotra A. Emergency department visits for nonurgent conditions: systematic literature review. Am J Manag Care. 2013;19:47-59.

9. Bezzina AJ, Smith PB, Cromwell D, Eagar K. Primary care patients in the emergency department: who are they? A review of the definition of the 'primary care patient' in the emergency department. Emerg Med Australas. 2005;17:472-9.

10. Oslislo S, Heintze C, Schmiedhofer M, Möckel M, Schenk L, Holzinger F. How to decide adequately? Qualitative study of GPs' view on decision-making in self-referred and physician-referred emergency department consultations in Berlin, Germany. BMJ Open. 2019;9:e026786.

11. Miyazawa A, Maeno T, Shaku F, Tsutsumi M, Kurihara H, Takayashiki A, et al. Inappropriate use of the emergency department for nonurgent conditions: Patient characteristics and associated factors at a Japanese hospital. J Gen Fam Med. 2019;20:146-53.

12. Şimşek P, Gürsoy A. Turkish health care providers' views on inappropriate use of emergency department: Who, when and why? Int Emerg Nurs. 2016;27:31-6.

13. Bektemur G, Osmanbeyoglu N, Cander B. Eurasian Journal of Emergency services report. Eurasian J Emerg Med. 2015;14:1-8.

14. 2017 Yılı Ocak-Ekim Dönemi Acil Servislere İlişkin Veriler: Türkiye Kamu Hastaneleri Genel Müdürlüğü İstatistik, Analiz, Raporlama ve Stratejik Yönetim Dairesi Başkanlığı verileri Aralık 2017   Available at: https://dosyamerkez.saglik.gov.tr/Eklenti/23496,2017-ocak-ekim-donemi-acil-servisverileri2pdf.pdf?0 (Accessed on: 13.12.2019).

15. Al-Otmy SS, Abduljabbar AZ, Al-Raddadi RM, Farahat F. Factors associated with non-urgent visits to the emergency department in a tertiary care centre, western Saudi Arabia: cross-sectional study. BMJ Open. 2020;10:e035951.

16. Akpinar Y, Demirci H, Budak E, Baran AK, Candar A, Ocakoglu G. Why do patients with minor complaints choose emergency departments and does satisfaction with primary care services influence their decisions? Prim Health Care Res Dev. 2018;19:398-406.

17. Idil H, Kilic TY, Toker İ, Dura Turan K, Yesilaras M. Non-urgent adult patients in the emergency department: Causes and patient characteristics. Turk J Emerg Med. 2018;18:71-4.

18. Brekke M, Carelli F, Zarbailov N, Javashvili G, Wilm S, Timonen M, et al. Undergraduate medical education in general practice/family medicine throughout Europe - a descriptive study. BMC Med Educ. 2013;13:157.

19. Sancton K, Sloss L, Berkowitz J, Strydom N, McCracken R. Low-acuity presentations to the emergency department: Reasons for and access to other health care providers before presentation. Can Fam Physician. 2018;64:e354-60.

20. Unwin M, Kinsman L, Rigby S. Why are we waiting? Patients' perspectives for accessing emergency department services with non-urgent complaints. Int Emerg Nurs. 2016;29:3-8.

21. Bianco A, Pileggi C, Angelillo IF. Non-urgent visits to a hospital emergency department in Italy. Public Health. 2003;117:250-5.

22. Backman AS, Blomqvist P, Lagerlund M, Carlsson-Holm E, Adami J. Characteristics of non-urgent patients. Cross-sectional study of emergency department and primary care patients. Scand J Prim Health Care. 2008;26:181-7.

23. Atenstaedt R, Gregory J, Price-Jones C, Newman J, Roberts L, Turner J. Why do patients with nonurgent conditions present to the Emergency Department despite the availability of alternative services? Eur J Emerg Med. 2015;22:370-3.

24. Xin H. Patient Dissatisfaction With Primary Care and Nonurgent Emergency Department Use. J Ambul Care Manage. 2019;42:284-94.

25. Byrne M, Murphy AW, Plunkett PK, McGee HM, Murray A, Bury G. Frequent attenders to an emergency department: a study of primary health care use, medical profile, and psychosocial characteristics. Ann Emerg Med. 2003;41:309-18.

26. Hansagi H, Olsson M, Sjöberg S, Tomson Y, Göransson S. Frequent use of the hospital emergency department is indicative of high use of other health care services. Ann Emerg Med. 2001;37:561-7.

27. Cunningham A, Mautner D, Ku B, Scott K, LaNoue M. Frequent emergency department visitors are frequent primary care visitors and report unmet primary care needs. J Eval Clin Pract. 2017;23:567-73.

28. Oh HC, Chow WL, Gao Y, Tiah L, Goh SH, Mohan T. Factors associated with inappropriate attendances at the emergency department of a tertiary hospital in Singapore. Singapore Med J. 2020;61:5-80.

The Assessment of End-Tidal Capnography Waveform Interpretation and Its Clinical Application for Emergency Residents in Malaysia: A Cross-Sectional Study

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Abstract

Aim: This study aimed to assess the adequacy of knowledge among emergency residents (ERs) and determine the correlation between the knowledge and practice of capnography waveform (CW).

Materials and Methods: This 6-month questionnaire-based cross-sectional study was conducted at the emergency department of a hospital. All ERs were included in this study. Respondents' knowledge was evaluated by exploring their interpretation of CW according to clinical situations and their ability in making appropriate clinical decisions and management. Pearson correlation statistic was used to determine the correlation between knowledge and practice.

Results: This study included 48 ERs. The mean scores for knowledge and practice (± standard deviation) were 5.69±1.82 and 4.40±1.8, respectively. No correlation was found between knowledge and practice (r=0.186, p=0.207).

Conclusion: ERs' ability to interpret CW was satisfactory. However, understanding the relevance of the CW findings and subsequent clinical management was poor.

Keywords: Emergency residents, capnography waveform, knowledge, practice

Introduction

End-tidal carbon dioxide ($EtCO_2$) is the concentration of carbon dioxide (CO_2) at the end of expiration. It provides information on ventilation (CO_2 elimination), perfusion (CO_2 transport in blood circulation), and metabolism (cellular metabolism and production of CO_2) (1-5).

Capnography Waveform (CW) is a useful, non-invasive, reliable, and real-time monitoring tool in emergency settings that can improve patient safety. It has been used extensively and became a standard of care to monitor the patient's ventilation during procedural sedation and analgesia (6). Moreover, it allows the rapid detection of airway obstruction, hypoventilation, and apnea in real-time (7,8). Henceforth, immediate intervention can be instituted early to prevent catastrophic consequences (9).

For patients with acute respiratory distress manifestations, clinical status, and CW findings provide essential clinical information. Abnormal CW is associated with higher intubation rates, intensive care unit (ICU) admissions, and mortality (10).

International Liaison Committee on Resuscitation recommended the application of quantitative waveform capnography during cardiopulmonary resuscitation (CPR) to ensure effective chest compression and to detect the return of spontaneous circulation (11,12). Moreover, CW may provide an objective basis to determine patients' prognosis, hence, terminating CPR (13). Continuous

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CW is also considered the gold standard for verifying proper endotracheal tube placement (1-4).

However, this monitoring technology is only as good as the user who analyses and interprets it. The ability to accurately interpret the CW is important but appropriately acting on the finding is important as well. The purposes of this study were to assess the knowledge of emergency residents (ERs) on CW who use it in their daily clinical practice and to determine the correlation coefficient between the ability of interpreting CW and the appropriateness of clinical intervention following the interpretation. We postulated that the mean score of knowledge and practice in CW and its application among ERs is 50% to 60%, and there is a significant positive correlation between knowledge and practice of CW.

We believe that knowledge and practice gap findings detected in this study can form a basis local education program development concerning the role of CW in clinical practice. The same questionnaire from this study can be utilized to evaluate the effectiveness of the education program.

Materials and Methods

Study Design and Setting

This questionnaire-based, cross-sectional study was conducted in the emergency department (ED), Hospital Melaka, Malaysia, over 6 months period that lasted from September 1st, 2019 to February 28th, 2020. Hospital Melaka is a tertiary hospital located in Melaka state, Malaysia, with multiple specialty disciplines and subspecialty service.

The number of ERs working in ED Hospital Melaka was inconsistent due to hospital administrative allocation, availability of new residents, and request from ERs to transfer to other departments. ED Hospital Melaka was staffed with 30 ERs in the year 2018, 35 ERs in the year 2019, and 45 in the year 2020. Their experience in ED varies, ranging from 0 months to 6 years, with the majority less than 3 years in ED. To ensure competency and up-to-date medical knowledge, continuing medical education (CME) sessions were held weekly to discuss various emergency topics, in a traditional pedagogy approach aided with simple technology, e.g. PowerPoint slides presentation or video demonstration. Inevitably ERs will miss part of the CME sessions due to working shifts. From the year 2019, capnography was available in ED Hospital Melaka (Oridion® sidestream device for the intubated patient only). Summary of CW in different clinical scenarios was printed and attached on the wall next to monitoring devices in the resuscitation zone to aid clinical judgment of clinicians when interpreting CW.

This study was conducted in compliance with the ethical principles outlined in the Declaration of Helsinki and Malaysia Good Clinical Practice (GCP) Guideline.

Population and Sample Size

ERs in ED Hospital Melaka were recruited through universal sampling. The ERs who were on leave during the study period and did not complete the questionnaire were excluded from the study.

The sample size was calculated using Power Analysis and Sample Size Software (PASS) version 11.0 (NCSS, LLC, Kaysvillie UT, USA). Sample size calculation followed Bujang and Baharum's (14) recommendations to analyze the correlation between knowledge and practice. To achieve a significant result (p<0.05) with sufficient power (80%) and at least a correlation coefficient of 0.4, the below formula was applied (14,15).

Sample size = N = $[(Z_\alpha + Z_\beta)/C]^2$

The standard normal deviate for $\alpha = Z_\alpha = 1.9600$

The standard normal deviate for $\beta = Z_\beta = 0.8416$

$C = 0.5 \times \ln[(1+r)/(1-r)] = 0.4236$

$N = [(Z_\alpha + Z_\beta)/C]^2 = 42$

A 10% dropout rate was added to the total sample to get the required sample size. As a result, the total number of 48 respondents was required for inferential analysis. Respondents were approached personally by the author to improve the engagement in this study to ensure the dropout rate not exceeding the estimation of 10%. Any confusion, doubts, and queries would be explained promptly, and the author would receive feedback directly after the questionnaire was answered.

Research Tool Development

We adapted The Association of Medical Education in Europe Guide no. 87 for educational research questionnaire development to formulate the questionnaire (16). The questionnaire construction process consists of five stages: item development, pretest, face validation, pilot study, and finalize questionnaire (16).

In the context of this study, knowledge is defined as the correct interpretation of CW tracing, and practice is defined as the correct management of patients based on the simulated clinical picture and end-tidal CW interpretation. The questionnaire was constructed with the concept of the minimally competent candidates (or "borderline candidates") to discriminate between candidates with and without adequate theoretical and applicable knowledge (17).

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Chee et al. Knowledge and Practice of Capnography Waveform

Stage 1: Item Development

An extensive literature review was conducted using textbooks, PubMed, and Google Scholar. The term "end-tidal capnography waveform" is synonymous with "$EtCO_2$", "waveform capnography", "end-tidal carbon dioxide", "capnography", "end-tidal capnography" and "$EtCO_2$ waveform monitoring". Existing questionnaires related to knowledge and practice towards end-tidal capnography waveforms were sought. Core topics in $EtCO_2$ were listed after interviews with emergency physicians and readings from journals, international guidelines, or consensus.

The knowledge section's core topics included normal waveform interpretations, indications of $EtCO_2$ monitoring, and causes of flat line tracings. The practice section's core topics included the application of $EtCO_2$ during CPR, mechanical ventilation, and pattern recognition of abnormal waveforms in different clinical scenarios.

Stage 2: Pretest of the Draft Questionnaire

Selected items were drafted into a questionnaire and pretested among 15 ERs. Interviews were conducted to check for comprehensiveness, readability, relevance, and clarity of the draft questionnaire. Feedbacks were considered, and corrections were made to the draft questionnaire.

Stage 3: Face and Content Validation

For face validation, a panel consisting of 6 experts in the field of end-tidal CW in the emergency setting was invited to validate the questionnaire (18,19). They are emergency physicians or consultants who have clinical experience in end-tidal CW, education/training, or survey study.

The content validity index (CVI) was calculated for each item to decide its acceptability. Experts were asked to rate items for clarity, relevance, representativeness, and importance on a 4-point scale. For instance, to rate relevance of an item, experts are given four options: 1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, 4 = highly relevant (20). The scale-level content validity index (S-CVI/Ave) was calculated using the averaging calculation method. Ratings of more than 0.9 are considered excellent content validity (21). In this study, S-CVI/Ave score for both knowledge and practice was 0.9 and above.

Stage 4: Pilot Study and Retest

A pilot test was carried out among 15 ERs, and a retest was conducted a week after. The intraclass correlation coefficient (ICC) was used to test the reliability of the questionnaire. ICC values of less than 0.5 indicate poor reliability, values between 0.5 and 0.75 indicate moderate reliability, values between 0.75 and 0.9 indicate good reliability, and values greater than 0.90 indicate excellent reliability (22,23). In this study, all the items achieved an ICC of more than 0.7.

Stage 5: Finalise Questionnaire

The final questionnaire consists of six items in the demographics section, 10 items in the knowledge section, and 10 items in the practice section (Appendix 1).

Data Collection

The questionnaire was distributed among respondents who fulfilled the criteria and consented from September 1st, 2019 to February 28th, 2020. Respondents who were involved in the pretest and pilot study were excluded. They were required to answer all the items within one hour, without discussing or refer to any resources.

Statistical Analysis

Statistical analysis was performed using Statistical Package for the Social Science version 20.0 (SPSS Inc. Cary, NC, USA). The distribution of the data set was determined by evaluating skewness and kurtosis results. The skewness and kurtosis value within -1 to +1 were considered normal distribution of the data set. Numerical data were reported either as mean [standard deviation (SD)] or median [interquartile range (IQR)]. Categorical data were reported as a percentage (%).

There were 10 items in the knowledge and practice section, respectively. One (1) mark would be given for the correct response in each item. The minimum score would be 0, and the maximum score would be 10 in each section. For each respondent, correct responses were summed up to give rise to a total knowledge and practice score. Then, the mean score for each section was analyzed with descriptive statistics function in SPSS.

To discriminate respondents with adequate theoretical and applicable knowledge and those without, a traditional passing mark of 60% in the professional medical examination was set in our study (24-26). Respondents who score 6.00 and above were considered "adequate", and those who score 5.99 and below were considered "inadequate". We have a similar understanding that there is no gold standard in standard-setting methods (24,27,28). Hence, the different methodology may yield different passing marks (17,28).

Correlation between knowledge and practice was analyzed using the Pearson correlation coefficient because the data was normally distributed. The correlation coefficient value of less than 0.2, 0.2 to 0.39, 0.4 to 0.59, 0.6 to 0.79, and 0.8 to 1.0 indicates very weak correlation, weak correlation, moderate correlation, strong correlation, and very strong correlation respectively.

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Point estimation from the general population mean with a lower and upper bound of 95% confidence interval was calculated. Therefore, p<0.05 was considered to be statistically significant.

Results

Demographic Characteristics

Forty-eight ERs were enrolled in the study. The respondents' age ranged from 26 to 32 years old (Table 1). The median (IQR) age of respondents was 27 (1) years old. The predominant gender of the respondents was female (70.8%). The duration of medical service among respondents ranged from 12 months to 52 months. The median (IQR) duration of respondents' medical service was 21 (8.8) months. The respondents' duration of ED service ranged from 14 days to 28 months. The median (IQR) years of experience in ED was 3 (3.5) months. Among 48 respondents, only one of them had formal training in CW application.

Capnography: Knowledge Score

The mean score of overall respondents' knowledge (± SD) was 5.69±1.82. The number of respondents who scored above 60% was 62.5% (Table 2). Item K3a had the highest percentage of correct response (100%), while item K2a had the lowest correct response percentage (33.3%) (Figure 1).

Capnography: Practice Score

The mean score of respondent skill/practicing ability was 4.40±1.81. The number of respondents who scored above 60%

was 29.2% (Table 2). Five out of 10 items had more than 50% correct responses (Figure 2). Item P2 had the highest percentage of correct responses (64.4%), while item P8 had the lowest correct response percentage (4.2%).

Correlation Between Knowledge and Practice Score

There was a weak and non-significant correlation between the two variables, r=0.19, p=0.20.
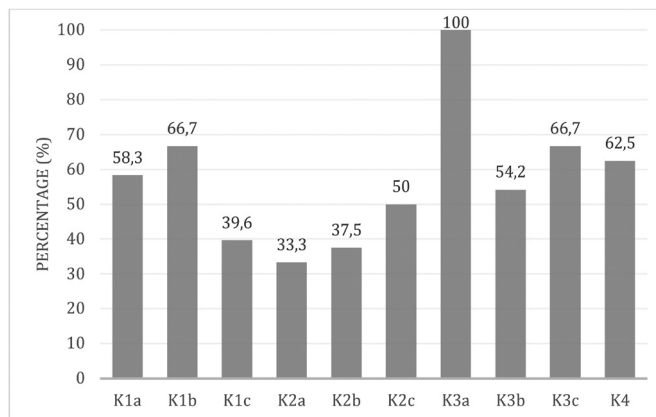
Figure 1. The correct response in the knowledge section

Y-axis/percentage (%): percentage of respondents answered correctly. X-axis/item: a total of 10 items, starts from item K1a and ends with item K4. Item K3a had the highest percentage of respondents who answered correctly (100%), while item K2a had the lowest percentage of respondents who answered correctly (33.3%).

Table 1. Characteristics of respondents		
Item	Mdn	IQR
Age (years)	27	26.5-27.5
Duration of medical service (months)	21	12.2-29.8
Duration of experience in ED (months)	3	0-6.5
Gender	**n**	**%**
Male	14	29.2
Female	34	70.8
Formal training in capnography application		
Yes	1	2.1
No	47	97.9
Mdn: Median, IQR: Interquartile range, ED: Emergency department, n: Number, %: Percentage		

Table 2. Adequacy level in knowledge and practice		
	Inadequate	Adequate
Knowledge	18 (37.5%)	30 (62.5%)
Practice	34 (70.8%)	14 (29.2%)
Respondents who scored correct responses of ≥60% in each section were considered achieved an adequate level of understanding		

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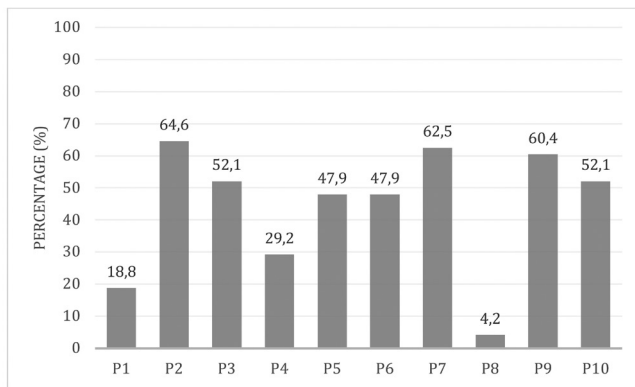
Figure 2. The correct response in the practice section

Y-axis/percentage (%): percentage of respondents answered correctly. X-axis/item: a total of 10 items, starts from item P1 and ends with item P10. Item P2 had the highest percentage of respondents who answered correctly (64.6%), while item P8 had the lowest percentage of respondents who answered correctly (4.2%)

Discussion

This questionnaire's objective was to assess the knowledge and practice of the ERs towards $EtCO_2$ interpretation and application because capnography offers great opportunities to improve the quality of treatments and give rescuers feedback on the effectiveness of life-saving procedures, particularly during the management of critically ill patients. However, without adequate knowledge of CW interpretation and application, capnography is just a fancy gadget without purpose. It is necessary to prepare future ERs on the right path of patients' safety and effective practice regarding the CW application.

In our study, the majority of the respondents were junior doctors. The most senior respondent in this study served 4 years in health service and 2 years in ED. There were a few identified reasons for lack of senior ERs. For instance, the diversity/complexity in patients' clinical presentations (trauma, acute surgical, neuro-psychiatric, acute medical, domestic violence, child abuse), shift duty, challenges in leave management, and "not knowing what is coming through the doors next" (29). In Malaysia scenario, ERs with a great interest in pursuing their career in Emergency Medicine by joining the master program or fellowship program will serve longer in the ED.

Being a junior ER and working in the overcrowding and unpredictable environment with undifferentiated cases is indeed a great challenge, particularly in making appropriate clinical reasoning and decision making of undifferentiated illness from different genders and age groups. ED clinician's responsibilities that exceed the junior ERs' capabilities may lead to stress, hence providing substandard management to patients.

In most of ED in Malaysia, the severity of the patient's condition was categorized into three zones, i.e., red zone (critical), yellow zone (semi-critical), and green zone (non-critical). Red zone and yellow zone patients suffered from life-threatening and potentially life-threatening conditions whereby the capnography evaluation is indicated in the measurement of adequacy of alveolar ventilation, airway integrity, cardiopulmonary function, and ventilator function. ED administrator tends to locate the junior ERs to the non-critical zones for them to familiarise with the new challenges, new workplace environment, and different type of cases. Therefore, it was not surprised if the respondents had inadequate knowledge of capnography and its application. Few studies revealed that despite the availability of capnography devices, there was a lack of knowledge and skills among emergency medical service providers (30,31).

This study revealed that most respondents (97.9%) did not receive any formal training in capnography during their undergraduate years and internship period. Probable reasons included $EtCO_2$ is not an important vital sign in Malaysia, it is not widely available throughout the country, and $PaCO_2$ level is available in arterial blood gases test (32-34).

The knowledge score distribution among the ERs of less than 6.0 and above 6.0 was 38% and 62%, respectively. Surprisingly, two-thirds of ERs had adequate knowledge of capnography. The mean ($\pm$ SD) score of overall respondents' knowledge was 5.69$\pm$1.82. All the respondents answered correctly regarding CW's indication during the management of sudden cardiac arrest or CPR (Question K3a). However, three-quarters of them did not answer correctly on the normal range of $EtCO_2$ (Question K2a).

Most ERs had achieved an adequate level in the knowledge section despite limited training, and previous exposure was an interesting finding. There are a few reasons to explain the above findings. In our opinion, the CW has a simple structure or shape, and the information is easily deduced if the respondents understood the respiratory system, carbon dioxide transport, and cellular metabolism. A study by Iyer et al. (35) in 2015 demonstrated after mild exposure and education, nearly all the respondents were able to achieve basic understandings and adequate knowledge in $EtCO_2$ readings. Moreover, in our ED, CW in different clinical scenarios was printed and exhibited on the wall next to the resuscitation zone's monitoring devices. The exhibited printed information provides interpretation assistance of the waveform and troubleshooting assistance to the doctors on duty. Interpretations and use of CW were discussed briefly during relevant topics in continuous medical education (CME) sessions, e.g., cardiac arrest, emergency intubation, and post-intubation care. ERs may also acquire knowledge on CW

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during attending relevant courses, e.g., advanced cardiac life support (ACLS) and mechanical ventilator workshop. And not to mention the role of emergency physicians who discussed the capnography's advantages and disadvantages during their ward round or bedside teaching.

In this study, most ERs (71%) had a practical score of less than 6.0, which is considered insufficient practical skill regarding response to abnormal CW. The mean (± SD) score of overall respondents in the practice section was 4.40±1.81. Most of the questions in the practice section were answered incorrectly by the ERs. Only 64% of respondents answered correctly for re-intubation in the event of continuous flat waveform tracings post-intubation, and only 4% of respondents able to recognize the leaking endotracheal tube and choose to re-intubate patients.

In our hospital setting, CW only available in the form of sidestream device for monitoring intubated patients in the resuscitation zone. Limited working experience in the resuscitation zone, less exposure to the practical use of waveform, and it was not consistently applied to the patient may contribute to the low competency level in the practice section of our study (36-38). The inconsistent use of CW among clinical staff in acute care settings, despite emerging evidence of CW monitoring in improving patient safety, is a discouraging fact. Lack of awareness and specific knowledge deficits on the importance of CW in clinical practice contribute to capnography application failure (39). The planned organizational effort for implementation plays a role in promoting CW (40,41). In the UK, the 4th national audit project of the Royal College of Anaesthetists and Difficult Airway Society (NAP4) recommended CW monitoring during intubation in the ED setting (42).

Competence is the acquisition of knowledge, skills, and abilities at a level of expertise sufficient to perform in an appropriate work setting. In simple words, knowledge and practice should always go hand in hand (30). Our study demonstrated an extremely weak correlation between the interpretation knowledge of CW and its clinical application. In other words, the respondent's knowledge was not reflected in their practice. Reasons for the insignificant correlation could be multifactorial. Lack of policy, lack of motivation, and inadequate training may be part of the reasons (43). We believe that the interpretation of CW is related to pre-existing theoretical knowledge but the clinical application requires practice and experience, hence the correlation was weak.

Interestingly, this finding was similar to a study conducted by Wylie et al. (31) in 2019, except the studied population were paramedics. The study demonstrated that pre-hospital care staff achieved high CW knowledge scores but low scores in CW

applications. However, the attributing factors were not studied (31).

Recommendations

Our study showed different results from other studies (30,44). It was also contrary to common study findings that higher knowledge scores were associated with higher practice scores (45-47), and vice versa. Hence, different strategies are required to improve the competency of ERs in CW. The training program is of utmost importance: Czyż et al. (30) in 2018 demonstrated that emergency medical services providers who received training in CW achieved significantly higher scores than those who did not receive training.

CME sessions regarding basic and advanced usage of CW should be organized at the departmental level. The knowledge of CW should be incorporated into other related courses, e.g., ACLS. Bedside teaching should be encouraged and continued. In particular, a specific indication of CW can be discussed, e.g., during CPR, with the addition of current evidence, benefits, and data interpretations rather than a general overview. The discussions will then serve as a gateway to other applications with CW (41). Diagram, poster, or flip chart regarding CW should be made available in the resuscitation zone. The logbook should include CW applications as one of the core competencies in the emergency residency program.

At the organizational level, the standard operating procedure of positive ventilated patient care should include CW monitoring. EtCO$_2$ level should be monitored in all positive ventilated patients and documented in medical records or charts (48,49). Stocks of capnography should be made available and easily accessible in the department (41).

Study Limitations

There are limitations to this study. The methodology and study design limit the sample, and the results cannot be generalized to other departments, e.g., ICU care settings, or different posts in emergency care settings, e.g., staff nurses. The closed-ended type instrument limits its ability to explore the reason for different competency levels in the knowledge and practice section. The difficulty level of each item and item discrimination were not analyzed in this study. The lack of respondents with previous training and experience in CW also makes studying the correlation between them and knowledge with practice difficult. We do not know whether senior ERs would have produced different outcomes in this study. Future studies should involve a different level of expertise or center and further validation of the instrument.

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Conclusion

The knowledge in CW among ERs, particularly junior residents, was sufficient. However, the appropriate response towards the abnormal finding of CW was questionable. Strategies should be formulated to enhance their knowledge and training on the daily application of CW, with the ultimate goal of improving patient safety.

Ethics

Ethics Committee Approval: This study was approved by the Malaysia Medical Research and Ethics Committee (MREC) through National Medical Research Register (ID: NMRR-19-1763-49223) on July 19th, 2019.

Informed Consent: Written consent was obtained from emergency residents working in the emergency department, Hospital Melaka who fulfiled inclusion criteria.

Peer-review: Externally peer-reviewed.

Author Contributions

Concept: R.C.C, R.A., M.I.Z., M.F.Y., Design: R.C.C, R.A., M.I.Z., M.F.Y., Supervision: C.R.C, R.A., M.I.Z., M.F.Y., Resources: R.C.C, R.A., M.F.Y., Materials: R.C.C, R.A., Data Collection and/or Processing: R.C.C, R.A., M.F.Y., Analysis and/or Interpretation: R.C.C, R.A., M.I.Z., Literature Search: R.C.C, R.A., M.F.Y., Writing: R.C.C, R.A., M.I.Z., M.F.Y., Critical Review: R.C.C, R.A., M.I.Z.

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References

1. Whitaker DK. Time for capnography - everywhere. Anaesthesia. 2011;66:544-9.

2. Kodali BS. Capnography outside the operating rooms. Anesthesiology. 2013;118:192-201.

3. Nassar BS, Schmidt GA. Capnography During Critical Illness. Chest. 2016;149:576-85.

4. Manifold CA, Davids N, Villers LC, Wampler DA. Capnography for the nonintubated patient in the emergency setting. J Emerg Med. 2013;45:626-32.

5. Ward KR, Yealy DM. End-tidal carbon dioxide monitoring in emergency medicine, Part 1: Basic principles. Acad Emerg Med. 1998;5:628-36.

6. Committee on Standards and Practice Parameters. Standards for Basic Anesthetic Monitoring. American Society of Anesthesiologists. Available at.http://www.asahq.org/quality-and-practice-management/standards-guidelines-and-related-resources/standards-for-basic-anesthetic-monitoring. Accessed: March 14, 2018.

7. Adams L, Butas S, Spurlock D Jr. Capnography (ETCO2), respiratory depression, and nursing interventions in moderately sedated adults undergoing transesophageal echocardiography (TEE). J Perianesth Nurs. 2015;30:14-22.

8. Burton JH, Harrah JD, Germann CA, Dillon DC. Does end-tidal carbon dioxide monitoring detect respiratory events prior to current sedation monitoring practices? Acad Emerg Med. 2006;13:500-4.

9. Richardson M, Moulton K, Rabb D, Kindopp S, Pishe T, Yan C, et al. Capnography for Monitoring End-Tidal CO2 in Hospital and Pre-hospital Settings: A Health Technology Assessment. Ottawa (ON):Canadian Agency for Drugs and Technologies in Health. 27 May 2016.

10. Nagurka R, Bechmann S, Gluckman W, Scott SR, Compton S, Lamba S. Utility of initial prehospital end-tidal carbon dioxide measurements to predict poor outcomes in adult asthmatic patients. Prehosp Emerg Care. 2014;18:180-4.

11. Link MS, Berkow LC, Kudenchuk PJ, Halperin HR, Hess EP, Moitra VK, et al. Part 7: Adult Advanced Cardiovascular Life Support: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2015;132(18 Suppl 2):S444-64.

12. Soar J, Nolan JP, Böttiger BW, Perkins GD, Lott C, Carli P, et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 3. Adult advanced life support. Resuscitation. 2015;95:100-47.

13. Kolar M, Krizmaric M, Klemen P, Grmec S. Partial pressure of end-tidal carbon dioxide successful predicts cardiopulmonary resuscitation in the field: a prospective observational study. Crit Care. 2008;12:R115.

14. Bujang MA, Baharum N. Sample size guideline for correlation analysis. World Jornal of Social Science Research. 2016;3:37-46.

15. Guenther WC. Desk Calculation of Probabilities for the Distribution of the Sample Correlation Coefficient. Am Stat. 1977;31:45-8.

16. Artino AR Jr, La Rochelle JS, Dezee KJ, Gehlbach H. Developing questionnaires for educational research: AMEE Guide No. 87. Med Teach. 2014;36:463-74.

17. Boursicot KA, Roberts TE, Pell G. Standard setting for clinical competence at graduation from medical school: a comparison of passing scores across five medical schools. Adv Health Sci Educ Theory Pract. 2006;11:173-83.

18. Lynn MR. Determination and quantification of content validity. Nurs Res. 1986;35:382-5.

19. Rubio DM, Berg-Weger M, Tebb SS, Lee ES, Rauch S. Objectifying content validity: Conducting a content validity study in social work research. Social work research. 2003;27:94-104.

20. Davis LL. Instrument rewiew: Getting the most from a panel of experts. Appl Nurs Res. 1992;5:194-7.

21. Waltz CF, Strickland OL, Lenz ER. Measurement in nursing and health research. 3rd ed. New York: Springer; 2005.

22. Portney LG, Watkins MP. Foundations of clinical research: applications to practice (Vol. 892). Upper Saddle River, NJ: Pearson/Prentice Hall; 2009.

23. Koo TK, Li MY. A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. J Chiropr Med. 2016;15:155-63.

24. Ben-David MF. AMEE Guide No. 18: Standard setting in student assessment. Medical Teacher. 2000;22:120-30.

25. Liu M, Liu KM. Setting pass scores for clinical skills assessment. Kaohsiung J Med Sci. 2008;24:656-63.

26. Tekian A, Norcini J. Overcome the 60% passing score and improve the quality of assessment. GMS Z Med Ausbild. 2015;32:Doc43.

27. Kane MT, Crooks TJ, Cohen AS. Designing and Evaluating Standard-Setting Procedures for Licensure and Certification Tests. Adv Health Sci Educ Theory Pract. 1999;4:195-207.

28. Downing SM, Tekian A, Yudkowsky R. Procedures for establishing defensible absolute passing scores on performance examinations in health professions education. Teach Learn Med. 2006;18:50-7.

29. Rosen B, Rosen P, Schofer J, Asher S, Wald D, Cheaito MA, et al. Is Emergency Medicine the Right Choice for Me? J Emerg Med. 2019;56:e35-8.

Chee et al. Knowledge and Practice of Capnography Waveform

Eurasian J Emerg Med.
2021;20(3): 161-71

30. Czyż R, Leśkiewicz M, Czyż I. Knowledge and skills toward capnometry and capnography among Emergency Medical Service providers. J Educ, Health Sport. 2018;8:121-7.

31. Wylie C, Welzel T, Hodkinson P. Waveform capnography in a South African prehospital service: Knowledge assessment of paramedics. Afr J Emerg Med. 2019;9:96-100.

32. Zwerneman K. End-tidal carbon dioxide monitoring: a VITAL sign worth watching. Crit Care Nurs Clin North Am. 2006;18:217-25.

33. Evans T, Laborato L, Lord J. Capnography the seventh vital sign. RT for Decision Makers in Respiratory Care. 2008;21:30-3.

34. Hunter CL, Silvestri S, Ralls G, Bright S, Papa L. The sixth vital sign: prehospital end-tidal carbon dioxide predicts in-hospital mortality and metabolic disturbances. Am J Emerg Med. 2014;32:160-5.

35. Iyer NS, Koziel JR, Langhan ML. A qualitative evaluation of capnography use in paediatric sedation: perceptions, practice and barriers. J Clin Nurs. 2015;24:2231-8.

36. Deiorio NM. Continuous end-tidal carbon dioxide monitoring for confirmation of endotracheal tube placement is neither widely available nor consistently applied by emergency physicians. Emerg Med J. 2005;22:490-3.

37. Ilko SA, Vakkalanka JP, Ahmed A, Evans DA, House HR, Mohr NM. End-tidal CO_2 Monitoring is Available in Most Community Hospitals in a Rural State: A Health System Survey. West J Emerg Med. 2019;20:232-6.

38. Turle S, Sherren PB, Nicholson S, Callaghan T, Shepherd SJ. Availability and use of capnography for in-hospital cardiac arrests in the United Kingdom. Resuscitation. 2015;94:80-4.

39. Cook TM, Woodall N, Frerk C. A national survey of the impact of NAP4 on airway management practice in United Kingdom hospitals: closing the safety gap in anaesthesia, intensive care and the emergency department. Br J Anaesth. 2016;117:182-90.

40. Obstfelder A, Engeseth KH, Wynn R. Characteristics of successfully implemented telemedical applications. Implement Sci. 2007;2:25.

41. Langhan ML, Kurtz JC, Schaeffer P, Asnes AG, Riera A. Experiences with capnography in acute care settings: a mixed-methods analysis of clinical staff. J Crit Care. 2014;29:1035-40.

42. Cook TM, Woodall N, Harper J, Benger J; Fourth National Audit Project. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 2: intensive care and emergency departments. Br J Anaesth. 2011;106:632-42.

43. Bowles TM, Freshwater-Turner DA, Janssen DJ, Peden CJ; RTIC Severn Group. Out-of-theatre tracheal intubation: prospective multicentre study of clinical practice and adverse events. Br J Anaesth. 2011;107:687-92.

44. Kiekkas P, Stefanopoulos N, Konstantinou E, Bakalis N, Aretha D. Development and psychometric evaluation of an instrument for the assessment of nurses' knowledge on capnography. Collegian. 2016;23:39-46.

45. Ahayalimudin N, Osman NN. Disaster management: Emergency nursing and medical personnel's knowledge, attitude and practices of the East Coast region hospitals of Malaysia. Australas Emerg Nurs J. 2016;19:203-9.

46. Pouraghaei M, Sadegh Tabrizi J, Moharamzadeh P, Rajaei Ghafori R, Rahmani F, Najafi Mirfakhraei B. The Effect of Start Triage Education on Knowledge and Practice of Emergency Medical Technicians in Disasters. J Caring Sci. 2017;6:119-25.

47. Sharifi Y, Nikravan Mofard M, Jamsahar M, Nasiri M, Safari M. Knowledge, Attitude, and Practice of Emergency Medical Services Staff in Bleeding Control of Trauma Patients; a Cross sectional Study. Arch Acad Emerg Med. 2020;8:e11.

48. Gulube SM, Wynchank S. Telemedicine in South Africa: success or failure? J Telemed Telecare. 2001;7 (Suppl) 2:47-9.

49. LaMonte MP, Bahouth MN, Hu P, Pathan MY, Yarbrough KL, Gunawardane R, et al. Telemedicine for acute stroke: triumphs and pitfalls. Stroke. 2003;34:725-8.

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Appendix 1

THE ASSESSMENT OF END-TIDAL CAPNOGRAPHY WAVEFORMS INTERPRETATION AND ITS CLINICAL APPLICATION FOR EMERGENCY RESIDENTS IN Malaysia: A CROSS-SECTIONAL STUDY

Section A: Demographics

Age: Gender: Male/Female

Years of medical service: year/s   month/s

Years of experience in the emergency department: year/s   month/s

Previous training in capnography waveforms: Yes/No

Years of experience in capnography waveforms monitoring:

Section B: Knowledge

This section consists of 4 questions related to end-tidal capnography waveforms interpretation. Select the correct answer.

1. Diagram below shows a normal end-tidal CO_2 capnography waveform tracings. AB-BC-CD-DE represents phases in a waveform produced by inspiration and expiration.
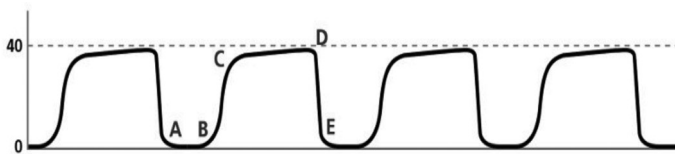
Please match the following:

Alveolar plateau	Early inspiration	Expiration	Early expiration
Late inspiration	Late expiration	Alpha angle	End-tidal CO_2

a. D represents _____

b. CD represents _____

c. DE represents _____

2. Please tick your answer

	Regarding $EtCO_2$ level	True	False	Unsure
a.	The normal range is 30 - 40 mmHg			
b.	Hypotension decreases $EtCO_2$ level			
c.	Hyperpyrexia increases $EtCO_2$ level			

3. Please tick your answer

	Indications of capnography waveform monitoring in the emergency department include	True	False	Unsure
a.	Cardiopulmonary resuscitation			
b.	Ischemic stroke			
c.	Dengue fever			

4. A 50 years old patient was intubated and sedated in the resuscitation zone. End-tidal capnography ($EtCO_2$) was applied

and produces the capnography waveform, as shown below. What are the possible causes?
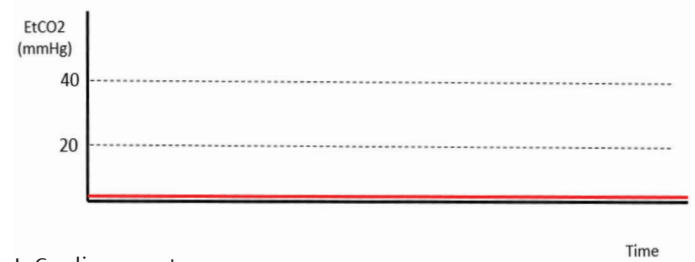
I. Cardiac arrest

II. Hypovolemia

III. Oesophageal intubation

IV. Kinked endotracheal tube

a. I & III.

b. I, II & IV.

c. I, III & IV.

d. I, II, III & IV.

Section C: Practice

This section consists of 10 questions related to capnography waveform simulation and application. Select the correct answer.

1. A 50 years old gentleman had a cardiac arrest in the emergency department. Cardiopulmonary resuscitation (CPR) commenced immediately, and the patient was intubated. End-tidal capnography ($EtCO_2$) applied. Tracings, as shown below with ongoing CPR.
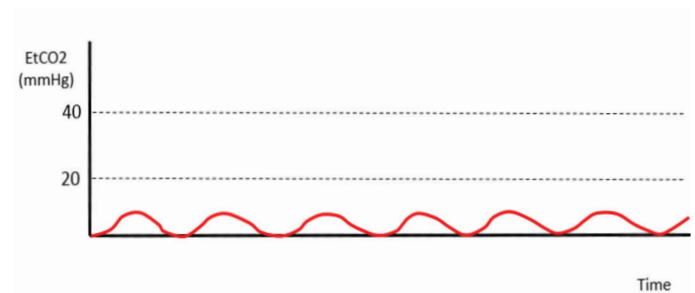
What is the most appropriate action?

a. Continue chest compression.

b. Switch compression provider.

c. Terminate chest compression.

d. Increase the volume of bagging.

2. A 60 years old gentleman had a sudden cardiac arrest. Cardiopulmonary resuscitation (CPR) commenced, and the

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patient was intubated. End-tidal capnography ($EtCO_2$) applied. Capnography waveform tracings, as shown below with ongoing chest compression.

What is the most appropriate action?

a. 5 point auscultation of the lungs.

b. Readjust ETT depth.

c. Re-intubate patient.

d. Switch compressor.

3. A 30 years old patient was intubated during cardiopulmonary resuscitation (CPR). End-tidal capnography ($EtCO_2$) applied. Capnography waveform, as shown below, was noted during chest compression.
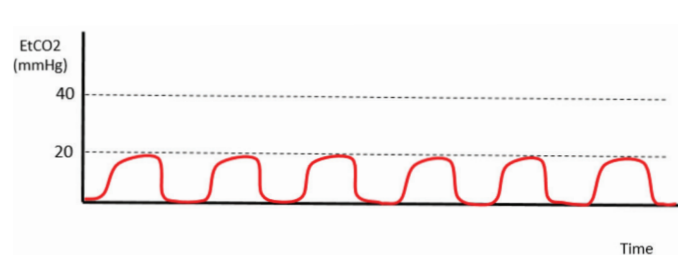
What is the most appropriate action?

a. Perform lung auscultation.

b. Continue high-quality CPR.

c. Increase the rate of bagging.

d. Switch chest compressor.

4. A 50 years old gentleman had a sudden cardiac arrest. Cardiopulmonary resuscitation (CPR) commenced. The patient was intubated, and end-tidal capnography ($EtCO_2$) was applied. High-quality Cardiopulmonary resuscitation (CPR) was performed for 20 minutes and remains asystole during pulse check. The capnography waveform below was noted persistently throughout the 20 minutes of chest compression.
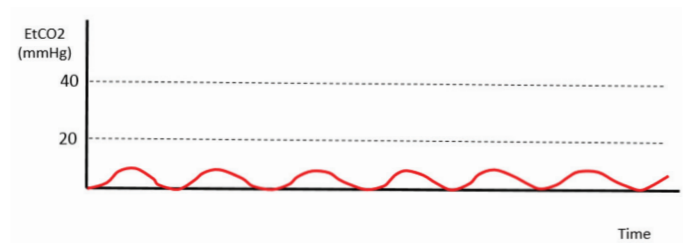
What is the most appropriate action?

a. Continue high-quality CPR.

b. Switch chest compressor.

c. Increase the rate of bagging.

d. Termination of resuscitation.

5. A 50 years old lady had a sudden cardiac arrest. Cardiopulmonary resuscitation (CPR) commenced immediately, and she was intubated. End-tidal capnography ($EtCO_2$) applied. High-quality CPR was performed for 20 minutes, and you noticed capnography waveform changes, as shown below.
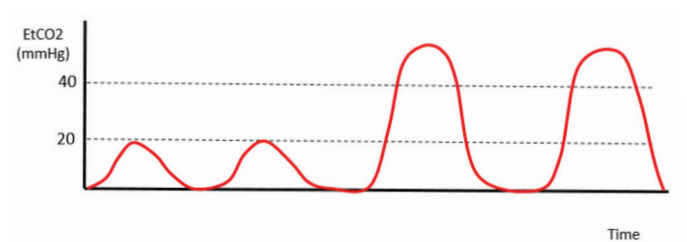
What is the most appropriate action?

a. Pulse check.

b. Increase the rate of bagging.

c. Decrease the volume of bagging.

d. Termination of resuscitation.

6. A 70 kg patient with an isolated severe traumatic brain injury was intubated. Ventilator connected and end-tidal capnography ($EtCO_2$) applied. Ventilator setting: mode SIMV, tidal volume 500ml, rate 22, IE ratio 1:2, FiO2 1.0. The capnography waveform is shown below.

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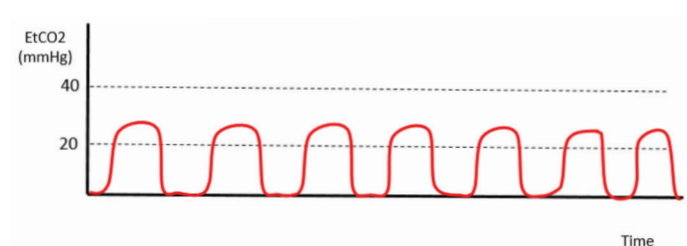
What is the most appropriate action?

a. Reduce the ventilation rate.

b. Increase tidal volume.

c. Prolonged I: E ratio.

d. Reduce FiO$_2$.

7. A 65 years old patient was intubated for poor respiratory effort and hypoxia secondary to severe pneumonia. The capnography waveform is shown below.
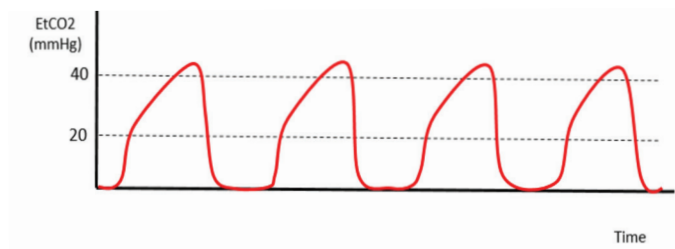
What is the most appropriate action?

a. Re-intubate the patient.

b. Increase the tidal volume setting.

c. Administer bronchodilator therapy.

d. Check the plateau pressure.

8. A 30 years old male patient was intubated in the resuscitation zone. The ventilator was connected, and end-tidal capnography (EtCO$_2$) was applied. Endotracheal tube (ETT) size 8mm was used, anchored at 24cm, and the pilot balloon inflated with 10cc of air (ETT cuff pressure measured 25cmH$_2$O). The capnography waveform is shown below.
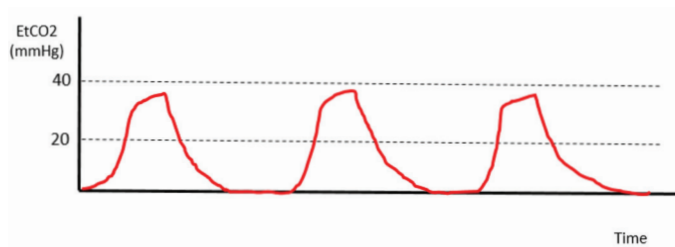
What is the most appropriate action?

a. Readjust ETT depth to 22cm.

b. Administer bronchodilator therapy.

c. Re-intubate with the same size endotracheal tube.

d. Inflate the pilot balloon with another 10cc of air.

9. A 25 years old gentleman had a severe maxillofacial injury. He was intubated and ventilated. End-tidal capnography (EtCO2) applied. Ventilator setting: mode SIMV, tidal volume (Vt) 480ml, rate 10, IE ratio 1:2, FiO2 1.0. The capnography waveform is shown below.
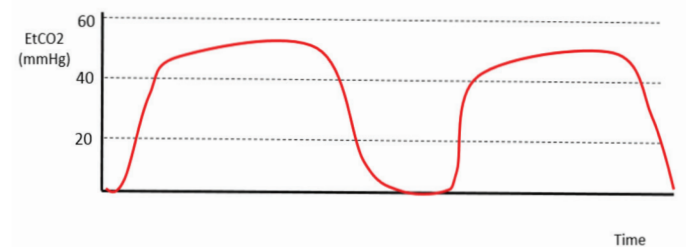
What is the most appropriate action?

a. Increase the I: E ratio to 1:3.

b. Increase Vt to 600ml.

c. Increase rate to 14.

d. Switch to CMV mode.

10. A 25 years old gentleman was intubated using an endotracheal tube (ETT) diameter of 8mm, anchored at 28cm, and the pilot balloon inflated to achieve ETT cuff pressure of 20-30 cmH$_2$O. The ventilator is connected, and end-tidal capnography (EtCO$_2$) was applied. Capnography waveform tracings, as shown below.
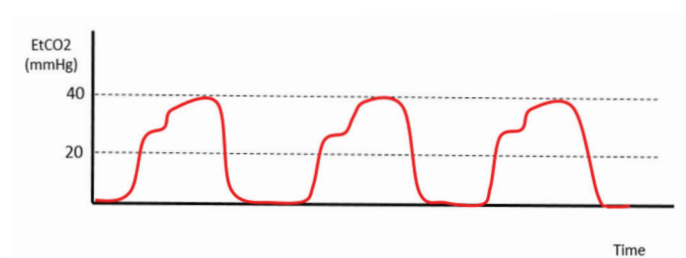
What is the most appropriate action?

a. Re-intubate with ETT size 7 mm.

b. Remove 5cc of air from the ETT cuff.

c. Administer bronchodilator therapy.

d. Readjust the depth of ETT.

- End of questionnaire -

A Study on the Effectiveness of Video Call Dispatcher-Assisted Cardiopulmonary Resuscitation in Enhancing the Quality of Cardiopulmonary Resuscitation Among Laymen Bystanders in Malaysia

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Abstract

Aim: Technology has enabled the utilization of dispatcher-assisted cardiopulmonary resuscitation (DA-CPR) through mobile video call for layman bystanders as opposed to the conventional audio call. This study aimed to examine the effects of medical guidance through a video call on cardiopulmonary resuscitation (CPR) quality during the management of cardiac arrest.

Materials and Methods: A quasi-experimental study was conducted on 102 participants. These participants were divided into two groups: laymen who received CPR instructions through dispatcher-assisted video call (n=51) and healthcare personnel (n=51) who did not receive any assistance. The compression rate and depth, compression fraction, chest recoil, and hand positioning were compared between the groups.

Results: Laymen who received video call DA-CPR performed better than the healthcare personnel in adhering to the recommended compression rate (109.7 min^{-1} vs 126.7 min^{-1}, p<0.05) and allowing chest recoil (94.8% vs 84.4%, p<0.05) but performed poorer in terms of compression depth (58.8% vs 98%, p<0.05) and chest compression fraction (49.2% vs 60.8%, p< 0.05). Hand positioning in the layman group was less accurate in comparison with that in the healthcare personnel group (90.2% vs 96.1%), but the result was not statistically significant (p=0.24).

Conclusion: In this study, video call DA-CPR allows laymen to deliver CPR with better compression rate, chest recoil, and hand placement than did healthcare personnel. However, inadequate compression depth and low chest compression fraction in the video call DA-CPR group show that more study is needed to deliver effective instructions during the video call to improve these areas.

Keywords: Dispatcher-assisted, video call, cardiopulmonary resuscitation, out of hospital cardiac arrest, mobile phone

Introduction

Out of hospital cardiac arrest (OHCA) is one of the most highlighted areas when discussing cardiopulmonary resuscitation (CPR). According to the American Heart Association (AHA), the survival rate of OHCA was 10-12% (1). A strong chain of survival has been shown to improve the chances of survival and recovery for cardiac arrest victims. Modifiable factors associated with increased OHCA survival includes early bystander CPR, Emergency medical service (EMS) response times, and application of an automated external defibrillator in communities (2). These factors represent opportunities for improvements in saving lives.

In the event of OHCA, prompt attendance by medical personnel trained in basic life support (BLS) or Advance Cardiac Life Support (ACLS) would be an ideal situation. However, in Malaysia, the average time taken for the ambulance to arrive at the scene is 19 minutes (3). Thus, to improve survival in OHCA, early bystander CPR is imperative (4). Regrettably, the rate of bystander CPR in developing nations is still relatively low at 10% and the quality

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of CPR is in doubt (5). Dispatcher-assisted CPR (DA-CPR) is an advocated solution. Dispatcher protocols designed to improve rapid recognition of arrest and coach CPR may increase survival by reducing preventable time delays to start of chest compressions and improving the quality of bystander CPR (6). Traditional communication via verbal instructions over the phone has a few limitations such as time delay due to the rescuer's conversation with the dispatcher and the inability for the dispatcher to receive real-time visual feedback of the rescuer during CPR (7).

DA-CPR in Malaysia is still in infancy. Lack of resources and financial constraints may affect their progress. With the advancement of mobile technology and widespread internet connectivity, video calls via smartphones have been highly plausible (8). Interactive audio-visual communication is doable. In addition to removing visual barriers that existed in the conventional audio calls, video communication offers real-time audio-visual feedback for both interactive parties, thus improving effective communication. One previous study that examined the differences in the quality of dispatcher-assisted chest compression between video coaching and audio coaching showed that the video coaching group achieved better results in terms of the compression rate, the accuracy of the compression site, and the minimization of the hands-off time (9). Additional benefits of video call DA-CPR include an enhancement in lay rescuer's confidence level, a positive effect on dispatcher's attitude, an improvement of chest compression rate and better airway manoeuvres (10-13).

Based on the current situation in Malaysia, the present study aimed to observe the efficacy of direct medical guidance through a video call during the management of OHCA. We hypothesized that the quality of CPR performed by laymen bystanders who received CPR instructions via video call communication is better than the quality of CPR performed by health care personnel (HCP) bystanders.

Materials and Methods

Study Design and Setting

This quasi-experimental study was conducted in the Emergency Department (ED) of the University Malaya Medical Centre over a span of 6 months duration. This study was approved by the Medical Research Ethics Committee of University Malaya (no: no: 2018829-6632, date: 01.02.2019).

Population and Sample Size

There were two groups involved in this non-randomized pre and post interventional study, i.e., laymen bystanders and HCP bystanders group. Those laypeople who accompanied their

parent, spouse, relative or friend at the non-critical zone of ED and who had no CPR training before (laymen bystanders) and HCP bystanders in ED (nurses, medical assistants, and doctors) with a valid BLS certificate were included in the study. The participant who had any physical disability or audio-visual impairment was excluded from the study. The whole idea of this study was to evaluate the CPR performance of laymen bystanders after receiving step-by-step guidance via video call from trained dispatcher. Those certified advanced cardiovascular life support (ACLS) instructor among the emergency residents were appointed as the dispatcher. To prove our hypotheses, the estimated sample size was calculated based on α precision of 0.05, a two-sided test, and an assumption of moderate effect. Our power calculation was performed in G-Power 3.1.3 software. Hundred and two participants (n=51 in each group) were required to make this study 80% power with a 5% significance level.

Materials and Procedures

During the early stages of the study, we explained the study objective, design, and procedure to those interested laypersons. Written informed consent was obtained once they clearly understood and agreed to take part in the study.

We positioned the simulation CPR mannequin (Resuci Anne QCPR, Laerdal, Stavanger, Norway) and laymen bystanders, in the middle of the room. Samsung Note Fan Edition mobile phone was fixed to a tripod and positioned beside the mannequin. To measure the quality of CPR, QCPR Instructor Apps (version 1.11.21) was connected to the mannequin via Bluetooth connectivity. The dispatcher was provided with an iPhone 8 and was stationed in a separate building.

During the second phase of the study, video calls between the dispatcher and the layman bystanders were made using the WhatsApp Messenger application (version 2.19.81) via the 3G network. Once they got connected, the dispatcher directed the laymen bystanders to perform CPR steps for 2 minutes according to the modified call card instruction module adapted from the national Malaysian Emergency Medical Dispatch protocol (AMPDS® v13.0, MAL-std). Similarly, HCP bystanders were asked to perform CPR on the same training mannequin as per the BLS algorithm but without any guidance or feedback.

Data Collection and Outcome

The quality of CPR performed by both groups was measured based on the criterion recommended by the 2015 AHA guidelines (14).

The measured variables included:

1. Chest compression rate.

2. Compression depth.

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3. Adequacy of chest recoil.

4. Correct hand placement in the mid sternum area.

5. Chest compression fraction (CCF)

We transferred all the collected data from the QCPR Instructor Apps into the collecting sheet then into the Google Sheet that was accessible via the investigator's Google Drive only. A study participant reference number was used to recognize the participants. All information and data collected either electronically or in the form of hard copy were destroyed after the storage duration unless required otherwise by the ethics committee, regulatory bodies, or institutional bodies.

Statistical Analysis

Participants who did not meet the inclusion criteria were excluded from statistical analyses. Statistical analysis was performed using Statistical Package for the Social Science (SPSS) version 21.0 (IBM enterprise). Numerical data were reported as mean (SD). Categorical data were reported as a percentage (%). According to the AHA Guideline 2015, the appropriate chest compression per minute, compression depth (cm) and chest compression fraction are 100-120, 5.0-6.0, and more than 60%, respectively.

Chi-square test was applied to determine the relationship between laymen bystanders and HCP bystanders chest compression rate and depth. The $p<0.05$ indicates that these variables are not independent of each other and that there is a statistically significant relationship between the categorical variables.

Two-tailed unpaired t-test was conducted within each group to determine the mean difference in the quality of CPR measurements and its significance. In the initial phase, The Kolmogorov-Smirnov normality test was applied to determine the distribution of data. i.e., normal, or abnormal data distribution. p-value of <0.05 means, the difference between the two samples is significant enough to suggest that the data do not follow a normal distribution. For analysis of normal distribution unpaired data, an independent t-test was applied. Before interpreting the data, Levene's test was conducted to look for homogeneity in the t-test. The differences are declared statistically significant if $p<0.05$.

Results

Demographic Characteristics

A total of 102 volunteers took part in the study. There were 51 participants in each group (Table 1).

The mean age (SD) of laymen bystanders and HCP bystanders were 29.4 (6.6) and 28.1 (4.0) years old, respectively. The predominant gender was female participants. All HCP bystanders were either diploma or degree holder. In comparison, only 75% of laymen bystanders had higher education background.

High-Quality CPR Performance

Over the two minutes, CPR process, the mean compression rate (SD) among the laymen bystanders that were guided by video call and among the HCP bystanders were 109.7 (19.1) min^{-1} and 126.7 (16.5) min^{-1}, respectively (Table 2). Astonishingly, more than half of laymen bystanders (51.0%) achieved a proper chest compression rate compared to HCP bystanders (37.4%). Statistically, there was no significant relationship exists between laymen bystanders CPR that were assisted with video call and HCP bystanders in performing appropriate chest compression rate, X^2 (1, n=102)=1.95, p=0.16.

Most of HCP bystanders executed an adequate depth of chest compression compared to the laymen bystanders (98.0% vs 58.8%, p<0.05). Statistically, there was a significant relationship exists between laymen bystanders who performed CPR under video call guidance and HCP bystanders in performing adequate depth of chest compression, X^2 (1, n=102)=23.18, p<0.05.

Table 1. Baseline characteristics of participants from the two study groups		
	Laymen bystanders	**HCP bystanders**
Gender		
Male, n (%)	25 (49)	20 (39.2)
Female, n (%)	26 (51)	31 (60.8)
Mean age (SD), years	29.4 (6.6)	28.1 (4.0)
Level of education		
Secondary, n (%)	13 (25.4)	0
Diploma, n (%)	6 (11.8)	28 (54.9)
Degree, n (%)	26 (51.0)	23 (45.1)
Postgraduate, n (%)	6 (11.8)	0
HCP: Health care personnel, SD: Standard deviation, n: Number		

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In terms of correct hand placement during chest compression, both groups (laymen bystanders and HCP bystanders) compressed the chest appropriately at the centre of the chest (90.2% vs 96.1%), X^2 (1, n=102)=1.38, p=0.24.

Regarding allowing complete recoil during chest compression, the video call assisted layman bystanders performance was better than HCP bystanders [94.8% vs 84.4%, X^2 (1, n=102)=7.14, p<0.05].

Independent t-test analysis of chest compression rate demonstrated a significant mean difference in chest compression rate between video call guided laymen bystanders CPR and HCP bystanders, t (100)=4.80, p<0.05 (Table 3). There was also a significant mean difference of chest compression fraction between video call guided laymen bystanders CPR and HCP bystanders, t (100)=7.43, p<0.05.

Discussion

This study demonstrated that in general, the HCP bystanders' compression rate was faster than the recommended compression rate (100-120 min^{-1}). This may be because most of the healthcare worker had not gone for any BLS or ACLS refreshment course for 1 year. This may lead to a decline in memory retention and skill set. Interestingly, about 50% of laymen bystanders with video call assistance performed an appropriate compression rate. Our finding was similar to other studies conducted by Yang et al. (15) and Lee et al. (9). Yang et al. (15) did a comparison study between interactive video call against audio call on the quality of dispatcher-assisted compression-only CPR. The study reported that 46.5% of the lay rescuers with video call guidance had performed chest compression at an appropriate rate. Lee et al. (9) examined the effect of cellular video phone demonstration on the quality of hands-only CPR compared to audio call. The study showed that 59% of the test subjects performed the chest compression according to the recommended compression rate. However, the mean compression rate in Yang et al. (15) and Lee et al. (9) studies were 95.5 min^{-1} and 99.5 min^{-1}, respectively. The fact that the video call in their studies was pre-recorded and could not provide live feedback on the quality of compression rate to the rescuer while the CPR was ongoing may be the main

Table 2. The quality of CPR between laymen bystanders with video call DA-CPR guidance and healthcare personnel bystanders

Quality of CPR	Laymen bystanders	HCP bystanders
Mean compression, rate/min (SD)	109.7 (19.1)	126.7 (16.5)
Allow complete chest recoil, (%)	94.8	84.4
Mean chest compression fraction, (%)	49.2	60.8
Correct hand placement, (%)	90.2	96.1
DA-CPR: dispatcher-assisted CPR, CPR: Cardiopulmonary resuscitation, HCP: Health care personnel, SD: Standard deviation		

Table 3. Comparison of two independent samples (chest compression rate and chest compression fraction between laymen bystanders with video call DA-CPR guidance and healthcare personnel bystanders

		Levene's test for equality of variances		t-test for equality of means						95% confidence interval of the difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	SE difference	Lower	Upper
Chest compression rate per minute	Equal variances assumed	0.018	0.893	4.802	100	0.000	16.980	3.536	9.965	23.996
	Equal variances not assumed			4.802	97.834	0.000	16.980	3.536	9.963	23.998
Chest compression fraction (%)	Equal variances assumed	0.392	0.533	7.428	100	0.000	11.588	1.560	8.493	14.683
	Equal variances not assumed			7.428	99.983	0.000	11.588	1.560	8.493	14.683
DA-CPR: dispatcher-assisted cardiopulmonary resuscitation, Sig: Significance, SE: Standard error										

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reason why few of the laymen bystanders did not perform well as expected. In contrast, the mean chest compression rate in our study was 110 min^{-1}. Most probably, the higher CPR rate in our study was attributed to the live feedback by the dispatchers. The dispatcher had instructed the lay rescuer to compress faster in synchrony with his counting whenever the dispatcher realized the rescuer was compressing too slow.

Our study demonstrated more subjects in the HCP bystanders group achieved appropriate compression depth (92.7%) compared to the video call assisted laymen bystanders group (57.5%). Bolle et al. (16) examined CPR quality between a video call and audio call among laymen bystander. The study revealed that the average chest compression depth performed by the participants in the video group was 3.7 cm with only 35% of the test subjects in the video group performed adequate compression depth (16). In another study conducted by Yang et al. (15) the researchers discovered that the video group subjects had a mean chest compression depth of 3.6 cm with only 20% of them achieved an adequate compression depth. Offering feedback on compression depth to the rescuer is extremely difficult as there is no way for the dispatcher to objectively evaluate the compression depth. Hence, the dispatcher is advisable to accentuate on "push hard" on every CPR cycle, and it does not matter whether the chest compression depth is adequate or not to ensure adequate compression depth is provided.

In addition to proper compression rate and compression depth, rescuers must also minimise interruption during chest compression to achieve high-quality CPR. The AHA guidelines 2015 recommends chest compression fraction (defined as the percentage of total resuscitation time that compressions are performed) of more than 60% as a measure of minimal interruption during chest compression (14). This study demonstrated that the mean chest compression fraction of video call assisted laymen bystanders did not accomplish the suggested parameter (49.2%) and mean chest compression fraction of HCP bystanders was acceptable though marginal result (60.8%). From our observation, layman rescuers took much longer time to open the airway and to ensure adequate rescue breaths were provided during the video call.

Regarding the correct hand placement during chest compression, the performance of laymen bystanders group was comparable to the HCP bystanders group (90.2% vs 96.1%). Similar findings were noted from Yang et al. (15) and Lee et al. (9) studies whereby the percentage of correct hand placement in their video call group were 84% and 71.8%, respectively. These results may be attributed to the fact that video call allows real-time visual feedback to the dispatcher and thus, can troubleshoot incorrect hand placement immediately.

We have no issue in claiming that video call assisted CPR expedites the initiation of life-saving intervention but we are still unsure the overall quality of CPR performed by naïve laymen bystanders that is guided by video call. However, we are very positive that video call assisted CPR may enhance the quality of CPR among CPR trained laypersons.

Study Limitations

There are a few limitations in this study. Firstly, this study was performed in a simulated cardiac arrest situation where other factors that may affect CPR performance such as prolonged CPR while waiting for EMS arrival, anxiety and stress are absent. Secondly, the mobile phone used in our study was placed in a fixed position with a tripod to maximise the audio-visual quality. In real life situation where there is only one rescuer who would make the phone call and perform CPR, it may be challenging to find a proper spot to place the mobile phone whilst simultaneously doing CPR and maintaining optimal audiovisual communication. Finally, the dispatcher used a modified dispatch protocol designed for audio DA-CPR. The development of a validated video call dispatch protocol in the future may elucidate the benefit of video call DA-CPR.

Conclusion

The majority of OHCA occurs in a public setting. Bystander CPR offers many survival advantages. Immediate CPR can double or triple chances of survival after sudden cardiac arrest. The chance of survival is higher if laymen bystanders provide high-quality CPR before the arrival of the EMS team. Here in our study we concluded that video call assisted CPR may enhance the quality of CPR provided it can evaluate the laymen bystanders performance and at the same time it can provide prompt feedback related to CPR interventions.

Ethics

Ethics Committee Approval: This quasi-experimental study was conducted in the Emergency Department of the University Malaya Medical Centre over a span of 6 months duration. This study was approved by the Medical Research Ethics Committee of University Malaya (no: 2018829-6632, date: 01.02.2019).

Informed Consent: Written informed consent was obtained once they clearly understood and agreed to take part in the study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: M.Z.A.M.N., A.M.N.A., Design: M.Z.A.M.N., A.M.N.A., Data Collection or Processing: M.F.Z., Analysis or Interpretation: M.F.Z., R.A., M.Z.A.M.N., A.M.N.A., Literature Search: M.F.Z., R.A., Writing: M.F.Z., R.A.

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Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Roger VL, Go AS, Lloyd-Jones DM, Adams RJ, Berry JD, Brown TM, et al. Heart disease and stroke statistics--2011 update: a report from the American Heart Association. Circulation. 2011;123:e18-209.

2. Bjørshol CA, Søreide E. Improving survival after cardiac arrest. Semin Neurol. 2017;37:25-32.

3. Nik Him NAS, Hussin K, Hassan MR, Hamzah ML, Fadzli A, Nik Mohamad NA. Ambulance Response Time at Three Selected Tertiary Hospitals in Malaysia: Performance of Hospital-Based Ambulance Equipped with Computerized Call Centre System. Mal J Appl Sci. 2018;3:42-50.

4. Nielsen AM, Isbye DL, Lippert FK, Rasmussen LS. Can mass education and a television campaign change the attitudes towards cardiopulmonary resuscitation in a rural community? Scand J Trauma Resusc Emerg Med. 2013;21:39.

5. Song KJ, Oh DJ. Current status of CPR in Korea. Korean J Med. 2007;73:4-10.

6. Rea TD, Eisenberg MS, Culley LL, Becker L. Dispatcher-assisted cardiopulmonary resuscitation and survival in cardiac arrest. Circulation. 2001;104:2513-6.

7. Merchant RM, Abella BS, Abotsi EJ, Smith TM, Long JA, Trudeau ME, et al. Cell phone cardiopulmonary resuscitation: audio instructions when needed by lay rescuers: a randomized, controlled trial. Ann Emerg Med. 2010;55:538-43.e1.

8. Suruhanjaya Komunikasi Dan Multimedia Malaysia, Malaysian Communications and Multimedia Commission. Hand phone users survey 2017, statistical brief number twenty-two. In: Commission MCaM, editor. Cyberjaya, Malaysia 2017. Available at: https://www.skmm.gov.my/skmmgovmy/media/General/pdf/HPUS2017.pdf

9. Lee JS, Jeon WC, Ahn JH, Cho YJ, Jung YS, Kim GW. The effect of a cellular-phone video demonstration to improve the quality of dispatcher-assisted chest compression-only cardiopulmonary resuscitation as compared with audio coaching. Resuscitation. 2011;82:64-8.

10. Bolle SR, Johnsen E, Gilbert M. Video calls for dispatcher-assisted cardiopulmonary resuscitation can improve the confidence of lay rescuers--surveys after simulated cardiac arrest. J Telemed Telecare. 2011;17:88-92.

11. Johnsen E, Bolle SR. To see or not to see--better dispatcher-assisted CPR with video-calls? A qualitative study based on simulated trials. Resuscitation. 2008;78:320-6.

12. Lin YY, Chiang WC, Hsieh MJ, Sun JT, Chang YC, Ma MH. Quality of audio-assisted versus video-assisted dispatcher-instructed bystander cardiopulmonary resuscitation: A systematic review and meta-analysis. Resuscitation. 2018;123:77-85.

13. Yang CW, Wang HC, Chiang WC, Chang WT, Yen ZS, Chen SY, et al. Impact of adding video communication to dispatch instructions on the quality of rescue breathing in simulated cardiac arrests--a randomized controlled study. Resuscitation. 2008;78:327-32.

14. Kleinman ME, Brennan EE, Goldberger ZD, Swor RA, Terry M, Bobrow BJ, et al. Part 5: Adult Basic Life Support and Cardiopulmonary Resuscitation Quality: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2015;132(18 Suppl 2):S414-35.

15. Yang CW, Wang HC, Chiang WC, Hsu CW, Chang WT, Yen ZS, et al. Interactive video instruction improves the quality of dispatcher-assisted chest compression-only cardiopulmonary resuscitation in simulated cardiac arrests. Crit Care Med. 2009;37:490-5.

16. Bolle SR, Scholl J, Gilbert M. Can video mobile phones improve CPR quality when used for dispatcher assistance during simulated cardiac arrest? Acta Anaesthesiol Scand. 2009;53:116-20.

A Comparison of Arterial and Venous Blood Gas Analysis and Its Interpretation in Emergency Department: A Cross-Sectional Study

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Abstract

Aim: This study aimed to determine the agreement between arterial blood gas (ABG) and venous blood gas (VBG) analyses in a pathologically diverse patient population who presented to the emergency department.

Materials and Methods: This cross-sectional study was conducted in the emergency department of a tertiary care hospital during the period from February 2019 to June 2020. A total of 113 patients presenting with various medical conditions confirmed on ABG by a physician were recruited. Both arterial and venous blood samples were collected for blood gas analysis. Using a Bland-Altman plot, data obtained were analyzed for agreement. IBM SPSS version 22 was used for the data analysis.

Results: Among the 113 study participants, the arterial and venous pH values, base excess, and bicarbonate level show acceptably narrow 95% limits of agreement in the Bland–Altman plot (−0.06 to 0.08, −4.08 to 2.30, and −2.59 to 0.89, respectively). Agreement in partial pressure of oxygen and oxygen saturation measurements was poor (95% limits of agreement, −8.38 to 101.06 and 0.35 to 0.58, respectively). Agreement of partial pressure of carbon dioxide shows an acceptably narrow agreement (95% limits of agreement, −10.61 to −2.18).

Conclusion: VBG analysis for pH, bicarbonate, and base excess may be a reliable substitute for ABG analysis in the initial evaluation of adult patients presenting to the emergency department.

Keywords: Blood gas analysis, venous blood gas analysis, venous and arterial blood sampling, agreement

Introduction

In emergency departments and intensive care, the routinely performed procedure is arterial blood gas analysis (ABG) (1). ABG is the gold standard procedure to know about the acid-base balance, oxygenation and ventilation-perfusion in patients in critical care treatment (2). Arterial blood gas analysis requires a sample of arterial blood, which is obtained mostly from radial or femoral arteries. The sampling requires deep puncture into one of the arteries, which can be painful to the patient. It may also lead to various complications like bleeding, hematoma formation, infection, embolism and formation of arterial aneurysm or in very severe cases compartment syndrome (3,4). In intensive care settings, to assess the patient status, there is a need for repeated ABG analysis. This can put the patient through painful needle punctures that can increase the chances of infection. The alternative to ABG is venous blood gas analysis (VBG). In intensive care and patients presenting to the emergency department, venous sampling is more convenient and easy to perform (5). Few venepunctures are required, thereby reducing the risk of needle stick injury to the health care professionals.

Acid-base balance measured through blood gas analysis plays a critical role in the planning of the course of treatment. The

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assessment is done in an arterial blood sample. In routine practice, the sampling results in the mixed sample or venous sample (6); this can cause detrimental effects in the diagnosis and treatment plan. Pulse oximetry measurements of arterial oxygen saturation draw a parallel to oxygen saturation as measured by ABG, and transcutaneous carbon dioxide tension can provide a useful guide to the adequacy of ventilation (7). The values of pH, bicarbonate, and carbon dioxide tension can be measured in arterial as well as venous blood gas analysis.

Various studies in the past have suggested that venous blood gas analysis can be considered as an alternate to the arterial blood gas analysis, VBG still has not gained much acceptance among clinicians (8-12). A study by Kelly et al. (8). has shown that venous bicarbonate estimation had a high level of agreement with the arterial value, with acceptably narrow 95% limits of agreement. A study by Ma et al. (10) proved that ABG results rarely influenced emergency physicians' decisions on diagnosis, treatment, or disposition in suspected diabetic ketoacidosis (DKA) patients. The usability of VBG in acid base status is still under research. The previous researchers suggested that VBG in place of ABG is sufficient to make clinical decisions. There is a lacuna in literature corresponding to the place of this current study. So, to add on to the available evidence and to study the pattern this current study was done. This present study was carried out to determine the agreement between ABG and VBG in a pathologically diverse patient population presenting to the emergency department of a tertiary care hospital.

Materials and Methods

A cross-sectional study was conducted at the emergency department and critical care units of VMKV Medical College Hospital, Salem during February 2019 - June 2020. The study was approved by the institutional ethical committee of VMKV Medical College Hospital, Salem. Informed written consent was obtained from all participants, and data confidentiality was maintained. For critically ill patients and those who were unconscious during the study, the consent was obtained from the attenders. All patients needing ABG as per clinician advised were recruited into the study. For the recruitment of the participants, convenience sampling was followed. All patients above the age of 18 were presenting to the emergency department and all patients requiring ABG for their treatment after initial emergency residence (ER) assessment were included in the study. Patients on anticoagulant therapy, Patients with bleeding disorders, patients with peripheral vascular disease/compartment syndrome and those Patients with arterial thrombosis were excluded from the study.

Methodology

After obtaining informed consent, detailed history and clinical examination were done for all patients. The need for ABG was assessed, and both arterial and venous samples were obtained within 2 minutes of each other. Both ABG and VBG were analysed in the same blood gas analyser (ABBOTT ABG POC analyser). The arterial blood was drawn from the radial or femoral artery—the venous blood from a peripheral vein and blood for other investigations. The blood samples were obtained in strict aseptic precautions in a pre-heparinised syringe and transported in the cold chain to the laboratory immediately. The ABG and VBG values were interpreted, and the data were compared.

Sample Size Calculation

The sample size was calculated assuming the expected mean difference of pCO_2 between ABG and VBG methods as three and standard deviation as 1.2 as per the study by Malatesha et al. (1) 26 females, mean; the maximum allowed difference pCO_2 between two methods was considered as 6. The other parameters considered for the sample size calculation included 5% alpha error and 80% power of the study.

The required sample size as per the calculation mentioned above was 86. To account for the non-participation rate/absence of about 20%, another 18 subjects will be added to the sample. Hence the final required sample size was 104 subjects. For better representation and availability, 113 subjects were considered in the final study.

Sample size calculation was done using Medcalc software (13).

Statistical Analysis

pH, HCO_3, base excess, pCO_2 and SpO_2 in ABG and VBG methods were considered as the primary outcome variables. Two procedures ABG vs VBG was considered as explanatory variable. Descriptive analysis was carried out by mean and standard deviation for quantitative variables, frequency and proportion for categorical variables. All quantitative variables were checked for normal distribution within each category of explanatory variable by using visual inspection of histograms and normality Q-Q plots. Shapiro-Wilk test was also conducted to assess normal distribution. Shapiro-Wilk test p-value of >0.05 was considered as normal distribution. Bland-Altmann plot 95% confidence interval (CI) was used to know the agreement of different parameters between ABG and VBG methods. The association between non-normal quantitative outcome was assessed by comparing the median values. Wilcoxon signed test was used to assess statistical significance.

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p-value <0.05 was considered statistically significant. IBM SPSS version 22 was used for statistical analysis (14).

Results

A total of 113 subjects were included in the final analysis. The mean age was 50.73 years in the study population. Among the study population, majority were male as 73 (64.60%). The mean systolic blood pressure was 120 (mmHg) in the study population. The mean diastolic blood pressure was 80.09 (mmHg) in the study population. The mean pulse rate was 89.66 (bpm) in the study population. The mean oxygen saturation was 0.92% in the study population. The mean respiratory rate (per min) was 25.81 in the study population (Table 1).

The mean difference of the pH between the two methods was 0.01, with 95% CI ranging from (–0.06 to 0.08). The mean difference of the pCO_2 between the two methods was –6.4 with 95% CI ranging from (–10.61 to –2.18). The mean difference of the HCO_3 between the two methods was –0.85 with 95% CI ranging from (–2.59 to 0.89). The mean difference of the Base excess between the two methods was –0.89 with 95% CI ranging from

(–4.08 to 2.30). The mean difference of the PO_2 between the two methods was 46.34, with 95% CI ranging from (–8.38 to 101.6). The mean difference of the oxygen saturation between the two methods was 0.47, with 95% CI ranging from (0.35 to 0.58) (Table 2). Bland Altmann plots depicting the difference in arterial and venous pH and pCO_2 measurements between average of arterial and venous pH and pCO_2 is represented in Figures 1 and 2.

Discussion

The study findings showed acceptable agreement between ABG and VBG analysis among the study participants. In literature, there is plenty of evidence for the agreement between ABG and VBG (8,10-12,15). Despite the available evidence in the literature, VBG has not gained confidence for routine usage among the clinicians. Few studies in the past have expressed reservations on the diagnostic accuracy of VBG inaccurate patient evaluation (12,16,17).

Table 1. Summary of baseline parameter (n=113)	
Parameter	Summary
Age, (mean ± SD) (years)	50.73±14.74 (range: 20 to 82)
Gender	
Male	73 (64.60%)
Female	40 (35.40%)
Vital signs, (mean ± SD)	
Systolic blood pressure, (mmHg)	120±25.77 (range: 60 to 210)
Diastolic blood pressure, (mmHg)	80.09±60.57 (range: 40 to 700)
Pulse, (bpm)	89.66±16.73 (range: 62 to 162)
Oxygen saturation, (%)	0.92±0.06 (range: 0.7 to 1)
Respiratory rate, (per min)	25.81±4.93 (range: 14 to 38)
SD: Standard deviation, n: Number	

Figure 1. Bland-Altmann plots of difference in arterial and venous pH measurements between average of arterial and venous pH

SD: Standard deviation

Table 2. Mean difference in lab parameter between two methods (n=113)					
Parameter	ABG (Mean ± SD)	VBG (Mean ± SD)	Difference (Mean ± SD)	Bland-Altman (95% CI)	
				Lower	Upper
Potential of hydrogen (pH)	7.32±0.19	7.31±0.18	0.01±0.04	-0.06	0.08
PCO_2 (mmHg)	41.98±16.36	48.38±16.42	-6.4±2.15	-10.61	-2.18
HCO_3 (mmol/L)	21.31±8.78	22.16±8.59	-0.85±0.89	-2.59	0.89
Base excess (mmol/L)	2.12±6	1.22±5.76	-0.89±1.63	-4.08	2.30
PO_2 (mmHg)	87.31±38.83	40.97±14.84	46.34±27.92	-8.38	101.06
Oxygen saturation	0.93±0.06	0.45±0.06	0.47±0.06	0.35	0.58
ABG: Arterial blood gas, VBG: Venous blood gas, SD: Standard deviation, CI: Confidence interval, n: Number					

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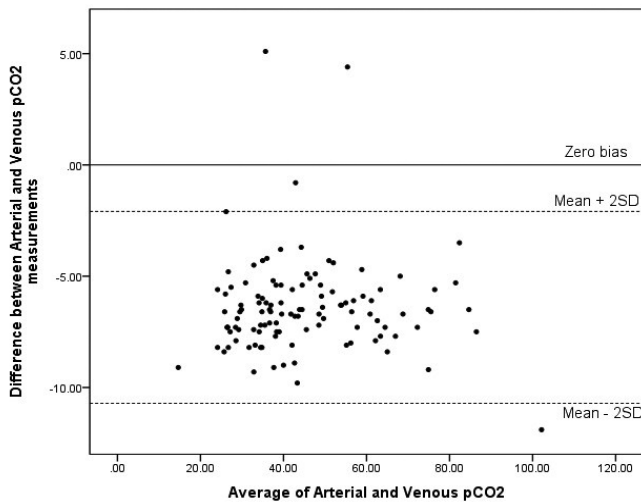
Figure 2. Bland-Altmann plots of difference in arterial and venous pCO$_2$ measurements between average of arterial and venous pCO$_2$

This present study was carried out to evaluate whether VBG can replace ABG in initial patient evaluation in emergency departments. As shown in results, the agreement is excellent with 95% limits of agreement as –0.06 to 0.08 in pH. In this present study, the agreement in pCO$_2$ and bicarbonate values show an acceptably narrow agreement compared to the previous study (12).

Agreement of pCO$_2$ in previous studies is good and within acceptably narrow limits, but in this particular study even though pCO$_2$ shows an acceptably narrow agreement (95% limits of agreement –10.61 to –2.18) since the zero bias is outside the limit. This indicates there is a significant difference between arterial and venous measurements. Hence the arterial and venous pCO$_2$ values cannot be replaced with each other.

As expected, the venous pO$_2$ and arterial pO$_2$ did not show good agreement in our study (95% limits of agreement –8.38 to 101.06), as the difference is too great to be clinically significant.

The mean difference of the HCO$_3$ between the two methods was –0.85 with 95% CI ranging from (–2.59 to 0.89). The mean difference of the Base excess between the two methods was –0.89 with 95% CI ranging from (–4.08 to 2.30). Both these parameters suggest agreement between ABG and VBG.

Among the previous available literature, the most commonly studied group of participants were a single diseased group like DKA and renal failure (10,11). In this study, only a few patients in the study group had extremes of pPH and were in shock; therefore, it was not possible to find the agreement and correlation of ABG and VBG values in those patients. Hence a more extensive study of patients in the extremes of pH and states of shock is needed to

comment on the agreement and correlation of patients in those states.

The strength of this study being, the study was conducted among the wide array of patients attending the emergency department. The limitation of the current study was the recruitment of the participants were not done randomly, and convenience sampling was followed.

Conclusion

Thus, we can conclude from my study that pH, HCO$_3$ and Base Excess agree well in ABG and VBG analysis, and both can be used interchangeably in the ER. We recommend that Based on the initial assessment of patients in the ER, VBG can be used as an alternative for ABG as it will not alter the treatment of the patient drastically.

Ethics

Ethics Committee Approval: Ethics Committee approval was taken before initiating the study from Vinayaka Mission's Kirupananda Variyar Medical College, Ethics Committee (number: VMKVMC&H/IEC/19/48, on 06.03.2019).

Informed Consent: Informed written consent was obtained from all participants, and data confidentiality was maintained.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: R.K.T., Concept: R.K.T., H.H.S.C., Design: R.K.T., H.H.S.C., M.D., Data Collection or Processing: R.K.T., M.D., K.N.P., Analysis or Interpretation: R.K.T., H.H.S.C., M.D., V.P.C., Literature Search: R.K.T., V.P.C., K.S.C., Writing: R.K.T., K.S.C.

Conflict of Interest: No conflict of interest was declared by the authors.

References

1. Malatesha G, Singh NK, Bharija A, Rehani B, Goel A. Comparison of arterial and venous pH, bicarbonate, PCO2 and PO2 in initial emergency department assessment. Emerg Med J. 2007;24:569-71.

2. Ziegenfuß T, Zander R. Understanding blood gas analysis. Intensive Care Med. 2019;45:1684-5.

3. Mortensen JD. Clinical sequelae from arterial needle puncture, cannulation, and incision. Circulation. 1967;35:1118-23.

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4. Bisarya K, George S, El Sallakh S. CASE REPORT Acute Compartment Syndrome of the Forearm Following Blood Gas Analysis Postthrombolysis for Pulmonary Embolism. Eplasty. 2013;13:e15.

5. Razi E, Nasiri O, Akbari H, Razi A. Correlation of arterial blood gas measurements with venous blood gas values in mechanically ventilated patients. Tanaffos. 2012;11:30-5.

6. O'Connor TM, Barry PJ, Jahangir A, Finn C, Buckley BM, El-Gammal A. Comparison of arterial and venous blood gases and the effects of analysis delay and air contamination on arterial samples in patients with chronic obstructive pulmonary disease and healthy controls. Respiration. 2011;81:18-25.

7. Jensen LA, Onyskiw JE, Prasad NG. Meta-analysis of arterial oxygen saturation monitoring by pulse oximetry in adults. Heart Lung. 1998;27:387-408.

8. Kelly AM, McAlpine R, Kyle E. Agreement between bicarbonate measured on arterial and venous blood gases. Emerg Med Australas. 2004;16:407-9.

9. Kelly AM, McAlpine R, Kyle E. Venous pH can safely replace arterial pH in the initial evaluation of patients in the emergency department. Emerg Med J. 2001;18:340-2.

10. Ma OJ, Rush MD, Godfrey MM, Gaddis G. Arterial blood gas results rarely influence emergency physician management of patients with suspected diabetic ketoacidosis. Acad Emerg Med. 2003;10:836-41.

11. Gokel Y, Paydas S, Koseoglu Z, Alparslan N, Seydaoglu G. Comparison of blood gas and acid-base measurements in arterial and venous blood samples in patients with uremic acidosis and diabetic ketoacidosis in the emergency room. Am J Nephrol. 2000 ;20:319-23.

12. Kelly AM, Kyle E, McAlpine R. Venous pCO(2) and pH can be used to screen for significant hypercarbia in emergency patients with acute respiratory disease. J Emerg Med. 2002;22:15-9.

13. Simsek FS, Balci TA, Dönder Y, Ugur K, Kilinc F, Cetinkaya Z, et al. The importance in diagnosing patients with conflicting observational data for post surgery radioiodinated ablation of thyroid remnants. Hell J Nucl Med. 2019;22:58-63.

14. Armonk NIC. IBM Corp. IBM SPSS Statistics for Windows, Version 22.0. 2013.

15. Middleton P, Kelly AM, Brown J, Robertson M. Agreement between arterial and central venous values for pH, bicarbonate, base excess, and lactate. Emerg Med J. 2006;23:622-4.

16. Brashear RE, Oei TO, Rhodes ML, Futty DE, Hostetler ML. Relationship between arterial and venous bicarbonate values. Arch Intern Med. 1979;139:440-2.

17. Dries DJ. Correlation of Central Venous and Arterial Blood Gas Measurements in Mechanically Ventilated Trauma Patients. Yearb Crit Care Med. 2007;2007:87-8.

Evaluation of Hyponatremia and Predictors of Hyponatremia in Patients Hospitalized with the COVID-19

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Abstract

Aim: The infection caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), called coronavirus disease-2019 (COVID-19), has been declared by the World Health Organization as a pandemic. Moderate and severe hyponatremia may develop in COVID-19 cases. This study aimed to evaluate the frequency and predictors of hyponatremia in patients hospitalized with COVID-19.

Materials and Methods: This retrospective study included patients aged >18 years who were admitted to our hospital between August 1st, 2020, and September 30th, 2020, with positive RNA polymerase chain reaction (PCR) test. Patients' demographic data, comorbidities, vital signs, physical examination findings, laboratory results, sodium levels, and hospital outcomes were evaluated.

Results: The study included 760 patients with positive PCR test results. Of all the patients, 47.6% were female, and the median age was 63 years. The in-hospital mortality rate was 11.7%. The median sodium level was 137 (134-140). Hyponatremia was present in 25.7% of the patients, and majority of the patients had mild hyponatremia. Hyponatremia was observed more frequently in patients with advanced age, male gender, diabetes, and severe pneumonia (p=0.041, p=0.003, p<0.001, p=0.002, respectively).

Conclusion: In this study, hyponatremia is relatively common in patients admitted with COVID-19 pneumonia, and it is associated with higher disease severity. The incidence of hyponatremia increases in older patients, male patients, patients with severe pneumonia, and patients with diabetes.

Keywords: COVID-19, hyponatremia, pneumonia

Introduction

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection epidemic has been named coronavirus disease 2019 (COVID-19) by the World Health Organization (WHO). COVID-19 disease is a respiratory disease detected in Wuhan, China, caused by a new coronavirus. COVID-19 spread rapidly to many countries and was declared as a pandemic by WHO (1). The disease is highly contagious and its main clinical symptoms are fever, dry cough, fatigue, myalgia, and shortness of breath. However, all these symptoms are not specific to the disease and the disease can progress rapidly to severe pneumonia. Severe acute respiratory syndrome (SARS) may develop in more severe cases. Pathogenesis of coronavirus-associated SARS is associated with cytokine storm that involves high serum proinflammatory cytokines and chemokines [interleukins 1, 6, 8 and 12 (IL-1, IL-6, IL-8, IL-12), tumor necrosis factor (TNF) - alpha and interferon (IF-N) - gamma] (2). A serum sodium concentration below 135 mmol/L is called hyponatremia. Hyponatremia is the most common electrolyte disorder. Hyponatremia is found in approximately 10%-15% of hospitalized patients (3). One of the common causes of hyponatremia is Syndrome of inappropriate antidiuretic hormone syndrome (SIADH) due to lung diseases (4). It occurs in approximately 25% of patients with pneumonia (3,4). In patients with pneumonia, a relationship between the presence of hyponatremia with a prolonged hospital stay, increased risk

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of admission to the intensive care unit (ICU), high hospital costs, and increased mortality has been observed (4-6). In patients with severe hyponatremia, it can be seen life-threatening complications such as encephalopathy, cerebral edema, seizures, and coma. Although the risk of hyponatremia among pneumonia patients varies according to the pathogen, 44%-46% of patients with Legionella pneumonia develop hyponatremia, and hyponatremia is observed in 8%-14% of patients in other community-acquired pneumonia etiologies (7,8).

In recent studies and case reports, it has been reported that patients with SARS-CoV-2 infection may develop moderate and severe hyponatremia (9-11). In these studies, there are publications suggesting that the presence of hyponatremia during the admission to hospital may be an indicator of potential COVID-19 infection (11). It is now known that severe systemic inflammation develops in COVID-19 patients. It is also thought that systemic inflammation may cause hyponatremia due to non-osmotic stimulation for antidiuretic hormone production. However, data on the prevalence, severity, and impact of hyponatremia in patients with COVID-19 are limited in the literature.

In this study, we aimed to evaluate the frequency of hyponatremia and predictors of hyponatremia in patients hospitalized due to COVID-19.

Materials and Methods

The study is retrospective and observational. Prior to implementation, our study's protocol was approved by the Ethics Committee of Ankara Keçiören Training and Research Hospital (2012-KAEK-15/2187) and Ministry of Health Scientific Research Committee. Since the first case of COVID-19 detected in our country, hospitalization, diagnosis, and treatment of patients are planned in our hospital according to the national COVID-19 guidelines published by the Ministry of Health. Our hospital has been serving as a pandemic hospital since April 2020. Patients are evaluated in emergency department and pandemic outpatient clinics and laboratory (complete blood count, routine biochemical tests, C-reactive protein, erythrocyte sedimentation rate, prothrombin time, partial thromboplastin time, D-dimer, fibrinogen). ferritin, and imaging studies [postero-anterior chest radiography and/or low-dose computed tomography (CT) of the thorax without contrast] are required.

Patients over the age of 18 who were admitted to Keçiören Training and Research Hospital between 01.08.2020-30.09.2020 with positive RNA polymerase chain reaction (PCR) test results that were followed up by hospitalization were included in the study.

Demographic data, complaints, comorbid diseases, vital signs, physical examination findings, laboratory results, hospital stay, and hospital outcomes of the patients were obtained from the hospital automation system and patient files. Hyponatremia was defined by natremia below 135 mmol/L. Patients were biochemically divided into subgroups according to plasma sodium concentrations at the time of admission to emergency department: mild hyponatremia (130-134 mmol/L), moderate hyponatremia (125-129 mmol/L), and severe hyponatremia (<125 mmol/L) (10). Patients referred from another hospital and who were found to have pseudo-hyponatremia as a result of etiological evaluation were excluded from the study. Patients who developed hyponatremia during their hospitalization were not included in the study, since iatrogenic causes of hyponatremia would confound analysis of the effect of SARS-CoV-2 on sodium levels. Patients were divided into two groups according to thorax CT. Patients with more than 50% of the entire lung area affected were considered to have moderate to severe pneumonia accordance with the national COVID-19 guidelines published by the Ministry of Health. In-hospital deaths of the patients were recorded.

Patients with incomplete data and those with negative PCR test results who were followed up with a pre-diagnosis of COVID-19 were excluded from the study.

Statistical Analysis

The analysis of all data obtained during the study and recorded in the study form was performed using IBM SPSS 20.0 (Chicago, IL, USA) statistics program. Whether the distribution of discrete and continuous numerical variables is suitable for normal distribution was investigated by the Kolmogorov-Smirnov test. Descriptive statistics and discrete and continuous numerical variables were shown as median [interquartile range (IQR): 25-75], and categorical variables as a number of cases and (%). Categorical variables were evaluated with chi-square and continuous variables with the Mann-Whitney U test. Predictors of hyponatremia were determined using univariate tests, and statistically significant (p<0.2) variables were tested with a multivariate logistic regression model. The fitness of this model was tested with the Hosmer-Lemeshow test. Before being included in the model, the correlation of the data was evaluated using the Spearman correlation test. p<0.05 were considered statistically significant.

Results

During the study period, 1,089 patients were hospitalized with the pre-diagnosis of COVID-19, and 760 patients with positive PCR test and complete data were included in the study (19

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patients were excluded because of missing data, 12 patients were excluded because of hypernatremia, 308 patients were excluded because of the PCR test is negative or missing).

47.6% of the patients were female and the median age was 63 (IQR: 52-72). The most common comorbidity in patients was hypertension with 43.9%. It was observed that the most common complaints of the patients were fever (61.2%) and cough (55.3%). Pneumonia was present in 89.7% of the patients and the lesions were bilateral in 84.5% of the patients. Eighty-nine (11.7%) patients died. The demographic data of the patients are given in Table 1.

Laboratory parameters measured at the time of admission are given in Table 2. The median sodium value of the patients was 137 (134-140). Hyponatremia was present in 25.7% of the patients, and the majority of the patients had mild hyponatremia (Table 3).

When hyponatremic and normonatremic patients were compared; It was determined that hyponatremic patients were older, hypertension, diabetes, coronary artery disease was more common, their saturations measured at the time of admission were lower, they had more pneumonic infiltration and severe pneumonia in chest imaging, and these patients needed more mechanical ventilation (for all values, p<0.05). In addition, patients with hyponatremia were found to have higher mortality and longer hospital stay (for all values, p <0.05) (Table 4).

Multivariate logistic regression analysis was performed to examine the effects of variables examined in Table 4 on hyponatremia together with other variables. Firstly, correlation analyses were made. It was observed that mechanical ventilation need correlated with (ICU) need, pneumonia correlated the severity of pneumonia, pneumonia correlated saturation and ICU need, and pulse rate/fever correlated with saturation (p<0.05, r>0.3). Diabetes, hypertension, saturation at admission, ICU need, severe pneumonia, time from onset to hospitalization, age, and gender were included in the multivariate model because of a p-value equal to or below 0.2 from Table 4 and noncorrelated or weak correlated in correlation analysis (p>0.05, p<0.05 and r<0.3)

After the model established by the Hosmer-Lemeshow test was found to be fit, it was found that hyponatremia was observed more frequently in patients with advanced age, male gender, diabetes, and severe pneumonia (p=0.041, p=0.003, p<0.001, p=0.002, respectively) (Table 5).

Table 1. Demographic data of patients (n=760)	
Age, years, median IQR (25-75)	63 (52-72)
Sex, n (%)	
Female	362 (47.6%)
Comorbidity, n (%)	
Hypertension	334 (43.9%)
Diabetes	224 (29.5%)
Coronary heart disease/KKY	132 (17.4%)
Chronic obstructive lung disease	59 (7.8%)
Hyperthyroidism	48 (6.3%)
Chronic kidney disease	36 (4.7%)
Other	77 (10.1%)
Drugs, n (%)	
Angiotensin-converting enzyme inhibitor	132 (17.4%)
Angiotensin receptor blocker	79 (10.4%)
Diuretic	113 (14.9%)
Vital signs, median IQR (25-75)	
Respiratory rate	16 (14-18)
Pulse	75 (70-82)
Body temperature	37.6 (37-38.1)
Saturation	90 (86.2-92)
***Admission complaints of patients, n (%)**	
Fever	465 (61.2%)
Cough/sputum	420 (55.3%)
Dyspnea	349 (45.9%)
Myalgia/fatigue	230 (30.3%)
Throat ache	55 (7.2%)
Diarrhea	82 (10.8%)
Nausea or vomiting	137 (18%)
Headache	73 (9.6%)
Anosmia	41 (5.4%)
Pneumonia, n (%)	
No-pneumonia	78 (10.3%)
Pneumonia severity	
Mild	487 (71.4%)
Moderate-severe	195 (28.6%)
CT results, n (%)	
Bilateral involvement	642 (84.5%)
Time from illness onset to hospital admission, days, median IQR (25-75)	5 (3-7)
Oxygen treatment, n (%)	
Non-invasive mechanical ventilation	59 (7.8%)
Invasive mechanical ventilation	74 (9.7%)
High flow oxygen treatment	89 (11.7%)
Renal replacement treatment, n (%)	14 (1.8%)
Prognosis, n (%)	
Healed and discharged	671 (88,3%)
Death	89 (11.7%)
ICU hospitalization, n (%)	92 (12.1%)
ICU stay time, median IQR (25-75)	13 (5-25)
Hospitalization length, median IQR (25-75)	6 (5-10)
*A patient may have more than one complaint, ICU: Intensive care unit, IQR: Interquartile range, CT: Computed tomography, n: Number	

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Table 2. Laboratory parameter of all patients upon admission	
Median IQR (25-75)	
Hemoglobin	13.3 (12.2-14.5)
White blood cell	6.300 (4.7-8.5)
Neutrophil	4.66 (3.14-6.98)
Lymphocyte	1.05 (0.72-1.49)
Platelet	208 (159-272)
C-reactive protein	53.4 (17.2-115.9)
Sedimentation	53 (34-74)
ferritin	302.7 (132.3-646)
D dimer	640 (370-1142.5)
Fibrinogen	509.2 (409-631)
Glucose	124 (103-169)
Urea	53 (34-474)
Creatinine	1 (0.835-1.19)
Glomerular filtration rate	72.3 (55.2-87.8)
Albumin	3.5 (3.2-3.8)
Sodium	137 (134-140)
Potassium	4.2 (3.94-4.55)
Chlorine	101.5 (98-104)
Troponin	5.15 (2.5-14.3)

Discussion

In this study, in which we evaluated the frequency of hyponatremia and its relation with mortality in patients hospitalized for COVID-19, we first showed that hyponatremia was common in COVID-19 patients, and approximately 25% of patients have hyponatremia. Secondly, we found that patients with hyponatremia were older, had more comorbidity, more severe pneumonia, and more need for mechanical ventilation, longer hospital stay, and more mortality. Finally, we found that hyponatremia was more common in older age, male gender, and those with diabetes and severe pneumonia.

Table 3. Sodium levels of all patients	
Hyponatremia	195 (25.7%)
Normonatremia	565 (74.3)
Hyponatremia severity	
Mild	152 (77.9%)
Moderate	32 (16.4%)
Severe	11 (5.6%)

Table 4. A comparison of the patient characteristics regarding sodium levels upon admission (hyponatremia/normonatremia)			
	Hyponatremia (n=195)	Normonatremia (n=565)	p-value
Age, years, median IQR (25-75)	**65 (56-73)**	**62 (50-71)**	**0.002**
Sex, n (%)			
Female	76 (39%)	286 (50.6%)	0.005
Comorbidity, n (%)			
Hypertension	109 (55.9%)	225 (39.8%)	<0.001
Diabetes	88 (45.1%)	136 (24.1%)	<0.001
Coronary heart disease	44 (22.6%)	88 (15.6%)	0.029
Chronic obstructive lung disease	10 (5.1%)	49 (8.7%)	0.211
Chronic kidney disease	13 (6.7%)	23 (4.1%)	0.191
Hypothyroidism	12 (6.2%)	36 (6.4%)	0.914
Vital signs, n (%)			
Pulse	76 (71-82)	75 (70-81)	0.187
Saturation	89 (83-91)	90 (88-92)	<0.001
Fever (temperature)	37.8 (37-38.2)	37.6 (37-38)	0.07
Pneumonia Presence, n (%)	187 (95.9%)	495 (87.6%)	0.001
Severe pneumonia, n (%)	75 (38.5%)	120 (21.2%)	<0.001
The need for mechanical ventilation, n (%)	27 (13.8%)	47 (8.3%)	0.025
ICU need, n (%)	34 (17.4%)	58 (10.3%)	0.08
CT results, n (%)			
Bilateral involvement	65 (43.3%)	7 (38.9%)	0.719
Time from illness onset to hospital admission, days, median IQR (25-75)	5 (4-7)	5 (3-7)	0.065
Hospitalization length, median IQR (25-75)	7 (5-12)	6 (5-9)	0.015
ICU time, median IQR (25-75)	12 (8-22)	13.5 (5-28)	0.713
In hospital mortality, n (%)	35 (25.7%)	54 (9.6%)	0.002
ICU: Intensive care unit, IQR: Interquartile range, CT: Computed tomography, n: Number			

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Table 5. Multivariate regression model to predict hyponatremia				
	Wald	p-value	OR	95% CI
Age	4.165	0.041	0.98	0.97-0.99
Gender	8.841	0.003	1.71	1.20-2.44
Diabetes	21.472	<0.001	2.36	1.64-3.4
Hypertension	1.941	0.164	1.31	0.89-1.93
Saturation	0.263	0.608	1.00	0.98-1.03
Time from illness onset to hospital admission, days	0.085	0.770	0.98	0.91-1.06
ICU need	0.009	0.924	0.97	0.547-1.72
Severe pneumonia	9.834	0.002	1.93	1.28-2.93
ICU: Intensive care unit, OR: Odds ratio, CI: Confidence interval				

Hyponatremia is most common electrolyte disorder in the clinic. Hyponatremia can be classified in various ways according to its severity (12). According to the blood levels, it can be classified biochemically as mild, moderate, and severe; according to the rate of development, those that develop in the last 48 hours are classified as acute hyponatremia, and those developing longer than 48 hours as chronic hyponatremia. Mild hyponatremia was present in most of our patients (77.9%) with hyponatremia. Hyponatremia is seen in 26%-28% of patients with pneumonia (4,13), and it has been observed that it is associated with an increased risk of ICU hospitalization, long-term stay, higher hospital costs, and increased mortality rates (4,6,7). Severe hyponatremia is associated with life-threatening complications, including encephalopathy, cerebral edema, seizures, coma, and pontine myelinolysis (secondary to increase excessively rapid sodium correction) (12). The frequency of developing hyponatremia among pneumonia patients varies. In studies published recently in the literature, moderate and severe hyponatremia has been reported in patients with SARS-CoV-2 infection (9,10). They suggested that the hyponatremia detected at admission could be an indicator of potential COVID-19 infection (11).

The frequency and severity of hyponatremia increase with age (12,14). In a prospective study, it was shown that the sodium level of 1/3 of the elderly individuals was <135 mmol/L, and in another study, the frequency of hyponatremia was 11.6% in individuals over the age of 75 (14,15). Hyponatremia in the elderly is one of the common causes of emergency admission (16). Hyponatremia in the elderly is often multifactorial and SIADH is the most common cause of hyponatremia (17). In addition to some diseases, many drugs can cause both direct effect and SIADH, and patients may develop hyponatremia (17,18). In our study, approximately 45% of our patients consist of geriatric patients. Most of the geriatric patients have at least one comorbidity, and

hyponatremia in these patients may have developed due to the above conditions together with the COVID-19 infection.

In COVID-19, hyponatremia may occur due to some physio-pathological changes. It is thought that it most commonly develops secondary to pneumonia (10,11). The development of hyponatremia due to pneumonia has been known for a long time. However, the mechanism of hyponatremia in pneumonia is not clearly understood. Often thought to be SIADH (10). Hypovolemia may develop in these concomitant patients due to factors such as insufficient oral intake, systemic vasodilation, vomiting, and extrarenal sodium losses due to diarrhea. In COVID-19, hyponatremia may develop due to both pulmonary and extrapulmonary mechanisms (19,20).

We found that hyponatremia developed more in patients with severe pneumonia (significant involvement on CT) and patients with low saturation. Mechanical ventilation and ICU requirements were higher in our patients with hyponatremia. As pneumonia severity increased in patients with COVID-19, hyponatremia was more frequent and more severe. Berni et al. (21) found a more severe outcome (a composite of disease severity which included mortality) in patients with hyponatremia hospitalized for COVID-19 in a small retrospective study.

In the regression analysis where we investigate the effects of the variables we obtained in univariate analysis in our study on hyponatremia, we found that the male gender developed hyponatremia 1.7 times, diabetes 2.3 times, and severe pneumonia 1.9 times more. Hyponatremia is an expected condition in advanced age and diabetic patients. Gender factor is an interesting result in the development of hyponatremia. Male patients came to the emergency department after a median of 5 (4-7) days after complaints start, and female patients in a median of 4 (3-6) days after the complaints start. We think that the late admission of male patients to the hospital and starting

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treatment later than women predispose to the increase in the severity of pneumonia and hyponatremia.

Study Limitations

Our study has some limitations. First of all, since it is a single-center study, our results cannot be generalized to all centers. Secondly, due to the retrospective nature of the study, missing data may have affected the results of the study. Also, since urinary sodium, osmolality, and Interleukin 6 levels were not examined in all patients, they were not included in the analysis. Consecutive sodium measurements were not performed in all patients. The median age of our patients is advanced and most of them have an accompanying disease. In addition, patients with COVID-19 who were discharged from the emergency department or who did not have an indication for hospitalization were excluded. Also, we were not evaluated the clinical findings and course of the patients. These situations may have affected our results.

Conclusion

Hyponatremia was common in patients admitted with COVID-19 pneumonia, and it is associated with COVID-19 disease severity in our study. The incidence of hyponatremia increases in geriatric patients, male patients, patients with severe pneumonia, and diabetic patients. The emergency physician should be aware that COVID-19 patients may have hyponatremia due to pneumonia and that the disease will be more severe in these patients, and the need for more intensive care and mechanical ventilation. Studies on larger cohorts may shed light on the physiopathology of hyponatremia in COVID-19.

Ethics

Ethics Committee Approval: The study is retrospective and observational. Prior to implementation, our study's protocol was approved by the Ethics Committee of Ankara Keçiören Training and Research Hospital (2012-KAEK-15/2187) and Ministry of Health Scientific Research Committee.

Informed Consent: This is a retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: F.N.K., F.K., Ş.K.G., Concept: E.E., F.K., S.D., H.U., Ş.K.G., Design: E.E., S.D., H.U., Data Collection or Processing: E.E., F.N.K., F.K., Analysis or Interpretation: E.E., S.D., H.U., Ş.K.G., Literature Search: E.E., F.N.K., F.K., Ş.K.G., Writing: E.E., H.U., Ş.K.G.

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References

1. Park SE. Epidemiology, virology, and clinical features of severe acute respiratory syndrome -coronavirus-2 (SARS-CoV-2; Coronavirus Disease-19). Clin Exp Pediatr. 2020;63:119-24.

2. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet. 2020;395:497-506.

3. Obradović D, Esquinas AM. Hyponatremia at discharge: A solid risk or accidental findings in Community-acquired pneumonia. Eur J Intern Med. 2020;78:135-6.

4. Nair V, Niederman MS, Masani N, Fishbane S. Hyponatremia in community-acquired pneumonia. Am J Nephrol. 2007;27:184-90.

5. Zilberberg MD, Exuzides A, Spalding J, Foreman A, Jones AG, Colby C, et al. Hyponatremia and hospital outcomes among patients with pneumonia: a retrospective cohort study. BMC Pulm Med. 2008;8:16.

6. Miyashita J, Shimada T, Hunter AJ, Kamiya T. Impact of hyponatremia and the syndrome of inappropriate antidiuresis on mortality in elderly patients with aspiration pneumonia. J Hosp Med. 2012;7:464-9.

7. Krüger S, Ewig S, Giersdorf S, Hartmann O, Frechen D, Rohde G, et al. Dysnatremia, vasopressin, atrial natriuretic peptide and mortality in patients with community-acquired pneumonia: results from the german competence network CAPNETZ. Respir Med. 2014;108:1696-705.

8. Schuetz P, Haubitz S, Christ-Crain M, Albrich WC, Zimmerli W, Mueller B; ProHOSP Study Group. Hyponatremia and anti-diuretic hormone in Legionnaires' disease. BMC Infect Dis. 2013;13:585.

9. Yousaf Z, Al-Shokri SD, Al-Soub H, Mohamed MFH. COVID-19-associated SIADH: a clue in the times of pandemic! Am J Physiol Endocrinol Metab. 2020;318:E882-5.

10. Frontera JA, Valdes E, Huang J, Lewis A, Lord AS, Zhou T, et al. Prevalence and Impact of Hyponatremia in Patients With Coronavirus Disease 2019 in New York City. Crit Care Med. 2020;48:e1211-7.

11. Habib MB, Sardar S, Sajid J. Acute symptomatic hyponatremia in setting of SIADH as an isolated presentation of COVID-19. IDCases. 2020;21:e00859.

12. Spasovski G, Vanholder R, Allolio B, Annane D, Ball S, Bichet D, et al. Clinical practice guideline on diagnosis and treatment of hyponatraemia. Eur J Endocrinol. 2014;170:G1-47.

13. Potasso L, Sailer CO, Blum CA, Cesana-Nigro N, Schuetz P, Mueller B, et al. Mild to moderate hyponatremia at discharge is associated with increased risk of recurrence in patients with community-acquired pneumonia. Eur J Intern Med. 2020;75:44-9.

14. Hawkins RC. Age and gender as risk factors for hyponatremia and hypernatremia. Clin Chim Acta. 2003;337:169-72.

15. Mannesse CK, Vondeling AM, van Marum RJ, van Solinge WW, Egberts TC, Jansen PA. Prevalence of hyponatremia on geriatric wards compared to other settings over four decades: a systematic review. Ageing Res Rev. 2013;12:165-73.

16. Nelson JM, Robinson MV. Hyponatremia in older adults presenting to the emergency department. Int Emerg Nurs. 2012;20:251-4.

17. Shapiro DS, Sonnenblick M, Galperin I, Melkonyan L, Munter G. Severe hyponatraemia in elderly hospitalized patients: prevalence, aetiology and outcome. Intern Med J. 2010;40:574-80.

18. Berl T. An elderly patient with chronic hyponatremia. Clin J Am Soc Nephrol. 2013;8:469-75.

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2021;20(3): 183-9

Emektar et al. Hyponatremia and Predictors in COVID-19

19. Ellison DH, Berl T. Clinical practice. The syndrome of inappropriate antidiuresis. N Engl J Med. 2007;356:2064-72.

20. Koizumi K, Yamashita H. Influence of atrial stretch receptors on hypothalamic neurosecretory neurones. J Physiol. 1978;285:341-58.

21. Berni A, Malandrino D, Parenti G, Maggi M, Poggesi L, Peri A. Hyponatremia, IL-6, and SARS-CoV-2 (COVID-19) infection: may all fit together? J Endocrinol Invest. 2020;43:1137-9.

Comparing Two Different Concentrations of Diphenhydramine Versus Lidocaine for Median Nerve Block in Emergency Department: A Double-Blind Randomized Clinical Trial

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Abstract

Aim: This study aimed to compare two different concentrations of Diphenhydramine vs. Lidocaine for median nerve block in terms of providing required anesthesia for repairing soft tissue injuries.

Materials and Methods: This double-blind, randomized clinical trial was conducted in Tehran, Iran, in 2019. Participants were randomly assigned to three groups. Group A received 3 cc of 0.5% diphenhydramine (n=68), group B received 3 cc of 1% lidocaine (n=68), and group C received 3 cc of 1% diphenhydramine (n=68). The onset of action, duration of anesthesia, pain during injection, and patients' satisfaction level were evaluated between the groups.

Results: Two hundred two patients with the mean age of 35.09±13.5 years took part in this study (52.5% of the males). Age (p=0.879), onset of action (p=0.251) and duration of anesthesia (p=0.081) had no significant difference among the three groups. The pain during injection between groups A and B (p=0.001) and between groups B and C (p<0.0001) had significant differences. Patients in group B had the significant highest level of satisfaction (p<0.0001).

Conclusion: In our study, two different concentrations of diphenhydramine had the same onset of action and duration of anesthesia compared to lidocaine. Lidocaine caused lower pain during injection compared to diphenhydramine, and the level of satisfaction was higher with lidocaine. Diphenhydramine had no significant difference with different concentrations in terms of pain during injection.

Keywords: Hospital emergency service, diphenhydramine, lidocaine, pain measurement, median nerve

Introduction

The use of local nerve anesthesia for hands is becoming increasingly common in emergency procedures. Emergency medicine physicians (EMPs) are conducting many simple intradermal procedures on the hand, e.g. laceration repair. A local anesthetic is an integral aspect of the procedures which consists of the specific structure for penetrating the lipid rich nerve membrane and water solubilizing and chain for making this connection. It blocks the autonomic, sensory and motor nervous impulses by preventing the sodium influx to the cells and membrane depolarization (1-3). The local anesthesia is mostly classified in to esters group such as procaine and tetracaine and amides group such as lidocaine and bupivacaine that have both negative and positive points (4). Therefore, choosing the best anesthetic agent to control pain with the highest efficacy and least pain at the site of injection is of paramount importance. EMPs are always looking for an anesthetic agent with an appropriate

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onset time and duration that causes the least adverse effects. Lidocaine is the safest and the most popular anesthetic drugs in the emergency department (ED) and is used in many procedures due to its short onset action. However, some patients reported an unclear or true history of hypersensitivity which makes the choice of the best anesthetic agent difficult (2,5-7). In many studies, diphenhydramine was selected as an alternative local anesthetic in such situations (6). The main use of diphenhydramine is as a first-generation antihistamine, but it also acts as a local anesthetic because of its three-dimensional structure like an amine terminus that is similar to other anesthetic drugs (7,8). A study in 2009 showed that 80% of patients realized the onset of anesthetization within five minutes following injection of a 1% solution of diphenhydramine, and that anesthetization lasted 15 minutes to three hours. However, the pain related to the injection of diphenhydramine was higher than that of lidocaine (7). Although some studies found pain and irritation from diphenhydramine injection, most studies did not show any allergic cross-reactivity (8).

Given the limited number of studies comparing the efficacy of diphenhydramine in different doses as a neural blocking agent especially for median nerve block.

This study aimed to compare two different concentrations of Diphenhydramine vs. Lidocaine for median nerve block in terms of providing required anesthesia for repairing soft tissue injuries.

Materials and Methods

Trial Design

This study was a double-blind clinical trial conducted at Imam Khomeini Hospital Complex affiliated to Tehran University of Medical Science, Tehran, Iran,during 2019. The executive protocol of the study was approved by the Ethics Committee of Tehran University of Medical Sciences (ethic code: IR.TUMS.IKHC. REC.1397.095) and registered in the Iranian Registry of Clinical Trials (registration number: IRCT20190318043088N1). The study was conducted in accordance with the Declaration of Helsinki Principles. Written informed consent was taken from all patients prior to their participation in the study. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Participants

Participants in the study were patients referred to the ED between the age of 16 and 65 years with an indication for Median nerve block (including lacerations to the palmar surface of hand, thumb, second or third finger or radial half of fourth finger or the nailbed of these fingers or the thenar eminence and lumbrical muscles of the first and second finger). Patients excluded from this

study were those who had known allergy to diphenhydramine or lidocaine, those who received any systemic anesthesia prior to the intervention and those who received monoamine oxidase (MAO) inhibitors (due to prolongation of MAO inhibitors anticholinergic effects) or barbiturates (due to increasing central nervous system sedation). Breastfeeding mothers, patients with severe asthma, uncontrolled hypertension, glaucoma, ischemic heart diseases, benign prostatic hyperplasia, hyperthyroidism, or pyloroduodenal obstruction were also excluded.

Interventions

Group A received 3 cc of 0.5% diphenhydramine, group B received 3 cc of 1% lidocaine, and group C received 3 cc of 1% diphenhydramine (9-11). The Caspian Tamin Pharmaceutical Co (Tehran, Iran) was the manufacturer of medications. Using 0.05 inch 27-gauge needles, median nerve block was performed by injecting 3 mL of the local anesthetic solution medial to the flexor carpi radialis tendon, 2 to 3 proximal to the wrist crease on a flat surface after cleaning area using chlorhexidine 2%. The solution was injected at a 45-degree angle to a depth of 16 mm (12). The anesthetization in all three groups of patients was assessed at 5, 10- and 15-minute intervals following administration of the anesthesia. The procedure ended whenever the patient declared they were pain free. Patients who were not anesthetized after 15 minutes, or who expressed dissatisfaction with the result, would be administered by 1% Lidocaine as a rescue dose.

Outcomes

The primary outcome including the pain score at injection site, onset of action (defined as the time when pain started to decrease) and duration of anesthesia (defined as the time from the onset action to the relapse of sensation) were assessed. At the end of the procedure, the patient's satisfaction with pain control during the procedure and the adverse effects during procedure or later (before ED discharge) were recorded as secondary outcomes. The satisfaction was recorded using a five-point Likert scale (not satisfied, slightly satisfied, satisfied, very satisfied, and extremely satisfied). The variables were compared among different treatment groups and between genders.

Sample Size

The sample size was calculated using the formula below and considering $\alpha=0.05$ and power of 80% as at least 14 in each arm of the study.

$$N = \frac{\left(Z_{1\alpha/2} + Z_\beta\right)^2 \left[(SD_1)^2 + (SD_2)^2\right]}{(M_1 - M_2)^2}$$

$\alpha = 0.05 \rightarrow Z_{1-\alpha/2} = 1.96$
$\beta = 0.2 \rightarrow Z_\beta = 0.84$

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Diphenhydramine: M1=1.56 and SD1=0.54, Lidocaine: M2=2.06 and SD2=0.41

Primary Assessment

Assessment of the patient's pain score was based on the Visual Analog Scale (VAS) a psychometric scale used to indicate the pain intensity at an injection site. Patients mark their level of pain along a straight-line scale from zero to 10 where patients without pain get zero and patients with the highest intensity of pain get 10 (13,14).

Randomization and Blinding

Randomization was done using computer-generated allocation table provided by RANDOM.ORG website (15), encoded with letter A, B or C by the supervisor of the project. Color and appearance of the drugs were identical and administered by the same-size syringes, percutaneously. A nurse was responsible for administration of drugs. Patients, nurse and statistical analyst were all blinded to their assessments.

Statistical Analysis

SPSS Version 22.0 (SPSS Inc., Chicago, IL, USA) was used to analyze the data. Quantitative variables were described using the mean ± SD and qualitative variables were described using the frequency and percentage of the data. Three variables were measured during the procedures: the pain score reported by the patients during the injection, the length of time to onset action, and the duration of anesthesia. The relationship between these three variables among the treatment groups was examined using One-way ANOVA and Tukey test. The relationship of onset action, duration of anesthesia and pain score between the genders was examined using independent sample t-test. The relation between categorial variables was examined using chi-square test and Fisher's exact test. P<0.05 was considered statistically significant.

Results

Two hundred four patients took part in the study (68 in each group). Figure 1 shows the CONSORT flowchart of the study patients. One patient from group B and one from group C reported a relapse of pain, 20 minutes after the injection. Those two patients required rescue intervention for injecting to the border of laceration and excluded from the analysis.

Finally, the data from 202 patients were analyzed of whom 52.5% were male. The mean age was 35.09±13.5 years (maximum and minimum of 16 and 64). The satisfaction level (p=0.662), onset action (p=0.667), duration of anesthesia (p=0.832) and
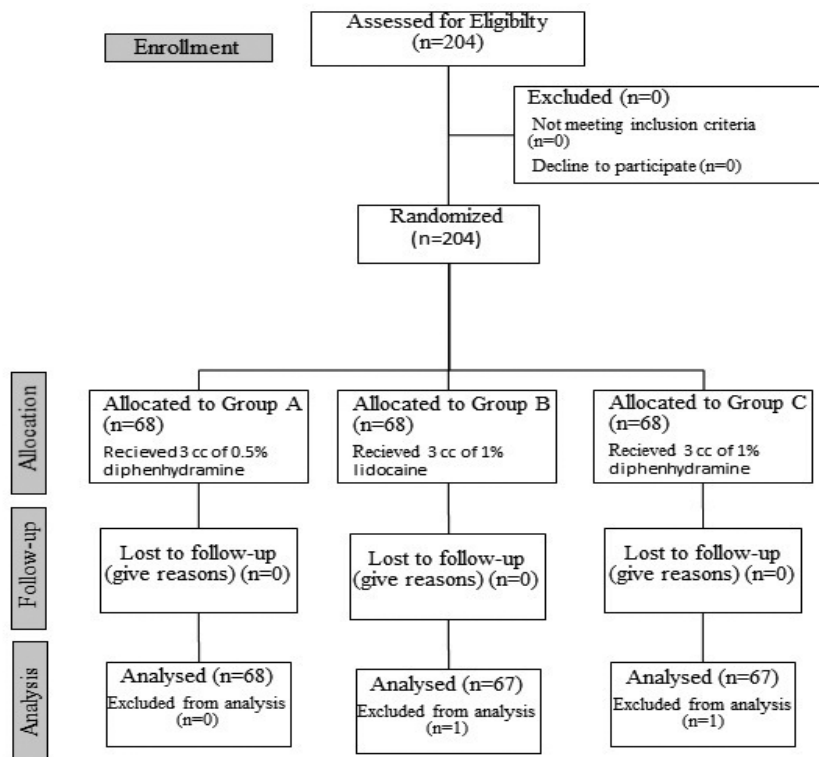
Figure 1. CONSORT flow diagram of the trial: CONSORT flow diagram showing participant flow through each stage of the randomized controlled trial (enrolment, intervention allocation, follow-up and data analysis)

CONSORT: Consolidated Standards of Reporting Trials, n: Number

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pain score (p=0.179) had no significant difference between the genders.

Comparing the primary outcomes among treatment groups showed that onset action, duration of anesthesia and pain score during injection were lower in group B, A and B, respectively. Comparing the secondary outcomes showed that patients in group A and C mostly reported "slightly satisfied" and patients in group B mostly reported "very satisfied". In addition, the frequency of adverse effect (erythema, drowsiness and both) was found only in 4.46% of patients which was higher in group C. (Table 1). Age (p=0.879), onset action (p=0.251) and duration of anesthesia (p=0.081) had no significant difference among treatment groups. There was a significant difference in reported pain score during injection among groups (p<0.0001). Tukey test (HSD) showed that the difference in pain during injection between groups A and B (p=0.001) and between groups C and B (p<0.0001) were statistically significant, but there was no significant difference between groups A and C, (p=0.367). The confidence interval of the pain score during injection ranged from 4.5 to 5.3 in group A, from 3.6 to 4.3 in group B and from 5 to 5.7 in group C. (Figure 2) The Tukey test put groups A and C with similar mean pain score during injection into a cluster and group B in another cluster. There was significant difference between patient's satisfaction level of different treatment groups (p<0.0001).

Discussion

This study compared the effects of two different doses of diphenhydramine versus lidocaine for median nerve block for intradermal procedures of the hand. The results indicated that the type and doses of medication had no significant relationship with onset time and duration of anesthesia induced by diphenhydramine, and both are comparable with what induced by lidocaine. Diphenhydramine injection, with any dose, was more painful than lidocaine injection. The mean pain score of two different used doses of diphenhydramine was not significant. As a result, patients receiving lidocaine had higher satisfaction level compared to patients receiving diphenhydramine. However, due to the absence of significant adverse effects, diphenhydramine can be considered as an appropriate alternative for lidocaine in median nerve block in patients with lidocaine hypersensitivity.
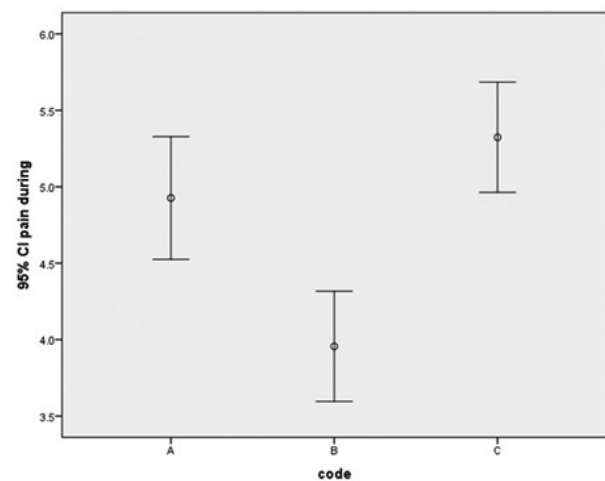
Figure 2. The pain score measured by Visual Analog Scale during injection of each group (A: 0.5% Diphenhydramine Injection; B: 1% Lidocaine Injection; C: 1% Diphenhydramine Injection)

CI: Confidence interval

Table 1. The quantitative and qualitative variables among treatment groups			Group A (n=68)	Group B (n=67)	Group C (n=67)	Total (n=202)
Variables						
Secondary outcomes	**Satisfaction level**	Extremely satisfied	1 (1.47)	0	0	1 (0.49)
		Very satisfied	14 (20.59)	37 (55.22)	13 (19.4)	64 (31.68)
		Satisfied	23 (33.82)	14 (20.89)	20 (29.85)	57 (28.21)
		Slightly satisfied	24 (35.29)	14 (20.89)	26 (38.8)	64 (31.68)
		Not satisfied	5 (7.35)	1 (1.49)	8 (11.94)	14 (6.93)
	Adverse effect	Erythema	2 (2.94)	0	2 (2.98)	4 (1.98)
		Drowsiness	1 (1.47)	0	4 (5.97)	5 (2.47)
		Both	0	0	1 (1.49)	1 (0.49)
Age (year)			35.67±13.29	34.49±13.23	35.1±14.14	35.09±13.5
Primary outcome	Onset action (min)		5.44±1.79	4.98±1.64	5.35±1.61	5.26±1.69
	Duration of anesthesia (min)		31.17±4.89	32.58±5.14	33.05±5.08	32.26±5.08
	Pain Score during injection		4.92±1.66	3.92±1.45	5.28±1.46	4.71±1.62
Date are frequency (percent) or mean ± SD. A: 0.5% Diphenhydramine Injection; B: 1% Lidocaine Injection; C: 1% Diphenhydramine Injection. SD: Standard deviation, min: Minimum, n: Number						

In almost all previous studies, similar to the results of our study, it was reported that diphenhydramine is a suitable not-questionable alternative for lidocaine (4). Although there are some disagreements (16). Except rare ones (8), mostly pointed to the pain at the injection site as the main side effect of using diphenhydramine for local anesthesia, so tried to find a proper intervention to reduce it. To the best of our knowledge there is not any study, comparing two different doses of diphenhydramine in this regard. Various studies suggested that the technique of anesthetic injection is an important factor in the amount of pain during injection. Hence, appropriate training for using less painful techniques can reliably limit the pain of local anesthetic injection (17-19).

A study investigated the efficacy of 1.8 mL of 1% diphenhydramine with 1:100,000 epinephrine, 1.8 mL of 2% lidocaine with 1:100,000 epinephrine, and the combination of these two solutions in inferior alveolar nerve block. The results showed that post-injection discomfort using diphenhydramine was significantly higher than lidocaine. Although, the successful anesthesia for lidocaine was the most and for diphenhydramine was the least (5).

Twenty-four persons volunteered for intradermal injection of 0.5 mL diphenhydramine 1% and 2%, lidocaine 1% and saline placebo. The efficacy of diphenhydramine 1% and lidocaine were significant higher than placebo and diphenhydramine 2%. However, diphenhydramine 1% and lidocaine had priority with each other. No significant complication was reported. Generally, the pain score of diphenhydramine injection was higher (20).

In a study among 23 patients referred for oral surgery and needed local injection. Sixteen patients with positive history of allergy to local anesthesia received 2 mL diphenhydramine 1% and seven patients without allergy received 2 mL procaine 2%. The results showed that the onset action of diphenhydramine was lower but the difference was no statistically significant. In addition, diphenhydramine had higher VAS score and lower duration of anesthesia. Using the diphenhydramine was accompanied with several complications including headache, bleeding, edema, pain and dizziness in one third of patients but no complication was observed in the use of procaine (21). When it comes to side effect, similar to our finding, different studies reported only limited and rare adverse effects of diphenhydramine and lidocaine. Hypersensitivity, pounding in chest and headache were some of adverse effects reported with lidocaine. Temporary hyperemia on injection site, erythema, tissue irritation, sedation and skin necrosis were some of the adverse effects of diphenhydramine (6, 7, 22-25). Some studies claimed that the adverse effects of these two drugs can be reduced by decreasing concentration or volume of the medication, or by combining them with other drugs such as epinephrine (4,7,26).

Study Limitations

In our study, the sample size was low due to the limited number of patients referred to ED with indication for median nerve block. Some variables such as age, gender, history of diabetes mellitus, hemodynamic changes, type and duration of procedure were not evaluated in the study. The incidence of adverse effects was very low which may be due to the excluding of all patients with history of hypersensitivity of diphenhydramine or lidocaine. In this regard, investigating the relationship between the adverse effects in different treatment groups was not statistically valuable. On the other hand, there was limited number of studies assessing the efficacy of diphenhydramine for median nerve block. Further studies are expected with higher sample size, different injection techniques and injection sites.

Conclusion

In summary, the present study evaluated the effect of two different concentrations of diphenhydramine and lidocaine in providing anesthesia via median nerve block, for simple hand procedures, and investigated the intensity of pain at injection site. The pain score of diphenhydramine injection, in its both concentrations, was higher than that of lidocaine, and patient satisfaction level was higher with lidocaine. Different doses of diphenhydramine did not result in a significant difference in onset of action or duration of anesthesia, or in pain score during injection.

References

1. Lovely LM, Chishti YZ, Woodland JL, Lalonde DH. How Much Volume of Local Anesthesia and How Long Should You Wait After Injection for an Effective Wrist Median Nerve Block? Hand (New York, NY). 2018;13:281-4.

2. Koay J, Orengo I. Application of local anesthetics in dermatologic surgery. Dermatol Surg. 2002;28:143-8.

3. Abdolrazaghnejad A, Banaie M, Tavakoli N, Safdari M, Rajabpour-Sanati A. Pain Management in the Emergency Department: a Review Article on Options and Methods. Adv J Emerg Med. 2018;2:e45.

4. Bina B, Hersh EV, Hilario M, Alvarez K, McLaughlin B. True Allergy to Amide Local Anesthetics: A Review and Case Presentation. Anesth Prog. 2018;65:119-23.

5. Willett J, Reader A, Drum M, Nusstein J, Beck M. The anesthetic efficacy of diphenhydramine and the combination diphenhydramine/lidocaine for the inferior alveolar nerve block. J Endod. 2008;34:1446-50.

6. Pickett LE, Macdonald J. Injectable Diphenhydramine Used as Anaesthetic for Wide Local Excision With Flap Closure. J Cutan Med Surg. 2017;21:256-7.

7. Pavlidakey PG, Brodell EE, Helms SE. Diphenhydramine as an alternative local anesthetic agent. J Clin Aesthet Dermatol. 2009;2:37-40.

8. Xia Y, Chen E, Tibbits DL, Reilley TE, McSweeney TD. Comparison of effects of lidocaine hydrochloride, buffered lidocaine, diphenhydramine, and normal saline after intradermal injection. J Clin Anesth. 2002;14:339-43.

Eurasian J Emerg Med.
2021;20(3): 190-5

Farahmand et al. Diphenhydramine vs. Lidocaine for Nerve Block

9. Nakamura T, Popitz-Bergez F, Birknes J, Strichartz GR. The critical role of concentration for lidocaine block of peripheral nerve in vivo: studies of function and drug uptake in the rat. Anesthesiology. 2003;99:1189-97.

10. Liu J, Lv X. The pharmacokinetics and pharmacodynamics of lidocaine-loaded biodegradable poly(lactic-co-glycolic acid) microspheres. Int J Mol Sci. 2014;15:17469-77.

11. Singer AJ, Hollander JE. Infiltration pain and local anesthetic effects of buffered vs plain 1% diphenhydramine. Acad Emerg Med. 1995;2:884-8.

12. Delaunay L, Chelly JE. Blocks at the wrist provide effective anesthesia for carpal tunnel release. Can J Anaesth. 2001;48:656-60.

13. Faiz KW. [VAS--visual analog scale]. (Article in German).Tidsskrift for den Norske laegeforening : tidsskrift for praktisk medicin, ny raekke. 2014;134:323.

14. Arhami Dolatabadi A, Memary E, Kariman H, Nasiri Gigloo K, Baratloo A. Intranasal Desmopressin Compared with Intravenous Ketorolac for Pain Management of Patients with Renal Colic Referring to the Emergency Department: A Randomized Clinical Trial. Anesth Pain Med. 2017;7:e43595.

15. RANDOM.ORG website. What's this fuss about true randomness? [Available at: https://www.random.org/

16. Bartfield JM, Jandreau SW, Raccio-Robak N. Randomized Trial of Diphenhydramine Versus Benzyl Alcohol With Epinephrine as an Alternative to Lidocaine Local Anesthesia. Ann Emerg Med. 1998;32:650-4.

17. Strazar AR, Leynes PG, Lalonde DH. Minimizing the pain of local anesthesia injection. Plast Reconstr Surg. 2013;132:675-84.

18. Lalonde DH, Price C, Wong AL, Chokotho T. Minimally painful local anesthetic injection for cleft lip/nasal repair in grown patients. Plast Reconstr Surg - Glob. 2014;2:e171-e.

19. Farhangkhoee H, Lalonde J, Lalonde DH. Teaching medical students and residents how to inject local anesthesia almost painlessly. Can J Plast Surg. 2012;20:169-72.

20. Green SM, Rothrock SG, Gorchynski J. Validation of Diphenhydramine as a Dermal Local Anesthetic. Ann Emerg Med. 1994;23:1284-9.

21. Uckan S, Guler N, Sumer M, Ungor M. Local anesthetic efficacy for oral surgery: Comparison of diphenhydramine and prilocaine. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1998;86:26-30.

22. Tigka E, Alevizou A, Kotsiou A, Tesseromatis C. The Influence of Diphenhydramine Administration on Lidocaine Protein Binding in Rat Serum and Tissues. Pharmacology. 2011;7:880-3.

23. Lu DP. Managing patients with local anesthetic complications using alternative methods. Pa Dent J (Harrisb). 2002;69:22-9.

24. Boren E, Teuber SS, Naguwa SM, Gershwin ME. A critical review of local anesthetic sensitivity. Clin Rev Allergy Immunol. 2007;32:119-28.

25. Thyssen JP, Menne T, Elberling J, Plaschke P, Johansen JD. Hypersensitivity to local anaesthetics--update and proposal of evaluation algorithm. Contact Derm. 2008;59:69-78.

26. Klein JA, Jeske DR. Estimated Maximal Safe Dosages of Tumescent Lidocaine. Anesth Analg. 2016;122:1350-9.

Evaluation of Epidemiological Factors of Radiological Imaging Methods in Thoracoabdominal Trauma Patients

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Abstract

Aim: Traumas continue to be the leading cause of death in healthy adults presenting to emergency services worldwide. This study aimed to analyze the epidemiological causes of life-threatening thoracoabdominal traumas.

Materials and Methods: One thousand and one hundred and twenty-one patients older than 18 years of age who presented to the emergency service due to trauma between January 1st, 2017, and December 31st, 2019, were included in this retrospective study. Traumas were grouped as falls, traffic accidents and penetrating injuries. Five groups were also formed according to radiological imaging methods.

Results: Mean age was 35.80±16.15 years in in-vehicle accidents and 46.56±17.64 years in penetrating injuries (p=0.001). It was found that 847 (75.6%) of the cases were falls, 222 (19.8%) were traffic accidents, and 52 (4.6%) were penetrating injuries. Sixty-seven (%6) of the cases underwent ultrasonography in falls from higher than 2 m, 399 (35.6%) of the cases underwent direct X-ray in falls from lower than 2 m, 9 (0.8%) cases underwent abdominal computed tomography (CT), 19 (1.7%) cases underwent multiple imaging in non-vehicle traffic accidents, and 24 (2.1%) cases underwent thoracic CT in falls from higher than 2 m. In the analysis of trauma types with variables, positive low and moderate correlation was found in all variables except for age.

Conclusion: Mortality and morbidity rates can be reduced by an early multidisciplinary approach to trauma cases and early decision of radiological imaging procedures to be carried out.

Keywords: Emergency service, epidemiology, trauma, mortality, radiological imaging

Introduction

Traumatic injuries cause undesirable workforce loss and even deaths in young and productive age group (1,2). The first hour following trauma is the golden time and it has a critical importance in preventing morbidity and mortality in the first 24 hours (3). For an urgent and comprehensive intervention to injured individuals following trauma, a good organization is required in the area they are in and in the hospital. Trauma-related deaths occur in trauma area, hospital emergency service and intensive care (4).

Trauma clinic is very heterogeneous in terms of its underlying causes and it is characterized by injury types and severity. Uncertainty of prognosis is due to causes related with anatomical,

professional, economic, political and cultural variables of risk factors (5). Trauma management before and inside the hospital requires a well-disciplined approach. Knowing about epidemiological factors ensures correct application of necessary algorithm in the management of trauma emergency approach. According to the data of World Health Organization (WHO); 29% of traumas are causes by traffic accidents, while 12.6% are caused by falls and 9.16% are caused by individual accidents (6). These data may differ between countries and regions. In addition, the fact that traffic accidents are more common in men shows the difference in gender in trauma patients. In studies, one out of ten deaths is caused by trauma in both genders. Traumatic causes are the primary cause of death and disability in individuals under

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35 years of age. While penetrating situations such as traffic accidents, violence and self-harm are the primary causes of trauma in individuals between the ages of 25 and 35, this rate decreases after the age of 45 and blunt trauma mechanisms such as home accidents and falls come to the fore after the age of 45 (7). While head trauma is observed in the first place in fall-related accidents, this is followed by extremity traumas and abdominal traumas. Head traumas cause more morbidity and mortality with their permanent sequelae. The rates may differ between countries or regions in terms of socioeconomic development. Economic development rates also affect morbidity and mortality. The leading causes of mortality are neurological damage and haemorrhage. The primary cause of death especially within the first hours is haemorrhage (4,8).

Penetrating trunk trauma is the second leading cause of death after head trauma (7,8). In developed countries, traffic accidents, falls and general blunt traumas are the most common injury mechanisms, while penetrating trauma including gunshot wounds and stab wounds are most common in developing countries due to ongoing violence and social unrest (9). Penetrating chest and abdominal trauma have high mortality rates when important structures such as the heart, great arteries and liver are involved at the scene (10,11).

Stabilization of the patient at the accident site prevents the patient's motor and sensory functions from getting worse. The leading cause of death is head traumas in-between the first and sixth days. Sepsis and multiple organ failure are longer term mortality causes of trauma (3,4,12). Knowing the dynamic and risk factors of trauma allows for emergency interventions for fatal or permanent disability due to injury.

The aim of this study is to show the relationship of damage observed in thoracic and abdominal regions in causes of trauma due to different mechanisms and to show trauma risks caused by trauma dynamics. In addition, the rate of use of imaging methods related with trauma dynamic was also found in the study. Therefore, in the light of epidemiologic data obtained, it will be possible to improve prevalence and incidence information in trauma patients and more coordinated and multidisciplinary approaches will be possible.

Materials and Methods

Study Design and Population

One thousand and one hundred twenty-one patients older than 18 years of age who presented to the emergency service due to trauma between January 1st, 2017 and December 31st, 2019 were included in this retrospective study. Minor home

and play accidents and cuts, isolated head-neck traumas and extremity traumas, patients who presented to the emergency service 48 hours after the trauma and those who did not undergo examination and imaging in the emergency service were excluded from the study. Trauma types and characteristics, radiological imaging, thoracic and minimal organ injuries of the patients were evaluated.

Traumas were divided into five general groups as falls [lower than 2 m (-2mF) and higher than 2 m (+2mF)], in-vehicle traffic accident (IVTA) and non-vehicle traffic accident (NVTA)], penetrating (piercing, cutting and firearm injuries) injuries (PI).

Five groups of thoracic traumas were formed as normal lung, right, left, bilateral and contusion. In addition, four groups were formed as absence of intra-abdominal organ injuries, spleen, liver and other (small and large intestine, kidney, ureter, etc.). The ribs were grouped in five as no fracture, single fracture, 2-3 fractures, flail chest and sternum fracture.

In the study, the patients with good and moderate general condition were evaluated in the trauma resuscitation room, those with poor coma score and consciousness level were evaluated in the emergency critic resuscitation room. Forensic forms were prepared for these patients, those who did not have tetanus vaccine had tetanus vaccine, those who required fluid and blood resuscitation were started fluid and blood resuscitation. All of the patients were recorded in the hospital automation and patient file records. Diagnoses, admission dates, communication information, demographic, clinical and laboratory data are in the registration system of our hospital.

Besides these, two groups were determined in terms of the presence or absence of thoracic vertebra, lumbal vertebra, hemothorax, pneumothorax, intraabdominal injury, artery injury and mortality.

Radiological Imaging

Patients who had good general condition, no thoracic and abdominal trauma, and who were thought to be bruised or have simple fractures and dislocations had direct X-rays. The patients who had stable general condition and vital signs underwent a thorough ultrasonography in the radiology unit. Patients with low coma score, poor general condition and instable vital signs underwent Focused Assessment Sonography for Trauma. The patients who were thought to have thoracic and/or lumbal vertebra fracture, thoracic injury, intraabdominal organ injury or haemorrhage and who could go to radiology unit underwent contrast and/or non-contrast computed tomography (CT). The patients who underwent multiple imaging were multiple trauma patients. These patients underwent imaging with the presence of a physician by taking

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resuscitation measures. All ultrasonography (USG) and CTs were analyzed jointly with radiology, emergency and related branch specialists.

After the study was approved by Clinical Researches Ethics Committee of Cumhuriyet University (decision no: 2019-12/22, date: 11.12.2019), it was carried out in accordance with Helsinki declaration for human researches.

Statistical Analysis

The data obtained from this study were analyzed with SPSS 20 (SPSS Inc., Chicago, IL, USA) program. Descriptive statistics were shown as mean ± standard deviation or median (minimum-maximum) for continuous variables, while nominal variables were shown as number of cases and percentage (%). Mann-Whitney U test and Kruskal-Wallis test were used while examining the differences between the groups. Chi-square analysis was used while examining the relationship between groups of nominal variables. Pearson correlation analysis was used for the linear correlation between the variables. Boxblot graph analysis was made for mortality, trauma and radiological imaging with age. While interpreting the results, values under 0,05 significance level were considered as statistically significant.

Results

Mean age of the 1121 patients was 41.17±16.65 years with an age distribution of 19-94 years and 379 (33.8%) were female. Of the trauma patients, 436 (38.9%) were 2mF, 411(36.7%) were +2mF,

36 (3.2%) were IVTA, 186 (16.6%) were NVTA and 52 (4.6%) were PI (p=0.001). Mortality was found in 23 (2.1%) of the patients (p=0.916, Table 1).

In terms of analysis according to trauma types, +2mF was the most frequent in both genders. Mortality was most frequent in +2mF with 11 (1%) cases and NVTA with 7 (%0.6) cases. Of the lung traumas, 105 (9.4%) were in the right, 91 (8.1%) were in the left and 18 (1.6%) were bilateral. Contusion was found in 30 (2.7%) of these cases. Twenty-five (2.2%) of the patients were found to have lumbal vertebra lesion, while 15 (1.3%) had thoracic vertebra lesion. Of all the cases, 28 (2.5%) were found to have pneumothorax injury, while 19 (1.7%) were found to have hemothorax injury and 45 (4%) were found to have abdominal injury. Of these abdominal injuries, 30 (2.7%) were found to have liver injury and 15 (1.3%) were found to have spleen injury. Of the thoracic injuries, 25 (2.2%) had single rib fracture, 7 (0.6%) had 2-3 ribs fracture, 7 (0.6%) had flail chest and 4 (0.4%) had sternum fracture. Vascular injury was found in 9 (0.8%) of the cases. One hundred and twenty-seven (11.3%) of the cases had USG, 869 (77.5%) had direct X-ray, 16 (1.4%) had abdominal CT, 56 (5%) had thoracic CT and 53 (4.7%) had multiple imaging (Table 2). Age analysis of trauma types can be seen in Figure 1.

Mortality occurred in 23 (2%) patients. Eighteen (1.6%) of these were male. In lung involvement, while right and left lungs were equal with 3 cases, mortality was accompanied bilaterally in two cases. No mortality occurred in patients with contusion. In lumbar vertebra injury, while there was one mortality, no mortality was

Table 1. Age distribution according to variables

Age distribution				
	All Patients	Min-max	Mean ± SD	p-value
Gender				
Female	379	19-90	39.26±15.91	0.007
Male	742	19-94	42.14±16.95	
Trauma				
-2mF	436	19-94	39.14±15.36	0.001
+2mF	411	19-94	43.57±17.62	
IVTA	36	19-83	35.80±16.15	
NVTA	186	19-90	40.13±16.24	
PI	52	21-80	46.56±17.64	
Mortality				
No	1098	19-94	41.18±16.67	0.916
Yes	23	20-67	40.56±16.18	
Total	1121	19-94	41.17±16.15	

-2mF: Falling from a height of less than two meters, +2mF: Falling from a height of more than two meters, IVTA: In-vehicle traffic accident, NVTA: Non-vehicle traffic accident, PI: Penetrating injury, SD: Standard deviation

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seen in thoracic vertebra, hemothorax, pneumothorax and vascular injuries. Most frequent mortality was found in spleen injury and patients who had direct X-ray (Table 3).

In both genders, +2mF was the trauma in which imaging method was used the most. In contusions, thoracic CT was more frequent in thoracic traumas, while multiple imaging was more frequent in left and bilateral lung injuries. In thoracic traumas, thoracic CT was the most frequent imaging method. However multiple imaging was the most frequent in lumbal and thoracic vertebra, pneumothorax, hemothorax, abdominal and intraabdominal injuries and vascular injuries (Table 4). Figure 2 shows the graph of radiological imaging methods by age.

Correlation of trauma types was made with the variables. No correlation was found with age. However, weak or moderate positive correlation was found in all the other parameters (Table 5).

Discussion

Knowing about the trauma epidemiology is an effective way of evaluating morbidity and mortality. This way, risk groups are determined, it is easier to apply clinical treatment and the coordination of trauma type becomes easier (13). Each country should know about their trauma epidemiological factors. In the light of the data obtained, regional algorithms can be developed for trauma control and prevention of accident risk

Table 2. Distribution of variables according to trauma types

Trauma types		-2mF n (%)	+2mF n (%)	IVTA n (%)	NVTA n (%)	PI n (%)	Total n (%)
Gender	**Female**	182 (16.2)	140 (12.5)	16 (1.4)	25 (2.2)	16 (1.4)	379 (33.8)
	Male	254 (22.7)	271 (24.2)	20 (1.8)	161 (14.4)	36 (3.2)	742 (66.2)
Mortality	**No**	436 (38.9)	400 (35.7)	35 (3.1)	179 (16)	48 (4.3)	1098 (97.9)
	Yes	0	11 (1)	1 (0.1)	7 (0.6)	4 (0.4)	23 (2.1)
Lung	**No**	420 (37.5)	295 (26.3)	19 (1.7)	117 (10.4)	26 (2.3)	877 (78.2)
	Right	6 (0.5)	48 (4.3)	5 (0.4)	34 (3)	12 (1.1)	105 (9.4)
	Left	7(0.6)	44((3.9)	9 (0.8)	23 (2.1)	8 (0.7)	91 (8.19
	Bilateral	0	9 (0.8)	2 (0.2)	5 (0.4)	2 (0.2)	18 (1.6)
	Contusion	3 (0.3)	15 (1.3)	1 (0.1)	7 (0.6)	4 (0.4)	30 (2.7)
Intra-abdomina organ injury	**No**	433 (38.6)	392 (35)	33 (2.9)	166 (14.8)	42 (3.7)	1066 (95.1)
	Liver	2 (0.2)	14 (1.2)	0	8 (0.7)	6 (0.5)	30 (2.7)
	Spleen	0	3 (0.3)	2 (0.2)	8 (0.7)	2 (0.2)	15 (1.3)
	Other	1 (0.1)	2 (0.2)	1 (0.1)	4 (0.4)	2 (0.2)	10 (0.9)
Thorax Injury	**No**	433 (38.6)	395 (35.2)	34 (3)	172 (15.3)	44 (3.9)	1078 (96.2)
	Single RF	3 (0.3)	13 (1.2)	1 (0.1)	6 (0.5)	2 (0.2)	25 (2.2)
	2-3 RF	0	2 (0.2)	0	3 (0.3)	2 (0.2)	7 (0.6)
	Flail Chest	0	1 (0.1)	1 (0.1)	1 (0.1)	4 (0.4)	7 (0.6)
	Sternum F	0	0	0	4(0.4)	0	4(0.4)
Radiological Imaging	**USG**	29 (2.6)	67 (6)	5 (0.4)	20 (1.8)	6 (0.5)	127 (11.3)
	Direct graph	399 (35.6)	300 (26.8)	22 (2)	123 (11)	25 (2.2)	869 (77.5)
	Abdominal CT	0	2 (0.2)	3 (0.3)	9 (0.8)	2 (0.2)	16 (1.4)
	Thorax CT	5 (0.4)	24 (2.1)	2 (0.2)	15 (1.3)	10 (0.9)	56 (5)
	Multiple Imaging	3 (0.3)	18 (1.6)	4 (0.4)	19 (1.7)	9 (0.8)	53 (4.7)

-2mF: Falling from a height of less than two meters, +2mF: Falling from a height of more than two meters, IVTA: In-vehicle traffic accident, NVTA: Non-vehicle traffic accident, PI: Penetrating injury, R: Rip, F: Fracture, USG: Ultrasonography, CT: Computed Tomography, SD: Standard deviation, n: Number

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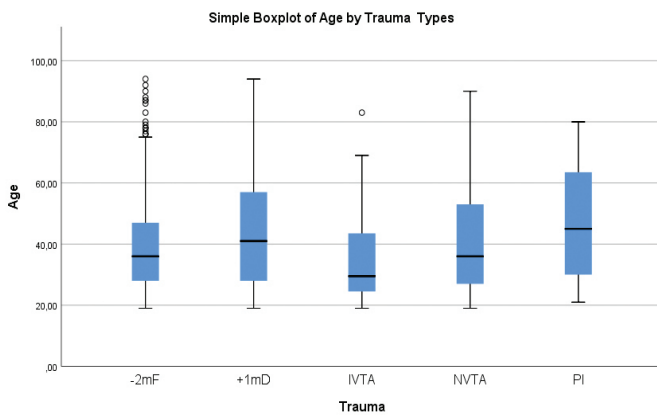
Figure 1. Distribution of age by trauma types

-2mF: Falling from a height of less than two meters, +2mF: Falling from a height of more than two meters, IVTA: In-vehicle traffic accident, NVTA: Non-vehicle traffic accident, PI: Penetrating injury

(behavioural changes, informative legal campaigns, firearms control, prevention of falls in the elderly, speed limits) and for post-traumatic approaches.

Knowing about the trauma mechanism is important in terms of determining the first intervention of the patient in accident scene and hospital. In developed countries, the most common injury mechanisms are traffic accidents, falls and general blunt traumas, while penetrating traumas including gunshot and stabbing injuries are more common in developing countries due to on-going violence and social unrest (7,10,11). Penetrating trunk trauma is the second leading cause of death after head trauma. Penetrating chest and abdominal trauma have high mortality rates when important structures such as the heart, great arteries and liver are involved at the scene (11-13). In a study, Larson stated that with the number of injured organs in

Table 3. Analysis of variables by mortality				
Mortality				
		No n (%)	Yes n (%)	Total n (%)
Gender	Female	374 (33.4)	5 (0.4)	379 (33.8)
	Male	724 (64.6)	18 (1.6)	742 (66.2)
Lung	No	862 (76.9)	15 (1.3)	877 (78.2)
	Right	102 (9.1)	3 (0.3)	105 ((9.4)
	Left	88 (7.9)	3 (0.3	91 (8.19
	Bilateral	16 (1.4)	2 (0.2)	18 (1.6)
	Contusion	30 (2.7)	0	30 (2.7)
Lumbal vertebra	No	1074 (95.8)	22 (2)	1096 (97.8)
	Yes	24 (2.1)	1 (0.1)	25 (2.2)
Abdominal injury	No	1055 (94.1)	21 (2.1)	1076 (96)
	Yes	43 (3.8)	2 (0.2)	45 (4)
Intra-abdominal organ injury	No	1046 (93.3)	20 (1.8)	1066 (95.1)
	Liver	30 (2.7)	0	30 (2.7)
	Spleen	12 (1.1)	3 (0.3)	15 (1.3)
	Other	10 (0.9)	0	10 (0.9)
Thorax injury	No	1056 (94.2)	22 (2)	1078 (96.2)
	Single RF	25 (2.2)	0	25 (2.2)
	2-3 RF	7 (0.6)	0	7 (0.6)
	Flail chest	6 (0.5)	1 (0.1)	7 (0.6)
	Sternum F	4 (0.4)	0	4 (0.4)
Radiological imaging	USG	125 (11.2)	2 (0.2)	127 (11.3)
	Direct graph	855 (76.3)	14 (1.2)	869 (77.5)
	Abdominal CT	14 (1.2)	2 (0.2)	16 (1.4)
	Thorax CT	55 (4.9)	1 (0.1)	56 (5)
	Multiple imaging	49 (4.4)	4 (0.4)	53 (4.7)
R: Rib, F: Fracture, USG: Ultrasonography, CT: Computed Tomography, n: Number				

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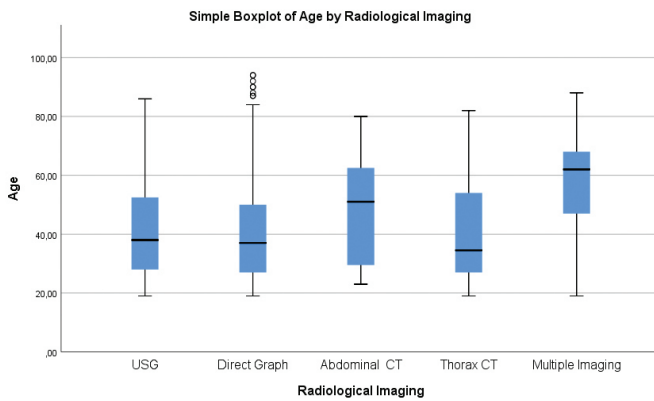
Figure 2. Distribution of age according to radiological imaging methods

USG: Ultrasonography, CT: Computed tomography

penetrating traumas, the rate of complications that may develop also increases (14).

In our study, penetrating injury rates were found as 1.4% for women, 3.2% for men and as 4.5% in total. Mortality rates were found higher in penetrating injuries, similar to previous studies. The rates of life-threatening thoracic trauma cases such as flail chest were found to be higher in our study in penetrating injuries.

Traffic accidents make up 35% of trauma deaths worldwide. In addition, they are the most frequent cause of individual injuries after accident (15). While statistical rates increase in developing countries, they are lower in developed countries due to increased protective measures. Interestingly, while head traumas were found to be more common in young individuals in traffic accidents in low-income countries, they were found to

Table 4. Analysis of variables according to radiological imaging

Radiological Imaging		USG n (%)	DG n (%)	ACT n (%)	TCT n (%)	MI n (%)	Total n (%)
Gender	Female	50 (4.5)	300 (26.8)	4 (0.4)	17 (1.5)	8 (0.7)	379 (33.8)
	Male	77 (6.9)	569 (50.8)	12 (1.1)	39 (3.5)	45 (4)	742 (66.2)
Lung	No	48 (4.3)	785 (70)	15 (1.3)	13 (1.2)	4 (0.4)	877 (78.2)
	Right	45 (4)	47 (4.2)	0	9 (0.8)	4 (0.4)	105 (9.4)
	Left	34 (3)	37 (3.3)	1 (0.1)	5 (0.4)	14 (1.2)	91 (8.19
	Bilateral	0	0	0	6 (0.5)	12 (1.1)	18 (1.6)
	Contusion	0	0	0	23 (2.1)	7 (0.6)	30 (2.7)
Lumbal vertebra	No	127 (11.3)	869 (77.5)	14 (1.2)	53 (4.7)	33 (2.9)	1096 (97.8)
	Yes	0	0	2 (0.2)	3 (0.3)	20 (1.8)	25 (2.2)
Thoracic vertebra	No	127 (11.3)	869 (77.5)	16 (1.4)	56 (5)	38 (3.4)	1106 (98.7)
	Yes	0	0	0	0	15 (1.3)	15 (1.3)
Pneumothorax	No	125 (11.2)	867 (77.3)	16 (1.4)	50 (4.5)	35 (3.1)	1093 (97.5)
	Yes	2 (0.2)	2 (0.2)	0	6 (0.5)	18 (1.6)	28 (2.5)
Hemothorax	No	127 (11.3)	869 (77.5)	16 (1.4)	56 (5)	34 (3)	1102 (98.3)
	Yes	0	0	0	0	19 (1.7)	19 (1.7)
Abdominal injury	No	127 (11.3)	868 (77.4)	8 (0.7)	56 (5)	17 (1.5)	1076 (96)
	Yes	0	1 (0.1)	8 (0.7	0	36 (3.2)	45 (4)
Intra-abdominal organ injury	No	127 (11.3)	868 (77.4)	7 (0.6)	55 (4.9)	9 (0.8)	1066 (95.1)
	Liver	0	1 (0.1)	2 (0.2)	0	27 (2.4)	30 (2.7)
	Spleen	0	0	6 (0.5)	1 (0.1)	8 (0.7)	15 (1.3)
	Other	0	0	1 (0.1)	0	9 (0.8)	10 (0.9)
Thorax injury	No	121 (10.8)	858 (76.5)	16 (1.4)	36 (3.2)	47 (4.2)	1078 (96.2)
	Single RF	6 (0.5)	10 (0.9)	0	8 (0.7)	1 (0.1)	25 (2.2)
	2-3 RF	0	0	0	6 (0.5)	1 (0.1)	7 (0.6)
	Flail Chest	0	0	0	6 (0.5)	1 (0.1)	7 (0.6)
	Sternum F	0	1 (0.1)	0	3 (0.3)	0	4 (0.4)
Vascular injury	No	126 (11.2)	868 (77.4)	16 (1.4)	53 (4.7)	49 (4.4)	1112 (99.2)
	Yes	1 (0.1)	1 (0.1)	0	3 (0.3)	4 (0.4)	9 (0.8)

USG: Ultrasonography, DG: Direct graph, ACT: Abdominal Computed Tomography, TCT: Thorax Computed Tomography, Multiple Imaging, R: Rip, F: Fracture, n: Number

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Table 5. Correlation of variables with trauma types		
Correlation	**Trauma types**	
	r	**p-value**
Age	0.050	0.092
Gender	0.172	0.001
Radiological imaging	0.245	0.001
Mortality	0.126	0.001
Lung	0.278	0.001
Lumbal vertebra	0.144	0.001
Thoracic vertebra	0.059	0.048
Pneumothorax	0.172	0.001
Hemothorax	0.135	0.001
Abdominal injury	0.197	0.001
Intra-abdominal organ injury	0.208	0.001
Thorax injury	0.200	0.001
Vascular injury	0.114	0.001

be more common in elderly individuals in developed countries due to increased longevity rates and comorbidities of the elderly population (7,16). In our study, in-vehicle traffic accident rates were lower than non-vehicle traffic accidents and mortality rates were lower. In addition, lung injury was found as 16.6% in non-vehicle traffic accidents and as 4.65 in penetrating injuries. Pneumothorax, hemothorax, sternum and more than two costal fracture cases were found to be in higher rates in non-vehicle traffic accidents.

In a meta-analysis by Stein et al. (17), it was found that mortality rates decreased by 50% in the last 150 years, while traffic accident rates continued to increase. Effective interventions are provided in trauma diagnosis and treatment due to advanced imaging techniques like computed axial tomography (4-6). In our study, while direct X-ray use was higher in falls from lower than 1 m, CT and multiple imaging uses were higher respectively in non-vehicle traffic accidents, falls from higher than 1 m and penetrating injuries.

Falls from different levels constitute 44% of trauma cases (18). In our study, falls were evaluated in two groups. While rates of fall from lower than 1 m were 16.2% in women, 22.7% in men and 38.9% in total, the rates of fall from higher than 1 m were 12.5% in women, 24.2% in men and 36.7% in total. In previous studies, 33%-47% head traumas, 15%-26% extremity traumas and 8%-17% abdominal traumas were observed in fall-related accidents (19).

In their study on trauma mechanism, Magnone et al. (20) suggested that falling from the same level could be included in major trauma depending on the patient's age and clinical state (20,21). It was shown that advanced age, hemodynamic imbalance, decreased consciousness and respiratory failure affected mortality regardless of trauma mechanism (22,23).

Spleen is one of the most frequently injured solid organs of the abdominal cavity. Coccolini et al. (24) examined a total of 124 patients with spleen injury and the most frequent injury mechanism was found as blunt trauma secondary to traffic accidents, followed by falls. Spleen is one of the most frequently injured organs in blunt abdominal trauma, while its incidence reaches only 7%-9% in penetrating traumas (25). In spleen injuries, early diagnosis may decrease trauma-related mortality (26). In our study, spleen injury rates were found to be higher in non-vehicle traffic accident injuries when compared with other traumas. Liver injuries were observed in higher rates in falls from higher than 1 m.

Study Limitations

One of the limitations of the study is the fact that the data were obtained from a single centre and retrospectively and the data intervals were limited in some patient groups. Another limitation was the fact that there may be loss in patient information and post-treatment follow-up.

Conclusion

The results obtained in our study will enable intervention without losing time in trauma area or in hospital in terms of triage and treatment of patients. Thus, it will be possible to prevent trauma-related mortality and morbidity in young and

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productive age group of the society. We think that advances in radiological imaging can reduce both mortality and morbidity.

Ethics

Ethics Committee Approval: This study was approved by Clinical Researches Ethics Committee of Cumhuriyet University (decision no: 2019-12/22, date: 11.12.2019), it was carried out in accordance with Helsinki declaration for human researches.

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: F.T.T., Concept: F.T.T., A.C., Design: A.C., Data Collection or Processing: A.C., Analysis or Interpretation: F.T.T., A.C., Literature Search: F.T.T., Writing: F.T.T.

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References

1. Department of Violence, Injury Preventionand Disability. Injuriesand Violence. The Facts. Geneva: World Health Organization, 2004:1-160.

2. Lin M, Kolosh KP, Fearn K. Injury Facts. Itasca: National Safety Council, 2011:1-6.2. The National Confidential Enquiryinyo Patient Outcome and Death. Trauma 2007. Available at: https://www.yumpu.com/en/document/read/27268831/injury-facts-2011-w-national-safety-council

3. Henry JA, Reingold AL. Prehospital trauma systems reduce mortality in devoloping countries: a systemic review and meta-analysis. J Trauma Acute Care Surg. 2012:73:261-8.

4. Holcomb JB, Wade CE, Brasel KJ, Vercruysse G, MacLeod J, Dutton RP, et al. Defining present blood component transfusion practices in trauma patients: papers from the Trauma Outcomes Group. J Trauma. 2011;71:315-7.

5. Ferre A. The value of life. J Trauma Acute Care Surg. 2021;91:23.

6. Kauvar DS, Wade CE. The epidemiology and modern management of traumatic haemorrhage: US and interventional perspectives. Crit Care. 2005;9:1-9.

7. Alberdi F, García I, Atutxa L, Zabarte M; Trauma and Neurointensive Care Work Group of the SEMICYUC. Epidemiology of severe trauma. Med Intensiva. 2014;38:580-8.

8. Hansen KS, Morild I, Engesaeter LB, Viste A. Epidemiology of severely and fatally injured patients in western part of Norway. Scand J Surg. 2004;93:198-203.

9. Okuş A, Sevinç B, Ay S, Arslan K, Karahan Ö, Eryılmaz MA. Conservative management of abdominal injuries. Ulus Cerrahi Derg. 2013;29:153-7.

10. Pooria A, Pourya A, Gheini A. A Descriptive Study on the Usage of Exploratory Laparotomy for Trauma Patients. Open Access Emerg Med. 2020;12:255-60.

11. Millán M, Ordoñez CA, Parra MW, Caicedo Y, Padilla N, Pino LF, et al. Hemodynamically unstable non-compressible penetrating torso trauma: a practical surgical approach. Colomb Med (Cali). 2021;52:e4024592.

12. Lefering R, Paffrath T, Bouamra O, Coats TJ, Woodford M, Jenks T, et al. Epidemiology of in-hospital trauma deaths. Eur J Trauma Emerg Surg. 2012;38:3-9.

13. DiMaggio CJ, Avraham JB, Lee DC, Frangos SG, Wall SP. The Epidemiology of emergency department trauma discharges in the United States. Acad Emerg Med. 2017;24:1244-56.

14. Larson CR, White CE, Spinella PC, Jones JA, Holcomb JB, Blackbourne LH, et al. Association of shock, coagulopathy, and initial vital signs with massive transfusion in combat casualties. J Trauma. 2010;69:26-32.

15. Sharma BR. Road traffic injuries: a major global public health crisis. Public Health. 2008;122:1399-406.

16. MRC CRASH Trial Collaborators. Predicting outcome after traumatic brain injury: practical prognostic models based on large cohort of international patients. BMJ. 2008;336:425-9.

17. Stein SC, Georgoff P, Meghan S, Mizra K, Sonnad SS. 150 years of treating severe traumatic brain injury: a systematic review of progress in mortality. J Neurotrauma. 2010;27:1343-53.

18. National Trauma Data Bank (NTDB) Annual Report. American College of Surgeons; 2012. Available at: https://www.facs.org/quality-programs/trauma/tqp/center-programs/ntdb

19. Roozenbeek B, Maas AI, Menon DK. Changing patterns in the epidemiology of traumatic brain injury. Nat Rev Neurol. 2013;9:231-6.

20. Magnone S, Ghirardi A, Ceresoli M, Ansaloni L. Trauma patients centralization for the mechanism of trauma: old questions without answers. Eur J Trauma Emerg Surg. 2019;45:431-6.

21. Gu F, Zhou J, Bian W, Ding J, Zou M, Lu S, et al. Effect of predictive trauma care on fracture healing and complications of traumatic fracture patients in emergency department. Am J Transl Res. 2021;13:3752-8.

22. Thompson L, Hill M, McMeekin P, Shaw G. Defining major trauma: a pre-hospital perspective using focus groups. Br Paramed J. 2019;4:16-23.

23. Gioffrè-Florio M, Murabito LM, Visalli C, Pergolizzi FP, Famà F. Trauma in elderly patients: a study of prevalence, comorbidities and gender differences. G Chir. 2018;39:35-40.

24. Coccolini F, Montori G, Catena F, Kluger Y, Biffl W, Moore EE, et al. Splenic trauma: WSES classification and guidelines for adult and pediatric patients. World J Emerg Surg. 2017;12:40.

25. Serna C, Serna JJ, Caicedo Y, Padilla N, Gallego LM, Salcedo A, et al. Damage control surgery for splenic trauma: "preserve an organ - preserve a life". Colomb Med (Cali). 2021;52:e4084794.

26. Orhon R, Eren SH, Karadayı S, Korkmaz I, Coşkun A, Eren M, et al. Comparison of trauma scores for predicting mortality and morbidity on trauma patients. Ulus Travma Acil Cerrahi Derg. 2014;20:258-64.

Competency of Emergency Physicians in Interpretation of Computerized Brain Tomography in Non-Traumatic Cases

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Aim: The Computerized Brain Tomography is extremely used in the diagnosis of the neurological diseases. The aim of the study was to evaluate the competency of emergency medicine physicians' in the evaluations and diagnosis of "computerized brain tomography" (CBT) of the neurological disease findings in non-traumatic cases

Materials and Methods: This study was made in the Emergency Department of a tertiary training hospital between 2015 and 2016. The CBT images, taken for the patients were evaluated by the emergency medicine physician. The tomography interpretations, provided by the radiology physicians, were considered as the gold standardas the accurate finding, and findings of the emergency medicine physician were compared with the accurate findings.

Results: Totally 197 patients inclueded. It was found that the sensitivity and specificity were as 96% and 88% in the grey white or separation, sensitivity was 91% and specificity was 76% in the ventricle constriction, average sensitivity and specificity were 99% and 86% in the SAK, EDH and SDH, and 99% and 97% in the cerebral infarct, and 97% and 91% in the cerebellar infarct, respectively.

Conclusion: In our study, emergency medicine physicians were highly successful in the interpretation of the CBT of patients with non-traumatic neurological incidents and it was in an excellent harmony with the radiologists' interpretations. The success rates of interpretation of CBT may be increased with practical and theoretical comprehensive training of the emergency medicine physicians.

Keywords: Emergency physician, non-traumatic neurological disease, computerized brain tomography, radiologist, competency

Introduction

Nowadays, emergency departments are an access point for the healthcare service of the patients, whose general situations are bad and critical. The brain vascular diseases occurring with the non-traumatic reason constitute a substantial part of the patients, who applied to the emergency department with the neurological indications and findings. The brain vascular diseases occurring with the non-traumatic reasons are the second leading cause of death following the heart disease and cancer in developed countries (1,2). It is also in the lead in terms of causing the death and disability among the neurological diseases in adults. It has an important place in the hospital applications and health expenses for the countries having a high socioeconomic level (1-4).

Computerized Brain Tomography (CBT) provides the rapid and reliable results in characterizing the life-threatening intracranial lesions such as intracranial hemorrhage, tumor and hydrocephaly and in a case where the emergency action is required. The usage area of CBT expanded by the technological developments for diagnosis, follow-up or research. The image quality and diagnostic accuracy rate of lesions increased by CBT (5).

CBT is frequently used in our emergency department as a substantial component of the clinical evaluation. Although many CBT studies in the emergency departments were made, the studies revealing CBT evaluation competency of emergency medicine physicians were still less.

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In our study, we aimed at researching the competency of emergency physicians in CBT evaluations for the non-traumatic cases. The aim of the study was to evaluate the competency of emergency medicine physicians' in the evaluation and diagnosis of "Computerized Brain Tomography" (CBT) of the neurological disease findings in non-traumatic cases.

Materials and Methods

This study was planned in a tertiary training hospital. An approval was taken from the ethics committee of the hospital after the study was planned.

The radiology and emergency medicine clinic trainers provided totally 4-hour training to the emergency medicine physicians about CBT evaluations, including 2-hour theoretical and 2-hour practical training.

CBT images of the patients included in the study were taken by Hitachi® 16-sliced tomography equipment, found in the Emergency Tomography unit within the emergency department. CBT scans for the patients were performed by using enhanced or unenhanced methods. The study was designed in order for the emergency physician to record the findings by evaluating CBT images taken and compare the findings of patients with these accurate radiology findings.

The subjects of this study were prospectively planned by one-year period starting from 01.03.2015 to 01.03.2016. The study included the patients at the age of 18 and over, who applied to the emergency department with the non-traumatic reasons and whose CBT was taken as a diagnostic examination during the evaluation. An informed consent was taken by the patients. The study excluded from the patients at the age of 18 and below, who had CBT images during the application, did not give a written consent and whose diagnoses were available.

CBT images taken to the patients were evaluated by emergency physician, and findings were recorded on the form prepared. The recommended findingswere indicated by the form by marking whether they were available (Table 1).

Statistical Analysis

The data were analyzed using SPSS version 23 (Statistical Package for the Social Sciences – IBM®).

The descriptive statistics were submitted as numbers and percentages for the categorical variables, and mean and standard deviation for the numerical variables. While the ANOVA test was used for the numerical variables in a case where the normal distribution assumption was provided for comparing the multiple independent groups, otherwise the Kruskal-Wallis Test was used. The chi-square test statistic was used for the categorical variables. The wrong positive, wrong negative, sensitivity, specificity, Positive Predictive Value (PPV), Area under curve (AUC) and kappa coefficient were calculated for computed tomography (CT) interpretations. The confidence interval of 95% and $p < 0.05$ values were used by statistically determining the significance level.

Results

The study included 197 patients, who presented atto the emergency department of tertiary training hospital and whose computerized brain tomography (CBT) was taken as a diagnostic method.

When demographical data of the patients included in the study scope were reviewedand age ranges of the patients included in the study scope were evaluated, the age ranges were calculated asas 18-45 for 11.7%, as 46-55 for 33% and as <66 for 53.3%. Mean

Table 1. Findings demanded to be specified by the emergency physicians in CBT evaluation	

● Cerebral edema findings
  - Grey-white ore separation
  - Extinction in sulcus
  - Constriction in ventricles
● Subdural hematoma
● Spidural hematoma
● Subarachnoidal hemorrhage
● Infarct areas
  - Cerebral infarct
  - Cerebellar infarct
● Intracranial mass existence
  - Edema effect
  - Shift existence
  - Hemorrhage in mass
	● Intracranial shift existence
	● Arterio-venous malformation finding
	● Intraparenchymal hemorrhage
	  - Enlargement in lateral ventricle
	  - Enlargement in 3rd ventricle
	  - Enlargement in 4th ventricle
	● Sinusitis findings
	● Venous sinus pathology
	  - Hydrocephaly
	● Bone pathology

The findings in the CBT in the radiology report and the findings determined by the emergency physician were compared at the end of study. CBT: Computerized brain tomography	

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age ± standard deviation (SD) of the patients was calculatedas 64.69±1.13 [minimum (min)=19 and maximum (max)=96].

The patients included in the study scope were females 44.2% and males 55.8%. While Unenhanced CBT scan was performed for 97.5% of the patients taking part in our study, both enhanced and unenhanced CBT scans and just Enhanced CBT were performed for 1.5% and 1% of the patients, respectively.

The cerebrovascular event (one-sided strength loss at 34% rate, consciousness change at 23.9% rate and speech disorder at 11.2% rate) was determined as an application reason to the emergency department in 136 patients (69%), who applied to the emergency department of our hospital and were included in the study scope. A headache in 17 patients (8.6%), dizziness in 15 patients (7.6%), fainting in 15 patients (7.1%), seizure in 14 patients (4.1%) and visual disorder (1%) were determined to follow up these complaints (Table 2).

When consciousness states of the patients were evaluated during the application for the emergency department, the Glasgow Coma Score (GCS) was determined as 15 for 136 patients (69%), as 13-14 for 37 patients (18.8%), as 9-12 for 15 patients (7.6%) and as 3-8 for nine patients (4.6%) (Table 3).

When examination and treatment outcomes of the patients taking part in the study are evaluated, while 40.6% of 197 patients were discharged; the remaining patients were hospitalized as 33.5% for the neurology service, as 12.2% for the intensive care unit, as 2% for the internal diseases service, as 3% for the neurosurgery service, as 1.5% for the oncology service and as 1% for the infectious diseases service (Table 4).

No statistically significant difference was detected as regards evaluating the life-threatening diagnosissuch as cerebral infarct, cerebellar infarct, and intracranial mass, intracranial shift existence, and intraparenchymal hemorrhage, enlargement in the sulcus and bone pathology between the emergency medicine physician and radiologist. But, a statistically significant difference was detected for the diagnosis of the non-fatal findingssuch as arteriovenous (AV) malformation, sinusitis, venous sinus pathology and hydrocephaly (Table 5).

The sensitivity, specificity, positive predictive value (PPV) and percentage of the values were shown in Table 6 for the success of the emergency medicine physician in the first diagnosis.

Discussion

The non-traumatic brain vascular diseases come as the third leading cause of death followingthe heart disease and cancer in developed countries (1,2). Fifteen million of humans have a stroke in every year around the world. Early diagnosis and treatment of the stroke have a substantial effect on the neurological functions and survival (6). CBT is one of the effective methods, which is used to determine the fibrinolysis contraindications and provide the stroke patient to receive a fibrinolytic treatment for the early period. CBT is the most cost-effective imaging strategy to be performed in the stroke patients for whom is rapidly taken

Table 2. Reasons for interpretation of computerized brain tomography (CBT)		
Primary complaint	n=192	%
One-sided strength loss Consciousness change Speech disorder	136	69
Headache	17	8.6
Dizziness	15	7.6
Fainting	14	7.1
Seizure	8	4.1
Visual disorder	2	1
The data are expressed as numbers (percentages), n: Number		

Table 3. Glasgow Coma Scale (GCS) data		
GCS	n=197	%
15	136	69
13-14	37	18.8
9-12	15	7.6
3-8	9	4.6
The data are expressed as numbers (percentages), n: Number		

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Table 4. Outcomes of the patients included in the study

		n=197	%
Outcomes	Discharged	80	40.6
	Hospitalization to intensive care unit	24	12.2
	Hospitalization to neurology service	66	33.5
	Referral to outside healthcare service	10	5.1
	Hospitalization to internal diseases service	4	2
	Hospitalization to general surgery service	1	0.5
	Hospitalization to neurosurgery service	6	3
	Hospitalization to oncology service	3	1.5
	Hospitalization to infectious diseases service	2	1
	Hospitalization to chest diseases service	1	0.5
The data are expressed as numbers (percentages), n: Number			

after bringing to the emergency department; however, it is not sensitive to the hemorrhages occurring before (7).

Although there are CT devices in many hospitals, not many sufficient radiologistsare found to interpret CT images. Moreover, there is not an interpretation system yet, rather than the physicians' interpretations in the evaluation of CT images (8). Hunter et al. (8) stated that CT images may only be interpreted by the radiologists working in developed medicine institutions and university hospitals, in their studies referring to the radiology support in the emergency departments (8). Torreggiani et al. (9) specified that the radiologist interpretation may not be simultaneously possible and the radiologist interpretation may be only performed 48 hours later, in their studies referring to the investigation of emergency radiology in Canada. Therefore, the emergency department physicians complain about the deficiency in current interpretation system.

The incidence rate of neurological diseases is observed to increase with age. The vascular elasticity decreases and its resistance increases in increasing age, and therefore, the frequency of many diseases such as hypertension, ischemic stroke, and hemorrhagic stroke increases. The patients' ages were found as 18-45 at 11.7%, as 46-55 at 33% and as <66 at 53.3%; when age ranges of the patients were evaluated by the study performed by us. The patients mean ages ± SD were calculated as 64.69±1.13 (min=19 and max=96). The similar results were obtained by the study performed by Ariesen et al. (10) in which they researched the intracranial hemorrhage risk factors of the general population, the study performed by Soriano-Tárraga et al. (11) in which they performed related to the age and stroke, and many studies performed in this respect. Çalışkan et al. (12) determined the mean age of totally 289 patients as 51.8 years (min=18 and max=87), including 142 males and 147 females, who presented to the emergency department of our hospitaldue

to splitting headache reason and whose CT and CTA were taken by the pre-diagnosis of subarachnoid hemorrhage (SAH) and aneurysm.

The cerebro vascular diseases (one-sided strength loss, consciousness change and speech disorder) was determined as an application reason for the emergency department with the highest rate of the patients, who applied to the emergency department of our hospital and were included in the study. A headache, dizziness, fainting, seizure and visual disorder followed up these complaints. Calışkan et al. (12) determined in their study that the patients had the complaints such as such as splitting headache and as well as vomiting, confusion, consciousness change and convulsion.

Al Reesi et al. (13) revealed in their study that the cerebrovascular event (CVE) (22%) and headache (21%) were the most frequent CBT scan indications (excluding trauma). Jamal et al. (14) specified in their study that the CVE (27%), headache (14.5%) and suspicious cases (12%) were the non-traumatic CBT scan indications.

Decreasing the grey-white ore separation is one of the cerebral ischemia indications in unenhanced CT, taken in the first a few hours following starting of the symptoms. This situation reveals itself as a certain decrease in the basal ganglia nuclei or as an intermingling density of the white ore and cortex, taking part under the insula and over the convexities (1). We determined in our study that the emergency physicians successfully diagnosed disruption of the grey-white ore separation, with 88% sensitivity and 96% specificity rates, respectively.

Another finding of the cerebral ischemia is the sulcal extinction. If these findings become rapidly evident, the degree of ischemia becomes splitting, too. However, diagnosis ability of the observers varies while determining these early findings and depends on the dimension of the infarct, severity of the ischemia and

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Table 5. Comparison of the patients' findings determined by the emergency physician and Radiology computerized brain tomography interpretations

		Emergency physician		Radiologist	
		n=197	%	n=197	%
Cerebral infarct*	Yes	61	31.0	77	39.1
	No	136	69.0	120	60.9
Cerebellar infarct*	Yes	1	1.5	5	2.5
	No	196	99.5	192	97.5
Intracranial mass*	Yes	3	1.5	4	2.0
	No	188	95.4	187	94.9
	Edema effect	6	3.0	6	3.0
Intracranial shift existence*	Yes	7	3.6	6	3.0
	No	190	96.4	191	97.0
AV malformation**	Yes	4	2.0	5	2.5
	No	193	98.0	192	97.5
Intraparenchymal hemorrhage*	Yes	10	5.1	10	5.1
	No	179	90.9	178	90.4
	Enlargement in lateral ventricle	6	3.0	7	3.6
	Enlargement in all ventricles	2	1.0	2	1.0
Sinusitis findings**	Yes	10	5.1	28	14.2
	No	187	94.9	169	85.8
Venous sinus pathology**	Yes	0	0	1	0.5
	No	197	100	196	99.5
Hydrocephaly**	Yes	0	0	1	0,5
	No	197	100	196	99.5
Bone pathology*	Yes	3	1.5	4	2.0
	No	194	98.5	193	98.0
Enlargement in sulcus*	Yes	24	12.2	60	30.5
	No	173	87.8	137	69.5
Other findings*	Yes	2	1.0	7	3.6
	No	195	99.0	190	96.4

*: p<0,05= There were no statistically significant differences between the 2 groups
**: p>0,05= Statistically significant compared to the radiolojist group.
AV: Arteriovenous, n: Number

appearance of the indications with imaging (1). We determined in our study that the emergency physicians successfully diagnosed extinction in the sulcus, with 76% sensitivity and 91% specificity rates, respectively.

The emergency physician mostly makes management plan for the patient by interpreting the brain CT images, without waiting for the radiologist interpretation in many emergency departments. Therefore, the accuracy of an interpretation made by the emergency physician is very important. Dolatabadi et al. (15) determined sensitivity and specificity interpretations of the emergency physicians as 86.5% and 81.4%, respectively; and they found thepositive predictive value (PPV) as 6.9%, negative

predictive value (NPV) as 86.9%, positive likelihood ratio (PLR) as 4.6% and negative likelihood ratio (NLR) as 0.16%, in a study performed by them by considering the radiology interpretation as a standard for the patients, who applied to the emergency department and whose brain CT was taken in the diagnosis phase (15). Khan et al. (16) revealed that the emergency department physicians found the sensitivity as 87.14%, the specificity as 12.86% and the kappa value as 0.64% in interpreting the brain CT, in the study performed by them referring to researching the evaluation of unenhanced brain tomography taken in the emergency department. Moreover, Harding et al. (17) specified that the emergency department physicians found the specificity as 98% in interpreting the brain CT, in the study performed by

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Table 6. Competency of the emergency medicine physicians in CBT evaluation					
	Competency of the emergency physicians				
	Specificity	Sensitivity	NPV	PPV	%
Grey-white ore separation	96.0	88.0	99.0	67	88
Extinction in sulcus	91.0	76.0	98.0	69	90
Constriction in ventricle	96.0	89.0	99.0	71	86
Subarachnoidal hemorrhage	97.0	86.0	97.0	92	90
Subdural hematoma	99.0	89.0	100.0	100	87
Cerebral infarct	99.0	97.0	100.0	93	89
Cerebellar infarct	97.0	91.0	100.0	69	84
Intracranial mass	98.0	85.0	99.0	64	74
Intracranial shift existence	94.0	84.0	98.0	73	82
AV malformation	96.0	89.0	100.0	79	94
Intraparenchymal hemorrhage	99.0	98.0	100.0	72	90
Sinusitis findings	99.0	98.0	99.0	75	86
Venous sinus pathology	95.0	91.0	99.0	80	71
Hydrocephaly	99.0	96.0	98.0	95	84
Bone pathology	97.0	84.0	92.0	64	86
Enlargement in sulcus	92.0	75.0	90.0	62	72
Other findings	89.0	92.0	89.0	78	88
CBT: Computerized brain tomography, PPV: positive predictive value, NPV: negative predictive value, AV: Arteriovenous,					

them referring to CT interpretation of the trauma patients having a SAH suspicion. In our study, an excellent harmony was found by diagnosis and brain CT interpretation of the emergency medicine physician. In addition, in our study, the sensitivity and specificity were found as 96% and 88%, respectively in the grey-white ore separation, while the sensitivity was 91% and the specificity was 76% in the ventricle constriction. The mean sensitivity and specificity were found as 99% and 86%, respectively in the SAH, EDH and SDH; while they were 99% and 97% in the cerebral infarct and %97 and %91 in the cerebellar infarct, respectively. Moreover, the main sensitivity and specificity determined to vary between 89%-99% and 75%-98%, respectively in the diseases such as intracranial mass, intracranial shift existence, AV malformation, intraparenchymal hemorrhage, sinusitis findings, venous sinus pathology, hydrocephaly, bone pathology and enlargement in the sulcus.

The kappa value was found to be 0.83 in a study performed by Al Reesi et al. (13) referring to comparing the diagnosis harmony between the emergency physicians and neuroradiologist. In the same study, they revealed that the results arising from the wrong interpretation of CT by the emergency medicine physicians rarely occurred.

It was determined in many studies that there was a diagnostic concordance between the emergency physicians and radiologists at the rate of 60%-94%. While this concordance was determined as 94% in the study performed by Jamal et al. (14), the kappa value was found as 0.78.

Study Limitations

Imaging of the mass and arteriovenous malformations was determined to be constrained due to being less the number of enhanced CBT taken.

Conclusion

In our study, emergency medicine physicians were highly successful in the interpretation. The findings of vital cerebral infarct (p=0.001), cerebellar infarct (p=0.035), intracranial mass (p=0.017), intracranial shift (p=0.027) and intraparenchymal hemorrhage (p=0.021) were in an excellent harmony with the radiology reports. These findings were generally found compatible with the literature. The sensitivity and specificity height constituted CBT evaluation competency of the emergency physician even in the non-vital subjects. Moreover, we thought that participation in the emergency physicians increased their competency in terms of the diagnosis during history, physical examination, follow-up and consultation periods of the patients. The success rates of interpretation of CBT may be increased with practical and theoretical comprehensive training of the emergency medicine physicians.

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In conclusion, In our study, emergency medicine physicians were highly successful in the interpretation of the CBT of patients with non-traumatic neurological incidents and it was in an excellent harmony with the radiologists' interpretations.

Ethics

Ethics Committee Approval: This study was approved by Antalya Training and Research Hospital Clinical Researches Ethics Committee (no: 62/16, date: 18.06.2015).

Informed Consent: It taken by the patients.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: M.A., Concept: M.A., Design: M.Y., M.K., Data Collection or Processing: M.A., M.Y., Analysis or Interpretation: M.K., Literature Search: M.A., M.Y., M.K., Writing: M.K.

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References

1. Stephen JXM, Werring DJ. Stroke: causes and clinical features. Medicine. 2020;48:561-6.

2. Miller CM. Stroke Epidemiology. In: Lapchak P., Yang GY. (eds) Translational Research in Stroke. Translational Medicine Research. Springer, Singapore, 2017 Available at: https://doi.org/10.1007/978-981-10-5804-2_3

3. Thrift AG, Howard G, Cadilhac DA, Howard VJ, Rothwell PM, Thayabaranathan T, et al. Global stroke statistics: An update of mortality data from countries using a broad code of "cerebrovascular diseases. Int J Stroke. 2017;12:796-801.

4. Poorthuis MHF, Algra AM, Algra A, Kappelle LJ, Klijn CJM. Female-and male-specific risk factors for stroke: a systematic review and meta-analysis. JAMA Neurol. 2017;74:75-81.

5. Paterson A, Frush DP. Dose reduction in paediatric MDCT: general principles. Clin Radiol. 2007;62:507-17.

6. Singletary EM, Zideman DA, Bendall JC, Berry DC, Borra V, Carlson JN, et al. 2020 international consensus on first aid science with treatment recommendations. Circulation. 2020;142(suppl1):S284-S334.

7. Li H, Yan L, Li MH, Li YD, Tan HQ, Gu BX, et al. Evaluation of intracranial aneurysms with high-resolution MR angiography using single-artery highlighting technique: correlation with digital subtraction angiography. Radiol Med. 2013;118:1379-87.

8. Hunter TB, Krupinski EA, Hunt KR, Erly WK. Emergency department coverage by academic departments of radiology. Acad Radiol. 2000;7:165-70.

9. Torreggiani WC, Nicolaou S, Lyburn I, Harrsi A, Buckley AR. Emergency radiology in Canada: a national survey. Can Assoc Radiol J. 2002;53:160-7.

10. Ariesen MJ, Claus SP, Rinkel GJE, Algra A. Risk factors for intracerebral hemorrhage in the general population: a systematic review. Stroke. 2003;34:2060-5.

11. Soriano-Tárraga C, Giralt-Steinhauer E, Mola-Caminal M, Ois A, Rodríguez-Campello A, Cuadrado-Godia E, et al. Biological age is a predictor of mortality in ischemic stroke. Nature. 2018;8:1-8.

12. Çalışkan, Emine, Dilek Öncel. Şiddetli baş ağrısı nedeniyle başvuran hastalarda kranial BT anjiyografide anevrizma ve subaraknoid kanama saptanma oranı [Article in Turkish]. Tepecik Eğit Hast Derg. 2015;25:101-5.

13. Al-Reesi A, Stiell IG, Al-Zadjali N, Cwinn AA. Comparison of CT head interpretation between emergency physicians and neuroradiologists. Eur J Emerg Med. 2010;17:280-2.

14. Jamal K, Mandel L, Jamal L, Gilani S. 'Out of hours' adult CT head interpretation by senior emergency department staff following an intensive teaching session: a prospective blinded pilot study of 405 patients. Emerg Med J. 2014;31:467-70.

15. Dolatabadi AA, Baratloo A, Rouhipour A, Abdalvand A, Hatamabadi H, Forouzanfar M, et al. Interpretation of computed tomography of the head: emergency physicians versus radiologists. Trauma Mon. 2013;18:86-9.

16. Khan A, Qashqari S, Al-Ali AA. Accuracy of non-contrast CT brain interpretation by emergency physicians: a cohort study. Pak J Med Sci. 2013;29:549-53.

17. Harding J, Craig M, Jakeman N, Young R, Jabarin C, Kendall J. Emergency physician interpretation of head CT in trauma and suspected subarachnoid haemorrhage-is it viable? An audit of current practice. Emerg Med J. 2010;27:116-20.