RESEARCH ARTICLE

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Local Anesthetic Systemic Toxicity Knowledge of Emergency Medicine Residents: A Cross-Sectional Study

ABSTRACT

Objective: Local anesthetics (LAs) are starting to be used after the discovery of cocaine, which is used in medical practice. Now LAs are used many procedures in many clinics, especially in emergency departments (EDs). The extensive use of LAs was brought side effects and toxicity. Local anesthetic systemic toxicity (LAST) have been reported from simple allergic conditions to cardiovascular and neurological complications that can be fatal. The study aims to evaluate the level of knowledge and awareness of LAST among emergency medicine residents (EMRs).

Methods: This was a questionnaire-based cross-sectional study. The questionnaires were sent to EMRs via e-mail, and responses were collected. The participants who gave informed consent included in the study, and who didn't use LAs in their daily practice were excluded. All of the participants responded all of the questions and responses were analyzed.

Results: 92 EMRs were included in the study. The median age of the participants was 29 (24-50) years, and 48.9% were women. In the research, no one could recognize all LAST symptoms, ranging from mild to severe. Only 16.3% of the participants answered all treatment options of the LAST correctly, and 27.2% knew the intravenous lipid emulsion dosage accurately.

Conclusions: The level of knowledge and awareness of the EMRs on LAST were insufficient. EMRs training rates on LAs and LAST were found to be low. In addition, it was stated that the patient's informed consent was not appropriately obtained from the vast majority of patients undergoing LA procedure. As the first study on LAST among EMRs, we believe that necessary arrangements should be made regarding the detected deficiencies.

Keywords: Local Anesthetics, Local Anesthetic Systemic Toxicity, Emergency Medicine Residents, Intravenous Lipid Emulsion

Acil Tıp Asistanlarının Lokal Anestetik Sistemik Toksisitesine İlişkin Bilgi Düzeyleri: Kesitsel Bir Çalışma

ÖZET

Amaç: Lokal anestetikler (LA) kokainin keşfiyle birlikte, özellikle acil servisler olmak üzere birçok klinik tarafından, birçok prosedürde kullanılmaktadır. LA' in yaygın kullanımı, beraberinde yan etki ve toksisite vakalarını da getirmiştir. Lokal anestetik sistemik toksisitesi (LAST) basit alerjik durumlardan ölümcül olabilecek kardiyak ve nörolojik komplikasyonlara kadar geniş bir yelpazede bildirilmiştir. Literatürde acil tıp asistanları (ATA)' nın LAST konusunda bilgi ve farkındalıklarını ortaya koyan çalışma bulunmamaktadır. Bu çalışmada ATA' nın LAST bilgi ve farkındalık düzeylerinin değerlendirilmesi amaçlanmıştır.

Gereç ve Yöntem: Bu çalışma anket tabanlı kesitsel bir çalışmadır. Anket formları e-mail yoluyla ATA' na gönderildi ve cevapları kayıt edildi. Aydınlatılmış onam veren ATA çalışmaya dahil edildi ve günlük pratiğinde LA kullanmayan ATA çalışmadan dışlandı. Tüm katılımcılar, bütün sorulara yanıt verdiler ve yanıtların analizleri yapıldı.

Bulgular: 92 ATA çalışmaya katıldı. Katılımcıların yaş ortancası 29 (24-50) ve %48,9 u kadındı. Çalışmamızda, hafiften ağıra doğru sıralanmış LAST semptomlarının tamamına ATA' nın hiçbiri doğru yanıt veremedi. Katılımcıların sadece %16,3 ü tüm LAST tedavi seçeneklerini ve %27,2 si intravenöz lipid emülsiyonu dozunu doğru olarak cevapladılar.

Sonuç: ATA' nın LAST konusunda bilgi ve farkındalık düzeyleri yetersizdir. LA ve LAST konusunda ATA' nın eğitimleri düşüktür. Ayrıca, LA kullanılan prosedürlerin çoğunda uygun aydınlatılmış onam alınmamaktadır. ATA arasında yapılan ilk çalışma olması nedeniyle, tespit edilen eksikliklere yönelik gerekli düzenlemelerin yapılacağına inanıyoruz.

Anahtar Kelimeler: Lokal Anestetikler, Lokal Anestetik Sistemik Toksisitesi, Acil Tıp Asistanları, İntravenöz Lipid Emülsiyonu

INTRODUCTION

Local anesthetics (LAs), which appeared from the beginning of the 20th century with the use of cocaine as an analgesic during surgical procedures, are continuing to be used commonly with intravenous and topical forms in peripheral blocks, spinal and epidural anesthesia, regional anesthesia, postoperative pain control, minor and major surgical procedures (1-3). This process, which started with the discovery of cocaine, brought addiction, other side effects, and risk of mortality (4, 5). Over time, new LAs such as lidocaine, mepivacaine, prilocaine, and bupivacaine have been developed for reducing the side effect potentials. However, there is not enough awareness about the side effects and toxicity of LAs, which are commonly used by non-anesthetists clinicians (emergency medicine physicians, surgeons, dentists, estheticians, dermatologists, etc.) in minor procedures (6). Although current guidelines contain recommendations to prevent local anesthetic systemic toxicity (LAST), it is unfortunately still seen as a frequently encountered clinical entity that is difficult to diagnose (3). The reported incidence of LAST ranges from 1/500 to 1/10.000 and the potential reasons for this wide range are the lack of standard definition, lack of reporting, and diagnostic failures due to a broad spectrum of LAST findings (3).

LAs complications have been reported in a wide range from simple allergic conditions to cardiovascular and neurological complications that can be fatal (3, 7). There are also cases that have been successfully treated following the recommendations of the clinical guidelines (8-10). Protocols for ensuring airway safety, assessment of circulation, and intravenous lipid emulsion (ILE) treatment are included in LAST treatment (3, 7). ILE treatment has taken place in laboratory studies and international guidelines (3, 7, 11, 12).

LAs are widely used in emergency departments (EDs), from minor surgical procedures to peripheral blocks. However, to the best of our knowledge, there is no study in the literature evaluating LAST knowledge and awareness of emergency medicine residents (EMRs). Consequently, in this study, we aimed to evaluate the LAST knowledge and awareness of residents working in the ED.

MATERIAL AND METHODS

Study Design: In this study, the internet-based assessment survey was used. After obtaining approval of the local ethics committee (2019/453), EMRs working in the ED of our country between November 1, 2019, and May 1, 2020, and giving informed consent for the study were included. EMRs who did not use LAs in their daily practice were excluded from the study. The questions in the questionnaire were prepared based on similar studies of the literature and our past experiences. The survey collected participants' demographic informations, LA usage practices, knowledge levels in diagnosis, and LAST treatment. In order to evaluate the scope and clarity of the survey, it was piloted with 20 EMRs beforehand. These participants were excluded from the study not to affect the results.

Data Collection: The questionnaire forms were sent to 250 EMRs via e-mail and asked to answer all questions. 120 EMRs that provided informed consent and answered all questions were included in the study. 28 EMRs were excluded from the study because they did not use LAs in their daily practice. The responses of a total of 92 EMRs were recorded and analyzed. The flow diagram of the study is demonstrated in Figure 1.

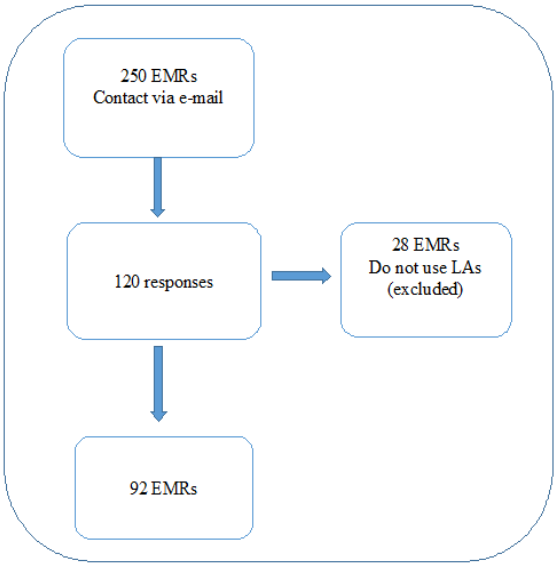

Figure 1. Flow diagram of the study. EMRs: Emergency medicine residents, LAs: Local anesthetics

Data Analysis: Descriptive statistics were summarized in numbers and percentages. Numerical variables were presented with median (min-max). Kolmogorov-Smirnov test was used to evaluate the distribution of numerical data. Pearson's chi-square test was used for categorical variables. IBM SPSS for Windows version 21 was used for statistical analyses. The statistical significance was accepted as $p < 0.05$.

RESULTS

92 EMRs participated in the study and answered all questions. The median age of the EMRs was 29 (24-50), and 48.9% were women. Demographic information, years of professional experience, and LAs usage practices of the participants are demonstrated in Table 1. In the research, no one could recognize all LAST symptoms, ranging from mild to severe. Only 16.3% of the participants answered all treatment options of the LAST correctly, and 27.2% knew the proper dose of the ILE. The percentages of

participants' responses to questions about LAST symptoms and treatment options are indicated in Table 2.

Table 1. Demographic data and local anesthetic use of the participants

Female, %	48.9
Age (years), median (min-max)	29 (24-50)
Total working time in ED (years), median (min-max)	3 (1-22)
Total working time as a resident (years), median (min-max)	2 (1-4)
Institution type, %	
Training and Research hospital	35.9
University hospital	62.0
Private hospital	2.2
Use of local anesthetics, %	
Lidocaine	66.3
Prilocaine	91.3
Bupivacaine	5.4
Lidocaine + Prilocaine	52.2
Lidocaine + Prilocaine + Bupivacaine	5.4
Alone	85.9
With adrenaline	32.6
Alone and with adrenaline	18.5
Administration route of LAs, %	
Intravenous	6.5
Subcutaneous	90.2
Intramuscular	15.2
Topical	44.6
Intranasal	2.2
Intraarticular	4.3
Procedure type of LAs usage, %	
Minor procedure	97.8
Regional block	34.8
Frequency of LAs usage, %	
Every day	39.1
≥2/week	27.2
1/week	25.0
1/month	8.7
Interventions to prevent toxicity, %	
Ultrasound guided	6.5
Negative aspiration	70.7
Test dose	13.0
Incremental injection	30.4
With adrenaline	8.7
Nothing	17.4

ED: Emergency department

No significant correlation was found between identifying all of the LAST treatment options and the proper dose of ILE, and the type of institution, frequency of use of LAs, and training about LAs. However, when we look at the answers of those who stated that they knew LAST treatment or who had encountered LAST before, there is a significant correlation between this group and correct response to ILE dosage properly.

But there is no correlation between this group and knowing LAST treatment options. In other words, accurate answers to ILE dosage were found to be significantly higher among those who thought they knew LAST treatment or who had encountered LAST before. The relationship between correctly responding to the LAST treatment options and the appropriate dose of ILE and the type of institution, frequency of use of LAs, training on LAs, state of believing to know LAST treatment, and state of encounter with LAST in the past is shown in Table 3. While 20.7% of the participants stated that they encountered before, the rate of those who stated that they knew LAST treatment and that they could treat LAST was 44.6% and 76.1%, respectively.

Table 2. Responses to symptoms and treatment of LAST

Symptoms of LAST (%)	
Allergy/Anaphylaxis	83.7
Metalic taste	42.4
Circumoral numbness	45.7
Dizziness	47.8
Tinnitus	37.0
Loss of consciousness	66.3
Seizure	62.0
Arrhythmia	81.5
Hypotension	81.5
Cardiovascular collapse	78.3
Recognize all the symptoms of LAST correctly	0.0
Treatment of LAST (%)	
Symptomatic	79.3
Antihistamines	56.5
Methylene blue	31.5
ILE	75.0
Resuscitation	71.7
Identifying all treatment options of LAST correctly	16.3

LAST: Local anesthetic systemic toxicity, ILE: Intravenous lipid emulsion

Regarding the answers given to the questions about LAs, 34.8% of the participants stated that they received training on LAs. 83.7% of the participants reported they did not calculate the dose before the procedure for patients with or without additional comorbidity. The rate of those who stated that they knew max and ml/mg doses of the LAs they used were 35.9% and 42.4%, respectively. Also, 84.8% of the participants stated that they did not explain the possible risks and receive consent from the patients before the procedure. In questions about ILE, 64.1% of the participants stated that ILE could be used in the LAST cases. However, 57.6% of the participants indicated that they had ILE in their departments, the rest reported that they did not have ILE in their departments or had no idea about it. Answers to questions about ILE are shown in Table 4.

Table 3. The relationship between correct answers and type of hospital, frequency of LAs usage, educational status, and LAST experience

	LAST treatment		ILE dose	
	C	p	C	p
Instution type, n (%)				
Training and Research	6 (18.2)	0.374	10 (30.3)	0.628
University	8 (14.0)		15 (26.3)	
Private	1 (50.0)		0 (0.0)	
Frequency of LAs use, n (%)				
Everyday	4 (11.1)	0.700	12 (33.3)	0.758
2/w	5 (20.0)		6 (24.0)	
1/w	4 (17.4)		5 (21.7)	
1/m	2(25.0)		2 (25.0)	
Education on LAs, n (%)				
Yes	4 (12.5)	0.748	13 (40.6)	0.106
No	7 (17.5)		8 (20.0)	
Don't remember	4 (20.0)		4 (20.0)	
Do you know the treatment of LAST?				
Yes	9 (22.0)	0.189	17 (41.5)	**0.006**
No	6 (11.8)		8 (15.7)	
Have you ever encounter LAST?				
Yes	2 (10.5)	0.519	12 (63.2)	**<0.001**
No	13 (18.6)		13 (18.6)	

LAs: Local anesthetics, LAST: Local anesthetic systemic toxicity, ILE: Intravenous lipid emulsion, C: Correct, the values considered statistically significant were shown in bold font (p <0.05).

Table 4. Responses to ILE treatment

Have you heard of ILE treatment? (%)	
Never heard of it	9.8
I have heard of it but I can't recall	26.1
I have read a scientific paper on it	23.9
I know when and how it is used	40.2
ILE treatment dose (%)	
1.5 ml/kg IV bolus, 0.25 ml/kg/min IV infusion	27.2
Have you ever used ILE? (%)	
No	64.1
Yes, I have used to treat LAST	18.5
Yes, I have used to treat another toxicity except LAST	26.1
Yes, I have used to treat both LAST and another toxicity	8.7

ILE: Intravenous lipid emulsion, LAST: Local anesthetic systemic toxicity

DISCUSSION

LAs are widely used in emergency medicine practice. Early diagnosis and treatment of possible toxicity findings of a group of drugs that are used so frequently and whose toxicity can cause mortality and severe morbidity is essential. In our study, we found that EMRs' knowledge and awareness on LAST was low.

None of the EMRs were recognized all of the symptoms related to the LAST. 16.3% of the participants identified all of the treatment options of LAST. In the study conducted by Karasu et al. among 102 residents, 15.8% of them were EMRs, LAST knowledge levels were found to be low, similar to our study (2). While the proportion of people using LAs "every day" was 44.4% in their study, it was found to be 39.1% in our study

When the answers to the questions about LAST symptoms were evaluated, questions about severe LAST findings such as arrhythmia, hypotension, cardiovascular collapse, seizure, and allergy/anaphylaxis were answered at high rates. Still, mild findings of LAST such as metallic taste, paresthesia around the mouth, and tinnitus were responded to less accurately (13). This situation constitutes a serious obstacle to the early diagnosis and treatment of LAST.

Comparing to the study by Urfalıoğlu et al. which conducted among ophthalmologists, EMRs tend to prefer ILE more frequently as a treatment option, and the answers are similar in other treatment options (13). It can be argued that this difference is based on the fact that ILE is an agent that can be used in different toxicity situations and that toxicology cases constitute an essential place in emergency medicine practice. However, when both LAST symptoms and responses to treatment options were evaluated in general, low rates of correct answers were obtained. Also, in the study conducted by Karasu et al., 19.8% of the participants stated that they received training on LAs, which was found to be 34.8% in our study (2). Undoubtedly, this rate is not enough. In this case, it is necessary to review the content and quality of the institutional and national emergency medicine education syllabus. 27.2% of the participants responded correctly to the appropriate treatment dose of ILE recommended by international guidelines. When the results of our study are evaluated in general, we can assume that EMRs have serious information deficiencies in the diagnosis and treatment of LAST.

No significant correlation was found between knowing all of the LAST treatment options and ILE dosage correctly and the type of institution, frequency of use of LAs, and training about LAs. In

this case, it can be said that LAST knowledge levels are not affected by the institution, the frequency of use of LAs, and previous training about LAs. However, EMRs who had encountered LAST cases or thought that they knew LAST treatment responded significantly higher to the ILE treatment dose. In this case, it can be said that the LAST experience contributed to the level of knowledge of the ILE treatment, rather than the institution and the training. It is also necessary to underline the importance of practice in emergency medicine residency training.

In terms of toxicity prevention measures, 70.7% of the EMRs preferred negative aspiration, while this rate was 6.1% in the study of Urfalıoğlu et al. (13). Negative aspiration can be applied quickly at the bedside, which may be the main reason for preference. Besides, although negative aspiration is recommended by international guidelines to prevent LAST, it can be said that the compliance of EMRs is not complete, or they were not given sufficient importance on that matter (7).

In our study, 20.7% of the participants stated that they had encountered LAST before, and 44.6% of them stated they knew about the LAST treatment. The rate of those who stated that they could manage LAST was 76.1%. It can be said that EMRs have high self-confidence in LAST because of the high rate of participants who think they can manage LAST despite their low level of knowledge and experience about LAST. Our study found that most of EMRs did not calculate the max and mg/ml doses of LAs they used before the procedure. In addition, the rate of EMRs who stated that they did not know the max and mg/ml doses of LAs they used were higher than the result of the study of Öksüz et al. conducted among dentists (14). The fact that the emergency medicine clinics are better equipped than dental clinics, and the EMRs have high self-confidence may be the reason why they act less cautiously in procedures using LAs. In conclusion, when we compare our results with the results of Öksüz et al.'s study, it can be said that dentists encounter less LAST and have more information about the LAs compared to EMRs (14).

Also, 84.8% of the participants stated that they did not receive informed consent by discussing the risks with the patients before the procedure. This situation undoubtedly carries the risk of causing some medico-legal conditions. In a study by Gaeta et al., it was found that EMRs did not receive formal training on informed consent (15). In this case, we can say that EMRs working in our country were suffering from the same problem.

While 67.4% of the participants stated that they did not have an idea about ILE treatment in the study conducted by Karasu et al., assessment of the questions about ILE showed that this rate was 9.8% in our study (2). Also, in our study, 64.1% of the participants stated that ILE therapy could be used in the treatment of LAST, while 40.2% reported that they know when and how to use it. It is obvious that EMRs have insufficient knowledge about ILE dosage as well as their awareness about ILE is not at the desired level. The knowledge and awareness of the diagnosis and treatment options of the toxicity of such frequently used agents in daily practice should be high.

LIMITATIONS

The first limitation of our study is that it was a questionnaire study, and participation was voluntary. We reached many EMRs, but some did not agree to participate. Since no questions were measuring LAs knowledge levels in the questionnaire, no comments could be made about the knowledge levels of EMRs about LAs. The limited number of studies in the literature related to LAST knowledge and awareness level may have caused limitations in evaluating the data. There is also a need for larger studies on this subject.

CONCLUSIONS

The knowledge and awareness of the EMRs about LAST were low and, unfortunately, insufficient. EMRs training rates on LAs and LAST were found to be low. In addition, informed consent was not obtained properly by EMRs from the vast majority of patients undergoing LA procedure. Due to being the first study on LAST among EMRs, we believe that necessary regulations should be made regarding the deficiencies detected. There is a need for national and international multi-centered studies on this subject.

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