Original Article

DOI: 10.14235/bas.galenos.2025.70457
Bezmialem Science

Impact of Online Education on LAST Knowledge in Anesthesiology and Intensive Care Specialists

Anesteziyoloji ve Yoğun Bakım Uzmanlarında LAST Bilgisi Üzerine Çevrim İçi Eğitimin Etkisi

Ayşe Gül KOÇOĞLU KINAL[1], Yunus Emre AYHAN[2]

[1]University of Health Sciences Türkiye, Dr. Siyami Ersek Thoracic and Cardiovascular Surgery Training and Research Hospital, Department of Intensive Care, İstanbul, Türkiye
[2]University of Health Sciences Türkiye, Prof. Dr. Cemil Taşcıoğlu City Hospital, Department of Clinical Pharmacy, İstanbul, Türkiye

ABSTRACT

Objective: Local anesthetic systemic toxicity (LAST) is a rare but potentially life-threatening complication of local anesthetic use. Despite its clinical importance, medical specialists often have limited knowledge on this topic, and structured training is rarely implemented. This study aimed to evaluate the effectiveness of a brief, structured online educational module in improving knowledge of LAST among anesthesiology and intensive care specialists.

Methods: This cross-sectional pre-post study included anesthesiology and intensive care specialists in İstanbul. Participants completed a 15-item multiple-choice knowledge test before and after a short educational intervention. The educational content, adapted from UpToDate®, was presented as a two-page plain-text document designed for 3-4 minutes of reading. Wilcoxon signed-rank tests were used to compare pre- and post-intervention scores, and multiple linear regression was performed to identify predictors of baseline knowledge.

Results: A total of 200 participants completed both assessments. The mean knowledge score increased significantly from 11.7±1.7 to 12.8±1.2 after the intervention ($p<0.001$). Improvements were most notable in knowledge of risk factors, prevention, and lipid emulsion therapy. Regression analysis indicated that older age and prior LAST training were negatively associated with baseline knowledge, while anesthesiology specialization was a positive predictor.

ÖZ

Amaç: Lokal anestezik sistemik toksisitesi (LAST), lokal anestezik kullanımına bağlı nadir ancak potansiyel olarak ölümcül bir komplikasyondur. Klinik önemine rağmen tıp uzmanlarının bu konudaki bilgi düzeyinin sınırlı olduğu ve yapılandırılmış eğitimlerin yaygın olmadığı bilinmektedir. Bu çalışmada, anesteziyoloji ve yoğun bakım uzmanlarının LAST konusundaki bilgi düzeyini artırmak amacıyla hazırlanan kısa ve yapılandırılmış bir çevrim içi eğitim modülünün etkinliğinin değerlendirilmesi amaçlanmıştır.

Yöntemler: Bu kesitsel öncesi-sonrası tasarıma sahip anket çalışmasına, İstanbul'da görev yapan anesteziyoloji ve yoğun bakım uzmanları dahil edilmiştir. Katılımcılara, eğitim öncesi ve sonrası 15 soruluk çoktan seçmeli bilgi testi uygulanmıştır. Eğitim içeriği, UpToDate® kaynaklarından derlenmiş olup, sade metin formatında ve 3-4 dakikalık okuma süresiyle tasarlanmış iki sayfalık bir doküman olarak sunulmuştur. Eğitim öncesi ve sonrası bilgi puanları Wilcoxon işaretli sıralar testi ile karşılaştırılmış; başlangıç bilgi düzeyini etkileyen faktörler çoklu doğrusal regresyon analizi ile değerlendirilmiştir.

Bulgular: Toplam 200 katılımcı her iki değerlendirmeyi tamamlamıştır. Eğitim sonrası ortalama bilgi puanı anlamlı şekilde artmıştır (öncesi: 11,7±1,7; sonrası: 12,8±1,2; $p<0,001$). En fazla artış risk faktörleri, korunma stratejileri ve lipid emülsiyon tedavisine yönelik sorularda görülmüştür. Regresyon analizinde, ileri yaş ve daha önce LAST eğitimi almış olmak başlangıç bilgi düzeyiyle negatif ilişki gösterirken, anesteziyoloji uzmanlığı pozitif belirleyici olarak bulunmuştur.

Address for Correspondence: Yunus Emre Ayhan MD, University of Health Sciences Türkiye, Prof. Dr. Cemil Taşcıoğlu City Hospital, Department of Clinical Pharmacy, İstanbul, Türkiye
E-mail: eczyunusemreayhan@gmail.com
ORCID IDs of the authors: A.G.K.K.: 0000-0002-6905-9532, Y.E.A.: 0000-0001-6093-0849

Cite this article as: Koçoğlu Kınal AG, Ayhan YE. Impact of online education on LAST knowledge in anesthesiology and intensive care specialists. Bezmialem Science. [Epub Ahead of Print]

Received: 08.05.2025
Accepted: 06.11.2025
Epub: 25.03.2026

ABSTRACT

Conclusion: A brief, focused online module significantly improved LAST-related knowledge among anesthesiology and intensive care specialists. These results emphasize the value of targeted education in enhancing preparedness for rare but critical complications in clinical practice.

Keywords: Local anesthetic systemic toxicity, anesthesiology, intensive care, online education, knowledge level

ÖZ

Sonuç: Kısa ve hedefe yönelik çevrim içi eğitim modülü, anesteziyoloji ve yoğun bakım uzmanlarının LAST konusundaki bilgi düzeyini anlamlı şekilde artırmıştır. Bu sonuçlar, nadir ancak kritik toksik komplikasyonlara hazırlık açısından yapılandırılmış eğitimlerin önemini ortaya koymaktadır.

Anahtar Kelimeler: Lokal anestezik sistemik toksisite, anesteziyoloji, yoğun bakım, çevrim içi eğitim, bilgi düzeyi

Introduction

Local anesthetics (LAs) are widely used by anesthesiologists, surgeons, emergency physicians, dentists, and other medical specialists in routine clinical practice (1). Despite their frequent use, awareness of LA systemic toxicity (LAST)—a rare but potentially life-threatening complication—remains limited (2-4). LAST can involve both the central nervous and cardiovascular systems and may occur with any type or route of LA administration (5,6).

Although the general safety of LAs is well-established, systemic toxicity remains a risk, especially with high doses, intravascular injection, or patient-specific factors (7). Preventive strategies such as ultrasound-guided administration have reduced the incidence of LAST, while therapeutic advances like lipid emulsion (LE) therapy have improved outcomes after toxicity occurs (4,7,8). Early recognition is essential, but previous studies have highlighted inadequate provider awareness, pointing to a need for improved education on prevention and management (2,4,9).

As clinicians directly responsible for administering LAs, anesthesiologists and intensive care specialists play a pivotal role in identifying and managing LAST. However, studies assessing their specific knowledge are scarce (4,10). In Türkiye, a prior study evaluated physicians' knowledge of LAST and LE therapy, mainly among LA users, highlighting important knowledge gaps (11). In one study, anesthesiology trainees demonstrated good understanding of symptoms, risk factors, LE therapy, and treatment protocols, though educational gaps still existed (4). In contrast, other research showed that physicians in non-anesthesiology specialties were often unaware of guideline-based treatment and LE use (2,12,13). These findings indicate a widespread necessity for structured education on LAST.

The primary aim of this study was to evaluate the effect of a brief, structured online educational module on the knowledge levels of anesthesiology and intensive care specialists regarding LAST. To our knowledge, this is among the few studies assessing such an intervention among experienced clinicians. The results are intended to support targeted educational strategies and contribute to safer clinical practices.

Methods

Study Design and Participants

This was a cross-sectional pre-post intervention study conducted via an online survey among anesthesiology and intensive care specialists working in İstanbul. The survey was distributed between February 14 and 22, 2025, via digital messaging platforms. The STROBE checklist was used to ensure reporting quality (14).

Ethics Approval and Consent to Participate

The study received ethical approval from the Non-Interventional Clinical Research Ethics Committee of İstanbul Medipol University (decision no: 170, date: 06.02.2025) and written informed consent was obtained from all participants. All procedures adhered to the ethical standards and the principles of the 1964 Helsinki Declaration and its later amendments.

Study Procedure

The study was implemented using a single Google Forms link containing three sequential phases:

Pre-education Survey: A 15-item multiple-choice test evaluating participants' baseline knowledge of LAST.

Educational Material: A concise, two-page plain-text summary adapted from the UpToDate® resource titled Local Anesthetic Systemic Toxicity (accessed January 8, 2025). The educational material and the full knowledge questionnaire were provided as Supplementary Files 1 and 2, respectively. It covered key topics such as pathophysiology, clinical signs, risk factors, prevention, management, and LE therapy. Designed for 3-4 minutes of reading, the content directly aligned with the test items.

Post-education Survey: The same 15-item test was repeated to assess knowledge improvement.

Questionnaire Development

The questionnaire was based on an extensive literature review and UpToDate® content (1-3,6-8,15,16). A clinical pharmacist and an intensive care specialist reviewed items for relevance and clarity. English-Turkish back-translation ensured linguistic accuracy.

A pilot test-retest with 20 physicians not included in the main study was conducted to evaluate internal consistency and inter-rater agreement. The internal consistency of the questionnaire, assessed using Cronbach's alpha, was calculated as 0.67. Although this value is considered borderline, it may be explained by the multidimensional nature of the questionnaire, which encompasses diverse domains of LAST. Two independent raters scored the same set of responses, and the item-level agreement showed moderate concordance (Cohen's kappa=0.588). A detailed contingency table is provided in Supplementary File 3.

The survey had two sections:

Sociodemographic data (10 items)

Knowledge and self-evaluation on LAST management (5 items)

Knowledge test (15 items) divided into seven domains:

LAST mechanism (Q1,2)

Pathophysiology (Q3,4)

Epidemiology (Q5,6)

Risk factors and prevention (Q7,8)

Clinical features (Q9,10)

Management (Q11,12)

LE therapy (Q13-15)

Each correct answer was scored as 1 point; total scores ranged from 0 to 15. Scores were categorized as low (0-5), moderate (6-10), and high (11-15).

Inclusion and Exclusion Criteria

Inclusion criteria were active employment as an anesthesiology or intensive care specialist in İstanbul and voluntary participation. Incomplete or duplicate responses were excluded.

Sample Size

Based on the estimated number of anesthesiology and intensive care specialists in İstanbul (approximately 1,000), the required sample size for a 95% confidence level and a 6% margin of error was calculated as 260. Although only 200 participants completed both the pre- and post-intervention questionnaires, this sample size was considered sufficient for within-subject statistical comparisons. A post-hoc power analysis confirmed that the study retained high statistical power (1-β=0.999) for paired t-tests.

Statistical Analysis

Categorical variables were reported as frequencies and percentages; continuous variables were expressed as mean ± standard deviation or median [interquartile range (IQR)]. Continuous variables were evaluated for normality using the Kolmogorov-Smirnov test and visual methods (histograms and Q-Q plots). Mann-Whitney U and Kruskal-Wallis H tests were used to compare baseline knowledge scores across participant subgroups (e.g., specialty, gender, years of experience). The Wilcoxon signed-rank test was used to compare participants' self-assessed knowledge scores and objective knowledge test scores before and after the educational intervention. Post-hoc power analysis confirmed that the study had adequate power (1-β=0.999) for within-subject comparisons based on paired t-tests, despite the response rate not reaching the initially projected level. Cronbach's alpha and intraclass correlation coefficient tested internal consistency and reliability. Multiple linear regression identified predictors of baseline knowledge scores using age, gender, specialty, workplace, years of experience, and prior LAST training. A stepwise method was used. Regression results included coefficients, 95% confidence interval (CI), p-values, and R^2 values. A p-value <0.05 was considered statistically significant. Analyses were performed using SPSS v29.0 (IBM Corp., Armonk, NY, USA).

Results

Participant Characteristics

Out of 622 invited physicians, 200 completed both pre- and post-intervention surveys (response rate: 32.1%). The median participant age was 42 years (IQR: 38-47), and 49% were male. Most participants specialized in intensive care (63.5%) and worked primarily in intensive care units (71.5%). More than half (55.5%) had 6-15 years of clinical experience. A total of 53.5% reported that their institutions lacked a formal LAST protocol, while 19% were unsure of whether such a protocol existed.

According to Table 1, 42.5% of participants reported using LAs daily. A total of 51% had never encountered a case of LAST in their clinical practice. Additionally, 47% had never received formal training on the topic. The primary sources of LAST-related knowledge were medical education (38%), academic articles or books (34.5%), clinical experience (14.6%), and in-service training or seminars (12.7%).

Self-assessed Knowledge

Participants' self-ratings of their knowledge are shown in Table 2. The majority of participants rated their knowledge of clinical symptoms as good (38%) or moderate (31%), while 13% considered their knowledge to be very good. For LAST procedures, 28% selected "good" and 11% "very good" for their knowledge of clinical symptoms. Regarding LE therapy, 31% rated their knowledge as good and 11% as very good.

Effect of Educational Intervention

Following the intervention, participants showed significant improvements in several areas (Table 3). Notably, understanding that intramuscular injection does

Table 1. Demographic and professional experience regarding local anesthetic systemic toxicity

Variables	Total (n=200)	Total score (pre-education), median (IQR)	Total score (post-education), median (IQR)	p
Age, median (IQR)	42 (38-47)	-	-	-
Gender, n (%)				
Male	98 (49)	13 (11-13)	13 (12-14)	0.185
Female	102 (51)	12 (10-13)	13 (12-14)	
Clinical expertise, n (%)				
Intensive care medicine	127 (63.5)	12 (10-13)	13 (12-14)	0.012
Anesthesiology	73 (36.5)	12 (11-13)	13 (13-14)	
Department, n (%)				
Intensive care unit	143 (71.5)	12 (10-13)	13 (12-14)	0.064
Operating room	57 (28.5)	12 (11-13)	13 (12-14)	
Total professional experience in the specialty (years), n (%)				
0-5 years	62 (31)	12 (11-13)	13 (12-14)	0.748
6-10 years	72 (36)	12 (11-13)	13 (12-14)	
11-15 years	34 (17)	12 (10-13)	13 (12-14)	
≥16 years	32 (16)	12 (11-13)	13 (12-14)	
Is there a protocol in your institution for the management of LAST?, n (%)				
Yes	55 (27.5)	12 (11-13)	13 (12-14)	0.011
No	107 (53.5)	12 (10-13)	13 (12-14)	
I am not sure	38 (19)	12 (10-13)	13 (12-14)	
How often do you use local anesthetics?, n (%)				
Daily	85 (42.5)	12 (11-13)	13 (12-14)	
Weekly	62 (31)	11 (10-13)	13 (12-14)	0.105
Monthly	9 (4.5)	12 (10-13)	13 (12-14)	
Rarely	44 (22)	12 (11-13)	13 (12-14)	
How often do you encounter LAST cases?, n (%)				
I have never encountered	102 (51)	12 (11-13)	13 (12-14)	0.176
Rarely (1-2 times per year)	0 (0)	-	-	
Frequently (once a month or more)	98 (49)	12 (11-13)	13 (12-14)	
Have you ever received education on LAST management?, n (%)				
Yes	106 (53)	12 (11-13)	13 (12-14)	0.070
No	94 (47)	12 (11-13)	13 (12-14)	
What is your source of information regarding LAST management?, n (%)				
Academic articles or books	130 (34.5)	-	-	-
Learning during medical education	143 (38)			
Through experience	55 (14.6)			
In-service training or seminars	48 (12.7)			

IQR: Interquartile range, LAST: Local anesthetic systemic toxicity

Table 2. Self-assessment of knowledge and competence in the management of local anesthetic systemic toxicity among participants

Competency area	1 (I don't know at all)	2 (I know a little)	3 (Moderate)	4 (Good)	5 (Very good)
LAST procedures, n (%)	16 (8)	33 (16.5)	73 (36.5)	56 (28)	22 (11)
LAST clinical symptoms, n (%)	6 (3)	30 (15)	62 (31)	76 (38)	26 (13)
Lipid emulsion therapy in LAST, n (%)	15 (7.5)	36 (18)	65 (32.5)	62 (31)	22 (11)
Cardiovascular support in LAST, n (%)	10 (5)	25 (12.5)	65 (32.5)	76 (38)	24 (12)

LAST: Local anesthetic systemic toxicity

Table 3. Assessment of correct response rates for survey questions on local anesthetic systemic toxicity

Questions and answers	Pre-education (n=200) (%)	Post-education (n=200) (%)	p
Q1: What is the primary mechanism of local anesthetic systemic toxicity (LAST)? A: Blocking voltage-gated sodium channels.	130 (65)	124 (62)	0.302
Q2: What causes differences in the cardiotoxicity of local anesthetics? A: Protein binding capacities of drugs, pKa values of local anesthetics, lipophilic properties of local anesthetics.	151 (75.5)	165 (82.5)	0.055
Q3: Which local anesthetic application method carries the highest risk of LAST? A: Intravenous injection.	181 (90.5)	186 (93)	0.234
Q4: In which situation does topical local anesthetic use pose the highest toxicity risk? A: Application to mucosal surfaces.	23 (11.5)	21 (10.5)	0.437
Q5: Which of the following does NOT increase the risk of LAST? A: Intramuscular administration of local anesthetics.	139 (69.5)	193 (96.5)	<0.001
Q6: In which patient group is LAST risk higher? A: Patients with renal failure, pregnant women, elderly individuals.	191 (95.5)	198 (99)	0.031
Q7: Which of the following methods is not recommended for preventing LAST? A: Injection under deep sedation.	182 (91)	193 (96.5)	0.018
Q8: What method is recommended to ensure the safe administration of local anesthetics? A: Slow and gradual injection, aspiration control, use of epinephrine containing solution.	180 (90)	193 (96.5)	0.008
Q9: Which of the following is NOT an early sign of LAST? A: Urinary retention.	178 (89)	183 (91.5)	0.250
Q10: Which of the following is an advanced symptom of LAST? A: Ventricular arrhythmia, hypotension, respiratory depression.	192 (96)	190 (95)	0.405
Q11: What should be the first step in LAST management? A: Oxygen administration and airway protection.	175 (87.5)	190 (95)	0.006
Q12: Which antiarrhythmic drug should be preferred during LAST? A: Amiodarone.	150 (75)	191 (95.5)	<0.001
Q13: What should be the initial dose of lipid emulsion therapy (lipid rescue) for effective treatment in a patient weighing <70 kg? A: 1.5 mL/kg.	142 (71)	196 (98)	<0.001
Q14: Under what conditions should lipid emulsion infusion be discontinued? A: When cardiovascular stability is achieved, When seizures are completely controlled, after the maximum dose (12 mL/kg) is administered.	159 (79.5)	164 (82)	0.306
Q15: What is the primary mechanism of lipid emulsion therapy in LAST management? A: Removing the local anesthetic from toxic areas.	173 (86.5)	183 (91.5)	0.075

A: Answer, Q: Question, LAST: Local anesthetic systemic toxicity

not increase LAST risk improved significantly (Q5, p<0.001). Participants also demonstrated increased awareness of safe practices, including avoiding injection under deep sedation (Q7, p=0.018) and applying slow, incremental injection with aspiration and epinephrine use (Q8, p=0.008). LE-related knowledge also improved: correct identification of the initial LE dose (1.5 mL/kg) for patients <70 kg increased significantly (Q13, p<0.001).

Knowledge Score Changes

As shown in Table 4, the proportion of participants who answered all LE-related questions correctly (Q13-15) increased from 47% to 73.5% post-intervention (p<0.001). The total mean knowledge score improved from 11.7±1.7 to 12.8±1.2 (p<0.001). Before the intervention, 77% of participants were classified as having high knowledge levels, and 23% as moderate. After the intervention, 97% reached high knowledge levels, with only 3% remaining in the moderate group (p<0.001; Figure 1).

Regression Analysis

Multiple linear regression was used to identify predictors of baseline knowledge (Table 5). The model was significant [F (1,198)=4.921, p=0.028], with R^2=0.024 and adjusted R^2=0.019. Older age was associated with slightly lower scores (B=-0.035, 95% CI: -0.069 to -0.002, p=0.038). Anesthesiology specialization was a positive predictor (B=0.576, 95% CI: 0.065 to 1.087, p=0.027). Surprisingly, prior LAST training was associated with lower baseline scores (B=-0.554, 95% CI: -1.047 to -0.062, p=0.028).

Table 4. Comparison of the total number of participants with correct answers before and after training across survey question categories

Classification of questions	Pre-education (n=200) (%)	Post-education (n=200) (%)	p
LAST Mechanism (Q1 and 2)			
0	20 (10)	15 (7.5)	0.376
1	79 (39.5)	81 (40.5)	
2	101 (50.5)	104 (52)	
Pathophysiology of LAST (Q3 and 4)			
0	18 (9)	12 (6)	0.554
1	160 (80)	169 (84.5)	
2	22 (11)	19 (9.5)	
Epidemiology of LAST (Q5 and 6)			
0	6 (3)	2 (1)	<0.001
1	58 (29)	5 (2.5)	
2	136 (68)	193 (96.5)	
Risk factors and prevention of LAST (Q7 and 8)			
0	4 (2)	0 (0)	<0.001
1	30 (15)	14 (7)	
2	166 (83)	186 (93)	
Clinical manifestations of LAST (Q9 and 10)			
0	2 (1)	3 (1.5)	0.618
1	26 (13)	21 (10.5)	
2	172 (86)	176 (88)	
Management of LAST (Q11 and 12)			
0	8 (4)	2 (1)	<0.001
1	59 (29.5)	15 (7.5)	
2	133 (66.5)	183 (91.5)	
Lipid emulsion therapy (Q13, 14 and 15)			
0	2 (1)	0 (0)	<0.001
1	16 (8)	4 (2)	
2	88 (44)	49 (24.5)	
3	94 (47)	147 (73.5)	
Total score, mean ± SD	11.7±1.7	12.8±1.2	<0.001

Q: Question, LAST: Local anesthetic systemic toxicity, SD: Standard deviation

Table 5. Multiple linear regression analysis of factors influencing baseline knowledge scores

Predictor	B	95% CI	SE	t	p
Intercept	13.248	11.794 to 14.702	0.737	17.968	<0.001
Age	-0.035	-0.069 to -0.002	0.017	-2.089	0.038
Gender	-0.369	-0.865 to 0.126	0.251	-1.470	0.143
Female	-0.369	-0.865 to 0.126	0.251	-1.470	0.143
Male	Reference				
Specialty	0.576	0.065 to 1.087	0.259	2.224	0.027
Intensive care	Reference				
Anesthesia	0.576	0.065 to 1.087	0.259	2.224	0.027
Department	0.402	-0.147 to 0.951	0.278	1.445	0.150
ICU	Reference				
Operating room	0.402	-0.147 to 0.951	0.278	1.445	0.150
Experience	-0.024	-0.263 to 0.214	0.121	-0.200	0.841
Increasing experience	-0.024	-0.263 to 0.214	0.121	-0.200	0.841
Previous LAST training	-0.554	-1.047 to -0.062	0.250	-2.218	0.028
Yes	-0.554	-1.047 to -0.062	0.250	-2.218	0.028
No	Reference				

LAST: Local anesthetic systemic toxicity, CI: Confidence interval, ICU: Intensive care unit, SE: Standard error

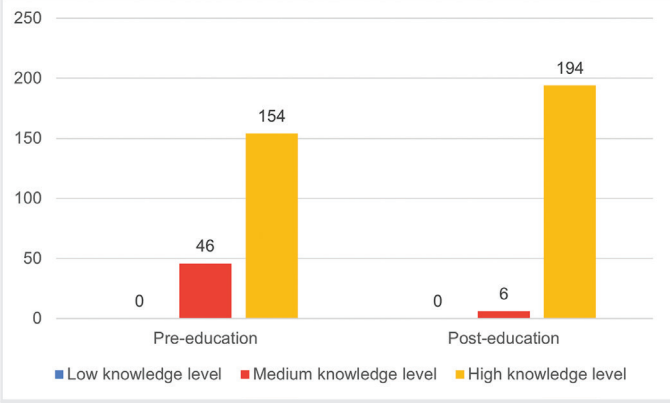

Figure 1. Comparison of total knowledge level group scores before and after education (p<0.001)

Discussion

This study evaluated the effectiveness of a brief educational intervention on improving anesthesiologists' and intensive care specialists' knowledge regarding LAST. The findings demonstrated a significant increase in objective knowledge scores following the intervention, particularly in areas such as management of LAST and the use of LE therapy. Although participants initially demonstrated moderate to high pre-education scores, the targeted education was effective in addressing their specific knowledge gaps.

In the current study, most anesthesiology and intensive care specialists rated their knowledge of LAST procedures, clinical symptoms, LE therapy, and cardiovascular support as moderate, good, or very good. These self-assessments are consistent with the findings of Rudra et al. (4), who reported high levels of confidence among anesthesiology trainees, particularly in areas such as prevention, risk factors, LE therapy, and site of administration. However, their study also revealed lower confidence in understanding the mechanism of LAST and in educational exposure, with a notable proportion of participants responding "neutral" or "disagree" to related items (4). Similarly, our study suggests that while general awareness of LAST among specialists is relatively positive, certain theoretical and training-related aspects remain insufficient. This discrepancy highlights the need for targeted educational interventions, especially in less emphasized areas like pathophysiology and structured instruction.

Our results align with previous national studies reporting suboptimal knowledge levels about LAST. In a study by Güler et al. (17), more than half of the participants had not received any training on LAs during their medical education, and only 22% were aware of the indications and use of LEs. Similarly, Karasu et al. (18) found that approximately two-thirds of physicians had never heard of LE therapy. Urfalıoğlu et al. (19) also reported that over 60% of ophthalmologists lacked knowledge about lipid use in LAST treatment. These findings collectively highlight the absence of standardized, comprehensive training on LAST across specialties.

Rudra et al. (4) reported that anesthesiology trainee physicians demonstrated a high level of knowledge regarding key aspects of LAST. Specifically, 100% correctly identified the contributing factors, 90% recognized the most common initial manifestation, 66% knew the timing of symptom onset, 87% identified the appropriate initial dose of LE therapy, and 83% were aware of the correct treatment

protocol (4). In contrast, participants in the present study showed lower levels of knowledge in these areas prior to the educational intervention. This discrepancy might be attributed to the fact that the participants in Rudra's study were still in training and likely had more recent exposure to LAST-related content. Meanwhile, the specialists in our study may have received such training earlier in their careers, with limited opportunities to refresh their knowledge due to infrequent clinical encounters with LAST. These findings emphasize the importance of continuous education and regular updates in clinical training.

The literature further supports the need for structured education programs. Munasinghe et al. (10) found that although 77% of Sri Lankan physicians claimed to have knowledge about LAST recognition and initial treatment, less than half correctly identified LE as the definitive therapy, and only two-thirds knew the correct dose. Similar to our findings, knowledge was significantly higher among anesthesiologists and postgraduate trainees compared to other physicians.

Similar to the findings of İlhan and Demir (13), the studies conducted by Karasu et al. (18) and Urfalıoğlu et al. (19) also demonstrated that most participants reported using LAs on a daily basis, yet the rates of formal training remained low, at 19.8% and 28.8%, respectively. Emergency physicians, who reportedly used LAs more frequently and had higher exposure to training, tended to answer LAST-related questions—such as symptoms, treatment, and LE dosage—more accurately. Despite the critical importance of education on LAST, İlhan and Demir (13) found no significant relationship between the frequency of LA use or prior training and the ability to correctly identify LAST symptoms, treatment strategies, or appropriate LE dosing. These findings suggest that the duration, quality, and content of existing LA-related training may be insufficient.

In the present study, participants who had previously received LAST training were found to have slightly lower total knowledge scores, possibly due to the extended time elapsed since their training and lack of regular clinical encounters with LAST. Karasu et al. (18) also reported that non-anesthesiology residents had lower rates of LAST education compared to anesthesiology trainees, a finding similarly reported by Sagir and Goyal (2), who documented limited knowledge and awareness among non-anesthesiology residents. Although İlhan and Demir (13) noted relatively higher training rates among emergency physicians, they still emphasized the inadequacy of overall educational exposure. In contrast, our study found that anesthesiology and intensive care specialists demonstrated comparatively acceptable levels of knowledge. Based on linear regression analysis, anesthesiologists appeared to have higher total knowledge scores, potentially due to their routine exposure to LAs in clinical practice. Interestingly, both increasing age and prior LAST training were negatively associated with total knowledge scores, further highlighting the need for continuous and updated educational initiatives in this field.

Numerous studies have highlighted insufficient knowledge of LAST among medical specialists, underlining the importance and necessity of targeted education (2,13,18). In the present study, both subjective self-assessments and objective test results indicated that anesthesiology and intensive care specialists had relatively high levels of knowledge regarding LAST. Nevertheless, gaps remained in certain fundamental areas, particularly concerning the underlying mechanisms of toxicity and prior educational exposure. These findings emphasize the need for structured and widespread educational programs to ensure safer clinical practice.

Previous literature has demonstrated the effectiveness of various training methods—ranging from live simulations to self-paced online modules—in enhancing knowledge and preparedness related to LAST (15,20,21). Consistent with these findings, our study showed that even a brief, targeted training intervention significantly improved participants' total knowledge scores, particularly in critical areas such as LAST management and the use of LE therapy.

Given that many participants reported the absence of a local protocol for LAST in their institutions, and nearly half indicated that they rarely encounter LAST cases or had never received prior formal education on the topic, the marked improvement observed after a short intervention highlights its potential impact. These results support the integration of routine, up-to-date, and accessible educational content on LAST within clinical training and continuing medical education programs.

Study Limitations

One of the main strengths of this study is its pre-post design, which allowed for a direct assessment of the impact of a brief educational intervention on knowledge levels regarding LAST among anesthesiology and intensive care specialists. Another strength of the study is the inclusion of a relatively large and well-defined sample of practicing specialists from multiple hospitals in İstanbul, which contributes to the generalizability of the findings. However, the final sample size was slightly below the initially estimated target. Additionally, the study provides valuable insights into the specific knowledge gaps and educational needs related to LAST, which can inform future training initiatives.

However, this study also has several limitations. First, data were collected through self-reported responses, which might be subject to recall and social desirability biases. Second, the study was limited to a single geographical region (İstanbul) and included only practicing specialists,

which might affect the external validity and generalizability of the findings. Third, the use of an online survey may have excluded participants less comfortable with digital tools, potentially introducing selection bias. Fourth, although the number of matched pre- and post-intervention responses (n=200) fell short of the estimated sample size based on a population of 1,000 professionals, post-hoc power analysis demonstrated adequate statistical power (1-β=0.999) for within-subject comparisons. Finally, the internal consistency of the knowledge questionnaire was relatively low (Cronbach's alpha=0.67), which might be attributed to the multidimensional content structure.

Conclusion

This study demonstrated that a brief, structured educational intervention significantly improved anesthesiology and intensive care specialists' knowledge of LAST, particularly in key areas such as clinical recognition, emergency management, and LE therapy. Although the majority of participants exhibited high baseline knowledge, the intervention effectively addressed specific knowledge gaps and underscored the importance of continuous education in rarely encountered but potentially life-threatening conditions such as LAST. The findings underscore the need to integrate LAST-focused content into specialty training curricula and continuing professional development programs. Establishing standardized institutional protocols and promoting regular refresher training may further enhance clinical preparedness and patient safety in settings where LAs are routinely administered.

Ethics

Ethics Committee Approval: The study received ethical approval from the Non-Interventional Clinical Research Ethics Committee of İstanbul Medipol University (decision no: 170, date: 06.02.2025).

Informed Consent: Written informed consent was obtained from all participants.

Footnotes

Authorship Contributions

Concept: A.G.K.K., Y.E.A., Design: A.G.K.K., Y.E.A., Data Collection or Processing: A.G.K.K., Analysis or Interpretation: Y.E.A., Literature Search: A.G.K.K., Y.E.A., Writing: A.G.K.K., Y.E.A.

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

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

Supplementary: https://d2v96fxpocvxx.cloudfront.net/cf9d60d6-523c-458a-a2e6-78728d3ffbb0/content-images/22a0d3dc-bb93-4f21-979a-e51b35785d5f.pdf

References

1. Collins J. Awareness of local anaesthetic toxicity issues among hospital staff. Anaesthesia. 2010;65:960-1.
2. Sagir A, Goyal R. An assessment of the awareness of local anesthetic systemic toxicity among multi-specialty postgraduate residents. J Anesth. 2015;29:299-302.
3. Mulroy MF. Systemic toxicity and cardiotoxicity from local anesthetics: incidence and preventive measures. Reg Anesth Pain Med. 2002;27:556-61.
4. Rudra R, Probert A, Ceasar J, Romanoski N. Local anesthetic systemic toxicity: an effort to identify knowledge gaps across specialties. PM R. 2024;16:434-40.
5. Rubin DS, Matsumoto MM, Weinberg G, Roth S. Local anesthetic systemic toxicity in total joint arthroplasty: incidence and risk factors in the United States from the national inpatient sample 1998-2013. Reg Anesth Pain Med. 2018;43:131-7.
6. Weinberg G, Barron G. Local anesthetic systemic toxicity (LAST): not gone, hopefully not forgotten. Reg Anesth Pain Med. 2016;41:1-2.
7. Liu SS, Ortolan S, Sandoval MV, Curren J, Fields KG, Memtsoudis SG, et al. Cardiac arrest and seizures caused by local anesthetic systemic toxicity after peripheral nerve blocks: should we still fear the reaper? Reg Anesth Pain Med. 2016;41:5-21.
8. Barrington MJ, Kluger R. Ultrasound guidance reduces the risk of local anesthetic systemic toxicity following peripheral nerve blockade. Reg Anesth Pain Med. 2013;38:289-99.
9. Di Gregorio G, Neal JM, Rosenquist RW, Weinberg GL. Clinical presentation of local anesthetic systemic toxicity: a review of published cases, 1979 to 2009. Reg Anesth Pain Med. 2010;35:181-7.
10. Munasinghe BM, Subramaniam N, Srisothinathan N, Jayamanne BDW. An online study of knowledge and practices of local anesthetic systemic toxicity among doctors in Sri Lanka. Anaesth Pain Intensive Care. 2022;26:69-74.
11. Başaranoğlu G, Teker MG, Saidoğlu L, Muhammedoğlu N, Haluk O. The knowledge of the physicians who use local anaesthetics about their toxicity and intralipid therapy. Turk J Anaesthesiol Reanim. 2010;38:262-6.
12. Walsh AM, Moran B, Walsh SA. Knowledge of local anesthetic use among dermatologists. Dermatol Surg. 2012;38:882-7.
13. İlhan B, Demir MC. Knowledge of local anesthetic systemic toxicity among emergency medicine physicians: a cross-sectional study. Signa Vitae. 2020;16:148-54.
14. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. J Clin Epidemiol. 2008;61:344-9.
15. Neal JM, Hsiung RL, Mulroy MF, Halpern BB, Dragnich AD, Slee AE. ASRA checklist improves trainee performance during a simulated episode of local anesthetic systemic toxicity. Reg Anesth Pain Med. 2012;37:8-15.
16. Mörwald EE, Zubizarreta N, Cozowicz C, Poeran J, Memtsoudis SG. Incidence of local anesthetic systemic

toxicity in orthopedic patients receiving peripheral nerve blocks. Reg Anesth Pain Med. 2017;42:442-5.

17. Güler O, Hakkoymaz H, Yaman FN, Ekingen E. Knowledge of emergency medicine physicians about local anesthetic toxicity and intravenous lipid treatment. Gazi Med J. 2020;31:371-4.
18. Karasu D, Yılmaz C, Akıncı SB, Teker G, Aksu C, Işık S, et al. Knowledge of the research assistants regarding local anaesthetics and toxicity. Turk J Anaesthesiol Reanim. 2016;44:201-5.
19. Urfalıoğlu A, Urfalıoğlu S, Öksüz G. The knowledge of eye physicians on local anesthetic toxicity and intravenous lipid treatment: questionnaire study. Turk J Ophthalmol. 2017;47:320-5.
20. Ferry SL, Cook KR. Local anesthetic systemic toxicity (LAST): increasing awareness through education. J Perianesth Nurs. 2020;35:365-7.
21. Bevil KM, Klesius LL, Chambers T, Borden SB. Educating perioperative nurses about local anesthetic systemic toxicity using high-fidelity simulation. Pain Manag Nurs. 2020;21:271-5.