Submitted: 26 March, 2021 Accepted: 21 April, 2021 Published: 08 November, 2021 DOI:10.22514/sv.2021.091

Open Access
Signa Vitae

ORIGINAL RESEARCH

Pre- and post-training changes in the test-ordering behavior of the emergency physicians in the management of adults with acute gastroenteritis

Sarper Yilmaz[1,*], Ozgur Karcioglu[2], Ozgur Dikme[2]

[1]Department of Emergency Medicine, University of Health Sciences, Kartal Dr. Lütfi Kırdar City Hospital, 34862 Kartal, Istanbul, Turkey
[2]Department of Emergency Medicine, University of Health Sciences, Istanbul Education and Research Hospital, 34098 Fatih, Istanbul, Turkey

***Correspondence**
sarperyilmaz08@gmail.com
(Sarper Yilmaz)

Abstract

Introduction: The aim of this study is to investigate the education-inflicted changes in the test-ordering behavior of the emergency physicians in the management of patients with a presumptive diagnosis of acute gastroenteritis (AGE).

Methods: The study was designed as a single-center interventional study and was conducted in a large training hospital over a two-month period. In the first month of the study; physicians' test ordering behavior in patients with acute AGE was analyzed (Group 1). After one-month period, physicians working in the hospital emergency department (ED) underwent a one-hour focused training on the management of patients with AGE. One month after the training, variations in test order habits were observed and recorded (Group 2). Before and after the training; demographic information, vital signs on admission, complaints, physical examination findings, associated conditions, and the work-up results were analyzed comparatively.

Results: Following the education session, there was a decrease of 6% in the rate of tests ordered for the patients and an increase of 11% in the rate of pathological findings on the laboratory work up. The patients' blood pressure, body temperature and heart rate were the factors without any effect on test-ordering behavior. In the present study, the ratio of patients ordered tests in the management of AGE in the ED was found to be lower and the rate of pathological findings was higher in the post-education period when compared to pre-education period.

Conclusions: Future population-based well-designed studies will enlighten the possible effect of education on test-ordering in acute medicine.

Keywords

Emergency department; Acute gastroenteritis; Test ordering; Education; Cost-effectiveness

1. Introduction

There is no universal definition of the specific clinical criteria that correlate with AGE. The 2016 American College of Gastroenterology (ACG) guidelines use a definition that emphasizes diarrhea in the diagnostic criteria, but also acknowledges that AGE can also be a "vomiting-predominant illness with little or no diarrhea" [1]. Although AGE is mostly a mild disease, certain clinical, demographic, or epidemiologic features can accompany complications or severe course of disease. People of all ages with acute diarrhea should be evaluated for dehydration, which increases the risk of life-threatening illness and death, especially among the young and older adults. Identification of the exact cause of diarrhea is not always necessary. Assessment of a stool specimen to determine the cause should be performed on patients at high risk of severe illness and for whom identification of a pathogen would be important for the patient or for public health reasons.

In selected and suspect cases; stool tests, duodenal fluid, blood cultures or culture-independent diagnostic tests (CIDTs) are recommended. However, there are no clear patient groups predefined for orders of blood biochemistry and complete blood count [2]. AGE represents one of the five leading causes of death worldwide and is the second most important cause of death for children under the age of five (behind acute respiratory infections). Most cases of AGE are associated with contaminated food and water resources and around 2.4 billion people globally do not have access to basic sanitation [3]. Although diarrhea is so common and causes substantial problems, there is no common protocol developed for the diagnosis and examinations for AGE. Laboratory work up is an integral part of the diagnostic investigation performed on patients presenting to EDs. Laboratory test orders in the ED are increasing worldwide, in accord with referral to the hospitals [4]. The number of patients increases by an average

of 2% each year and the number of tests increases by an average of 10% each year. As a result, it is obvious that the number of tests has increased more rapidly than the number of patients. As a result of the development of more complex tests, clinicians' dependence on clinical laboratories is increasing [5]. Axt-Adam *et al*. [6] reported that three main factors affected the physicians' test-ordering behavior. These factors are defined as training and information transfer, feedback, and others. In this study, we selected patients who were admitted to the Emergency Department (ED) due to diarrhea as the chief complaint. The reason is that although AGE is one of the most common complaints in the ED, the subject of "Which patient should blood be taken from" is not clearly stated in the guidelines yet and it is up to clinician's opinion.

There is significant variation in test-ordering rates in EDs, and there has been a tremendous increase in utilization of advanced imaging despite little evidence to suggest associated improvement in patient outcomes. The etiology of this increase is likely multifactorial and may include malpractice concerns, need for diagnostic certainty, lack of satisfactory clinical decision instruments, poor availability or interpretation of such tools, inadequate training in evidence-based medicine, slow knowledge propagation, aggressive financial incentives, overt requests of consultants and referring physicians, increased patient census and/or workloads and overall complexity of emergency care. The use of point of care (POC) laboratory testing in the ED to improve ED throughput has become widespread, resulting in overuse of resources, sometimes even multiple testing because of clinical "traditions" and provider mistrust of POC test accuracy [7–10]. Therefore, the objective of the present study is to investigate the education-inflicted changes in the test-ordering behavior of the emergency physicians in the management of patients with a presumptive diagnosis of AGE.

2. Material and methods

The study was designed as a single-center interventional (before-after) study.

2.1 Inclusion/exclusion criteria

Patients who were admitted to the ED of the University of Health Sciences, Istanbul Training and Research Hospital for two months and were evaluated and whose ICD-10 Diagnosis Code K52 was recorded by the physician in the hospital information system were included in this study. Patients aged 18 and over were included in the study. Following receipt of ethical committee approval (No. 2017/1123), patients who presented to the ED and were diagnosed with ICD-10-CM Code K52 within a month following (between 10.10.2018 and 09.11.2018) were evaluated as group 2.

2.2 Procedures

Patients who presented to the ED between 10.09.2018 and 09.10.2018, registered with ICD-10-CM Code K52 in the hospital information system thereafter, were evaluated as group 1. The resident were given a one-day focused training in the ED on the management of the patients with acute gastroenteritis. In this training session, IDSA guidelines and literature data were discussed and recommendations for patients presenting to hospital with diarrhea were summarized, under the light of contemporary evidence-based medicine [2, 11]. The training was provided by the most experienced specialist in the clinic.

In the last fifteen minutes of the training, the participants were provided with several realistic scenarios and were asked questions derived from the information in the training session. By answering all questions correctly, the participants were made aware of the purpose of the training and incorporated the information in their knowledge base. Thirty clinicians actively working in the clinic at that time were enrolled in the study and attended the training session. Education session included elements covering general information, cost-effectiveness, protocols from medical literature to support decision making processes.

Before and after the training; demographic information, vital signs on admission-Systolic blood pressure (SBP), Diastolic blood pressure (DBP) , body temperature, Glasgow Coma Scale (GCS), length of stay (LOS) in the ED, presenting complaints (nausea, vomiting, abdominal pain, fecal blood, fecal mucus), physical examination findings (guarding, rebound), accompanying diseases [(diabetes mellitus (DM), coronary artery disease (CAD), Chronic liver disease (CLD) , hypertension (HT), chronic kidney disease (CKD), chronic obstructive pulmonary disease (COPD)), work up results (Sodium (Na), Potassium (K), urea, creatinine, glucose, white blood cells)] and test results were compared. Blood pressures and pulse rates in patients are classified according to ESC 2018 guidelines [12]. The duration of the patient's stay in ED (length of stay, LOS) is calculated as the period from the admission (registration process) followed by examination by the physician to the discharge from the ED. The hospital registration system calculates this time automatically.

Hospital laboratory reference ranges for blood test were taken as a guide for assignment of the results to groups: low, medium and high. Determination of hospital reference ranges; NCCLS (National Committee for Clinical Laboratory Standards) and IFCC (International Federation of Clinical Chemistry) made according to the recommendations [13, 14].

3. The characteristics of the study center and the ED

The ED is located in a level-one education and research hospital. Patients can access the facility from many centers of Istanbul as they have transportation abilities via sea, air and railway. There are a total of 30 beds in ED and 30 clinicians actively caring for patients, under supervision of an education chair and a clinical coordinator. Six physicians actively care for patients in each shift. ED has its own integrated and dedicated "ED Laboratory" and the average turnover time for blood chemistry has been recorded as 90 minutes.

3.1 Statistical analysis

Statistical Package for Social Sciences (SPSS) 22.0 for Windows (IBM, Armonk, NY) program, mean, standard deviation, range, frequency and ratio values in descriptive statistics of

data, Kolmogorov Smirnov test for the distribution of numerical variables, Mann-Whitney U test for the analysis of quantitative independent data, chi-square test for the analysis of qualitative independent data, Fischer's exact test when the chi-square test conditions were not met, Student *t*-test for comparison of means were used and statistical alpha significance level was accepted as $p < 0.05$.

3.2 Limitations

The study focused on the test orders and the behavioral outputs of test-ordering, therefore, the post-treatment clinical course of the patients were not investigated and analyzed. The findings of the present study cannot be extrapolated for the population as it has been conducted in a single center.

4. Results

Within the two-month study period, a total of 36,828 patients were admitted to the study center, 1430 (3.96%) of these patients had the chief complaint of diarrhea. As it is known, this rate can fluctuate dramatically, especially with seasonal effects and during epidemic periods. In addition, there are literature data indicating an ambiguity of guidelines and lack of robust policies with regards to work up in these patients. This results in a high rate of unnecessary tests in the management of diarrhea which in turn, these tests would trigger boosted periods of stay in the ED, together with increased workload and costs. For this reason, the study was designed to enroll patients who were admitted to the ED due to diarrhea.

A total of 925 adult patients of group 1 (pre-training) and 505 patients of group 2 (post-training) were included in the study. A majority of the sample (n = 773; 54.1%) were women, while 657 (45.9%) were men. The mean age was found to be 35 years (range: 18 and 101 years). The mean age of the patients who had undergone work up were found statistically significantly higher than those who had not in both study periods (p = 0.001). In both groups, a total of 613 patients were ordered tests and 817 were not. A total of 415 (44%) of 925 patients and 188 (37%) of 505 patients were worked up in group 1 and group 2 respectively. The age, systolic pressure, pulse rate, temperature and GCS values of the patients who presented to the ED with diarrhea did not differ significantly ($p > 0.05$) before and after training. While the length of stay in the ED in the pre-training group was 70 minutes (95.5 ± 88.9), while it was 60 minutes (84.5 ± 80.7) in the post-training group (p = 0.007). The analysis of clinical and laboratory findings and the differences between pre-and post-training groups is shown in Table 1.

As for the pre-training group, test-ordering tendency in the management of the patients with systolic BP values evaluated as hypotensive was found to be significant (p = 0.012). As for the post-training group, the effect of changes in diastolic and systolic blood pressure values on blood test-ordering was not significant ($p > 0.05$).

No statistically significant difference was found between the pre-training and post-training group in terms of the results of laboratory work up depending on fever and pulse rate changes ($p > 0.05$). Comparison of the correlation between vital signs and test-ordering in pre-and post-training patients is shown in Table 2.

Before the training session, a statistically significant difference was found in the rate of test-ordering for patients with pregnancy status, with abdominal pain and blood in the stool complaints, and with abdominal guarding on physical examination ($p < 0.050$). After the training, no significant difference was found in test-ordering depending on pregnancy status, patient complaints and physical examination findings. In addition, after the training; there was no patient with presence of fecal blood and/or fecal mucus. There was no patient with marked dehydration before and after the training.

When associated diseases were examined; 22 patients (1.5%) had DM, 95 patients (6.6%) had HT, 114 patients (8.0%) had CRF, 12 patients (0.8%) had COPD, 16 patients (1.1%) had CAD, and 42 patients (2.9%) had CLD. Mushroom intoxication, DM, HT, CRF, COPD, CAD, CLD rate did not differ significantly before and after the training ($p > 0.05$). However, it was found that the patients who were admitted to ED and those who had these associated diseases had significantly more examinations. After the training, DM, CAD, CLD patients with additional diseases did not change the rate of ordered work up, HT, CRF, COPD patients with additional diseases were determined to decrease the amount of ordered examination.

While 415 (44%) of the admitted 925 patients were examined before the training, 188 (37%) of the admitted 505 patients were examined after the training. A 7% decrease was found in the rate of test-ordering during the post-training period, and this difference was statistically significant. The rate of hyponatremia was higher in patients who were examined after the training (p = 0.024). There was no statistically significant difference between the levels of potassium, glucose, urea and leukocytes before and after the training ($p > 0.05$). When the ratios were compared, it was found that the pathological output rate of sodium was found to be the highest and glucose was the lowest figures among others. The comparison of electrolyte, urea creatinine and leukocyte values in the pre-and post-training patient is shown in Table 3.

The model was found to be significant in the regression analysis performed as dependent variable, test-ordering status, independent variables pregnancy and abdominal pain (p = 0.001). Other variables were excluded because their effects were found to be nonsignificant in the model. The independent variables were significant in the pregnancy model (95% CI 0.57 to 0.739; p = 0.015) and abdominal pain (95% CI 0.384 to 0.767; p = 0.001). Other variables were found insignificantly related. The regression model disclosed that the degree of relationship between the dependent and the independent variables in accord with Cox-Snell R^2 and Nagelkerke R^2 was 5.6%, and 7.5%, respectively.

5. Discussion

Although it is very common and causes important problems, patients diagnosed with AGE are treated with serious mistakes. Paying attention to some basic points will provide satisfactory results for patients and physicians and also prevent economic losses caused by unnecessary examination requests. A mul-

TABLE 1. The analysis of clinical, laboratory findings and the differences between pre-and post-training groups.

		Pre-training		Post-training		*p*	
		Mean. ± s.d./n-%	Median	Mean. ± s.d./n-%	Median		
Age (years)		38.6 ±17.2	34.0	38.8 ± 16.6	35.0	0.609	M
Sex	Female	480 ± 51.9%		293 ± 58.0%		**0.026**	X^2
	Male	445 ± 48.1%		212 ± 42.0%			
SBP (mmHg)		124.8 ± 15.7	121.0	125.2 ± 18.1	124.0	0.568	M
DBP (mmHg)		69.7 ± 10.8	70.0	72.2 ± 12.7	70.0	**0.000**	M
Pulse rate (bpm)		91.6 ± 16.4	89.0	91.5 ± 15.9	90.0	0.821	M
Fever (°C)		36.2 ± 0.5	36.0	36.2 ± 0.5	36.0	0.662	M
GCS		15.0 ± 0.0	15.0	15.0 ± 0.0	15.0	1.000	M
Hospitalization	No	923 ± 99.8%		504 ± 99.8%		1.000	X^2
	Yes	2 ± 0.2%		1.0 ± 0.2%			
LOS in the ED (minutes)		95.5 ± 88.9	70.0	84.5 ± 80.7	60.0	**0.007**	M

SBP, Systolic blood pressure; DBP, Diastolic blood pressure; GCS, Glasgow Coma Scale; LOS, Length of stay; X^2, Chi-square test; m, Mann Whitney-U test.

TABLE 2. Comparison of the correlation between vital signs and test- ordering in pre-and post-training patients.

Vital signs	Period	Comparison	Test				^{a}p
			Not done		Done		
			N	%	N	%	
SBP (mmHg)	Pre-training	Hypo (<90)	1	33.3	2	66.7	^{p}0.012*
		Normal (140–90)	448	56.3	348	43.7	
		Hyper (>140)	54	42.9	72	57.1	
	Post-training	Hypo (<90)	1	77.8	2	22.2	^{p}0.082
		Normal (140–90)	262	63.9	148	36.1	
		Hyper (>140)	45	52.3	41	47.7	
DBP (mmHg)	Pre-training	Hypo (<60)	143	56.3	111	43.7	^{p}0.567
		Normal (90–60)	348	54.0	297	46.0	
		Hyper (>90)	12	46.2	14	53.8	
	Post-training	Hypo (<60)	77	67.5	37	32.5	^{p}0.085
		Normal (90–60)	226	61.7	140	38.3	
		Hyper (>90)	11	44.0	14	56.0	
Fever (°C)	Pre-training	Low (<36)	4	57.1	3	42.9	^{p}0.984
		Normal (36–37.5)	447	55.0	366	45.0	
		High (>37.5)	1	50.0	1	50.0	
	Post-training	Low (<36)	2	66.7	1	33.3	^{p}0.921
		Normal (36–37.5)	272	63.1	159	36.9	
		High (>37.5)	1	50.0	1	50.0	
Pulse rate (bpm)	Pre-training	Bradycardia (<60)	2	28.6	5	71.4	^{p}0.355
		Normal (60–100)	375	55.0	307	45.0	
		Tachycardia (>100)	126	53.4	110	46.0	
	Post-training	Bradycardia (<60)	2	50.0	2	50.0	^{p}0.512
		Normal (60–100)	250	63.5	144	36.5	
		Tachycardia (>100)	62	57.9	45	42.1	

*DBP, Diastolic blood pressure; SBP, Systolic blood pressure; p, Pearson Chi-Square; *$p < 0.05$.*

TABLE 3. Comparison of electrolyte, urea, creatinine and leukocyte values in pre-and post-training patients.

		Pre-training		Post-training		*p*
		n	%	N	%	
Sodium (mEq/L)	Hyponatremia (<135)	127	31	78	41.5	^{p}0.024*
	Normal (135–145)	281	68.5	110	58.5	
	Hypernatremia (>145)	2	0.5	0	0	
Potassium (mEq/L)	Hypokalemia (<3.5)	40	11.8	28	15.2	^{p}0.502
	Normal (3.5–5)	295	87	154	83.7	
	Hyperkalemia (>5)	4	1.2	2	1.1	
Creatinine (mg/dL)	Normal (0.6–1.2)	270	65.9	128	68.1	^{p}0.065
	Abnormal (<0.6, >1.2)	140	34.1	60	31.9	
Glucose (mg/dL)	Normal (60–126)	380	92.9	177	94.1	^{p}0.123
	Abnormal (<60, >126)	29	7.1	11	5.9	
Urea (mg/dL)	Normal (≤40)	313	77.7	142	76.3	^{p}0.078
	Uremia (>40)	90	22.3	44	23.7	
WBC (WBC/microL)	Leukopenia (<4.000)	6	1.4	4	2.1	^{p}0.873
	Normal (4–11.000)	243	58.6	109	58	
	Leukocytosis (>11.000)	166	40	75	39.9	

*p, Pearson Chi-Square; *p < 0.05; WBC, white blood cells.*

tifaceted education and feedback strategy can significantly and persistently decrease laboratory utilization by practicing community physicians [15]. In this study, we also found that the rate of test-ordering decreased after a training given to the physicians with respect to the patients who presented to the ED with diarrhea complaints. We didn't provide feedback about the tests ordered by the physicians and their costs. In the study, we have focused on the effect of the training on the rate of the test-ordering without feedback and abnormality rates of the results. The rate of test-ordering was significantly lower in the post-training group than in the pre-training group. It is concluded that if the study had feedback and other parameters, the decrease in the rate of test-ordering would be higher, and more successful results could be obtained. In the study by Dr. Sönmez *et al.* [5], conducted via comparison of state hospitals and educational research hospitals, the mean pathological outcome rate of the tests ordered in the outpatient (ambulatory) clinics was 26.8% in both groups. In this study, the mean pathological outcome rate was 24% before the training and 26% after the training. In both cases, we had close results to Dr. Sönmez's ED study.

In the patients admitted to the ED with diarrhea the examinations were evaluated before and after the training, hyponatremia, hypopotassemia and uremia were found to be higher in the post-training group. However, when the pre- and post-training period was compared, only statistically significant difference was found in the rate of hyponatremia. It was thought that this may be due to the increased awareness of the recognition of more risky patients in terms of dehydration and electrolyte disturbance, especially in the post-training group [16].

Although the rate of ordered tests decreased after the training, the percentages of pathological outputs of them increased. When the rates were compared, sodium was determined to exhibit the highest pathological output rate and glucose had the lowest one. It is found that, by training, the possibility of pathological results will increase, and the decision will be made more accurately in the selection of patients to be examined after training.

Several factors affect the length of stay (LOS) of patients in ED. Sariyer *et al.* [17] searched for the effects of variables including demographic data, gender, age, patient's triage category on admission to ED, diagnosis, date (month and day of the week) of the referral on the LOS in the ED were investigated. All except for the month of the year were reported to have a significant impact on LOS. In this study, the effect of the rate of test ordering on the LOS in ED was investigated and a significant decrease was found in the post-training period.

The present study is not free of limitations. Single-centered design prevents extrapolation of the findings for the whole population. The education session could have been organized better and validated in accord with literature data in order to elicit a stronger response from the physicians which can last longer in their decision making processes.

6. Conclusions

In this study, it was found that the rate of tests ordered for the patients admitted to the ED with AGE decreased after the training given to the emergency physicians. Following the training session, the rates of pathological results of the work up were increased. While the test-ordering tendency in patients with a history of pregnancy while presenting to the ED due to diarrhea as the chief complaint increased after the training session, presence of abdominal pain were found to reduce test-ordering habit significantly. Future population-based studies

will enlighten the impact of training sessions on test-ordering in EDs and primary care facilities.

AUTHOR CONTRIBUTIONS

SY, OK and OD designed the research study. SY performed the research. SY, OK and OD analyzed the data. SY, OD and OK wrote the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study protocol was approved by the Institutional Review Board (No. 2017/1123).

ACKNOWLEDGMENT

Thanks to all the peer reviewers for their opinions and suggestions.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest. Ozgur Karcioglu is a member of the Editorial Board of this journal.

REFERENCES

[1] Riddle MS, DuPont HL, Connor BA. ACG clinical guideline: diagnosis, treatment, and prevention of acute diarrheal infections in adults. American Journal of Gastroenterology. 2016; 111: 602–622.

[2] Shane AL, Mody RK, Crump JA, Tarr PI, Steiner TS, Kotloff K, *et al*. 2017 infectious diseases society of america clinical practice guidelines for the diagnosis and management of infectious diarrhea. Clinical Infectious Diseases. 2017; 65: 1963–1973.

[3] World Health Organization, Pan American Health Organization. The World Health report 1996: fighting disease, fostering development. 1996.

[4] Stuart PJ, Crooks S, Porton M. An interventional program for diagnostic testing in the emergency department. Medical Journal of Australia. 2002; 177: 131–134.

[5] Sönmez Ç, Akın Kadir O, Kösem A, *et al*. Determining unnecessary test requests by comparing the pathological result rates of the tests. 2014. Available at: https://images.slideplayer.biz.tr/10/2750520/slides/slide_1.jpg (Accessed: 1 May 2021).

[6] Axt-Adam P, van der Wouden JC, van der Does E. Influencing behavior of physicians ordering laboratory tests: a literature study. Medical Care. 1993; 31: 784–794.

[7] Fermann GJ, Suyama J. Point of care testing in the emergency department. Journal of Emergency Medicine. 2002; 22: 393–404.

[8] Hasanali Jafarpoor, Parvaneh Vasli, Houman Manoochehri, Farid Zayeri. Measuring Family-centered Care in Intensive Care Units: Developing and Testing Psychometric Properties. Signa Vitae. 2020; 16: 82-91.

[9] Dashevsky M, Bernstein SL, Barsky CL, Taylor RA. Agreement Between Serum Assays Performed in ED Point-of-Care and Hospital Central Laboratories. West J Emerg Med. 2017; 18: 403–409.

[10] Lee-Lewandrowski E, Corboy D, Lewandrowski K, Sinclair J, McDermot S, Benzer TI. Implementation of a point-of-care satellite laboratory in the emergency department of an academic medical center. Impact on test turnaround time and patient emergency department length of stay. Archives of Pathology Laboratory Medicine. 2003; 127: 456–460.

[11] Guerrant RL, Van Gilder T, Steiner TS, Thielman NM, Slutsker L, Tauxe RV, *et al*. Practice guidelines for the management of infectious diarrhea. Clinical Infectious Diseases. 2001; 32: 331–351.

[12] Williams B, Mancia G, Spiering W, *et al*. 2018 ESC/ESH Guidelines for the management of arterial hypertension. ESC Scientific Document Group. European Heart Journal. 2018; 39: 3021–3104.

[13] GL Horowitz, S Altaie, JC Boyd. Defining, establishing, and verifying reference intervals in the clinical laboratory; approved guideline. 3rd edn. CLSI document C28-A3. Wayne, PA: Clinical and Laboratory Standards Institute. 2008.

[14] Solberg HE. International federation of clinical chemistry (IFCC), scientific committee, clinical section, expert panel on theory of reference values, and international committee for standardization in haematology (ICSH), standing committee on reference values. approved recommendation (1986) on the theory of reference values. Part 1. The concept of reference values. Journal of Clinical Chemistry and Clinical Biochemistry. 1987; 25: 337–342.

[15] Bunting PS, van Walraven C. Effect of a controlled feedback intervention on laboratory test ordering by community physicians. Clinical Chemistry. 2004; 50: 321–326.

[16] Tiryaki Ö. Evaluation of management and antimicrobial therapy of patients admitted due to diarrhea in the emergency department, Dokuz Eylül University Hospital, Izmir, TURKEY. Thesis Study. 2005. (In Turkish)

[17] Sarıyer G, Ataman MG, Kızıloğlu İ. Factors affecting length of stay in the emergency department: a research from an operational viewpoint. International Journal of Healthcare Management. 2020; 13: 173–182.

How to cite this article: Sarper Yilmaz, Ozgur Karcioglu, Ozgur Dikme. Pre- and post-training changes in the test-ordering behavior of the emergency physicians in the management of adults with acute gastroenteritis. Signa Vitae. 2021;17(6):37-42. doi:10.22514/sv.2021.091.