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Short Communication

Impact of a structured influenza seminar on pediatric residents' knowledge and attitudes: a pre-post single-group study

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ABSTRACT

Background. Influenza remains a primary global health concern associated with significant morbidity and mortality, especially among high-risk pediatric populations. Pediatric residents are involved in the diagnosis, treatment, and prevention of influenza during their training; however, gaps in influenza-related knowledge have been reported. The aim of this study was to evaluate the impact of a structured educational seminar on improving pediatric residents' knowledge of influenza symptoms, complications, treatment, and vaccination practices.

Methods. This prospective, single-center, pre-post study included pediatric residents at a tertiary hospital. Participants completed the same structured 25-item questionnaire immediately before and one month after a 60-minute educational seminar on influenza. The questionnaire assessed knowledge of clinical symptoms, transmission routes, antiviral treatment, chemoprophylaxis, and vaccination. Item-level correct response rates and the total knowledge score (range 0-25) were compared between pre- and post-seminar assessments.

Results. Sixty-two residents participated. After the seminar, correct response rates increased for several clinical features, including sudden onset of illness ($p = 0.006$), rapid progressive disease ($p = 0.003$), diarrhea ($p < 0.001$), abdominal pain ($p < 0.001$), febrile seizure ($p = 0.003$), and complex febrile seizure ($p < 0.001$). Knowledge regarding transmission routes and oseltamivir-related adverse effects improved significantly ($p < 0.05$), while chemoprophylaxis-related items showed mixed changes in correct response rates. The total knowledge score increased from 14 (interquartile range [IQR]: 12-16.25) to 18 (IQR: 15-21) after the seminar ($p < 0.001$).

Conclusion. A single, structured educational seminar was associated with improvements in several domains of influenza-related knowledge among pediatric residents. The observed declines in selected chemoprophylaxis items indicate that some topics may require repeated or reinforced educational approaches.

Key words: children, influenza, post-training, resident, survey.

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Influenza remains a significant cause of morbidity and mortality worldwide, particularly among children and other high-risk populations.[1,2] Early recognition of clinical manifestations, appropriate antiviral treatment, and timely vaccination are essential components of effective influenza management in pediatric practice.[1-3] Pediatric residents, who are actively involved in frontline patient care during their training, play an important role in the diagnosis, treatment, and prevention of influenza.

Previous studies have shown that physicians' knowledge and attitudes toward influenza may influence diagnostic accuracy, treatment decisions, and vaccine-related counseling.[4-6] Despite the availability of evidence-based guidelines, gaps in influenza-related knowledge have been reported among resident physicians, particularly regarding atypical clinical manifestations, indications for antiviral therapy, chemoprophylaxis, and vaccination recommendations.[7-9] Educational interventions have therefore been proposed to improve residents' understanding of influenza and support guideline-concordant practice.[10]

Short, structured educational programs are commonly used in residency training; however, data evaluating their effectiveness in improving pediatric residents' influenza-related knowledge are limited.[11,12] In addition, it remains unclear whether such interventions have a similar impact across different levels of training or reduce knowledge differences between junior and senior residents. The aim of this study was to evaluate changes in pediatric residents' influenza-related knowledge following a structured educational seminar.

Materials and Methods

This prospective study was carried out at the University Faculty of Medicine, Tepecik Training and Research Hospital in İzmir, Türkiye. Pediatric residents employed at the hospital during the study period constituted the study population. Residents with more than two years of clinical experience were categorized as *senior residents*, while those with less than two years of experience were categorized as *junior residents*. Residents on maternity, military, or research leave, and those who did not provide informed consent, were excluded.

Data were collected using a structured questionnaire administered face-to-face immediately before an influenza educational seminar. After completing the pre-training questionnaire, all participants attended a standardized, in-person educational seminar that addressed key aspects of influenza, including clinical features, transmission routes, complications, treatment options, and vaccination guidelines. The seminar lasted 60 minutes, was delivered by two pediatric infectious disease specialists, and combined didactic teaching with case-based discussions and interactive question-and-answer sessions. Educational materials were prepared in accordance with American Academy of Pediatrics (AAP) recommendations.[3]

The questionnaire consisted of 25 items assessing residents' knowledge of influenza-related clinical manifestations, transmission routes, antiviral treatment, chemoprophylaxis, and vaccination. It included single best-answer questions as well as statements intended to evaluate both correct and incorrect concepts, in accordance with current guideline recommendations. Items related to clinical recognition and transmission focused on typical symptoms, modes of spread, and contagiousness. Treatment-related questions addressed indications for antiviral therapy, treatment duration, and commonly reported adverse effects. Vaccination-related items examined recommended age groups, high-risk populations, and scenario-based immunization strategies.

Knowledge of chemoprophylaxis was assessed by presenting appropriate and inappropriate clinical and epidemiological statements, with responses recorded as correct or incorrect. Additional items gathered information

on demographic characteristics, influenza vaccination status, and reasons for non-vaccination.

The study was conducted between August 31, 2021, and December 1, 2021, just before the influenza season. One month after the seminar, the same questionnaire was re-administered to assess changes in knowledge. Written informed consent was obtained from all participants, and participation was voluntary, and anonymized numeric codes were used to match pre- and post-surveys. The study protocol was approved by the local ethical committee (decision no. 2019/12-22).

Statistical analysis

Statistical analysis was performed using SPSS 24.0 (IBM Corp, Armonk, NY). Categorical data were summarized as numbers and percentages, and continuous variables as mean ± standard deviation or median (interquartile range [IQR]), as appropriate. Pre-post comparisons of categorical variables were conducted using McNemar's test, while paired t-tests or Wilcoxon signed-rank tests were used for continuous variables, depending on data distribution. $P < 0.05$ was considered statistically significant. The total knowledge score was defined as the sum of correct responses across all 25 items (range 0-25).

Results

All 62 pediatric residents working at the same hospital participated in the study. The median age was 29 years (IQR 27-29), 75.8% (n = 47) were female, and 61.3% (n = 38) were senior residents. A total of 16.1% (n=10) reported having a chronic disease. Influenza vaccination rates did not differ between residents with and without chronic diseases ($p = 0.790$).

In the previous season, 71.0% (n = 44) of residents reported not being vaccinated. The most common reasons were lack of time (54.5%), perception that the vaccination was unnecessary (11.4%), vaccine unavailability (9.1%), and concerns about safety (4.5%). For the current season, 64.5% (n = 40) reported willingness to be vaccinated, 30% indicated that the COVID-19 pandemic influenced this decision.

Baseline knowledge of influenza symptoms was highest for fever, myalgia, and headache, and lowest for complex febrile seizures, diarrhea, and abdominal pain. As shown in Table I, post-seminar correct response rates increased for several symptoms, with statistically significant improvements in recognition of sudden onset of illness ($p = 0.006$), rapidly progressive disease ($p = 0.003$), abdominal pain ($p < 0.001$), diarrhea ($p < 0.001$), febrile seizures ($p = 0.003$), and complex febrile seizures ($p < 0.001$). Before the seminar,

Table I. Recognition of influenza symptoms by pediatric residents: before and after the seminar

Symptoms	Number of residents providing correct responses		p value
	Pre-survey, n (%)	Post-survey, n (%)	
Fever	62 (100)	62 (100)	-
Headache	60 (96.8)	61 (98.4)	1.000
Sudden onset of illness	44 (71)	54 (87.1)	0.006
Rapid progressive disease	33 (53.1)	47 (75.8)	0.003
Diarrhea	22 (35.5)	42 (67.7)	<0.001
Sore throat	49 (79)	54 (87.1)	0.302
Stomachache	22 (35.5)	47 (75.8)	<0.001
Myalgia	58 (93.5)	61 (98.4)	0.250
Cough	53 (85.5)	57 (91.9)	0.344
Fatigue	60 (96.8)	62 (100)	0.500
Febrile seizure	30 (48.3)	45 (72.6)	0.003
Complex febrile seizure	14 (22.6)	31 (50)	<0.001

senior residents demonstrated higher correct response rates for some symptoms; however, no significant junior-senior differences remained after the seminar (p > 0.05 for all).

Regarding transmission routes, droplet transmission was most frequently identified at baseline (95.2%, n = 59). Post-seminar rates were 95.2% (n = 59) for droplets (p = 1.000), 58.1% (n = 36) for aerosols (p = 0.020), 59.7% (n = 37) for contact (p < 0.001), and 35.5% (n = 22) for autoinoculation (p < 0.001). Awareness that influenza can be transmitted before symptom onset increased from 72.6% to 90.3% (p = 0.019). No significant differences were observed between senior and junior residents (p > 0.05 for all).

Knowledge of oseltamivir indications showed stable baseline performance, with no significant junior-senior differences before or after the seminar (p > 0.05 for all). Correct identification of nausea and vomiting as the most common adverse effects increased from 77.4% to 95.2% after the seminar (p<0.001).

Correct identification of pediatric risk factors for severe influenza was high at baseline and increased across all items following the seminar, without significant differences between training levels (Table II).

In vaccine-related scenarios, correct response rates improved for children aged 6 months to 8 years requiring two doses (67.7% to 82.3%, p=0.030), while correct response rates for universal vaccination recommendations showed a numerical increase that was not statistically significant (77.4% to 88.7%, p=0.143; Table III).

For chemoprophylaxis items, mixed changes were observed. Correct identification of the statement that household contacts should not routinely receive treatment showed a numerical decrease that did not reach statistical significance (87.1% to 75.8%, p=0.090), whereas correct identification of chemoprophylaxis indications in closed settings increased from 72.6% to 88.7% (p=0.021; Table III).

The total knowledge score increased significantly after the seminar (median [IQR]: pre-seminar 14 [12-16.25] vs post-seminar 18 [15-21]; Wilcoxon signed-rank test, Z = −5.918, p < 0.001).

Discussion

Influenza has long been a significant public health concern, causing acute respiratory infections, severe pneumonia, and, in some

Table II. Knowledge of pediatric residents regarding influenza vaccine recommendations for high-risk children: before and after the seminar

Risk groups	Number of residents showing the correct response		p value
	Pre-survey, n (%)	Post-survey, n (%)	
Children with chronic pulmonary disease	62 (100)	62 (100)	-
Children with chronic cardiac disease	57 (91.9)	58 (93.5)	1.000
Immunosuppressive children	61 (98.4)	62 (100)	1.000
Children with chronic kidney disease	57 (91.9)	59 (95.2)	0.720
Children with an increasing risk of aspiration	49 (79)	54 (87.1)	0.260
Children with metabolic diseases	57 (91.9)	58 (93.5)	1.000
Children with sickle-cell anemia	41 (66.1)	55 (88.7)	0.001
Children requiring constant salicylate treatment	48 (77.4)	55 (88.7)	0.110

Table III. Pediatric residents' knowledge of chemoprophylaxis indications in children: before and after the seminar

Propositions (if any transmission modes anticipated)	Number of residents showing the correct response		p value
	Pre-survey, n (%)	Post-survey, n (%)	
If a family member receives oseltamivir treatment, other household members should be considered for chemoprophylaxis (correct)	54 (87.1)	47 (75.8)	0.090
Children in high-risk groups who have not received the current season's influenza vaccine should be considered for chemoprophylaxis (correct)	52 (83.9)	42 (67.7)	0.020
Individuals living with or caring for immunocompromised children should receive chemoprophylaxis, especially if the current season's vaccine may not protect against the circulating virus (correct)	49 (79)	47 (75.8)	0.830
Chemoprophylaxis is not recommended for all school-aged children between 8 and 18 years unless they belong to a high-risk group or have had significant exposure (incorrect)	55 (88.7)	59 (95.2)	0.340
Children under six months of age are at high risk and cannot be vaccinated; therefore, chemoprophylaxis should be given to their close contacts (correct)	13 (21)	13 (21)	1.000
If a positive case is identified in a closed setting, such as a dormitory or military barracks, chemoprophylaxis should be administered to close contacts, including roommates, to prevent an outbreak (correct)	45 (72.6)	55 (88.7)	0.021

cases, death, and is associated with a substantial global disease burden in children.[13] While most cases resolve within a few days, the virus is still associated with substantial morbidity and mortality, particularly among high-risk groups.[2,3] Timely recognition of clinical manifestations, identification of individuals at risk for severe disease, and appropriate use of antiviral treatment or prophylaxis are essential components of effective influenza management. Vaccination remains the most effective preventive strategy, and healthcare workers play a key role not only in self-protection but also in reducing transmission to vulnerable patients and promoting vaccine uptake through informed recommendations.[2,3]

In the present study, influenza vaccination uptake among pediatric residents was low, with 71% reporting not being vaccinated during the previous influenza season. Commonly reported barriers included a lack of time, the perception that vaccination was unnecessary, limited access, and concerns about vaccine safety. These findings are consistent with previous studies demonstrating persistently low influenza vaccination rates among healthcare workers despite long-standing recommendations.[5,6,9,10] Notably, willingness to receive the influenza vaccine in the current season was higher than in the previous season. This observation may reflect increased awareness of viral transmission and disease severity during the COVID-19 pandemic; however, causal inferences cannot be drawn from the study design. Similar observations have been reported in prior studies, indicating that major public health events may temporarily improve vaccine acceptance among healthcare professionals.[11,12]

Chronic illness is a well-established risk factor for severe influenza, and vaccination is strongly recommended for individuals with underlying conditions.[2] However, in our cohort, no

significant association was observed between chronic disease and influenza vaccination status. This finding aligns with previous studies indicating that, even among high-risk groups, influenza vaccination coverage remains suboptimal.[14-16] Given the relatively young age and generally good health status of pediatric residents, traditional risk-based motivators such as age and comorbidity may be insufficient to drive vaccination behavior in this population. These results highlight the need for targeted educational and institutional strategies to improve vaccine uptake among young healthcare professionals.

Encouragingly, participants demonstrated strong baseline knowledge of certain high-risk conditions for severe influenza, such as chronic pulmonary disease and immunosuppression. Following the educational seminar, correct response rates showed an upward trend; however, these changes did not reach statistical significance, and differences between junior and senior residents diminished. Taken together, these findings do not demonstrate a statistically significant improvement but suggest that structured educational interventions may contribute to more uniform knowledge patterns across different levels of clinical experience.

Recognition of influenza symptoms is critical for timely diagnosis and appropriate management, particularly in severe cases where treatment should not be delayed while awaiting confirmatory testing.[2,17] In our study, common symptoms such as fever, myalgia, and headache were well recognized at baseline, whereas atypical or less common manifestations, including complex febrile seizures, diarrhea, and abdominal pain, were frequently underrecognized. Senior residents initially showed greater awareness of these atypical presentations, likely reflecting broader clinical experience. After the seminar, recognition of these symptoms improved, and the knowledge gap between junior and senior residents disappeared. This pattern suggests that targeted educational efforts may improve recognition of atypical influenza presentations, an important prerequisite for timely diagnosis and appropriate clinical decision-making.

Influenza transmission is most widely associated with droplet spread; however, aerosol transmission, direct contact, and autoinoculation also contribute to viral spread.[3] Inadequate recognition of these transmission routes may compromise infection control practices. In the current study, awareness of non-droplet transmission routes, particularly autoinoculation, was limited at baseline but improved following the seminar. These findings indicate that targeted educational content may help address specific gaps in understanding transmission mechanisms, which is relevant for infection prevention knowledge among trainees.

Oseltamivir remains the primary antiviral agent for influenza treatment, despite concerns regarding emerging resistance.[18,19] Correct use of oseltamivir, including appropriate indications, dosing, and duration, is emphasized in clinical guidelines and remains an important component of influenza management education. In our study, over half of the participants knew that high-risk and severe cases require prompt antiviral therapy. After the seminar, the correct identification of common adverse effects improved significantly, and knowledge gaps between experience levels narrowed. These findings may reflect confusion arising from complex clinical scenarios or overgeneralization of treatment principles during training. Importantly, these findings suggest that educational interventions should be balanced and should clearly distinguish between treatment and prophylaxis to reduce the risk of misunderstanding.

This study has several important limitations. First, it was conducted at a single center with a relatively homogeneous group of pediatric residents, which may limit generalizability. Second, although knowledge retention was demonstrated one month after the seminar, long-term retention and its translation into clinical practice were not evaluated. Future

multicenter studies with extended follow-up are warranted to determine whether such educational benefits can be maintained over time. Third, the questionnaire was developed in accordance with guideline recommendations but was not formally validated, which should be considered when interpreting the results. Moreover, the absence of randomization, a control group, and blinding fundamentally limits causal inference, and knowledge was assessed through self-reported responses rather than objective measures of clinical behavior or patient outcomes. Observed changes cannot be confidently attributed to the educational seminar alone and may reflect testing effects, recall bias, or short-term learning. Therefore, the findings should be interpreted as descriptive of short-term changes in knowledge rather than as evidence of educational effectiveness.

Although this study has limitations, our findings suggest that a structured educational seminar can improve multiple domains of influenza-related knowledge among pediatric residents and reduce disparities between junior and senior trainees. At the same time, declines observed in some items suggest that certain topics may require more careful, repeated educational attention. Incorporating regular, guideline-based training sessions into pediatric residency programs may support sustained knowledge acquisition and improve preparedness for seasonal and emerging viral infections.

Conclusion

Our findings indicate that pediatric residents had notable gaps in influenza-related knowledge, especially regarding transmission, atypical symptoms, and antiviral use. After the seminar, higher correct response rates were observed across multiple knowledge domains at all training levels, with a reduction in initial differences between junior and senior trainees. However, remaining inaccuracies suggest the need for repeated, targeted educational efforts. Incorporating guideline-based training into pediatric residency programs may improve consistency in pediatric residents' influenza-related knowledge and preparedness.

Ethical approval

The study was approved by Tepecik Training and Research Hospital's Ethics Committee (date: 22.12.2019, number: 2019/12-22).

Author contribution

The authors confirm contribution to the paper as follows: Study conception and design: PGS, YEK, EKÖ, AKA; data collection: PGS, YEK, EBY; analysis and interpretation of results: PGS, YEK, EBY, DY; draft manuscript preparation: PGS, YEK, EKÖ, DY. All authors reviewed the results and approved the final version of the manuscript.

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Conflict of interest

The authors declare that there is no conflict of interest.

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