The Importance of Smartphones in the Diagnosis in Children Applied with the Complaint of Rash

Döküntü Şikayetiyle Başvuran Çocuklarda Akıllı Telefonların Tanı Koymadaki Önemi

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Abstract

Objective: Computer technology has found widespread use in our daily lives and has become an important part of the medical field. Studies have been conducted on the use of smartphones in the field of medicine. In our study, we aimed to demonstrate the importance of smartphone use in the diagnosis of pediatric patients with rash complaints.

Material and Methods: The clinical and laboratory findings of the patients with rash who presented to the pediatric emergency and outpatient clinics of our hospital between December 2020 and January 2022 were prospectively investigated. At least two images of the exanthema, if any, the image of the enanthema, detailed medical history, physical examination findings, and a standardized patient registration form were submitted to the pediatric infectious diseases specialist (PIDS) via WhatsApp together with the preliminary diagnosis made by the examining resident. The diagnosis was confirmed with examination by the PIDS specialist within two consecutive weekdays. The year of residency training of the consulting physician and whether they received outpatient pediatric infectious diseases training were also noted.

Results: A total of 196 cases were included in the study. The rate of accurate diagnoses made by the PIDS on the phone was 89.8%. The mean age of the patients was 67.1 ± 58.1 months (1-210 months). Regarding the seasonal distribution of the diseases, dermatitis was found to occur at higher rates in winter compared to autumn (p= 0.015). Other diseases did not differ by season. When the distribution of the preliminary diagnoses made by the PIDS on the phone was evaluated, it was seen that shingles, hand-foot-mouth disease, herpes virus infection, impetigo, scarlet fever, multisystem inflammatory syndrome in children, fungal

Öz

Giriş: Bilgisayar teknolojisi, günlük hayatımızda yaygın kullanım alanı bulmuş ve tıp alanının önemli bir parçası haline gelmiştir. Akıllı telefonların tıp alanında kullanımı ile ilgili yapılan çalışmalar mevcuttur. Çalışmamızda, döküntü şikayeti olan çocuk hastaların tanılarının konulmasında akıllı telefon kullanımının önemini göstermeyi amaçladık.

Gereç ve Yöntemler: Hastanemizin çocuk acil ve polikliniklerine Aralık 2020-Ocak 2022 tarihleri arasında başvuran ve döküntülü hastalığı bulunan olguların, klinik ve laboratuvar bulguları prospektif olarak incelendi. Döküntü ile başvuran hastadan ekzanteme ait en az iki görüntü, varsa enantemin görüntüsü, ayrıntılı anamnez ve fizik muayene ile hasta kayıt formu standardize şekilde doldurularak muayene eden asistan hekim tarafından konulan ön tanı ile birlikte WhatsApp aracılığıyla çocuk enfeksiyon hastalıkları uzmanına (ÇEHU) danışıldı. Takip eden ilk iki iş gününde ÇEHU muayenesi ile tanı doğrulandı. Danışan doktorun asistanlık eğitim yılı ve çocuk enfeksiyon hastalıkları poliklinik eğitimi alıp almadığı ayrıca not edildi.

Bulgular: Çalışmaya 196 olgu dahil edildi. ÇEHU'nun telefonla doğru tanı koyma yüzdesi %89.8'di. Hastaların yaş ortalaması 67.1 ± 58.1 (1-210 ay) aydı. Hastalıkların mevsimlere göre dağılımına bakıldığında dermatitin kış ayında sonbahara göre daha yüksek oranda olduğu görüldü (p= 0.015). Diğer hastalıkların mevsimlere göre farklılık göstermediği görüldü. ÇEHU'nun telefonda koyduğu ön tanıların dağılımlarına ayrı ayrı bakıldığında zona, el-ayak-ağız hastalığı, herpes virüs enfeksiyonu, impetigo, kızıl, çocuklarda multisistem enflamatuvar sendrom, mantar enfeksiyonu, eritema multiforme, Epstein-Barr virüs enfeksiyonu, pitriyazis likenoides et varioliformis akuta (PLEVA), psoriasis, pellegra, leis-

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infections, erythema multiforme, Epstein-Barr virus, pityriasis lichenoides et varioliformis acuta (PLEVA), psoriasis, pellagra, leishmaniasis, erysipelas, neonatal pustular melanosis, orf and Henoch-Schönlein purpura (HSP) were diagnosed with 100% accuracy.

Conclusion: Utilization of smartphones in diagnosing exanthematous diseases can reduce patient waiting times, allow for early initiation of treatment, and facilitate more rapid contact with specialists.

Keywords: Smartphone, child, rash, WhatsApp

hmaniasis, erizipel, neonatal püstüler melanoz, orf ve Henoch-Schönlein purpurası (HSP) hastalıklarına %100 doğrulukla tanı konuldu.

Sonuç: Döküntülü hastalıklara tanı koyarken akıllı telefon kullanımı, hasta bekleme süresinin azalmasını, tedavinin daha hızlı başlatılmasını ve alanında uzman doktora daha hızlı erişim gibi imkanlar sağlayabilmektedir.

Anahtar Kelimeler: Akıllı telefon, çocuk, döküntü, WhatsApp

Introduction

Smartphones and instant messaging applications are as widely used among healthcare professionals as they are among the general public (1). Many viral skin diseases affecting children pose a diagnostic challenge for clinicians. Most of these diseases can be conveniently grouped as maculopapular, petechial, papular, or vesicular based on the clinical appearance of the exanthem (2).

Rash in children is one of the most common causes of admission to emergency and outpatient clinics. The more common causes of fever and maculopapular eruptions include infectious processes with rashes [such as roseola, rubeola, rubella, parvovirus B19, hand-foot-mouth disease, scarlet fever, meningococcemia, Epstein-Barr virus (EBV) infection], hypersensitivity reactions (exanthematous drug reactions), and vasculitides (such as Kawasaki disease). A disease with a rash can range from being mild and self-limiting to fatal without prompt intervention. Therefore, rapid diagnosis and intervention are important. The use of smartphone applications in facilitating the diagnosis of exanthematous diseases and consulting with experts in the field has started to play an important role in medicine (3).

In our study, we aimed to evaluate the effectiveness of the WhatsApp application in quickly reaching an accurate diagnosis for children with rash.

Materials and Methods

Children aged 1 day to 18 years who presented with a rash to pediatric emergency and outpatient clinics of Necmettin Erbakan University Meram Faculty of Medicine between December 2020 and January 2022 were included in our study. A total of 211 cases were evaluated. Twelve patients were excluded as they did not come for follow-up at the pediatric infectious diseases clinic despite being consulted with a pediatric infectious disease specialist (PIDS) via WhatsApp. Additionally, three patients were excluded due to conditions not involving an exanthematous disease, such as diaper dermatitis. The clinical and laboratory findings of the patients were prospectively examined. At least two images of the exanthema, if any, the image of the enanthema, detailed medical history, physical examination findings, and a standardized patient registration form were submitted to the PIDS via WhatsApp together with the preliminary diagnosis made by the examining resident. The residents' years of training and whether they worked in the pediatric infectious diseases clinic were recorded. The initial diagnosis of the patient was established, and tests were planned based on this initial diagnosis. The diagnosis was confirmed with examination by the PIDS within two consecutive weekdays. The initial diagnosis made by the resident was compared with the diagnosis of the PIDS.

All data were analyzed using the SPSS 25.0 software package. Variables were summarized as frequency (n), percentage (%), arithmetic mean, standard deviation, median (minimum-maximum). A significance level of $p < 0.05$ was considered for the analysis results. Ethics committee approval of the study was obtained from the Ethics Committee of Necmettin Erbakan University Meram Faculty of Medicine (2020/2913).

Results

The mean age of 196 patients included in the study was 67.1 ± 58.1 months (1-210 months), 112 (57.1%) were male and 84 (42.9%) were female. It was observed that 41 (20.9%) patients had rashes in spring, 69 (35.2%) in summer, 40 (20.4%) in autumn, and 46 (23.5%) in winter.

The distribution of diseases is shown in Table 1, categorized as non-infectious causes, herpes virus (HSV) infections, superficial skin infections and cellulitis, parasitic and fungal infections, subcutaneous skin infections, and other viral infections. The seasonal distribution of the most common exanthematous diseases is illustrated in Figure 1.

It was observed that the occurrence of diseases varied significantly by season ($p = 0.020$). Dermatitis was more prevalent in winter compared to autumn ($p = 0.015$). No significant seasonal variation was found in the distribution of other diseases ($p > 0.05$).

The accuracy of diagnoses made by the PIDS via phone and those made by residents compared to the definitive diagnosis is presented in Table 2.

When comparing the accuracy of diagnoses for the eight most common exanthematous diseases, no significant difference was found between residents based on their seniority and whether they worked in the infectious disease clinic ($p > 0.05$).

The accuracy of the PIDS's diagnoses for specific diseases made via phone was 100% for herpes zoster, hand-

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Table 1. Diagnostic distribution of patients presenting with rash

Diagnoses	n= 196 (%)
Non-infectious Causes	76 (38.8)
Dermatitis	20 (10.2)
Insect bite	16 (8.2)
Urticaria	13 (6.6)
Drug allergy	6 (3.1)
Eczema	5 (2.6)
Allergic rash	5 (2.6)
Akne	3 (1.5)
Vasculitis	2 (1.0)
Psoriasis	1 (0.5)
Pellagra	1 (0.5)
Neonatal pustular melanosis	1 (0.5)
Pityriasis rosea	1 (0.5)
Henoch-Schönlein purpura	1 (0.5)
PLEVA	1 (0.5)
Herpes Virus Infections	55 (28.1)
Shingles	26 (13.3)
Chickenpox	12 (6.1)
Sixth disease	10 (5.1)
Herpes simplex virus	7 (3.6)
Superficial Skin Infections and Cellulitis	10 (5.1)
Impetigo	6 (3.1)
Scarlet fever	3 (1.5)
Erysipelas	1 (0.5)
Parasitosis and Fungal Infections	9 (4.9)
Scabies	5 (2.6)
Fungal infection	3 (1.5)
Leishmaniasis	1 (0.5)
Subcutaneous Tissue Infections	2 (1.0)
Erythema multiforme	2 (1.0)
Other Viral Infections	44 (22.4)
Viral eruption	24 (12.2)
Hand-foot-mouth disease	15 (7.7)
Multisystem inflammatory syndrome in children	3 (1.5)
Epstein-Barr virus infection	1 (0.5)
Orf	1 (0.5)

foot-mouth disease, HSV infections, impetigo, scarlet fever, multisystem inflammatory syndrome in children (MIS-C), fungal infections, erythema multiforme, EBV infection, pityriasis lichenoides et varioliformis acuta (PLEVA), psoriasis, pellagra, leishmaniasis, erysipelas, neonatal pustular melanosis, orf, and Henoch-Schönlein purpura (HSP), with the lowest accuracy observed for pityriasis rosea.

Residents achieved 100% accuracy in diagnosing urticaria, chickenpox, herpes, scabies, MIS-C, fungal infections, erythema multiforme, psoriasis, pellagra, leishmaniasis, erysipelas, and pityriasis rosea. The lowest accuracy rates were found for EBV infection, PLEVA, neonatal pustular melanosis, orf, and HSP.

Discussion

Smartphones and instant messaging applications are as widely preferred among healthcare professionals as they are among the general public (1). Planning trainings on responsible social media and smartphone use is believed to contribute to the development of better-equipped physicians (4). Smartphone applications are frequently used in the medical field to facilitate the diagnosis of exanthematous diseases (3,5). In our study, we planned to evaluate the use of smartphones in pediatric cases presenting with rashes.

For the purposes of our study, we chose WhatsApp as the application for conducting consultations, which were performed using a brief clinical history and at least two photos of the rash. In a similar study conducted by dermatologists in Norway, the Askin® application was used for consultations on exanthematous diseases. It has been reported that in the Askin® application, the referring physician writes a brief history about the patient in a designated section of the application, answers predefined questions ranging from 1 to 5, takes a photo of the affected skin area, and also utilizes the AskinScope® dermatoscopy lens, which can be attached to the smartphone camera, to send dermatoscopic images. It was also noted that the referring physician received responses from the consultant physician through the same application (6). It is understood that the Askin® application is more specific for the consultation of exanthematous diseases compared to WhatsApp, but WhatsApp is also one of the applications that can be used safely due to its easy accessibility and high diagnosis rates.

The mean age of the patients in our study was 67.1 ± 58.1 months. In another similar study, the age range of patients presenting with exanthematous diseases was reported to be between birth and 10 years (5). In a similar study conducted by Devrim et al., the mean age of patients was 58.1 ± 45 months (1). In our study, 112 (57.1%) of the patients were male, and 84 (42.9%) were female. In another similar study, out of 194 patients, 58 (29.9%) were female and 136 (70.1%) were male (1).

Forty-one (20.9%) of our patients had rashes in the spring, 69 (35.2%) in the summer, 40 (20.4%) in the autumn, and 46 (23.5%) in the winter. There was no significant difference in the distribution of diseases according to seasons. It was found significant that only dermatitis was more frequent in winter. In another study, out of a total of 879 patients, 118 were diagnosed with dermatitis, and it was reported that 68 (28.3%)
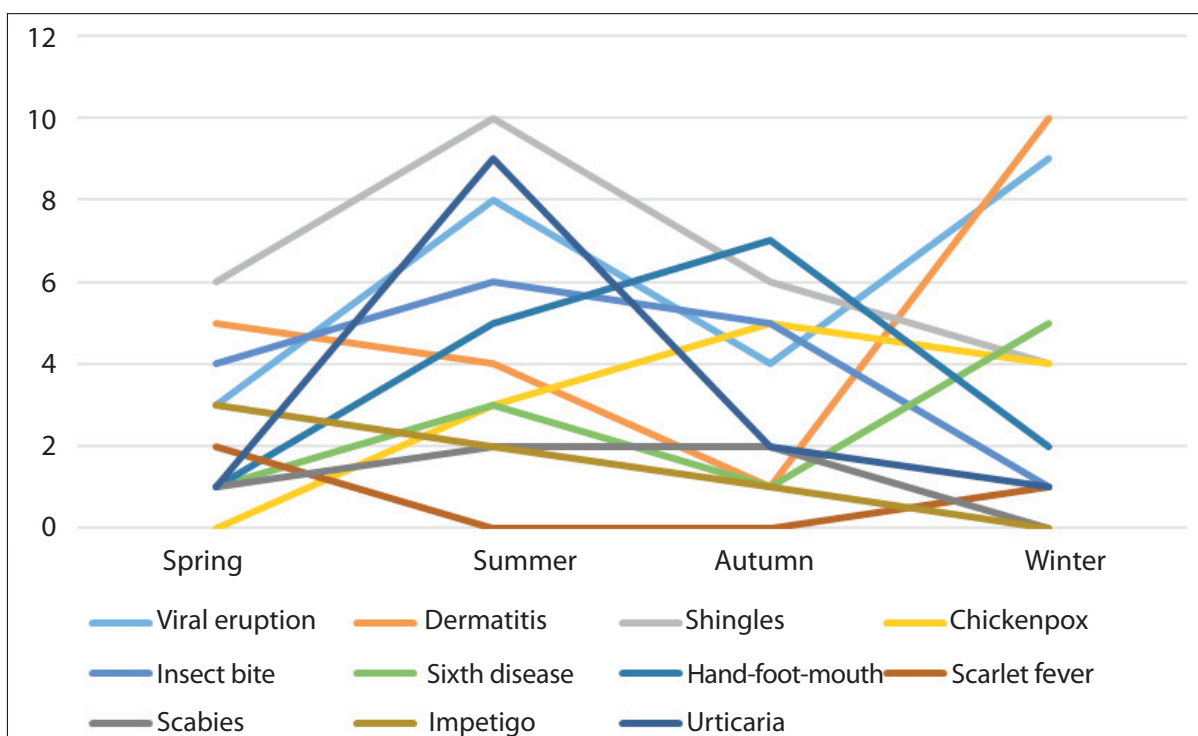
Figure 1. The seasonal distribution of the most common exanthematous diseases.

Table 2. Accuracy rates of diagnoses made by pediatric infectious disease specialists via WhatsApp and those made by resident doctors, in comparison to definitive diagnoses

Characteristics	Accurate Diagnosis/Total Patients	%	p*
Residents-PIDS	163/196-176/196	83.2-89.8	**0.028**
First-year resident-PIDS	32/37-35/37	86.5-94.6	0.257
Second-year resident-PIDS	35/42-37/42	83.3-88.1	0.480
Third-year resident-PIDS	27/34-31/34	79.4-91.2	0.102
Fourth-year resident-PIDS	69/83-73/83	83.1-88.0	0.285
Worked in the infectious diseases clinic-PIDS	76/89-76/89	85.4-85.4	>0.999
Did not work in the infectious diseases clinic-PIDS	87/107-100/107	81.3-93.5	**0.003**
*Marginal Homogeneity test. PIDS: Pediatric infectious diseases specialist.			

of these patients presented in the winter (7). Although the seasonal distribution of other diseases in our study did not show significant differences, a detailed examination revealed that the most common diseases, shingles, insect bites, and urticaria, were seen in the summer; chickenpox and hand-foot-mouth disease in the autumn; and sixth disease predominantly in the winter. It is known that the type and frequency of exanthematous diseases are directly or indirectly affected by the climate. The climatic factors determining the frequency of these diseases are cold, heat, light, sunlight, and humidity (8). Low temperatures and low humidity in winter are considered etiological factors for dermatitis (9). This may explain the high incidence of dermatitis observed in the winter in our study. However, in the literature, chickenpox is seen

at high rates in late winter and spring, differing from our study data, and hand-foot-mouth disease is observed particularly between spring and early autumn, which is consistent with our data (10,11). This was attributed to the study period coinciding with the SARS-CoV-2 pandemic and the isolation measures implemented.

When we examined the distribution of definitive diagnoses of the diseases in our study, it was found that 76 (38.8%) were due to non-infectious causes (dermatitis, insect bites, urticaria, drug allergy, eczema, other allergic rashes, acne, vasculitis, psoriasis, pellagra, neonatal pustular melanosis, pityriasis rosea, HSP, PLEVA), 55 (28.1%) were HSV infections (shingles, chickenpox, sixth disease, HSV infection), 10 (5.1%) were superficial skin infections and cellulitis (impetigo, scarlet

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fever, erysipelas), 9 (4.6%) were parasitosis and fungal infections (scabies, fungal infections, leishmaniasis), 2 (1%) were subcutaneous skin infections (erythema multiforme), and 44 (22.4%) were other viral infections (non-specific viral eruptions, hand-foot-mouth disease, MIS-C, EBV infection, orf). In a similar study, the most common definitive diagnoses among 194 patients were chickenpox in 33 patients (17%), skin infections (including impetigo, ecthyma, erysipelas, and cellulitis) in 33 patients (17%), shingles (herpes zoster infection) in 13 patients (6.7%), insect bites in 10 patients (4.6%), and HSV infections in 13 patients (6.7%) (1).

MIS-C is a serious disease with a high rate of morbidity and mortality, and early diagnosis is important (12). Despite the recent identification of MIS-C following the COVID-19 pandemic, and although the three patients who presented had blanching maculopapular non-specific rashes, they were correctly diagnosed (100%) by the residents who examined them at admission. This was thought to be related to our center providing active services during the COVID-19 pandemic and being a referral center for complicated cases. Additionally, the high awareness of MIS-C due to its prominence might be related to residents sharing information about the rashes on their social media accounts, increasing awareness about the disease.

In our study, the percentage of accurate diagnoses by the PIDS via phone was 89.8%. When we compared the diagnoses made by PIDS over the phone with the preliminary diagnoses made by the residents after evaluating the patients, a high concordance was observed. When this comparison was classified according to the seniority of the residents, no difference was found. However, when we classified and compared residents based on their working status in the infection clinic, the accuracy of the diagnoses made by PIDS was found to be significantly higher for those not working in the clinic. When we compared the diagnoses made by residents who worked in the pediatric infectious diseases clinic with the preliminary diagnoses by PIDS, the accuracy rates were found to be the same. In another study, children presenting to the pediatric emergency department with rashes were diagnosed by sending at least two images taken by residents via WhatsApp to the chief consultant of the pediatric infectious diseases department. The patients were then re-evaluated by another PIDS on the first working day following the initial consultation, and the definitive diagnoses were recorded and compared with the initial diagnoses. It was reported that the initial diagnoses made via WhatsApp were 96.3% consistent with the definitive diagnoses (1). However, to the best of our knowledge, there is no study in the literature that compares the diagnoses made by residents based on their seniority and their working status in the pediatric infection clinic with the diagnoses made by PIDS via WhatsApp, evaluating the accuracy rates against definitive diagnoses.

In our study, the rate of correct diagnosis for the eight most common diseases did not differ according to the seniority of residents and their working status in the infectious diseases outpatient clinic. The most common diseases reported were shingles, non-specific viral eruptions, dermatitis, insect bites, hand-foot-mouth disease, urticaria, chickenpox, and sixth disease, while in another study, the most common exanthematous diseases were chickenpox, skin infections (ecthyma, erysipelas, impetigo, cellulitis), shingles, insect bites, and herpes simplex virus infections (1). In another study conducted in India, the most common exanthematous diseases were reported as impetigo, miliaria, scabies, furunculosis, dermatitis, and papular urticaria (7).

In our study, PIDS achieved 100% accuracy in diagnosing shingles, hand-foot-mouth disease, herpes, impetigo, scarlet fever, MIS-C, fungal infections, erythema multiforme, EBV infections, PLEVA, psoriasis, pellagra, leishmaniasis, erysipelas, neonatal pustular melanosis, orf, and HSP via phone. The lowest accuracy rate (one patient) was observed with pityriasis rosea, which was attributed to it being a primary skin disease that is infrequently seen in our clinic. Other diseases with lower accuracy rates included vasculitides (50%), eczema (60%), acne (66.7%), and drug allergy (66.7%). In a similar study, it was reported that seven patients were not correctly diagnosed initially via WhatsApp. These misdiagnoses included four cases of measles, one case of staphylococcal scalded skin syndrome, one case of cutaneous leishmaniasis, and one case of petechial rash (1).

Residents achieved 100% accuracy in diagnosing urticaria, chickenpox, HSV infections, scabies, MIS-C, fungal infections, erythema multiforme, psoriasis, pellagra, leishmaniasis, erysipelas, and pityriasis rosea. The lowest accuracy rates were found for EBV infection (0%), PLEVA (0%), neonatal pustular melanosis (0%), orf (0%), and HSP (0%). Our study demonstrated that the residents were able to diagnose common diseases more accurately, reflecting the diagnosis distribution of patients presenting with rashes in pediatric emergency services and pediatric outpatient clinics.

The most critical step in diagnosing exanthematous diseases is clinical examination, which often allows for direct diagnosis. The most common ones are maculopapular rashes (13). In our study, the residents provided preliminary diagnoses through clinical examination during the initial visit, and the accuracy of the diagnoses was compared with the preliminary diagnoses made by PIDS via WhatsApp and the definitive clinical diagnosis. Although applications such as WhatsApp significantly aid in the early diagnosis of exanthematous diseases, clinical examination remains essential.

Conclusion

In conclusion, while the primary approach to exanthematous diseases is examination and workup, the use of smart-

phones can facilitate faster access to specialists, reducing patient wait times and enabling quicker treatment initiation, especially in cases requiring differential diagnosis. Additionally, this method can provide a valuable educational opportunity for residents.

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