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Triage performance in adolescent patients with SARS-CoV-2 infection in Israel

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ABSTRACT

Objective: The aim of this study was to assess the performance of the Pediatric Canadian Triage and Acuity Scale (PaedCTAS) in adolescent patients with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection.

Methods: A time-series study was conducted in the Emergency Departments (EDs) of 17 public hospitals during the Delta (B.1.617.2) variant spread in Israel. Data were collected prospectively from June 11, 2021 to August 15, 2021. Multivariate regression analyses were performed to identify independent variables associated with hospital admission and with admission to an Intensive Care Unit (ICU).

Results: During the study period, 305 SARS-CoV-2 patients ages 12–18 years presenting to the ED were included, and 267 (87.5%) were unvaccinated. Sixty-seven (22.0%) and 12 (3.9%) patients were admitted to pediatric wards and ICUs, respectively. PaedCTAS level 1–2 and the presence of chronic disease increased the odds of hospital admission (adjusted odds ratio (aOR) 5.74, 95% CI, 2.30–14.35, $p < 0.0001$), and (aOR 2.9, 95% CI, 1.48–5.67, $p < 0.02$), respectively. PaedCTAS level 1–2 and respiratory symptoms on presentation to ED increased the odds of ICU admission (aOR 27.79; 95% CI, 3.85–176.91, $p < 0.001$), and (aOR 26.10; 95% CI, 4.47–172.63, $p < 0.0001$), respectively. PaedCTAS level 3–5 was found in 217/226 (96%) of the patients who were discharged home from the ED.

Conclusions: The findings suggest that PaedCTAS level 1–2 was the strongest factor associated with hospital and ICU admission. Almost all the patients who were discharged home had PaedCTAS level 3–5. Study findings suggest good performance of the PaedCTAS in this cohort.

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Abbreviations: SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; ED, Emergency Department, ICU=Intensive Care Unit; RT-PCR, reverse-transcriptase polymerase chain reaction; PedCTAS, Pediatric Canadian Triage Acuity Scale.

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1. Introduction

In children, infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) can result in severe illness that requires hospitalization or treatment in the intensive care unit (ICU) [1-3]. Efficient Emergency Department (ED) triage is important to ensure the ongoing provision of high-quality care to these patients.

On June 2, 2021, the Israel Ministry of Health approved the use of the SARS-CoV-2 vaccine in patients aged 12–15 years [4,5]. The Delta (B.1.617.2) variant spread that started in Israel in mid-June 2021 provided an opportunity to evaluate the performance of ED triage in adolescent patients with SARS-CoV-2 infection.

In Israel, pediatric ED staff use the Pediatric Canadian Triage Acuity Scale (PaedCTAS) to triage patients. The aim of this study was to assess the performance of the PaedCTAS in adolescent patients with SARS-CoV-2 infection in Israel.

2. Methods

2.1. Study design and participants

A time-series study was conducted in the EDs of 17 public hospitals in Israel.

SARS-CoV-2 patients ages 12–18 years presenting to the EDs during the Delta (B.1.617.2).

variant spread were included. Data were collected prospectively from June 11, 2021, to August 15, 2021. Patients were included if they were admitted to the ED because of an acute illness and had a positive SARS-CoV-2 test result confirmed by using nasopharyngeal sample reverse transcriptase-polymerase chain reaction (RT-PCR). Patients had the SARS-CoV-2 test prior to ED arrival or at the ED after a decision to hospitalize was made.

ICU admission criteria included the need for respiratory support, such as the use of high flow nasal canula or continuous positive airway pressure, and/or the need for advanced monitoring.

Patients were categorized as being vaccinated if the second SARS-CoV-2 vaccine dose had been administered at least two weeks before ED admission [5].

2.2. Pediatric ED triage in Israel

In Israel, all children aged 0–18 years are seen in Pediatric EDs. Since 2015, the Pediatric ED staff use the PaedCTAS to triage patients [6], a triage system that has been used widely in Canada and other countries since 2001. Using this method, patients are divided into five acuity levels according to their medical or traumatic problem: level 1 – patient requires immediate evaluation and care, level 2 – patient requires evaluation and care within 15 min, level 3 – patient requires evaluation and care within 30 min, level 4 – patient requires evaluation and care within 60 min, and level 5 – patient requires evaluation and care within 120 min [7]. The triage is performed using a Hebrew version of the PaedCTAS by a registered nurse, trained in using the PaedCTAS [8].

The institutional review board of each participating center approved the study and waived the need for individual informed consent based on strict safeguarding of participant anonymity by de-identifying patients during database entry.

2.3. Statistical analysis

Data were analyzed with SPSS 21 version (SPSS-IBM, Chicago, IL). Multivariate regression analyses were performed to identify independent variables associated with hospital admission, and with admission to ICU. The variables introduced in the regression model were based on clinical relevance. In addition to the PaedCTAS level, we included age, sex, SARS-CoV-2 vaccination status (unvaccinated, vaccinated), known chronic disease (asthma, oncologic or hematologic disease, neurologic disease, obesity, other), and ED presentation (non-respiratory symptoms, respiratory symptoms).

3. Results

Overall, 305 SARS-CoV-2 patients aged 12–18 years visited the EDs of the 17 participating hospitals during the study period; 267 (87.5%) were unvaccinated and 38 (12.5%) were vaccinated. Sixty-seven (22.0%) and 12 (3.9%) patients were admitted to pediatric wards and ICUs, respectively (Table 1). One patient with a severe neurologic disorder died in the ICU due to respiratory failure. This 17-year-old female was referred to the ED four weeks after receiving the second SARS-CoV-2 vaccine. Among the patients who were discharged from the ED, 217/226 (96%) had PaedCTAS levels of 3–5 (Table 1).

Of the 29 patients with PaedCTAS level 1–2, 8 had PaedCTAS level 1 and 21 had PaedCTAS level 2. All the 8 patients with PaedCTAS level 1 were admitted to hospital and 7 were admitted to ICU. Of the 21 patients with PaedCTAS level 2, 12 were admitted to pediatric wards and 9 were discharged, 5 of whom had respiratory symptoms at presentation.

PaedCTAS level 1–2 and the presence of chronic disease increased the odds of hospital admission (adjusted odds ratio (aOR) 5.74, 95% CI, 2.30–14.35, $p < 0.0001$) and (aOR 2.9, 95% CI, 1.48–5.67, $p < 0.02$), respectively. PaedCTAS level 1–2 and respiratory symptoms on ED admission increased the odds of ICU admission (aOR 27.79; 95% CI, 3.85–176.91, $p < 0.001$) and (aOR 26.10; 95% CI, 4.47–172.63, $p < 0.0001$), respectively (Table 2).

Table 1
Demographic and clinical characteristics.

	Discharge ($n = 226$)	Admission to a pediatric ward ($n = 67$)	Admission to ICU ($n = 12$)
Age, median (IQR), y	15 (13–16)	15 (14–16)	14 (13–15)
Sex, n (%)			
Male	90 (39.8)	36 (53.7)	3 (25)
Female	136 (60.2)	31 (46.3)	9 (75)
PaedCTAS Level, n (%)			
1–2	9 (4.0)	13 (19.4)	7 (58.3)
3–5	217 (96.0)	54 (80.6)	5 (41.7)
SARS-CoV-2 Vaccination Status, n (%)*			
Unvaccinated	196 (86.7)	60 (89.0)	11 (91.7)
Vaccinated	30 (13.3)	7 (10.5)	1 (8.3)
History			
-Healthy	193 (85.4)	45 (67.2)	6 (50)
-Known chronic disease, n (%)	33 (14.6)	22 (32.8)	6 (50)
Asthma	10	1	0
Oncologic or hematologic disease	6	6	0
Neurologic disease	3	3	2
Obesity	2	2	3
Other	12	10	1
ED Presentation, n (%)			
-Non-respiratory symptoms	202 (89.4)	63 (94.0)	3 (25)
Fever	113	39	1
Gastrointestinal symptoms**	18	7	0
Neurological symptoms***	17	11	2
Other	54	6	0
-Respiratory symptoms	24 (10.6)	4 (6.0)	9 (75)
Respiratory distress	13	4	9
URTI****	11	0	0

Notes
Abbreviations: ED = Emergency Department, ICU = Intensive Care Unit, URTI = Upper Respiratory Tract Infection, SARS-CoV-2 = Severe Acute Respiratory Syndrome Coronavirus 2, PaedCTAS = Pediatric Canadian Triage and Acuity Scale.
*Patients were categorized as being vaccinated if the second BNT162b2 mRNA vaccine dose had been administered at least two weeks before ED admission.
**Vomiting, diarrhea, abdominal pain.
***Seizure, headache, myalgia.
****Cough, rhinorrhea, sore throat.

4. Discussion

Triage systems are intended to quickly identify patients who require immediate care and optimize the use of medical resources [6-8]. The differences in the presentation of SARS-CoV-2 infection between adults, older children and younger children emphasize the importance of triage [9].

The major finding of this study is that a high acuity triage score was the strongest factor associated with the admission of adolescents with SARS-CoV-2 infection to hospital and to ICU. Another important finding is that almost all the patients who were assigned low acuity triage scores were discharged home from the ED. This finding suggests that a low acuity triage score was predictive of hospital discharge. Collectively, these results suggest good performance of the paedCTAS in this cohort of adolescent patients with SARS-CoV-2 infection. Similar findings on the performance of the PaedCTAS were reported during the pre-SARS-CoV-2 era by a Canadian multicenter study and an Israeli single-center study [7,8].

Similar to a previous study, the most common symptom at ED presentation was fever, followed by respiratory symptoms, and gastrointestinal symptoms [2].

We found that the presence of chronic disease was independently associated with hospital admission. Asthma, oncologic or hematologic disease, neurologic disease and obesity were the main chronic diseases reported. This finding is corroborated by recent studies that investigated the association between comorbidity and hospital admission in SARS-CoV-2 pediatric patients [1-3]. Another important finding is that the presence of respiratory symptoms on ED admission was strongly associated with ICU admission, a finding that is well-known in adults with SARS-CoV-2 infection [10]. This finding is corroborated by a recent study that reported that symptoms of respiratory infection were predictive of ICU admission in children [3].

Our study has several limitations. Firstly, the number of patients in this study is relatively small. Because of the small size of our cohort, it may be underpowered to detect a potential association between vaccination status and hospitalization. Secondly, the 17 medical centers of the study are public hospitals and patients who attended prehospital emergency care facilities were not represented. Thirdly, variation between hospitals in ICU admission policy is a possible limitation. Fourthly, since healthcare systems vary greatly across countries, our findings may not be generalizable to other populations.

In summary, study findings suggest that PaedCTAS level 1–2 was the strongest factor associated with hospital and ICU admission, and that almost all patients who were discharged home had PaedCTAS level 3–5. The findings suggest good performance of the PaedCTAS in this cohort. To our knowledge, this is the first study that has provided data on triage performance in adolescents with SARS-CoV-2 infection. Our findings contribute to the existing research on children with SARS-CoV-2 infection.

Table 2
Results of multivariable regression analyses of factors associated with hospital admission of Emergency Department patients aged 12–18 years with SARS-CoV-2 infection

	Admission to the hospital *			Admission to ICU		
	aOR	*95% CI*	*P value*	*aOR*	*95% CI*	*P value*
Age	1.01	0.85–1.20	0.87	O.91	0.55–1.50	0.71
Female	Ref	–	–	Ref	–	–
Male	0.69	0.39–1.23	0.21	2.75	0.40–18.68	0.30
PaedCTAS level						
3–5	Ref	–	-	Ref	–	–
1–2	5.74	2.30–14.35	<0.0001	27.79	3.85–176.91	<0.001
Vaccination status**						
Vaccinated	Ref	–	–	Ref	–	–
Unvaccinated	0.97	0.46–2.01	0.93	1.12	0.41–3.03	0.81
ED Presentation		–			–	
Non-respiratory	Ref	–	–	Ref	–	–
Respiratory	1.46	0.61–3.45	0.39	26.10	4.47–172.63	<0.0001
Known Chronic Disease	2.90	1.48–5.67	0.02	1.97	0.37–10.53	0.42

Notes
aOR = adjusted Odds Ratio, CI = Confidence Interval, ICU = Intensive Care Unit, ED = Emergency Department,
PaedCTAS = Pediatric Canadian Triage and Acuity Scale.
*To a pediatric ward or ICU.
**Patients were categorized as being vaccinated if the second BNT162b2 mRNA vaccine dose had been administered at least two weeks before ED admission.

Contributors' statement

Dr. Nitai Levy contributed to study conceptualizationm, designed the study, performed data curation, analyzed and interpreted the data, reviewed the literature, and critically revised the article; Dr. Nir Friedman designed the study, analyzed and interpreted the data, reviewed the literature, and critically revised the article. Dr. Nir Friedman has equal contribution as first author; Dr. Or Kaplan, Dr. Gabi Padeh, Dr. Danna Krupik,

Dr. Nachshon Buchshtav, Dr. Shirly Gamsu, Dr. Giora Weiser, Dr. Naama Kuchinski Cohen, Dr. Zeev Schnapp, Dr. Noy Cohen, Dr. Jordanna H. Koppel, Dr. Danit Porat, Dr. Moran Gal, Dr. Alexandra Gleyzer, and Dr. Tali Capua performed data curation, analyzed and interpreted the data, carried out the initial analyzis and critically revised the article. Prof Itai Shavit conceived the idea for the study, analyzed and interpreted the data, and drafted the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Access to data

Dr. Nitai Levy, Dr. Nir Friedman, and Prof. Itai Shavit have full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Financial disclosure

None declared for all 18 authors.

Conflict of interest

For all 18 authors, there are no potential conflicts of interest, real or perceived in the study design, the collection, analysis, and interpretation of data, the writing of the report, and the decision to submit the paper for publication.

Competing interests and funding

No honorarium, grant, or other form of payment was given to anyone to produce the manuscript.

Ethics committee approval

The study was approved by the institutional review boards of each of the 17 participating centers (Ref # 0086-21-ASF).

CRediT authorship contribution statement

Nitai Levy: Writing – review & editing, Validation, Methodology, Formal analysis, Data curation. **Nir Friedman:** Writing – review & editing, Validation, Methodology, Formal analysis, Data curation. **Or Kaplan:** Writing – review & editing, Investigation, Data curation. **Gabi Padeh:** Writing – review & editing, Investigation, Data curation. **Danna Krupik:** Writing – review & editing, Investigation, Data curation. **Nachshon Buchshtav:** Writing – review & editing, Investigation, Data curation. **Shirly Gamsu:** Writing – review & editing, Investigation,

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