Assessment of hospitalized patients with coronavirus disease 2019: a Saudi Arabian isolation center experience

Amira H. Allam[a], Mohamed S. Sadek[a], Mohamed A. Abdellatif[b], Tahany M. Gouda[a]

[a]Department of Chest, Faculty of Medicine, Benha University, Benha, [b]Department of Radiology, Faculty of Medicine, Al-Azhar University, Cairo, Egypt

Correspondence to Amira H Allam, MD, Department of Chest Diseases, Faculty of Medicine, Benha University, Benha 13512, Egypt. Tel: 013/3225491; fax: 0133227491-0133213511;
e-mail: amrhoc@yahoo.com

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Introduction
Coronaviruses are a large family of viruses that lead to diseases in animals or humans.
Objective
To assess clinical, radiological, and laboratory criteria, as well as treatment of patients hospitalized with coronavirus disease 2019, and the relation to radiological progression and hospital stay.
Patients and methods
This study was a prospective observational study conducted in an isolation sector in a private hospital in Saudi Arabia. Data were obtained from electronic records.
Results
A total of 30 patients were enrolled (24 males and six females), and their mean age was 51.2±15.05 years. The presenting symptoms were fever (83.3%), cough (33.3%), shortness of breathing (26.7%), body aches (16.7%), and sore throat (10%). Chest radiograph was abnormal in 76.6%. C-reactive protein (CRP) was high at 112.59±140±0.50 mg/l, and serum ferritin was 763.21±652.18 μg/l. Lactate dehydrogenase (LDH) was higher than normal at 312.86±161 U/l. Mean D-dimer was 0.97±1.11 μg/ml. international normalized ratio was 1.09±0.194. Fibrinogen was high at 575.32±220.08 mg/dl, and activated partial thromboplastin time was 37.94±17.46 s. There was a strong positive correlation between serum ferritin and temperature, LDH, and aspartate transaminase. CRP had a strong positive correlation with alanine transaminase, total leukocytic count, lymphocytes, and neutrophil/lymphocyte ratio. Hospital stay was positively correlated with ferritin. LDH was negatively correlated with lymphocytic count. The correlation between radiological course and laboratory follow-up was poor.
Conclusion
Coronavirus disease 2019 affects males more than females and is more in elderly. Fever is a common presenting symptom. Infection affects many blood indices, such as LDH, ferritin, CRP, and fibrinogen. Radiological course of the lesions is not affected by those blood indices, whereas hospital stay is affected. The outcome is favorable in most of the patients.

Keywords:
assessment, coronavirus disease 2019, experience, hospitalized, Saudi Arabia

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Introduction

Coronaviruses are a large family of viruses that can lead to diseases in animals or humans [1]. Since December 2019, the outbreak of pneumonia cases caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has prompted the announcement of a public health emergency of international concern [2].

In 2002–2003, a new coronavirus of the β genera and with origin in bats crossed over to humans via the intermediary host of palm civet cats in the Guangdong province of China. This virus was named SARS coronavirus, and it affected 8422 people mostly in China and Hong Kong and caused 916 deaths (mortality rate 11%) before being controlled [3]. It is possible that this experience along with other infectious diseases permitted China to respond efficiently and quickly with coronavirus disease 2019 (COVID-19) pandemic [4].

In 2012, the Middle East respiratory syndrome coronavirus (MERS-CoV), again of bat source, was discovered in Saudi Arabia with dromedary camels as the intermediate host and affected 2494 people and caused 858 deaths (fatality rate 34%) [5]. Since 2012, Saudi Arabia has attained enormous experience from the MERS-CoV endemic. For instance, after the

discovery of the MERS-CoV, the Saudi Ministry of Health has directly incorporated a command and control center and accelerated the formation of the Saudi Center for Disease Control and Prevention, which are now operational and are in the battleground of the country response to SARS-CoV-2 [6].

Aim

The aim was to assess clinical, radiological, and laboratory criteria, as well as treatment of patients hospitalized in an isolation sector with COVID-19, and the relation to radiological progression and hospital stay.

Patients and methods

This was a prospective observational study conducted in an isolation sector in a private hospital (which includes patient ward and ICU) in Jeddah, west Saudi Arabia. An informed consent was taken from patients to declare their data from electronic medical records. We started to collect data, after approval of local ethical committee, from May 12, 2020 till June 25, 2020. Data were collected from electronic health system including those on admission, all initial and follow-up investigations, treatment given, and date of discharge.

A total of 30 patients, who were admitted to the isolation center of the hospital after being diagnosed as positive for COVID-19, were enrolled into the study. The patient was considered being positive based on real-time reverse transcriptase-PCR assay of nasopharyngeal or oropharyngeal swab specimens; the test was done in the central laboratory of the Ministry of Health. Blood samples of the patients were analyzed in the hospital laboratory. Blood tests were performed including C-reactive protein (CRP), lactate dehydrogenase (LDH), and ferritin, as well as routine biochemistry tests, using Archetic (Abbott, Abott Park, Illinois, USA). Hemoglobin and complete blood count were done using Bechman Coulter (USA). Bleeding parameters [D-dimer, international normalized ratio, activated partial thromboplastin time (aPTT), and fibrinogen] were done using Sysmex (Wakinohama-Kaigandori, Chuo-ku, Kobe, Japan). Computed tomography (CT) was done to one patient, to decrease the risk of infection transmission; in all other patients, chest radiograph was done using a mobile device (Mobillett Elara Max, Germany).

The study was in accordance with the ethical standards of the institution and national research committee and with the 1964 Helsinki declaration and its later amendments.

Statistical analysis

Statistical data analysis was done using SPSS (IBM, New York, New York, USA). Descriptive data were presented as mean±SD or as a frequency and percentage. χ^2 test was used to compare categorical variables, whereas Student t test was used to compare continuous variables. Pearson correlation (r) was used to study the association between variables, and significant value was determined as P value less than or equal to 0.05.

Results

This study included 30 patients who were hospitalized in an isolation unit based on PCR-positive results for COVID-19. A total of 24 (80%) patients were males, whereas six (20%) were females. The presenting symptoms of patients were fever in 25 (83.3%), cough in 10 (33.3%), shortness of breathing in eight (26.7%), body aches in five (16.7%), and sore throat in three (10%). Average temperature on admission was 38.2±0.79°C and average pulse was 99.53±16.02 beat/min.

Chest radiograph was abnormal in 23 (76.6%) patients. Lung affection was bilateral in 23 (70%) patients, whereas in 6.6%, lesions were unilateral. Lesions were multifocal in 22 (95.65%) and solitary in one (4.35%) patient of those cases with radiological changes. Changes were in the form of alveolar and interstitial pattern (in the form of linear branching density) in 20 (86.95%) patients and only interstitial densities in three (13.05%). Alveolar lesions were smaller than 3 cm in 16 of 20 patients with alveolar lesions, with incidence of 80%, whereas the lesions were larger in 20% of cases. Follow-up of chest radiograph (2–5 days according to clinical situation) shows progressive changes in 15 (65.2%) of patients, regressive in five (21.3%), and stationary in three (13.5%) of patients.

Laboratory investigations for these patients have shown a high CRP level of 112.59±140±0.50 (minimum value was 3.27 and maximum 640 mg/l). Serum ferritin was 763.21±652.18 (minimum 28.33 and maximum 2000 µg/l). LDH was higher than normal, where it was 312.86±161.57 (minimum 111 and maximum 874 U/l). The rest of chemical indices are shown in Table 1.

Bleeding indices were done for most cases, where D-dimer was done for all of them, whereas partial thromboplastin time, international normalized ratio, and fibrinogen were done for 27 patients. Results are shown in Table 1.

Table 1 Baseline characteristics investigations and treatment of the study group

Study variables	Mean	SD	Minimum	Maximum	Variable	*n* (%)
Age	51.2 years	15.05	26	84	Sex	
					Males	24 (80)
					Females	6 (20)
Temperature	38.2°C	0.79	36.8	40	Symptoms	
Pulse	99.53 bpm	16.02	72	128	Fever	25 (83.3)
Laboratory					Sore throat	3 (10)
CRP	112.59 mg/l	140.50	3.27	640	Cough	10 (33.3)
D-dimer	0.97 µg/ml	1.11	0.19	4.49	SOB	8 (26.7)
INR	1.09	0.194	0.84	1.92	Body ache	5 (16.7)
PTT	37.94 s	17.46	20.50	112.9	Treatment	
Fibrinogen	575.32 mg/dl	220.08	204	900	Paracetamol	23 (76.7)
LDH	312.86 U/l	161.57	111	874	Azithromycin	17 (56.7)
Ferritin	763.21 µg/l	652.18	28.33	2000	Tavanic	6 (20)
Serum CL	99.74 Meq/l	5.395	78	106	Meronam	12 (40)
Serum NA	135.82 mmol/l	4.36	119	141	Pip/tazo	3 (10)
Serum K	4.16 mmmol/l	0.642	2.58	5.78	Cephalosporin	8 (26.7)
HBa1C	9.09%	3.23	5.24	15.63	Targocid	2 (6.67)
AST	42.44 U/l	40.52	10.80	212.30	Linezolid	2 (6.67)
ALT	43.07 U/l	54.70	6.70	279	Oseltamivir	2 (6.67)
BUN	18.29 mg/dl	15.73	4	67	Enoxaparin	30 (100)
Creatinine	1.17 mg/dl	1.19	0.50	7.19	Therapeutic	13 (43.3)
CBC					Prophylactic	17 (56.7)
HB	13.39 g/dl	1.7	8.4	17.60	Mechanical ventilation	3 (10)
HCT	40.75%	7.33	15.80	50.40		
TLC	7.03×10^3/µl	4.51	2.70	26.10		Associated diseases
Neutrophils	5.23×10^3/µl	4.31	0.70	23	DM	12 (40)
Neutrophils%	68.25	16.92	23	92.10	HTN	6 (20)
Lymphocytes	1.15×10^3/µl	0.524	.30	2.7	MS	1 (3)
Lymphocytes%	22.31	13.12	3.3	59	Hypercholesterolemia	1 (3)
Neutrophil/lymphocyte ratio	6.80	8.66				
Monocytes	0.69×10^3/µl	0.85	0.20	5		
Monocytes%	9	4.22	2.5	17		
Platelets	214.1×10^3/µl	92.57	99	531		
Hospital stay	7.6 days	6.25	1	25		

ALT, alanine transaminase; AST, aspartate transaminase; BUN, blood urea nitrogen; CL, chloride; CRP, C-reactive protein; HB, hemoglobin; HBa1C, glycated hemoglobin; HCT, hematocrit; INR, international normalized ratio; K, potassium; LDH, lactate dehydrogenase; NA, sodium; PTT, partial thromboplastin time; TLC, total leukocytic count.

There was no statistically significant difference regarding sex in the study variables except in serum ferritin, neutrophils %, and monocytes % (P =0.003, 0.028, and P<0.001, respectively) (Table 2).

Some laboratory investigations were repeated for follow-up of patients during their hospital stay; there was no difference between baseline and follow-up laboratory indices, except in serum chloride and platelets (Table 3).

Correlation between some of the study variables was done by Pearson correlation coefficient. There was a strong positive correlation between serum ferritin and temperature, LDH, and aspartate transaminase. CRP had a strong positive correlation with alanine transaminase and some blood parameters (total leukocytic count, lymphocytes, and neutrophil/lymphocyte ratio). Hospital stay was positively correlated with ferritin and LDH, whereas negatively correlated with lymphocytic count (Table 4). Correlations between radiological course and laboratory follow-up, mainly CRP, were poor, except monocytes, as shown in Table 5 and Fig. 1.

The average hospital stay was 7.6±6.25 days (minimum 1 day and maximum 25 days). A total of 27 patients were admitted in a ward, whereas three were mechanically ventilated. As fever was the presenting symptoms in most patients, paracetamol was given in 23 (76.7%). Enoxaparin anticoagulant was given to all patients, with 13 (43.3%) patients given therapeutic doses (80 mg) and 17 (56.7%) given prophylactic doses (40 mg). Antibiotics were given in 27 patients, with three patients treated with hydroxychloroquine. The

Table 2 Sex differences in the study group

Variables	Male	Female	*P*
Age	49.46±15.31 years	58.17±12.77 years	0.19
Pulse	99.0±14.04 B/M	101.67±23.98 B/M	0.80
Temperature	38.21±0.81°C	38.15±.81°C	0.87
Laboratory			
D-dimer	0.85±0.98 µg/ml	1.44±1.54 µg/ml	0.41
INR	1.09±0.22	1.08±0.07	0.90
PTT	39.36±19.54 s	33.00±4.64 s	0.19
Fibrinogen	567.09±231.978 mg/dl	604.14±187.96 mg/dl	0.69
LDH	315.27±165.17 U/l	304.00±162.04 U/l	0.88
Ferritin	866.78±687.37 µg/l	348.97±190.33 µg/l	0.003
CRP	106.02±146.65 mg/l	138.86±120.590 mg/l	0.58
AST	44.64±45.09 U/l	34.37±15.11 U/l	0.38
ALT	46.77±61.68 U/l	30.13±9.06 U/l	0.25
BUN	17.96±14.41 mg/dl	19.80±22.1 mg/dl	0.87
Creatinine	1.23±1.31 mg/dl	0.94±.54659 mg/dl	0.42
CL	100.42±3.55 meq/l	97.25±9.74 meq/l	0.47
NA	136.59±2.91 mmol/l	133.00±7.40 mmol/l	0.29
K	4.19±0.52 mmol/l	4.03±1.035 mmol/l	0.73
CBC			
HB	13.61±2.04 g/dl	12.45±1.71 g/dl	0.18
HCT	39.74±7.86%	38.93±5.25%	0.77
TLC	6.94±4.90×10^3/µl	7.38±2.1×10^3/µl	0.77
Neutrophils	4.98±4.64×10^3/µl	6.22±2.72×10^3/µl	0.41
Neutrophils %	65.01±16.43	81.18±12.96	0.028
Lymphocytes	1.24±0.50×10^3/µl	0.78±0.49160×10^3/µl	0.08
Lymphocytes %	24.54±12.74	13.42±11.52	0.07
Monocytes	0.59±0.25×10^3/µl	1.10±1.92×10^3/µl	0.54
Monocytes%	10.01±4.06	4.95±1.69	<0.001
Platelets	198.88±71.52×10^3/µl	274.83±143.65×10^3/µl	0.26
Hospital stay	7.75±6.25 day	7.00±6.78 days	0.81

ALT, alanine transaminase; AST, aspartate transaminase; BUN, blood urea nitrogen; CL, chloride; CRP, C-reactive protein; HB, hemoglobin; HBa1C, glycated hemoglobin; HCT, hematocrit; INR, international normalized ratio; K, potassium; LDH; lactate dehydrogenase; NA, sodium; PTT, partial thromboplastin time; TLC, total leukocytic count.

Table 3 Baseline and follow-up laboratory parameters of the study group

	Baseline	Follow up	*P* value
CRP	112.59±140.50	68.86±14.06	0.22
Serum CL	98.29±6.04	100.56±5.50	0.013
Serum NA	135.06±4.87	136.56±4.84	0.17
Serum K	4.0832±0.66	4.1458±.53	0.66
HB	13.39±1.7	13.1±1.44	0.24
HCT	40.75±4.93	39.72±5.02	0.18
TLC	6.0667±2.6	6.76±3.42	0.18
Neutrophils	4.2760±2.56	4.88±3.40	0.22
Neutrophils%	67±16.19	65.24±18.07	0.54
lymphocytes	1.1833±.52	1.26±.49	0.48
Lymphocytes%	23.12±13.14	24.7±15.25	0.50
Monocytes	0.5042±.2	0.5±.23	0.95
Monocytes%	9.1±3.9	8.54±3.6	0.47
Platelets	201.05±75.8	288.45±119.5	0.001

CL, chloride; CRP, C-reactive protein; HB, hemoglobin; HCT, hematocrit; K, potassium; NA, sodium; TLC, total leukocytic count.

details of antibiotics given and number of patients treated are shown in Table 1. Oseltamivir was given to two patients before it was removed from the protocol. Tocilizumab was given to two patients, where one of them was severe mechanically ventilated patient; in both of them, serum ferritin was 2000. All patients were discharged from hospital except one patient who died in hospital.

Table 4 Pearson correlation of the study variables

	Temp	D-dimer	PTT	Fibrinogen	CRP	LDH	Ferritin	AST	ALT	TLC	Lymphocytes	N/L ratio	Stay
Temp	1												
D-dimer	r .218P.25	1											
PTT	r.112P.58	r-.184p.36	1										
Fibrinogen	r.109P.59	r.315p.11	r.304P.13	1									
CRP	r-.008P.97	r.320p.08	r.105P.60	r.315P.11	1								
LDH	r.313P.10	r-.052P.79	r.137P.51	r.104P.62	r.212P.28	1							
Ferritin	r.412P.007	r-.141P.46	r.350P.074	r.315P.11	r.247P.19	r.527P.004	1						
AST	r.284P.14	r-.015P.94	.005P.98	r.094P.65	r.352P.066	r.371P.057	r.434P.021	1					
ALT	r.118P.56	r.125P.53	r.035P.87	r.068P.78	r.644P<.001	r.172P.40	r.235P.24	r.743P<.001	1				
TLC	r-.070P.72	r.271P.15	r.132P.51	r216P.28	r.751P<.001	r.077P.67	r.160P.39	r.197P.32	r.675P<.001	1			
Lymphocytes	r-.138P.47	r-.244P.19	r-.255P.20	r-.307P.12	r.771P<.001	r.060P.76	r-.124P.52	r-.123P.53	r.190P.34	r-.213P.26	1		
N/L ratio	r-.208P.28	r.333P.077	r.200P.33	r.165P.42	r.740P<.001	r.164P.41	r.046P.81	r.230P.25	r.648P<.001	r.320P.09	r-.600P.001	1	
stay	r-.297P.11	r.249P.18	r.264P.18	r.264P.18	r.096P.613	r.595P.001	r.480P.007	r.052P.79	r.032P.87	r.168P.38	r-.415P.02	r.115P.55	1

ALT, alanine transaminase; AST, aspartate transaminase; CRP, C-reactive protein; LDH, lactate dehydrogenase; PTT, partial thromboplastin time; TLC, total leukocytic count.

Discussion

SARS-CoV-2 belongs to the genus Betacoronavirus in the family Coronaviridae [2]. The WHO formerly termed this infectious disease novel coronavirus-infected pneumonia and the virus had been called 2019 novel coronavirus (2019-nCoV). On February 11, 2020, the WHO officially retitled the clinical condition COVID-19 [7].

On January 20, 2020, Chen *et al.* [8] described 99 cases with SARS-CoV-2-infected pneumonia. This case series revealed that older males with comorbidities as a result of weaker immune function were the most susceptible to COVID-19 incidence.

Many studies increasingly cleared that death rate increases with age. Children under 9 years of age seem to be largely unaffected, either with no or mild symptoms or none have died owing to COVID-19 infection, whereas people over the age of 80 years and those with chronic diseases are the most vulnerable. For those who cross 80 years, ~14.80% of those infected die [9]; this agrees with this work, where most of cases were males (80%) patient, and the mean age was 51.2±15.05 years.

The clinical features of COVID-19 are diverse; the most frequent clinical features include fever (not in all), cough, sore throat, headache, fatigue, headache, myalgia, and breathlessness [9]. In our study, fever was present in 83.3%, cough in 33.3%, shortness of breathing in 26.7%, body aches in 16.7%, and sore throat in 10%. Huang *et al.* [9] first noted clinical features of 41 patients proved to be infected with COVID-19 on January 2, 2020. The initial symptoms were fever (98%), cough (76%), dyspnea (55%), myalgia or fatigue (44%), sputum production (28%), headache (8%), hemoptysis (5%), and diarrhea (3%). Only one patient did not present fever in the early stage of disease.

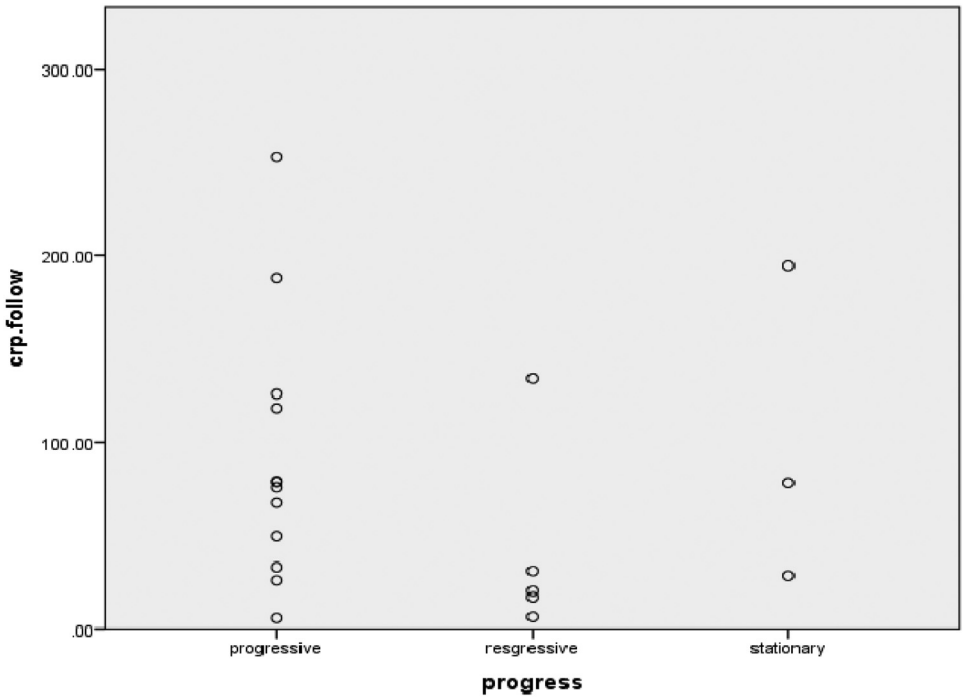
Because of infection control concerns related to patient transport to CT bodies and the inefficiencies in imported CT room decontamination, portable chest radiography is presumably the most extensively utilized method for detection and follow-up of lung abnormalities. In fact, the American College of Radiology mentioned that CT decontamination required after scanning COVID-19-infected patients may disturb radiological service availability and advised that portable chest radiography may be considered to minimize the risk of cross-infection [10].

Table 5 Correlation between radiological progression and some follow-up laboratory parameters

	CRP	TLC	Lymphocytes	Neutrophils follow-up	Monocytes
Progression of radiology	*r*–0.075	r 0.102	r 0.333	r 0.026	r 0.625
P	0.75	0.67	0.15	0.91	0.002

CRP, C-reactive protein; TLC, total leukocytic count.

Figure 1



Correlation between radiological progression and CRP follow-up. CRP, C-reactive protein.

For this reason, CT was done for only one patient, whereas portable chest radiograph was done for the rest of the patients. It showed multifocal bilateral affection in most of the patients. Salehi *et al.* [11], in their systematic review of CT images in 919 patients with COVID-19, found the characteristic patterns and distribution of CT manifestations, such as ground-glass opacification (88.0%), bilateral involvement (87.5%), peripheral distribution (76.0%), and multilobar (more than one lobe) involvement (78.8%). In this study, laboratory tests showed higher than normal levels of CRP, LDH, and ferritin. CRP was strongly correlated to elevated liver enzymes, whereas LDH and ferritin were strongly correlated to length of hospital stay. In the study by Guan *et al.* [12], displaying results from different provinces in China, interesting biochemical findings were described: CRP was raised in 60.7% of patients. In a pooled analysis of nine published studies (n=1532 COVID-19-infected patients), elevated LDH levels were associated with a ~6-fold increase in odds of developing severe disease and a ~16-fold increase in odds of mortality in patients with COVID-19 [13]. Ferritin is a key mediator of immune dysregulation, especially under extreme hyperferritinemia, via direct immune-suppressive and pro-inflammatory effects, contributing to the cytokine storm [14]. In the study by Chen *et al.* [8], 63 of 99 patients with COVID-19 had serum ferritin way above the normal range. Another study showed that in patients who died owing to COVID-19, ferritin levels were elevated upon hospital admission and throughout the hospital stay [15].

In a study by Ranucci *et al.* [16] on 60 patients with COVID-19 ARDS, serum fibrinogen was higher than normal, with an association between fibrinogen and interleukin-6 levels; this coincides with our study where fibrinogen was higher than normal.

Conclusion

COVID-19 affects males more than females and is more in elderly. Fever is a common presenting symptom. Infection affects many blood indices, such as LDH, ferritin, CRP, and fibrinogen. Radiological course of the lesions is not affected by those blood indices, whereas the length of hospital stay is affected. The outcome is favorable in most of the patients.

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Conflicts of interest
There are no conflicts of interest.

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