Emergency Department Triage in the Era of COVID-19: The Sheba Medical Center Experience

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ABSTRACT **Background:** Sheba Medical Center, Tel Hashomer, is a tertiary hospital located in the center of Israel. It is the largest hospital in Israel and was the first to face coronavirus disease-2019 (COVID-19) patients in the country at the beginning of the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) pandemic.

Objectives: To describe our experience with the COVID-19 pandemic, focusing on our triage method in the emergency department (ED). Our goal was to keep the main hospitalization buildings clean of infection by separating COVID-19 positive patients from COVID-19 negative patients.

Methods: We divided our ED into two separate sections: a regular non-COVID-19 ED and an advanced biological ED. We created clear protocols of triage for suspected and confirmed COVID-19 patients. We reviewed the data of patients admitted to our ED during the month of March and analyzed the results of our triage method in separating COVID-19 positive from negative patients.

Results: During the month of March 2020, 7957 patients were referred to our ED. Among them 2004 were referred to the biological ED and 5953 were referred to the regular ED. Of the 2004 patients referred to the biological ED, 1641 (81.8%) were sampled for SARS-CoV-2 polymerase chain reaction of whom 143 (8.7%) tested positive. Only two COVID-19 positive patients unintentionally entered the main clean hospital, making our triage almost full proof.

Conclusions: Our triage method was successful in separating COVID-19 positive from negative patients and maintained the regular hospital clean of COVID-19 allowing treatment continuation of regular non-COVID-19 patients.

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KEY WORDS: coronavirus disease-2019 (COVID-19), emergency department (ED), pandemic, triage

The world pandemic of the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) began in China at the end of December 2019 and began spreading around the world during the month of January 2020 [1]. The contagious nature of coronavirus disease-2019 (COVID-19) and the high number of patients seeking medical assistance presented a great challenge of triage for hospital emergency departments (EDs). Several medical centers have described their experience of triage in medical facilities and EDs [2-8].

The European Society for Emergency Medicine recently published a position paper on how to treat COVID-19 patients in the ED [9]. To date, no good model exists for protecting patients and healthcare workers from infection; hence, enabling continued medical care to patients without COVID-19.

The first known patient in Israel was detected on 20 February 2020 and was hospitalized in our hospital, making Sheba Medical Center the first hospital in Israel to face COVID-19 patients [10]. One of our main goals and challenges was to prevent the admission of COVID-19 positive patients into hospital units to protect both patients and healthcare workers from infection and to enable ongoing care to regular non-COVID-19 patients.

For this purpose, we designated a unique section for COVID-19 patients, which was separated from other facilities. This section consisted of four main components: a corona internal medicine building (a total of six wards with 250 beds), a corona critical care unit (CCCU) with a maximum capacity of 97 beds, a corona psychiatric ward with 16 beds, and a corona ED for quick triage of suspected or confirmed corona patients.

The biggest challenge was to keep our hospital facilities as clean as possible to avoid COVID-19 infection. Once a COVID-19 positive patient enters the hospital, both the healthcare workers and other patients are in danger of getting infected. In addition, environmental contamination with SARS-CoV-2 of medical equipment and the facility itself is a significant threat. The best way to deal with this hazard is to prepare an attentive and methodological triage by managing suspected COVID-19 positive patients with effective, professional, and fast diagnostic and treatment techniques using maximum isolation of staff and other patients.

*The first and second authors contributed equally to this study

In this article we describe our experience with triage in the ED of the Sheba Medical Center in the beginning of the COVID-19 pandemic.

PATIENTS AND METHODS

EMERGENCY DEPARTMENT

The ED is the main port of entry to the hospital; hence, it has an important role as the main gatekeeper. We divided the ED into two main sections: a general ED dealing with non-COVID-19 patients and an advanced biological ED dealing with suspected and confirmed COVID-19 patients. A professional well-trained and experienced triage nurse wearing protecting personal equipment (PPE) was placed in front of the main entrance to the ED and directed all incoming patients to one of the two sections. Screening for suspected COVID-19 patients was based on epidemiology, medical history, and clinical manifestations.

High suspicion based on epidemiology and medical history included:

- Mandatory home isolation due to arrival from abroad within the past 14 days
- Exposure to a verified COVID-19 patient within the past 14 days
- Arrival from an endemic community within Israel
- Highly suspected clinical manifestations included one or more of the following:
- Fever above 38ºC
- Cough not related to a chronic lung condition such as asthma or chronic obstructive pulmonary disease
- Respiratory distress
- Community-acquired pneumonia

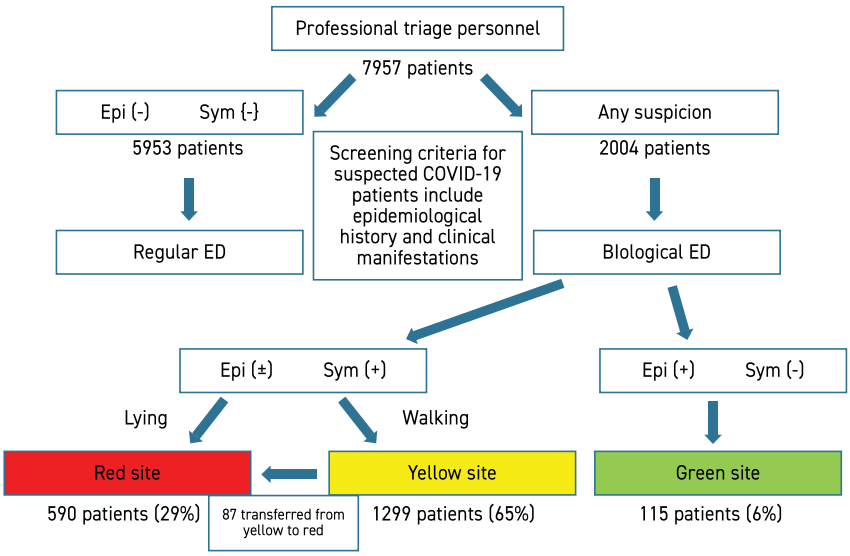
A patient with no epidemiological or clinical criteria entered the clean ED while a patient exhibiting one or more of the COVID-19 positive criteria was sent to the biological ED.

The biological ED was also subdivided into three different sections, which were assigned three different colors (green, yellow, red). The triage nurse directed each patient to a different section according to the clinical and epidemiological status [Figure 1]. All three sections had no contact with the clean ED so that patients would not interact with each other. Medical teams were also separated.

All suspected patients were screened for SARS-CoV-2 using rtPCR testing for three genes (N gene, E gene, and RdRP gene; Seegene, South Korea). Nasopharyngeal samples were taken via three swabs obtained from the throat and each nasal nare, reaching the nasopharynx.

The green section was designated for patients with high epidemiological suspicion but no clinical manifestations suggestive of COVID-19, for example an orthopedic patient in home isolation with no fever or respiratory symptoms. Patients with high clinical suspicion (with or without a clear epidemiological history) were treated in the yellow or red sites depending on the severity of their symptoms. Walking patients were treated in the yellow site (no more than two patients at a time with a two-meter distance between them). Prone patients were transferred to the red site via a different entrance from the regular ED entrance. The red section had three different compartments. Compartment A, which included two negative pressure beds and four highly separated beds, was reserved for patients with high epidemiological suspicion and a highly suggestive respiratory illness. Compartment B consisted of 14 beds and was reserved for patients with a medium epidemiological risk (e.g., home

Figure 1. Schematic triage in the emergency department



ED = emergency department, Epi = epidemiological history, Sym = clinical symptoms

isolation due to remote contact) but clear clinical features of COVID-19, and compartment C, consisting of 10 beds, was kept for patients with low epidemiological risk. Figure 2 shows the decision making process of the triage nurse.

DEVICES TO IMPROVE ISOLATION IN THE BIOLOGICAL EMERGENCY ROOM AND ENHANCE SAFETY OF STAFF

- Portable flat panel detector allowed for digital radiography enableed bedside high image quality with fast wireless data transmission
- Arterial blood gas point-of-care machine in a biological safety cabinet with laminar airflow inside the biological ER enabled fast test results, without having to transfer the samples to a clean area inside the hospital
- Safe COVID nasopharyngeal screening devices enabled nasal and oral samples for COVID-19 polymerase chain reaction (PCR) without direct contact with the patient
- Noninvasive ventilation devices, such as hood-helmet, allowed treating patients in need for respiratory support without creating aerosolized droplets
- Intubation with a glidescope, which is used for difficult airway management, provided better visualization of the larynx, making the intubation process shorter and safer for the physician
- Room monitoring by camera and remote robots with examination capabilities enabled collection of preliminary medical information and allowed for basic physical examination of simple cases with minimal contact with the patient. Basic physical examination included visual observation, measurement of vital signs, and remote examinations of larynx, heart, and lungs

PATIENTS WHO REQUIRED EMERGENCY TREATMENT OUTSIDE THE EMERGENCY DEPARTMENT

If a patient in the biological ED required emergency treatment that could not be administered in that section, such as surgery, catheterization, computed tomography scan, cesarean section, they were transferred, via a specific route cleared in the hospital, to the designated area for suspected or confirmed COVID-19 patients. Medical staff treating these patients were required to wear the same PPE as the ED personnel.

DISCHARGING A PATIENT FROM THE BIOLOGICAL EMERGENCY DEPARTMENT

Patients were discharged from the biological ED according to their clinical condition to one of four possible locations: home isolation, isolation outside the hospital facility (collective isolation in designated facilities such as COVID-19 hotels), hospitalization in one of the COVID-19 designated wards, and hospitalization in one of the clean non-COVID-19 wards. When the medical and social condition allowed, the patient was discharged to home isolation, even before receiving the COVID-19 PCR results. On receiving the results, the patient was notified at home and if necessary, was transferred to another isolation facility. This method of discharge was organized with a designated car taking the patients directly to their place of residence without contacting any other person on the way. All other discharge options required a confirmation of COVID-19 virus status.

Those with a negative COVID-19 result who required hospitalization were transferred to one of the clean non-COVID-19 hospital wards, but droplet+ isolation precautions were used. These precautions included hospitalization in single-bed rooms when possible, PPE including surgical mask, gown, gloves, and face shield visor. Those with a verified positive COVID-19 were transferred to the specialized COVID-19 wards depending on their clinical status. Positive COVID-19 patients were transferred via a rear exit of the red site without entering the hospital corridors [Figure 2].

RESULTS

EXPERIENCE IN THE EMERGENCY DEPARTMENT

From 1 to 31 March 2020, 7957 patients were referred to our ED. Among them 2004 patients were referred to the biological ED and 5953 patients were referred to the regular ED. Among those who were referred to the biological ED, 503 patients were referred directly to the red section and 87 were transferred from the yellow to the red section due to their clinical status or need for monitoring, bringing the total patients in the red site to 590. The yellow section received a total of 1386 patients, of whom 87 were transferred during their stay to the red section, making the total number of patients in this section 1299. The green section received a total of 115 patients [Figure 1]. The average time for decision making in the biological ED was 5.25 hours. Of the 2004 patients referred to the biological ED, only 1641 (81.8%) were sampled for SARS-CoV-2 PCR; 1476 (89.9%) tested negative and 143 (8.7%) tested positive [Table 1]. Of the 590, 1299, and 115 patients in the red, yellow and green sections, respectively, 67 (11.3%), 75 (5.8%), and 1 (0.9%) eventually tested positive for SARS-CoV-2.

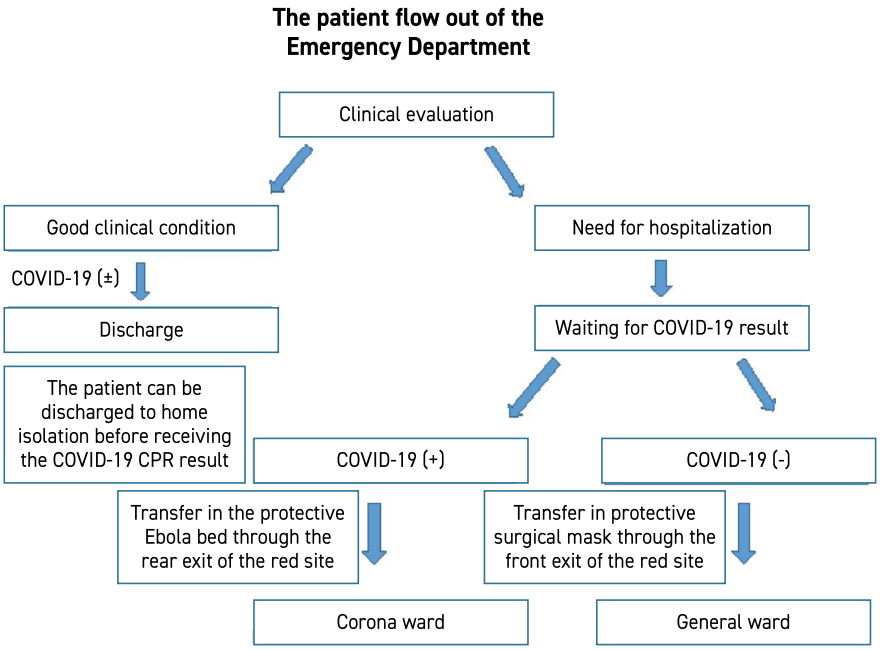
Among the 143 positive patients, 67 were in the red section, 75 in the yellow section, and only one patient in the green section, showing that separating the green patients from the rest was indeed beneficial. The rate of positive results was 13.8% in the red section, 5.4% in the yellow section, and 0.8% in the green section. The rate of positive results increased over time from 0% during the first week of the month to 14.3% during the last week of the month [Figure 3].

During the entire month of March 2020, only two patients who eventually had positive PCR results were accidentally hospitalized in the clean hospital.

DISCUSSION

We described our method of triage that enabled us to prevent the admission of positive COVID-19 patients into the main hospital

Figure 2. The patient flow out of the emergency department



and thus to protect our patients and our medical staff from infection. It also allowed for the continuation of care to COVID-19 negative patients. Our triage was based on two separate sections in the ED: a regular ED dealing with non-COVID-19 patients and an advanced biological ED dealing with suspected and confirmed COVID-19 patients.

Healthcare workers are at the front lines of this kind of warfare and as such, should be fully protected, both to ensure their own safety and to guarantee the best patient treatment. One of the major threats for a hospital during a pandemic is losing trained healthcare workers to the biological infection at hand.

All healthcare workers in the biological ED used full PPE, which included a disposable surgical cap, N95 protective mask, goggles, two layers of disposable latex gloves, a protective robe (liquid impermeable), and protective overshoes. We also distributed surgical masks to every patient entering the biological ED for them to wear through the entire stay. These masks were required to protect both healthcare workers and other patients in the same ED site.

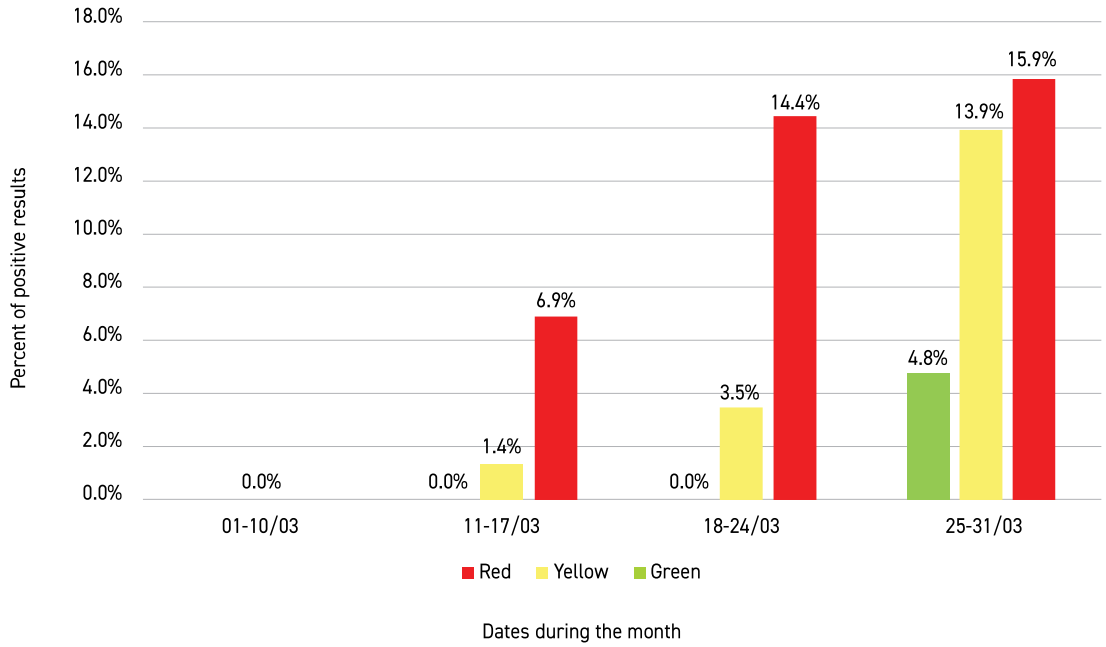
The first triage was conducted by a trained and experienced nurse who directed the patients to the designated section according to their answers to a questionnaire regarding their epidemiological and medical history and off-course their clinical manifestations. Nevertheless only 81.8% were sampled for SARS-CoV-2 PCR, which indicates that additional physician evaluation may eliminate some unnecessary testing. The rate of positive tests was

Table 1. Total number of patients and the rate of positive and negative results in the different sections of the biological emergency department

Section	Total	Positive PCR N (%)	Negative PCR N (%)	Inconclusive Result (%)	Sample invalid (%)
Red	590	67 (11.4%)	511 (86.6%)	-	12 (2%)
Yellow	1021	75 (7.4%)	935 (91.6%)	6 (0.6%)	5 (0.4%)
Green	31	1 (3%)	30 (97%)	-	-
Total	1642	143 (8.7%)	1,476 (89.9%)	6 (0.4%)	17 (1%)

PCR = polymerase chain reaction

Figure 3. Percent of positive results in the three sections (red, yellow, green) of the biological emergency department during the month of study (March 2020)



8.7% and increased over the month, which reflected the better selection of patients directed to the biological ER and the overall increased COVID-19 prevalence in the country. Using similar case criteria Wee et al. [7] reported lower rates of positive tests (3.8%), and Tolia et al. [8] reported similar rates (10.2%). These findings suggest that only one out of 10–20 suspected patients had COVID-19 infection. In order to decide whether a patient could enter the main hospital building or should be sent to the designated COVID-19 facilities, the patient was required to wait in the ED for the SARS-CoV-2 PCR results. Therefore, one of the greatest challenges was to shorten the time interval to receive the reverse transcriptase polymerized chain reaction (rt-PCR) results for the COVID-19. In our ED the average time to make the decision was 5.25 hours and the rate limiting factor was the time to receive the lab results. We gave our ED the highest priority in getting results from our lab but still it took between 4-10 hours to receive the results. This poses a great threat on the patient flow regarding the biological ED. Currently, we have started using a rapid test (GeneXpert®, Cepheid, USA). We worked on a test that would enable us to receive accurate results within 2 hours. This faster time would allow an easier decision making and relieve the pressure on the red site.

As mentioned, the biological ED had a limited capacity that could limit patient inflow. To improve the patient inflow we had to improve the outflow. We therefore discharged patients to home isolation, when the medical and social condition allowed it, even before receiving the COVID-19 PCR results. We were in contact with the patients and after receiving the results, we notified them at home and if necessary, transferred them to another isolation facility. This method of discharge was organized with a designated car taking the patients directly to their place of residence to eliminate any further contacts.

One major dilemma of this routine, however, was how to manage patients who stayed in the biologic ED and were finally negative for COVID-19. Because the length of stay in the biological ED (especially in the red site) was quite long due to the time needed for PCR results, these patients were exposed to COVID-19 positive patients for a time ranging between 4 to 10 hours. Even though we tried to separate the patients inside the biological ED using 2 meters spacing between beds when possible and applying a surgical mask to every patient, this was not full proof and patients sometimes took off their mask.

Further complicating the patient placement issue was the fact that an initial negative PCR does not fully rule out COVID-19. False negative results have been reported, either due to low initial viral load, imperfect nasopharyngeal sampling, or test sensitivity. Thus, any patient from the COVID-ED with a negative result, was isolated under droplet + precautions in a non-COVID regular ward.

Due to these circumstances, we treated COVID-19 negative patients leaving the red site as being exposed, and therefore we put patients in droplet+ isolation if hospitalized. Potentially,

routine serologic testing, which is expected to become available, will resolve this dilemma and relinquish the need for isolation. During the study period we were successful in keeping our hospital clean almost 100% of the time (2 of 7957 patients unintentionally entered the clean ED = 0.02%). Wee et al. [7] were able to pick up 84.2% (59/70) of COVID-19 cases in the ED. While, our system successfully identified COVID-19 patients in 98.5% (143/145).

We encourage all hospitals, to adopt our practices. These actions could help hospital management focus attention as needed on the different aspects of the hospital needs.

CONCLUSIONS

Making an effort to separate the patient flow (COVID-19 vs. non-COVID-19) from their arrival at the ED until their discharge from the hospital will help hospitals deal successfully with the pandemic and better protect healthcare workers and non-COVID patients.

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References

1. Zhou P, Yang XL, Wang XG, et al. A pneumonia outbreak associated with a new coronavirus of probable bat origin. *Nature* 2020; 579: 270-3.
2. Mareiniss DP. The impending storm: COVID-19, pandemics and our overwhelmed emergency departments. *Am J Emerg Med* 2020; 38 (6): 1293-4.
3. Carenzo L, Costantini E, Greco M, et al. Hospital surge capacity in a tertiary emergency referral centre during the COVID-19 outbreak in Italy. *Anaesthesia* 2020; 75 (7): 928-34.
4. Davarpanah AH, Mahdavi A, Sabri A, et al. Novel screening and triage strategy in Iran during deadly coronavirus disease 2019 (COVID-19) epidemic: value of humanitarian teleconsultation service. *J Am Coll Radiol* 2020; 17 (6): 734-8.
5. Qadan M, Hong TS, Tanabe KK, Ryan DP, Lillemoe KD. A multidisciplinary team approach for triage of elective cancer surgery at the Massachusetts General Hospital during the novel coronavirus COVID-19 outbreak. *Ann Surg* 2020; 272 (1): e20-e21.
6. Shah PB, Welt FGP, Mahmud E, et al. Triage considerations for patients referred for structural heart disease intervention during the coronavirus disease 2019 (COVID-19) pandemic: an ACC /SCAI consensus statement. *Catheter Cardiovasc Interv* 2020; 13 (13): 1607-8.
7. Wee LE, Fua TP, Chua YY, et al. Containing COVID-19 in the emergency room: the role of improved case detection and segregation of suspect cases. *Acad Emerg Med* 2020; 27 (5): 379-87.
8. Tolia VM, Chan TC, Castillo EM. Preliminary results of initial testing for coronavirus (COVID-19) in the emergency department. *West J Emerg Med* 2020; 21 (3): 503-6.
9. Garcia-Castrillo L, Petrino R, Leach R, et al. European Society for Emergency Medicine position paper on emergency medical systems response to COVID-19. *Eur J Emerg Med* 2020; 27 (3): 174-7.
10. Appel S, Kaidar-Person O, et al. The coronavirus pandemic in Israel: implications for radiation oncology departments. *IMAJ* 2020; 22: 211-13.

Capsule

Association between statewide school closure and COVID-19 incidence and mortality in the United States

In the United States, states enacted non-pharmaceutical interventions, including school closure, to reduce the spread of coronavirus disease 2019 (COVID-19). All 50 states closed schools in March 2020 despite uncertainty if school closure would be effective. COVID-19 cumulative incidence in states at the time of school closure ranged from 0 to 14.75 cases per 100 000 population. School closure was associated with a significant decline in the incidence of COVID-19 (adjusted relative change per week, -62% [95% CI, -71% to -49%]) and mortality (adjusted relative change per week, -58% [95% CI, -68% to -46%]). Both of these associations were largest in states with low cumulative incidence of COVID-19 at the time of school closure. For example, states with the lowest incidence of COVID-19 had a -72% (95% CI, -79% to -62%) relative change in incidence compared with -49% (95% CI, -62% to -33%) for those states with the highest cumulative incidence. In a model derived from this analysis, **Auger** et al. estimated that closing schools when the cumulative incidence of COVID-19 was in the lowest quartile compared with the highest quartile was associated with 128.7 fewer cases per 100 000 population over 26 days and with 1.5 fewer deaths per 100 000 population over 16 days. States that closed schools earlier, when cumulative incidence of COVID-19 was low, had the largest relative reduction in incidence and mortality. However, it remains possible that some of the reduction may have been related to other concurrent non-pharmaceutical interventions.

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Eitan Israeli

Nothing limits intelligence more than ignorance; nothing fosters ignorance more than one's own opinions; nothing strengthens opinions more than refusing to look at reality.
Sheri Stewart Tepper (1929–2016), American writer of science fiction, horror and mystery novels)