Flattening the COVID-19 Curve: The Unique Role of Emergency Medical Services in Containing a Global Pandemic

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ABSTRACT **Background:** The potential excess flow of patients into emergency departments and community clinics for testing and examination during a pandemic poses a major issue. These additional patients may lead to the risk of viral transmission to other patients and medical teams. To contain the spread of coronavirus disease-2019 (COVID-19), the Israeli Ministry of Health initiated a plan spearheaded by Magen David Adom (MDA), Israel's national emergency medical services (EMS) organization.

Objectives: To describe outbreak containment actions initiated by MDA, including a COVID-19 tele-triage center and home testing by paramedics.

Methods: Retrospective analysis was conducted of de-identified data from the call management and command and control systems during the first period of the COVID-19 outbreak in Israel (23 February 2020–15 March 2020).

Results: During the study period, the total number of calls to the dispatch centers was 477,321 with a daily average of 21,696, compared to 6000–6500 during routine times. The total number of COVID-19 related calls was 334,230 (daily average 15,194). There were 28,454 calls (8.51% of all COVID-19 related calls, average 1293/day) transferred to the COVID-19 call center. Of the COVID-19 call center inquiries, 8390 resulted in the dispatch of a dedicated vehicle, including a paramedic wearing personal protective equipment, to collect samples for testing (daily average 381).

Conclusions: Maximizing EMS during a pandemic using phone triage, in addition to dispatching paramedics to perform home testing, may significantly distance infected patients from the public and health care system. These steps can further minimize the spread of disease.

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KEY WORDS: coronavirus disease-2019 (COVID-19), emergency medical services (EMS), epidemics, Magen David Adom (MDA), pandemics

In December 2019, the World Health Organization (WHO) China Country Office was informed of cases of pneumonia of unknown etiology detected in Wuhan City, Hubei Province of China. In January 2020 a new type of coronavirus, severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), was isolated and identified as the cause of the rapidly evolving endemic known as coronavirus disease-2019 (COVID-19). This virus soon spread to many countries, leading the WHO to declare it a pandemic [1]. This novel coronavirus proved to be highly contagious and resilient. Fever and cough are the most common symptoms along with fatigue, pneumonia, headache, diarrhea, hemoptysis, and dyspnea [2-4].

A major problem that occurred in the Hubei Province of China (and later in Northern Italy) was the excess flow of patients into hospital emergency departments and community outpatient clinics. This increase caused a crisis for these medical facilities and elevated the risk of viral spread, including to medical teams. The Israeli Ministry of Health (IMOH) anticipated these threats, and by the end of January 2020, initiated a national plan for the prevention and containment of COVID-19 [5].

Magen David Adom (MDA), Israel's national emergency medical services (EMS) organization, was chosen as the main coordinator of this plan. Acting on this directive, MDA expanded its National Medical Emergency Dispatch Center (NMEDC), opened a dedicated COVID-19 call center, and trained its paramedics to collect samples from suspected patients.

EMS are designed to provide citizens with prompt, safe, and effective access to the healthcare system in times of urgent need and are defined by the WHO as an integral part of any effective and functional health care system [6,7]. EMS operate through first responders and ambulances [8]. Its main role is to respond quickly and efficiently by providing first aid instructions via the dispatcher while simultaneously sending first responders and ambulance teams to provide emergent medical care and transport to the hospital [9,10]. Appropriate telephone-triage

is essential to ensure proper response and to prioritize limited resources [11].

During epidemic outbreaks, EMS should be involved in the decision-making processes together with all health care leaders to improve the effectiveness of outbreak containment [12-14]. Containment should begin at the dispatch center where a high index of suspicion needs to be implemented. In suspected cases, the dispatcher should instruct the responding teams to take preventive measures such as donning personal protective suits and notifying the hospital to prepare isolation units [15,16].

The objective of this paper is to describe the role of EMS in a pandemic outbreak, including the dedicated MDA COVID-19 tele-triage center and home testing by paramedics.

PATIENTS AND METHODS

SETTING

Israel has a population of over 8.9 million residents living in a region of 22,072 square kilometers [17]. Medicine in Israel is socialized, and all citizens belong to one of four health maintenance organizations (HMOs), except for soldiers who receive health care from the military [18,19].

MDA operates eight emergency medical dispatch centers where in routine times 22 call takers are receiving emergency calls and eight dispatchers are responsible for 743 basic life support (BLS) ambulances, 308 mobile intensive care units (MICUs), and over 600 first responder motorcycles, bicycles, and mini vehicles in 163 stations spread throughout 10 regions countrywide. The emergency phone number is 1-0-1. Information from received calls is entered by the dispatchers into a unified command and control system. The dispatchers, both volunteer and employed, are trained and experienced emergency medical technicians and paramedics. The system automatically dispatches the closest first responders together with the appropriate level ambulances, depending on the urgency and medical needs at the scene. The command and control system is connected to the dedicated "My MDA" telephone-based application developed by MDA for the general public. All aspects of event management are conducted through the MDA Teams application including requests from dispatch and notification to hospitals [20].

MDA RESPONSE TO COVID-19

THE COVID-19 CALL CENTER

The first COVID-19 case in Israel was diagnosed on 20 February 2020 and hospitalized in what later became the Department of Internal Medicine: Corona Care Unit at the Sheba Medical Center [21]. Three days later a special call center was opened specifically to deal with issues related to COVID-19. This facility was first located in a computer classroom, mobile command and control center truck, and other ad hoc rooms adding up to 100 workstations. Later an emergency tent was added containing 100 more workstations divided into six separate compartments to avoid the spread of infection if one of the call takers became ill.

The COVID-19 call center was opened as a subsidiary of the NMEDC and was staffed 24 hours per day, seven days per week by EMS dispatchers together with public health representatives from the IMOH. In addition, it was staffed by 300 call takers from management as well as volunteers. One experienced supervisor oversaw every six call takers. Information technology staff provided 24-hour on-site support and installed updates and upgrades for the system during the night. MDA call takers and dispatchers were trained to conduct initial triage for signs suspicious for COVID-19.

The main goal of the center was to prevent the spread of COVID-19 to non-exposed patients and to identify and test those who were suspected of having the disease.

WORKFLOW

When a call was received by the emergency number and an emergency was ruled out, if there were either concerning epidemiologic or clinical criteria, the call was transferred to the COVID-19 center.

To facilitate the work at the call center, a flowchart that was jointly developed by MDA and the IMOH was programmed into the command and control system together with information on endemic areas and infected patient routes to identify suspicious cases [Figure 1]. In addition, the "My MDA" application used by the public was updated with a self-use interactive questionnaire based on the flowchart so that in many cases one did not need to call the emergency number.

Using the flowchart, COVID-19 call takers then inquired about symptoms and possible exposure. The calls were divided into three categories:

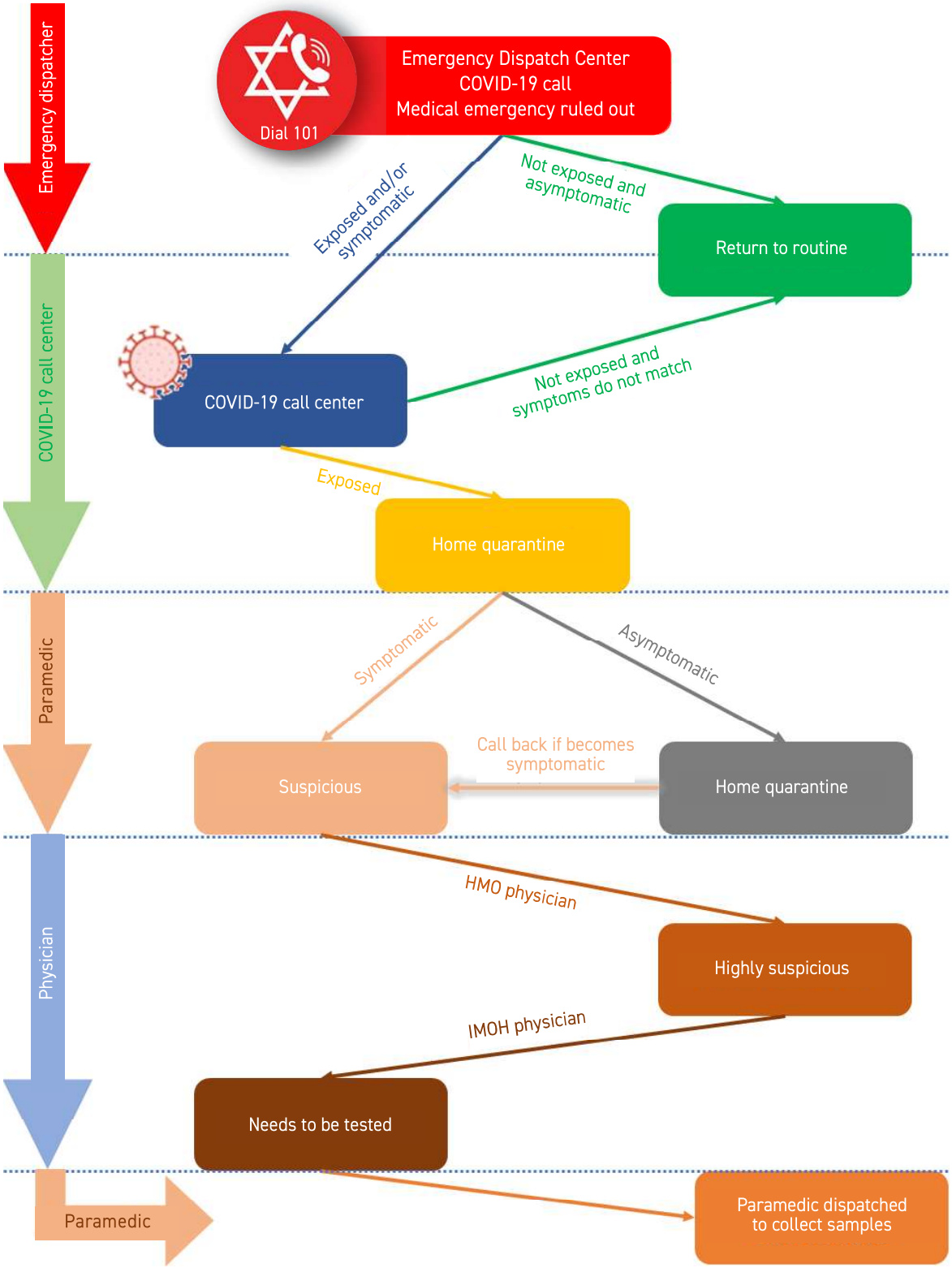
- Unexposed
- Exposed or spent over 15 minutes near a confirmed case but asymptomatic
- Exposed or spent over 15 minutes near a confirmed case and symptomatic

If exposure was confirmed, the callers were instructed to stay at home and quarantine. They then received a call from a paramedic to further inquire about symptoms. If there was a clinical picture suspicious of COVID-19, the paramedic then contacted a physician. After a conversation with the HMO/military physician, if there was a suspicion of COVID-19, the details were transferred to an IMOH physician for a final decision whether to send a paramedic for sample collection. In that case, an MDA paramedic wearing personal protective equipment was dispatched to collect the samples.

In cases where COVID-19 was confirmed by the laboratory after sample collection, an ambulance team was sent to transport the patient on a dedicated negative-pressure hooded bed to the dedicated COVID-19 sections of the emergency departments.

Figure 1. Coronavirus disease-2019 (COVID-19) work flowchart

IMOH = Israeli Ministry of Health, HMO = health maintenance organization



DATA COLLECTION

The study period began on 23 February 2020, with the opening of the dedicated COVID-19 call center and extended through 15 March 2020. Data was extracted through the institutional business intelligence system from the call management and the command and control systems. The data were entered into a spreadsheet Excel 2016 (Microsoft Corp, Redmond, WA, USA). Data were analyzed and compared between the COVID-19 outbreak and the pre-pandemic period in February and March 2019. Data on confirmed COVID-19 positive patients were collected from the IMOH Spokesman daily reports [22]. This study involved only retrospective de-identified data. It was approved by the Scientific Committee of Magen David Adom and the Shaare Zedek Medical Center institutional review board, which waived written informed consent.

RESULTS

During routine times there are approximately 6000–6500 daily calls to the NMEDC. In the study period, there was a gradual increase in the total number of calls ranging from 10,762 daily at the beginning of the study period to a maximum of 52,714 on the last day. This is an average 17.72% daily increase and an absolute increase of 389.82% compared to the pre-endemic period [Figure 2]. The number of confirmed COVID-19 cases in Israel increased from 2 to 252 during this time. As of 3 March 2020, the number of confirmed cases in Israel was 250 of which 231 (92.4%) were in mild condition, 11 (4.4%) in moderate condition, 4 (1.6%) in critical condition, and 4 (1.6%) recovered [22].

Initially, exposure was defined as return from endemic countries (including China, Thailand, Korea) and direct contact with a group of travelers from South Korea in Israel. On 3 March 2020, the IMOH added quarantine requirements for those returning from Germany, Switzerland, Spain, and Austria. The NMEDC received 40,168 calls on the next day compared with the daily average of 10,297 since the establishment of the COVID-19 call center, an increase of 290%. The next morning, the IMOH was notified about confirmed cases in a group of tourists after returning to Greece and one American tourist after returning to the United States. On that day 28,018 calls were received, marking another 111% increase in calls over the daily average, which on that day was already 13,285.

During the study period, the total number of calls to the NMEDC was 477,321 with a daily average of 21,696. The total number of COVID-19 related calls was 334,230 with a daily average of 15,194. This represented 70% of the total number of calls. The total number of routine emergency calls was 143,091 with a daily average of 6,504. There was no increase in the routine emergency calls beyond the natural growth rate [Figure 2]. Similarly, the increase in the average number of ambulances dispatched daily during the studied period from 2080 per day

Figure 2. Correlation between number of confirmed coronavirus disease-2019 (COVID-19) cases in Israel and calls to the National Medical Emergency Dispatch Center

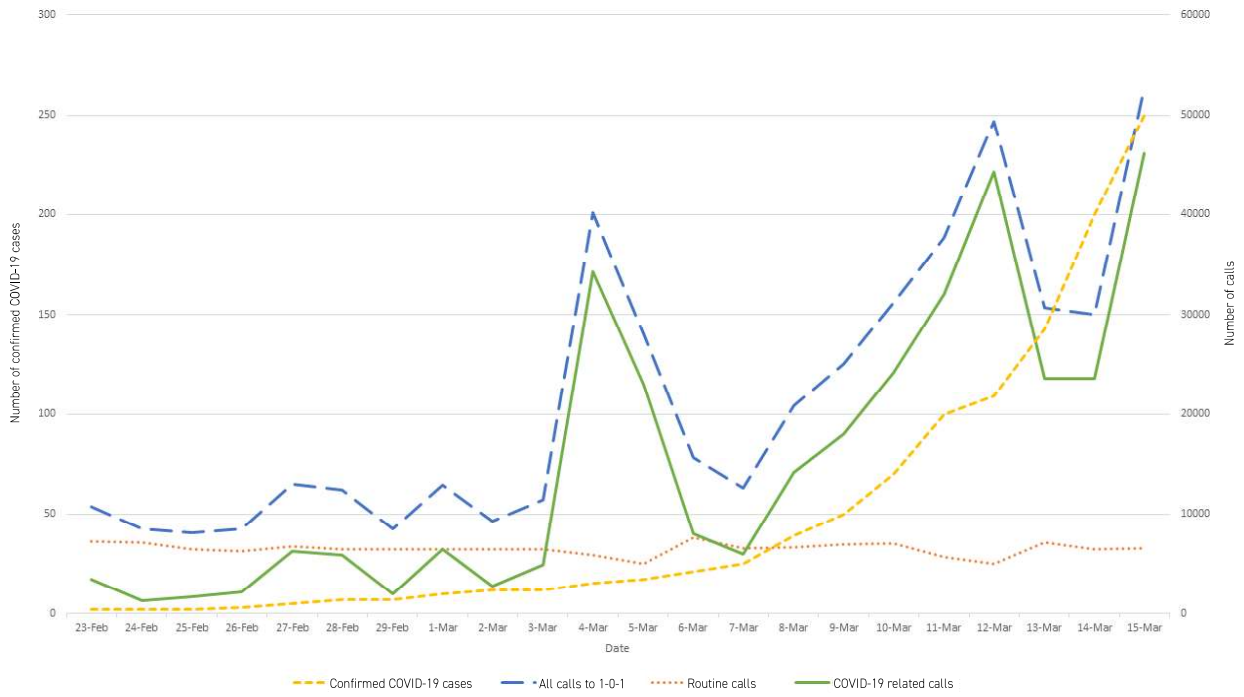
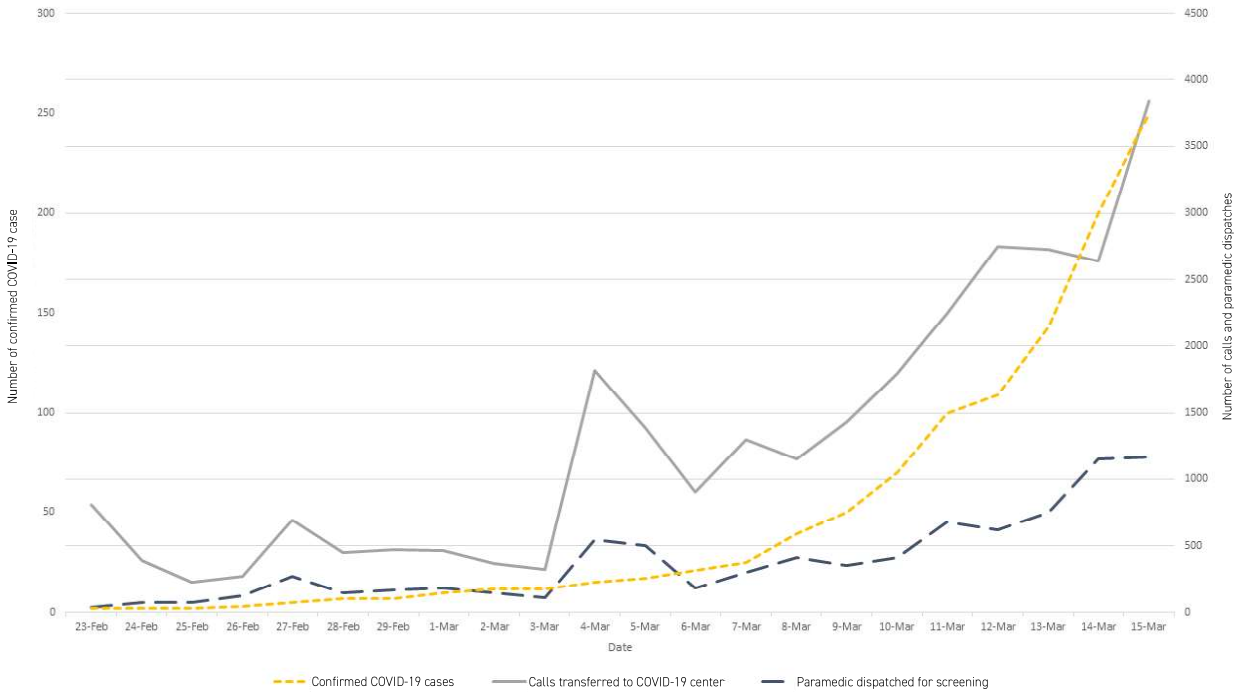


Figure 3. Correlation between the number of confirmed coronavirus disease-2019 (COVID-19) cases in Israel, calls to the COVID-19 call center, and dispatches for sample collection



to 2209 in February/March 2019 was within the natural yearly increase of 3–6% [23].

There were a total of 28,454 calls (average of 1293 per day) which were transferred to the COVID-19 call center, which amounted to 8.51% of all COVID-19 related calls. Eventually 8390 (29.49%) of the calls transferred to the COVID-19 call center resulted in a paramedic dispatched on a dedicated vehicle equipped with personal protective equipment, disinfection materials, and kits to collect a sample for testing (an average of 381 per day, range 41–1165) [Figure 3].

DISCUSSION

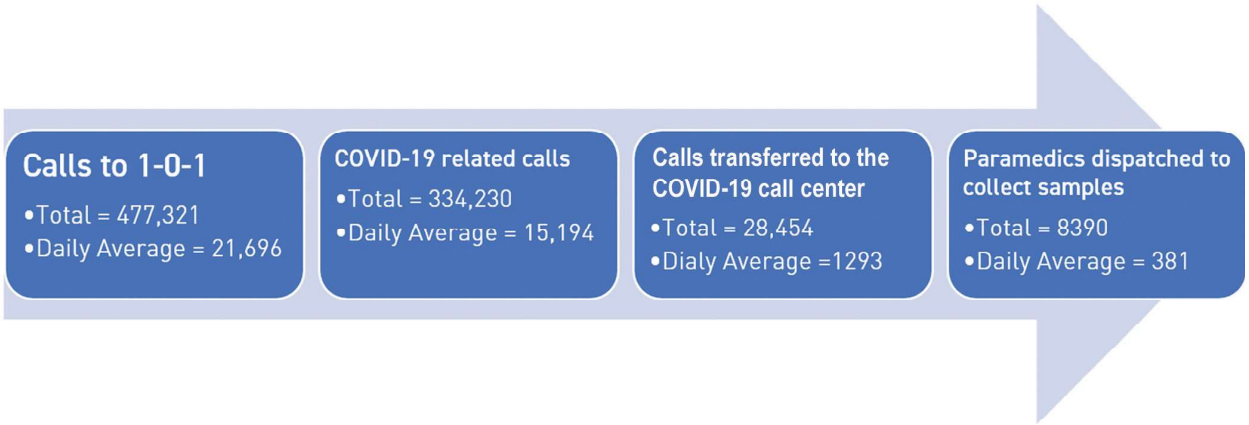
The WHO national capacities review tool for a novel coronavirus (nCoV) checklist states the measures needed for a state/country to contain an endemic of nCoV [24]. MDA, with its position in the Israeli health system, was able to provide an answer to most of these measures. The only major change was training MDA teams to collect samples from suspected patients.

The number of routine ambulance calls did not change during this time. As the number of exposed and confirmed cases in Israel increased, more calls were made to the emergency number [Figure 2]. The addition of the COVID-19 dedicated call center together with additional call takers allowed the main dispatchers to maintain routine emergency calls.

The rate of dispatch of paramedics for sample collection increased with the number of ill citizens and the number of calls to the COVID-19 call center [Figure 4]. However, the number and rate of confirmed COVID-19 cases did not rise exponentially unlike other infected countries around the globe. Particularly in the Lombardy region of Italy, one can observe that the epidemic curve (number of infected patients over time) from 19 February 2020 to 8 March 2020, was growing exponentially, whereas in Israel the epidemic curve was growing linearly [25]. Despite efforts by the Italian authorities to limit the viral transmission of the disease in the Lombardy region by restricting movement, the number of people visiting emergency departments was much greater than the health system could cope. As a result, the disease transmission rate and mortality rate increased, including among medical staff, due to the limited capacity of the health system to provide appropriate medical care. MDA's efforts at that time were to distance the patients who were either suspected or confirmed to be positive for COVID-19 from the public by screening them at home and by providing protected transport to the dedicated COVID-19 sections of the emergency departments. Thus, these patients did not spread the infection to drivers, on public transportation, or in hospital and clinic waiting rooms.

During the study period, there were three dates (29 February 2020, 7 March 2020, and 14 March 2020) that were Saturday, the Jewish Sabbath when Orthodox and traditional Jews

Figure 4. Flowchart depicting the activities of Magen David Adom including those of the National Medical Emergency Dispatch Center, coronavirus disease-2019 (COVID-19) call center, and paramedic dispatch to collect samples



may have avoided calling the COVID-19 center for information, except if they believed it was an urgent health matter. This can explain the decrease in the total number of calls on Saturdays while the rate of calls transferred to the COVID-19 call center and the rate of paramedics dispatched for sampling both remained in the same trajectory. One can infer from this that the initial triage concerning COVID-19 made before transfer to the dedicated COVID-19 call center was done correctly.

MDA is required by law to be prepared for any occurrence of a natural or other type of disaster. For this reason, MDA is a dynamic and elastic organization with features that are based on organizational, human, and technological factors. The organizational factor is based on the method that: "what works in routine has a better chance of functioning during an emergency." The human factor is based on 2500 employees and 24,000 volunteers who are a major force multiplier especially during times of disaster. MDA volunteers undergo the same training as salaried staff and take part in all aspects of MDA activities, thereby staying up to date with medical and organizational protocols. During their volunteering, they gain extensive experience in triage, which prepares them for an active role in disaster response without any delay for training. The technological factor is based on an in-house information technology department which includes a programming unit. The telephony and command and control array are designed to be expandable to a capacity of at least 10 times that of routine activity and all systems are flexible as the programming department can add and update features immediately as needed [20]. This allows the ability to maintain routine functions in addition to responding adequately to a pandemic outbreak.

CONCLUSION

Maximizing EMS during a pandemic using dedicated phone triage along with dispatching paramedics to carry out home testing, may significantly distance infected patients from the public and the health care system. This can further minimize the spread of disease. An EMS organization should employ volunteers in their routine activities, as they will be prepared for response during times of disaster.

It seems that incorporating MDA from the beginning of the COVID-19 pandemic in Israel helped slow the spread of disease by enabling suspected patients to avoid hospitals and community clinics and by managing the treatment of mild cases of COVID-19 patients at home allowing hospitals to be used for severe cases.

While Israel is a relatively small country with a nationwide standardized EMS system, the same concepts presented here may apply to designated geographic regions, provinces, or individual states around the world.

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Capsule

Viral and host factors related to the clinical outcome of COVID-19

Zhang et al. analyzed clinical, molecular, and immunological data from 326 patients with confirmed severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) infection in Shanghai. The genomic sequences of SARS-CoV-2, assembled from 112 high-quality samples together with sequences in the Global Initiative on Sharing All Influenza Data (GISAID) dataset, showed a stable evolution and suggested that there were two major lineages with differential exposure history during the early phase of the outbreak in Wuhan. Nevertheless, they exhibited similar virulence and clinical outcomes. Lymphocytopenia, especially reduced CD4+ and CD8+ T cell counts at hospital admission and was predictive of disease progression. High levels of interleukin (IL)-6 and IL-8 during treatment were observed in patients with severe or critical disease and correlated with decreased lymphocyte count. The determinants of disease severity seemed to stem mostly from host factors such as age and lymphocytopenia (and its associated cytokine storm), whereas viral genetic variation did not significantly affect outcomes.

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Eitan Israeli

A book must be an axe for the frozen sea inside of us.
Franz Kafka (1883–1924), Bohemian novelist and short-story writer, widely regarded as one of the major figures of 20th century literature