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# Rapid Sequence Adaptation: Establishing the First Military COVID-19 Ward in a Large Civilian Medical Center

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## Abstract

**Background:** Coronavirus disease (COVID-19) challenged health systems worldwide. Even though an early aggressive containment strategy successfully delayed the initial outbreak in Israel, eventually COVID-19 care came at the expense of other patients. To increase the national surge capacity, a COVID-19 facility was established in an underground emergency hospital. Operation of Military COVID-19 Wards (MCWs) in the facility was assigned to the Israeli Defense Force Medical Corps, which does not operate hospitalization facilities regularly. We hypothesized that military health care providers could be quickly mobilized, trained, and deployed to a civilian facility to operate a MCW.

**Methods and findings:** To test this hypothesis, we examined the timeline of MCW deployments and conducted a retrospective cohort study comparing patients admitted to the MCW during the first and second deployments. The cohorts were compared in terms of patient characteristics at presentation, in-hospital COVID-19 care and quality of care measures. The MCW admitted its first patient 10 days after the operation was announced and 5 days after it was reopened. 52 and 182 patients were treated during the first and second deployments, respectively. No significant differences in age, sex, time after symptom onset or diagnosis, and COVID-19 severity at presentation were found between deployments. A significantly higher proportion of patients treated during the second deployment were vaccinated (p=0.03). No significant differences were found in maximal respiratory support, the use of Dexamethasone or anticoagulation. The use of remdesivir on the other hand, was significantly less prevalent in the second deployment (p<0.0001). No significant differences in length of stay, discharge destination or mortality were found between deployments.

**Conclusion:** Opening the MCW increased the national surge capacity within days, thereby relieving the overextended national healthcare system. The only differences found between deployments reflected external changes in vaccine availability and standard of care. The MCW proved to be an agile strategy in mitigating unpredictable surges in health care demand.

**Keywords:** COVID-19; Military; Surge capacity

**Abbreviations:** COVID-19: Coronavirus disease; MCWs: Military COVID-19 wards

## Background

The Israeli Defense Force Medical Corps has been providing medical aid in humanitarian crises worldwide well over half a century [1-5]. These events often produce many casualties thereby overwhelming local health systems lacking in medical personnel and adequate infrastructure. Similarly, the Coronavirus disease (COVID-19) pandemic challenged health care systems as hospitalization rates surged rapidly, ICU capacities were stretched, and healthcare providers were quarantined at masses and precluded from treating patients.

Israel's healthcare system serves more than 9 million people with relatively limited resources compared to other OECD countries [6-8]. These narrow safety margins forced Israel to an early aggressive containment strategy as it first encountered COVID-19 [9]. Tight travel restrictions, PCR testing, self-reported quarantine and lockdowns delayed peak transmission by weeks. Nonetheless, following a rapid surge in new cases in July 2020, it became apparent that the healthcare system was struggling as operating-room activity decreased by at least 40% [10] and post-operative mortality increased [11]. The national surge capacity was no longer just a healthcare measure, but rather a key parameter for decision makers in directing the extent of public restrictions including decision on lockdowns initiation and relief.

The largest and only tertiary care center in northern Israel, Rambam Health Care Campus (hereafter referred to as

Rambam) set out to establish the largest COVID-19 facility in Israel [12]. An underground emergency hospital was redesigned to enable hospitalization of up to 770 patients, including 170 ICU beds. This step increased the national surge capacity but came at a heavy price on non-COVID-19 services at the hospital. At this point, the Medical Corps was assigned by the national government to incorporate military healthcare providers that would operate Military COVID-19 Wards (MCWs) within the existing Rambam infrastructure, termed operation "Brotherhood".

We hypothesized that military health care providers could be quickly mobilized, trained and deployed to a civilian facility to operate a MCW. Furthermore, we hypothesized that the MCW may be required to redeploy if another COVID-19 surge would occur. To test these hypotheses, we examined the timeline of MCW deployments and compared the patient cohorts treated during deployments. To the best of our knowledge, this was the first time that a military medical unit set up within a civil facility to treat COVID-19 patients as an independent ward.

# Methods

## Operation "Brotherhood"

A timeline including operation and redeployment announcements, training and deployments in the context of COVID-19 propagation in Israel is shown in **Figure 1** . For this purpose, we obtained the number of nation-wide new severe COVID-19 patients who were admitted per day from the Israel Ministry of Health website [13]. Data corresponding to the second and 3rd waves (June first 2020–February 20th 2021) were plotted over time with an overlaying timeline of the operation.

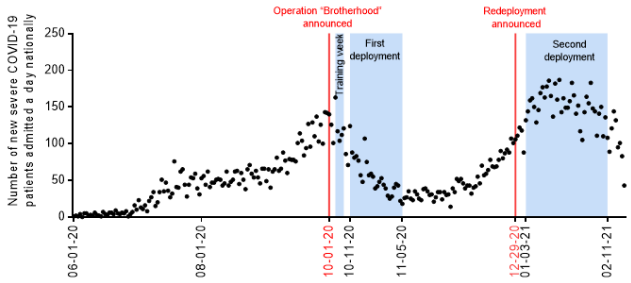


**Figure 1:** Operation "Brotherhood" timeline in context of the number of new severe COVID-19 patients admitted a day nationally over time.

## The military COVID-19 ward

The MCW was organized similarly to non-military COVID-19 wards. A director and deputy director were appointed in addition to 3 attending physicians. Attending physicians were certified in internal medicine or family medicine. 14 pre-residency physicians were trained as house physicians. The healthcare team was completed by 24 nurses including a head nurse, 17 medics, 2 clinical pharmacists and 2 physical therapists. All in all, 64 professionals were trained and deployed. An additional reserve of 20 physicians and 23 nurses were trained in case operating two MCWs simultaneously would be needed.

## Study design and patient characteristics at presentation

A retrospective cohort study comprised of 52 and 182 patients admitted to the MCW during the first and second deployments respectively was conducted. The study was approved by the local IRB. Patient characteristics at presentation including age, sex, number of COVID-19 vaccine doses per patient, time after symptom onset and diagnosis, and COVID-19 severity were collected from the electronic health record (**Table 1**). COVID-19 severity stratification was based on the Israeli MOH recommendations for COVID-19 inpatients [14].

| | First deployment | Second deployment | P-value |
|---|---|---|---|
| Patients | n=52 | n=182 | |
| Age, average ± SE, years | 62 ± 2.8 | 64 ± 1.3 | 0.35 |
| Sex, n (%) | | | 0.78 |
| Male | 29(56) | 106(58) | |
| emale | 23(44) | 76(42) | |
| COVID-19 vaccine doses per patient, n (%) | | | 0.03 |
| 0 | 52(100) | 160(88) | |
| 1 | 0(0) | 18(10) | |
| 2 | 0(0) | 4(2) | |
| Time after symptom onset, Average ± SE, days | 7.4 ± 0.4 | 6.5 ± 0.3 | 0.33 |
| Time after diagnosis, average ± SE, days | 5.7 ± 0.6 | 4.7 ± 0.4 | 0.26 |
| COVID-19 severity, n (%) | | | 0.89 |
| Mild | 15(29) | 56(31) | |
| Moderate | 16(31) | 51(28) | |
| Severe | 21(40) | 75(41) | |

**Note:** COVID-19 vaccines became available on December 19th 2020 and by beginning of the second deployment (January 3rd 2021) 13.9% of the Israeli population received a single dose of vaccine [13].

**Table 1:** Patient characteristics at presentation compared between deployments.

## Therapeutic interventions and patient outcomes

Respiratory support was provided as needed to maintain oxygen saturation above 92%. The use of low flow oxygen via

nasal cannula or face mask, or high flow oxygen via high flow nasal cannula was collected from the electronic health record along with the use of Remdesivir, Dexamethasone and anticoagulation (**Table 2**). Quality of care measures including length of stay, discharge destination and in-hospital mortality were also derived from the electronic health record (**Table 2**).

| | First deployment | Second deployment | P-value |
|---|---|---|---|
| Patients | n=52 | n=182 | |
| Maximal respiratory support, n (%) | | | 0.959 |
| None | 19(36) | 64(35) | |
| Low flow oxygen | 21(41) | 78(43) | |
| High flow oxygen | 12(23) | 40(22) | |
| Remdesivir, n (%) | 19(36) | 4(2) | <0.0001 |
| Dexamethasone , n (%) | 35(67) | 122(67) | 1 |
| Anticoagulation, n% | 43(82) | 131(72) | 0.093 |
| Length of stay, average ± SE , days | 5.2 ± 0.5 | 4.2 ± 0.3 | 0.109 |
| Discharge destination, n (%) | | | 0.399 |
| Home | 30(58) | 120(66) | |
| Rehab/Nursing home/Transfer to another ward | 20(38) | 53(29) | |
| ICU | 2(4) | 9(5) | |
| Mortality, n (%) | 3(6) | 18(10) | 0.297 |

**Table 2:** Patient treatment and outcomes compared between deployments.

### Statistical methods

Categorical variables are presented as absolute counts and percentages, while continuous variables are presented as mean ± Standard Error (SE). T test was used to compare continuous variables, while a $\chi^2$ test was used to compare categorical ones. Graphpad Prism 5.0 f software (Graphpad Prism, San Diego, CA) was used to plot and analyze the data. To assess significance, $p<0.05$ was considered statistically significant.

## Results

The announcement of operation "Brotherhood" and redeployment is marked in red while the training week and both deployments are marked in blue. Dates are formatted as month-day-year (**Figure 1**).

July 2020 was the beginning of a surge of COVID-19 patients in Israel, i.e. second wave, coming to a maximum of over 10,000 new diagnoses daily and 150 severe COVID-19 patients admitted a day in late September 2020 (**Figure 1**). Operation "Brotherhood" was announced with the clear aim to increase the national surge capacity. Three days after announcing the operation, a 5-day long training week at rambam began with enough physicians, nurses, physical therapists, pharmacists and medics to operate two MCWs simultaneously. Led by rambam and medical corps experts, the training period focused on bringing the team to speed with the current body of knowledge on COVID-19 care, COVID-19 critical care and personal protective equipment instructions. Additional training on rambam electronic health records, advanced cardiovascular life support and core subjects in internal medicine was provided to ease the transition toward treating inpatients.

Three days after training was completed, the MCW, capable of caring for 40 patients at a time, was opened on October 11th. A few hours later, the first patient was admitted, heralding a month of activity (i.e. first deployment) until the MCW closed on November with a significant decline in new severe COVID-19 daily admissions. Unfortunately, in January of 2021 the number of new severe COVID-19 patients admitted a day nationally soared to an all-time maximum, necessitating the reopening of the MCW (i.e. second deployment) only 5 days after redeployment was announced. Five weeks later, the MCW was once again closed as the national COVID-19 burden lightened.

A total of 52 patients were admitted to the MCW during the first deployment compared to 182 patients during the second deployment (**Table 1**). The average patient age was 62 years old in the first deployment and 64 years old in the second deployment ($p=0.35$). There was a male predominance in both deployments (56% and 78%) with no significant difference between deployments ($p=0.78$). A significant difference in the distribution of COVID-19 vaccine doses was found ($p=0.03$) as 12% of the patients who were treated during the second deployment were partially or fully vaccinated, compared to none during the first deployment.

Patients were admitted on average 7.4 days after symptom onset and 5.7 days after diagnosis in the first deployment and insignificantly earlier in the second deployment, 6.5 and 4.7 days respectively. 40% of patients in the first deployment and 41% in the second deployment were diagnosed as severe COVID-19 at presentation with no significant differences in COVID-19 severity distributions ($p=0.89$).

During hospitalization most patients required respiratory support including either low or high flow oxygen in both deployments (**Table 2**). Most patients were treated with dexamethasone and anticoagulation in both deployments. Remdesivir was administered to 36% of patients during the first deployment but only 2% during the second deployment ($p<0.0001$).

Patients were discharged on average 5.2 days after admission in the first deployment and insignificantly earlier, after 4.2 days, during the second deployment. Few patients, 4%-5%, were transferred to the ICU as a result of respiratory failure requiring intubation and mechanical ventilation. 6% and 10% of the

patients died during hospitalization with no significant difference between deployments (p=0.297).

## Discussion

The COVID-19 pandemic challenged health systems and provoked large-scale reallocations of resources. Militaries around the world were called to assist civilian systems in many different ways and places. For example, a field ICU in Bahrain [15] and France [16] were deployed and military doctors and nurses were deployed to existing civil and military medical facilities [17]. However, we are unaware of a military medical unit set up within a civil facility as described here.

The MCW proved to be an agile solution to unpredictable surges in health care demand. The ward was fully operational in 10 days from the operation announcement (**Figure 1**) and redeployed in less than a week. The MCW increased the national surge capacity by 5% and the second stand-by MCW allowed an additional potential 5% increase in national surge capacity. All in all, enough military personnel were trained to admit 80 patients in 7 days after arriving at Rambam.

A total of 234 patients were treated at the MCW, mostly during the second deployment. No significant differences in age, sex, time after symptom onset or diagnosis, and COVID-19 severity at presentation were found between deployments (**Table 1**). The only significant difference in patient characteristics between deployments we found was the vaccination status (**Table 1**) that emerged as an important factor in mitigating disease burden in Israel between the two periods.

When the patients treated in both deployments were compared in terms of COVID-care, no significant differences were found in maximal respiratory support, the use of Dexamethasone or anticoagulation (**Table 2**). A significant difference was found in the use of Remdesivir, which was much more prevalent during the first deployment compared to the second deployment (**Table 2**). This is probably the result of Remdesivir recommend for patients receiving low flow oxygen by the ACTT-1 trial [18] during the first deployment but not during the second deployment following the publication of the SOLIDARITY trial [19]. Currently, Remdesivir is thought to shorten time to recovery and reduce the risk of COVID-19 progression in patients who are at high risk of hyper inflammation, diagnosed early during illness and require supplemental oxygen [20]. Albeit a clinically significant endpoint and cost-effective practice, a narrow window of opportunity limits the use of Remdesivir in our experience.

No significant differences were found in quality of care measures including length of stay, discharge destination and in-hospital mortality (**Table 2**). Notably, the in-hospital mortality rate was about 1.5 times higher during the second deployment albeit not a statistically significant finding (p=0.297). This may be the result of higher national patient load [21], or the emergence of new COVID variants. Regardless of the explanation, this highlights the need for early national surge capacity increasing interventions.

We have found this type of deployment advantageous in a number of ways. First, it allowed the MCW to form quickly as mobilizing significant independent medical resources under uncertainty is well-within the military repertoire. Second, it accelerated team building. While most of the personnel have not worked together before this operation, they could rely on shared Medical Corps organizational culture, norms and even jargon to unify them. Finally, allowing the military physicians to be fully responsible for their patients, under the guidance of experts in internal medicine and related fields, pushed them out of their comfort zone and required mastering COVID-19 care which would have been probably less crucial had civilian experts been integrated into the MCW. Albeit a “one disease” ward, most military physicians in the IDF treat young and generally healthy patients unlike the patients one would find hospitalized for COVID-19. Participants reported a profound learning experience, a sense of rising to the challenge and decrease in the sense of burnout.

Nonetheless, this study and the concept of the MCW are not free of limitations. The patient cohorts presented are relatively small and were not compared to other cohorts so we cannot be sure that they represent patients encountered elsewhere. Furthermore, the second deployment cohort included patients who had been vaccinated against COVID-19 whereas in most of the world at that time vaccinations were not available. The MCW itself is not necessarily an easily reproducible operation. The Israeli Defense Army Medical Corp relies mostly on healthcare providers which have been trained by the civilian health care system and therefore are familiar with it and capable of caring for patients which are not typically encountered in the military setting such as geriatric patients. Countries whose military healthcare providers are trained solely in a military setting may find treating COVID-19 patients more challenging. Finally, dedicating the personnel necessary to operate the MCW came at a price to the Medical Corps itself which was carrying out all of its routine tasks, caring for soldiers suffering from COVID-19 and spearheading the COVID-19 vaccination campaign in the army.

## Conclusion

At the time of writing this manuscript, many countries including Israel are threatened by another wave of COVID-19, in spite of vaccination efforts. The idea of a military ward integrated into a civilian center could also be used for other pandemics (such as seasonal flu). In addition to increasing the national surge capacity, MCWs could improve the interface between military and civilian medical systems, thereby improving care in both systems. For example, soldiers could benefit better access to tertiary care, military health care providers may benefit clinical exposure, and the civilian healthcare system could benefit from young motivated physicians which are also experienced leaders. Time will tell whether the MCW was a singular event formulated to answer a unique need or perhaps the beginning of a more diverse healthcare system.

## Ethics Approval and Consent to Participate

The study was approved by the local IRB.

## Consent for Publication

Not applicable.

## Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Competing Interests

The authors declare that they have no competing interests.

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No funding was provided for this study.

## Authors' Contributions

GS, GT and AF conceptualized the study and wrote the manuscript with input from all authors. GS analyzed the data. OT, GZ and NG collected data regarding patient care. AB, NF, EG and EK interpreted data regarding quality of care. YSM, KH and MH interpreted data regarding COVID-19 care. All authors read and approved the final manuscript.

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Not applicable

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