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Bucharest mobile military hospital – response to the COVID-19 pandemic

Florentina Ionita Radu[1,2], Ileana Mariana Mates[1], Valeriu Gheorghita[1,3]

Abstract: *The idea of using mobile hospitals - a fully functional hospital is a system with a high degree of complexity - in case of a pandemic crisis, is not new, but shows how much they are needed.*

Solutions belonging to the category of mobile architecture are increasingly common, technical and logistic difficulties are solved in more perfect way. This applies mostly to objects with simple layouts and functional relationships, with relatively little technical equipment. In the case of healthcare facilities there are several factors increasing the difficulty: multitude of functional connections, sanitary requirements, technical equipment, and internal infrastructure.

The Romanian military and civilian specialists from Bucharest Central Military Emergency University Hospital (SUUMC) showed that is possible to build a hospital as a modular and mobile structure in order to fight COVID 19, but the strategic actions and the effort needed to organize and run mobile hospital far exceeds the expenditure, protocols and specialized M.D.s necessary to run the stationary hospital.

Keywords: *mobile hospitals, COVID-19, strategic actions*

INTRODUCTION

SARS-CoV-2, the causative agent of COVID-19, is a newly discovered coronavirus. It is transmitted through respiratory droplets and direct contact; other modes of transmission (i.e. airborne and digestive) have been proposed, but they are still under investigation. The average incubation period is estimated at 5 to 6 days, ranging from 1 to 14 days [1]. There is currently no approved specific treatment or vaccine against COVID-19.

Business-as-usual service delivery approaches are not sufficient to respond in the fight against COVID 19, once cluster of cases or widespread community transmission is registered and superior capacity will be needed.

While World Health Organization (WHO) advises that aggressive measures to find, isolate, test, treat and trace are the best ways to stop the spread of this virus, public health interventions to "flatten the curve" may slow transmission and mitigate peak capacity needs. Modelling studies point to the impact of nonpharmaceutical interventions (NPIs), such as physical distancing, school and university closures, banning of mass gatherings, and remaining indoors, on spreading the number of cases over a longer period to give health systems the opportunities they need to cope with caseloads [1, 2, 3, 4]

These models have helped to reinforce the message from WHO about the implementation of such measures, alongside widespread testing, to detect cases and break chains of transmission. In addition to these measures, phased plans for creating surge capacity in acute and intensive care will help respond to COVID-19 cases while maintaining essential health services.

Surge capacity is the ability of a health system to manage a sudden and unexpected influx of patients in a disaster or

[1] Carol Davila University Emergency Military Hospital, Bucharest, Romania
[2] Titu Maiorescu University, Bucharest, Romania
[3] "Carol Davila" University of Medicine and Pharmacy, Bucharest Romania

emergency situation.

Surge capacity can be created from intrinsic and extrinsic resources. The former covers all local resources that can be used for the response, while the latter involves leveraging resources from outside the affected area (across geography or across specialty).

As the COVID-19 pandemic necessitates both in tandem in all countries, this note covers both these aspects together. Creating surge capacity involves a comprehensive approach linking the 4 S's of surge capacity: space, staff, supplies and systems. [5]

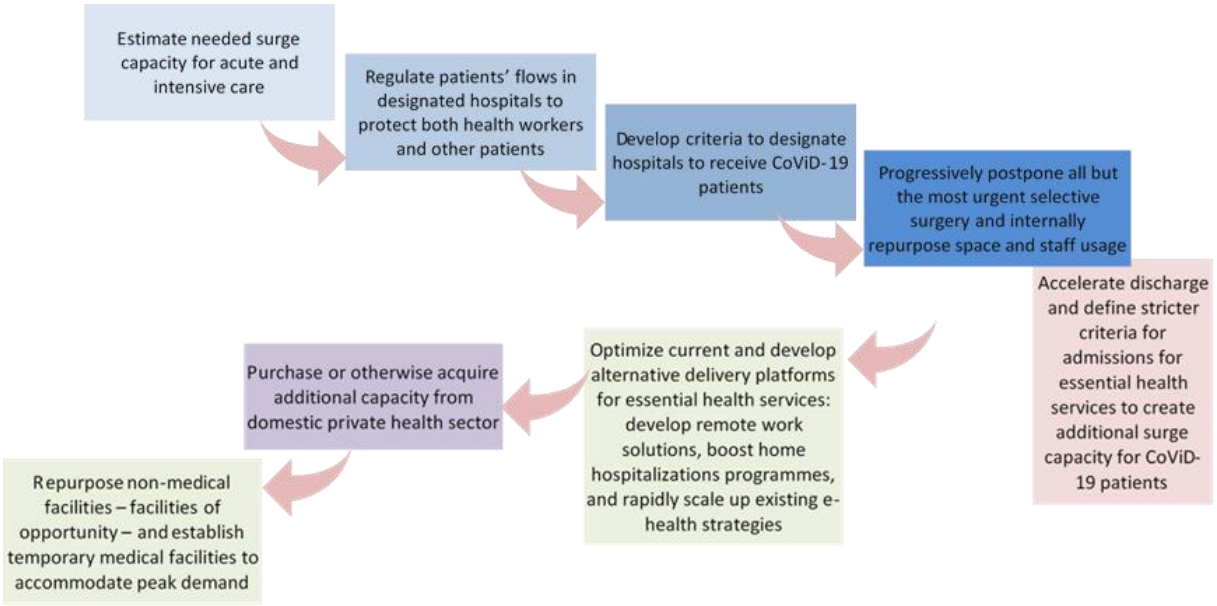
RECOMMENDATIONS AND STRATEGIC ACTIONS

In the following, are presented the recommendations and strategic actions to activate surge capacity in line with the 4 S's drawing on past experiences in emergencies and on the emergent experiences of world countries in the COVID-19 response.[6]

Strategic action 1. **Create and activate a stepwise plan to expand physical space to care for COVID-19 patients respecting infection prevention and control protocols**.

This action requires the following steps, and is schematically presented in the Figure 1.

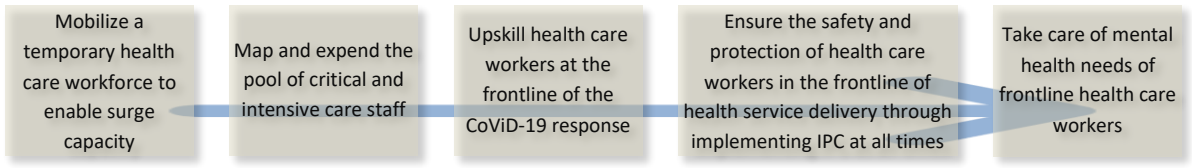
Figure 1: Necessary steps for strategic action 1



Strategic action 2. Identify the health workforce available for surge capacity demands, and repurpose and upskill for rapid deployment to meet surge capacity needs

The steps necessary for this strategic action are depicted in Figure 2.

Figure 2. Necessary steps for strategic action 2



Strategic action 3. Ensure adequate supplies to support surge in demand

The necessary steps for strategic action 3 are presented in Figure 3.

Strategic action 4. Establish systems to manage and align policies to meet surge in demand

The steps that are necessary for strategic action 4 are mentioned in Figure 4.

Figure 3: Necessary steps for strategic action 3

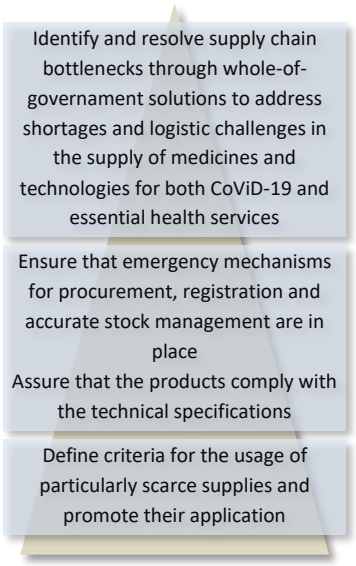
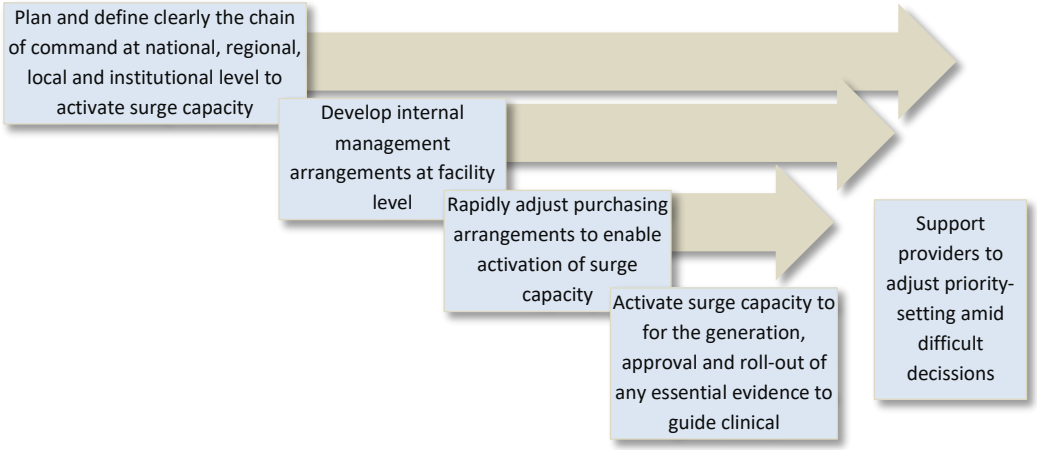


Figure 4: Necessary steps for strategic action 4



THE ROL 2 MILITARY HOSPITAL AT THE ANA ASLAN INSTITUTE IN OTOPENI, NEAR BUCHAREST – A CASE STUDY

The ROL 2 military hospital was installed at the Ana Aslan Institute in Otopeni city, near Bucharest, to support the Romanian government as a response to the Covid-19 pandemic. The ROL 2 was declared operational on Saturday, March 28, in the presence of President Klaus Iohannis and Prime Minister Ludovic Orban, the Ministry of Defense announced.

Once accredited by the Ministry of Health, the ROL 2 hospital will operate as an external facility of the Central Military Emergency University Hospital (SUUMC). The mild and medium cases of COVID-19 will be admitted and treated in this medical facility (Figure 5).

Figure 5: The ROL 2 first medical team

The ROL 2 mobile military hospital operate as a stand-alone entity (as in the American solutions), or in conjunction with the whole hospital – Bucharest Central Military Emergency University Hospital (but still autonomously, as in European solutions). These two variants are taking into account

organisation of space or technological line flow. The difference between the two models comes down to one important aspect: in the European pattern patients' flow is unidirectional, almost linear, from the entrance of the patient to the segregation area (TRIAGE), through diagnostic and treatment facilities ending at the hospital bed wards). This is due to the principles of Emergency Department (DE) operation. ED is an integral part of the hospital and at the same time it is an emergency path of hospitalization. The American ED is more autonomous unit, operating often as an outpatient clinic compared to European standards: the TRIAGE and central nurse station become the most important areas of the ED. Other functions of the ED are grouped around the focal point of the nurse station. The flow of patients through the ED is less structured, without clearly separate movement paths, always through the nurse point.

In the case of building a mobile military hospital there are several factors increasing the difficulty: multitude of functional connections, sanitary requirements, technical equipment, and internal infrastructure, which includes both the military and civilian objectives.

The mobile military hospital is built as a reaction to disasters, both natural and those resulting from human factor, for "emergency" (acute and crisis situations) activities. An emergency medicine, no matter of the form of its organisation, is a set of medical actions, serving a life rescue.

The technical solutions are related to 2 terms: modularity and mobility. Modularity should provide a construction of possibly most numerous and diverse structures of various purposes. Mobility is to ensure a solution which enables the module (typical commodity container) to be loaded and transported by standard ways: truck or a ship, or even air-borne.

For this achievement, the management of the Bucharest Central Military Emergency University Hospital (SUUMC) conceived a procedure which has been developed to support hospital preparedness for the management of COVID-19 patients, based on European Centre for Disease Prevention and Control recommendations [7]. The procedure started with the procurement and stock management. A procurement procedure to acquire the necessary materials and supplies was activated on short notice and alternative suppliers have been identified. The acquisition team took into account that if main suppliers should run out of stock (especially for personal protective equipment (PPE)) a buffer stock of key supplies has been acquired (e.g. for hand and respiratory hygiene, PPE, isolation, ICU supplies, mechanical respirators). A procedure to monitor and regularly update the inventory and a stock inventory have been conducted. In order to avoid misuse or overuse, a plan was developed to keep track and custody of key supplies (e.g. PPE, ventilators, cleaning and disinfection material, alcohol solution etc.).

The maximum facility capacity, including the maximal number of ICU beds, mechanical ventilators, bins for infectious waste, and the required human resource capacities (M.D.s, healthcare workers and cleaning personnel) and supply capacity have been calculated.

Storage facilities which meet all demands with respect to temperature, humidity, cold-chain, logistics etc., for additional stock have been identified, also a proper amount of cleaning and disinfection products shown to be effective against coronaviruses is available. A procedure to ensure that equipment is in perfect working order and can be quickly replaced whenever necessary was developed.

All staff, healthcare and non-healthcare workers, have been informed and trained on the following topics: Case definitions, Hand and respiratory hygiene, How to use PPE's and know the documents outlining the procedures, Triage procedures, Placement and movement of patients in isolation, Internal and external communication lines and rules, Sick-leave policy and what to do if staff members show symptoms and Security plan.

Procedures for patient prioritization (e.g. triage, discharge criteria, triggers to postpone elective hospitalizations or interventions) are in place A patient' system before they arrive at the hospital is in place: phone/email/telemedicine services are in place for possible cases.

A procedure for the cleaning of the rooms on a regular basis and after a patient's discharge has been established.

Figure 6: The ROL 2 mobile military hospital – general view

The ROL2 mobile military hospital, made up of medical tents and containers (Figure 6) is intended for the triage, diagnosis and hospitalization of patients confirmed with COVID-19. The structure of the hospital is composed of two parts: the medical and the administrative part. The medical part is structured in the following sections/laboratories/

compartments:
- Emergency Room Unit (ERU) with 20 beds
- Infectious Diseases Department (IDD) with 120 beds
- Intensive Care Unit (ICU) with 24 beds
- Imagistic Laboratory
- Medical Analysis Laboratory
- Pharmaceutical point

The hospital was equipped with medical equipment necessary for the diagnosis and treatment of patients with COVID-19, as follows: necessary RT-PCR for the identification of COVID-19, biochemistry analyzer, mobile radiology apparatus, ultrasound device, oxygen concentrators, pulse oximeters, laryngoscopes, intermittent mechanical compression devices, patient heating system, trolleys for the storage of sanitary materials and medicines, , air purification devices, wheel sprayers for car-trucks disinfection.

The Intensive Care Unit (ICU) was equipped with specific beds, secretion aspirators, oxygen pumps, automatic syringes with related stations, mechanical fans, and monitors for monitoring vital functions. Very important is the fact that telemedicine system has been installed with video cameras for the monitoring of patients, so the medical staff can keep them under observation, with minimal contact.

The Emergency Room Unit (ERU), adjacent to the patient triage area, is equipped with 8 beds and a stationary area featured with 6 compartments of 2 beds for patients waiting for lab results and for carrying out complementary investigations (interdisciplinary evaluations, imaging investigations). If the number of patients presented is greater than the capacity to take in the ERU, there are two waiting areas for patients featured with chairs located at a distance of at least 1 meter, in an adjacent tent (Figure 7).

The Infectious Diseases Department (IDD) is designated for the admission of patients confirmed with COVID-19. The section is provided with 120 beds equally distributed in 30 individual reserves with own sanitary group. Each reserve is provided with medical equipment and equipment for the permanent monitoring of patients, with the possibility of ensuring the oxygen requirement to patients who do not meet the criteria for admission to the intensive care unit. All IDD rooms are sterile environments; all personnel wear protective clothing (scrubs), shoe covers, masks, caps, eye shields and other coverings.

The inventory for 1 IDD reserve (Figure 8) includes: 4 beds, disposable linen, 1 TV set, 1 telephone and equipment for the medical supervision of patients (nurse-call system), 1 refrigerator, 4 stands of infusion, 1 acute care physiologic monitoring system (comprehensive patient monitoring systems that can be configured to continuously measure and display various parameters via electrodes and sensors connected to the patient), 4 pulse oximeters, 1 treatment table, 4 bedside tables. Lingerie is changed daily and whenever necessary.

Figure 7: The Emergency Reception Unit (ERU)

Upon admission to the IDD, each patient will receive a disposable kit containing: 1 disposable pajamas, 1 pair of disposable slippers, 1 toothbrush and toothpaste, 2 absorbent fields (towels) size 90/140 cm^2. These materials will be later distributed, whenever appropriate.

Figure 8: IDD reserve

The medical part also comprises:

• **The Intensive Care Unit** (ICU) is undergoing an arrangement with 24 beds and it is located in the annex building of the ROL 2 hospital. Patients with severe respiratory disorders cannot be properly treated in tents, as

they must benefit, for a certain period of time, of special care and connection to mechanical fans.

• **Two own laboratories** (Figure 9) where diagnostic tests (RT-PCR) and respectively hematological and biochemical investigations (complete blood count, CBC (hemoglobin), Erythrocyte Sedimentation Rate (ESR), coagulation test, myoglobin, D-Dimer, blood chemistry tests including Ferritin, troponin test, procalcitonin (PCT), presepsin (P-SEP), HBV, HCV, HIV Screening Tests, detection of SARS CoV 2 with RT-PCR) will be performed.

Figure 9: Laboratory for diagnostic tests (RT-PCR) and hematological - biochemical investigations

• **Imaging laboratory** provided with a mobile radiology device and Computer Tomography machine.

• **Pharmaceutical point** (Figure 10) where antiviral drugs necessary for the treatment of patients confirmed according to the national protocol adopted at the level of the Ministry of Health and taken over by this structure will be available.

Figure 10: Pharmaceutical point

At the ROL 2 hospital level, the functional circuits with the delimitation of the red and green areas, are ensured by providing separate flows for patients and medical staff, with rooms for equipping the medical and auxiliary staff and separate rooms with their own sanitary for undressing.

The sections and compartments of the ROL 2 hospital are computer interconnected between them and the command point, as well as with the computer network of S.U.U.M.C "Carol Davila".

The payroll comprises a total of approximately 270 positions distributed over each structure. For the operationalization of the ROL 2 Hospital, the personnel will be provided from the human resources of the S.U.U.M.C. and partly from the Medical Directorate.

The work program of the staff is structured on each separate compartment, in 12-hour shifts, over a 7-day cycle and is provided by working medical corps, made up of doctors, nurses, stretches. After this period of 7 days, the work team enters the period of self-isolation for a period of 7-14 days, a necessary measure for both the rest and the physical and mental recovery of the personnel and for the epidemiological supervision. The activity will be continued by other working medical corps, following the same structure.

At the entry and exit of the 7-day work cycle, the entire workforce will be clinically evaluated and the diagnostic test using RT-PCR for COVID-19 will be performed. Also, the staff will be tested as needed if it becomes symptomatic during the activity.

The work program is structured as follows:

- 7 consecutive days with 7 days rest for doctors and 14 days for nurses, nurses, stretches and medical administrators;
- Daily, there will be two shifts (day and evening) at 12 hours intervals; the ranges are from 08:00 – 20:00, respectively 20:00 – 08:00;
- Each 12-hour work program is provided by separate working medical corps.
- The structure and work schedule for a 7-day cycle of the IDD
- 2 specialist/consultant doctors (infectious diseases and pneumology or internal medicine);
- 6 residents (infectious diseases – 2 and internal medicine – 4);
- 12 nurses (also includes the head nurse);
- 4 orderlies;
- 2 stretches.

The procedure described may not be applicable to all military or civilian hospitals and may need to be adapted to the specific characteristics of the hospital, the individual national health system, legislation and community where the hospital is located.

"Today I visited the ROL 2 Military Hospital, a medical facility made in record time by the Army and the military medical personnel. Romania is prepared to cope as well as possible with this epidemic and I assure you that we will continue to

take all necessary measures to be even better prepared," Klaus Iohannis (Figure 11) said after visiting the hospital. [9]

Figure 11: The Romanian President Klaus Iohannis and Major General Assoc. Prof. Florentina Ioniță-Radu MD, PhD at the inauguration of the ROL 2 military hospital installed at the Ana Aslan Institute in Otopeni (Photo: Presidency.ro)

The same ROL 2 military hospital was deployed in 2015 when it was supposed to treat potential Ebola infection cases. It was also used in NATO military exercises in 2019, including Vigorous Warrior – the biggest medical military exercise ever organized by NATO, which was hosted by Romania.

"*I have entrusted the supreme ally commander of Europe with the task of coordinating all the means of supporting, coordinating and directing all the excesses at national level to the allies who need support at this particular moment, a first step taken by NATO, at this moment, is to provide the logistics of allies who need support in the fight against the coronavirus pandemic*." said Mircea Geoana, NATO Deputy Secretary General. [10]

CONCLUSIONS

The set up of the mobile military hospital installed at the Ana Aslan Institute in Otopeni, near Bucharest, to support the Romanian government as a response to the Covid-19 pandemic complies all the health requirements regulations defined by the National Authority of Quality Management in Health (Autoritatea Naţională de Management al Calităţii în Sănătate – ANMCS) throughout specific accreditation standards for medical units.

Further studies are necessary in order to determine the Covid-19 pandemic amplitude actions to end it, and future research projects destined to cover the need and development of these mobile hospitals, which involve a multitude of functional connections, sanitary requirements, technical equipment, and internal infrastructure is necessary.

Note

The ICU is arranged in the annex building of the ROL 2 hospital. Patients with severe respiratory disorders cannot be properly treated in tents, as they must benefit, for a certain period of time, of special care and connection to mechanical fans.

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