Global Clinical Engineering Journal

Special Issue 3

Publisher Longhorn Surgical Consulting, LLC

open access

www.GlobalCE.org

Editor's Corner

Yesterday I was visiting my friend who manages one of the largest rental medical equipment company in the US. He told me that a customer desperately called him from a small town in the state of Louisiana and begged for two mechanical ventilators for a local healthcare facility. The customer, a local medical equipment supplier, told my friend that he has been calling everywhere for days but so far came up without one. Then, when my friend told him that he could immediately ship him the ventilators, the last two that the clinical engineers at his lab just serviced, this customer started to cry from happiness knowing that a couple more patients will be cared for. The pride and mission-accomplished look on the face of the clinical engineering staff standing next to me, silently listening to the story, was clear. They knew that their important job impacts and help real people, real patients in critical need.

FIGURE. Engineering technician, Rocky, perform the final test on a ventilator before placing her signature on the tag that states – PATIENT READY.

Clinical engineering professionals from around the world, like many other professionals nowadays, are struggling with their feelings of being overwhelmed, navigating changing ambiguities, and of having such a burden of a life-critical mission. Their mission, managing technology that now focuses on attending to the support of urgent safe patient care, is challenged by the loss of regular (or normal) access to supply chain sources. Just a few weeks ago they could so simply and easily obtain medical equipment, disposable accessories, spare parts, manuals, and even qualified personal. Now, they search for personal protective gear, for rental or refurbished devices, seek newly released guidance on how to disinfect devices, and understand the impact of the latest regulatory changes. Simultaneously, they also have to deal with the sudden arrival of new inventory containing never-seen-before equipment for converting non-care locations into patient care isolation areas. All the while every country is trying to get a handle on what kind and how many medical devices are out there. We all share the challenges, but on top of that, we also see firsthand the loss of lives and the growing worries of the virus-contracted patient's families, old and young alike.

These are unprecedented times; these are not normal times and special measures are being deployed daily. In January, just 10 weeks ago, I was part of a group of colleagues who initiated a Coronavirus call for action in response to emergency requests for assistance from our clinical engineering colleagues in China. Three weeks ago, I was helping to gain access to Coronavirus testing kits coming from China to the US. How quickly the world turns and how little we were prepared. Everywhere, plans and processes are changing. It is critical that in such times, clinical engineers will be served by rapid and reliable news and updates. The Internet contains many stories, and some are true and factual. But who has the time or knowledge to verify the source? Not when you are so committed, as our clinical engineering readers are, to deliver the most optimal and safe technology possible that our healthcare system needs. We cannot afford the time to sift through all these postings. But

these professionals are in constant need for up-to-date and reliable information that will help them to speed the construction of health isolation facilities, the conversion of hospital bed areas into isolated patient areas, the testing and servicing of medical products arriving in their facilities for the first time, and locating manuals, accessories, integration tools, and user information. Significant help is coming now in the form of the new IFMBE/Clinical Engineering Division curated and daily updated social media site Hacking Covid19, you can register at http://eepurl.com/gXOqlz.

This is one of the reasons that the *Global Clinical Engineering Journal* has committed to quickly assemble and publish a special issue of the Journal on technology, engineering, and healthcare services that focus on improving our chances in the fight over the COVID-19 pandemic. We have a target to get this done in two months' time. We are committed to do whatever we can to help our readers learned from colleagues who have been through this fight. Through the collection, reviewing, and publishing of a series of manuscripts about healthcare facility operation during this COVID-19 pandemic from China, Italy, the USA, and other localities we hope that our field will advance and be better prepared for future challenges. The sharing of lessons learned will no doubt contribute to the improvement of patient-care services everywhere. I am calling on every member practicing in our filed to commit to write diaries of what is taking place at their jobs and submit their stories so that the rest of us can learn from them.

As I write this message, the combined effects of new capabilities and rapid information, along with virtual telehealthcare and 3-D printing have pushed us into territory that requires more evidence-based validation and professional engagement. If you do not believe that new products or services are being delivered with recognized and acceptable risks, you should sound the alarm. We, at the *Global CE Journal*, are working closely with IFMBE/CED on updating and expanding training and on resource sharing initiatives that will help you be successful in your career and fulfill patients' expectations of our profession.

On behalf of all the patients in the world, I thank the silent heroes who manage and service one of the most important building blocks of modern healthcare delivery. We care about your families not less than you care for our patients!

Stay healthy and safe.

Together we can do it better!

Dr. Yadin David

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WHO Update Column

By Adriana Velazquez Berumen

In the midst of the novel coronavirus (Covid-19) pandemic, today, more than ever, medical devices are indispensable to save lives. Furthermore, clinical engineers, healthcare technology managers and biomedical engineering technicians are important in the resourcing, equipping and sustainment of medical devices supporting life sustaining treatments.

The WHO has published a wide range of Covid-19 information and resources which are consolidated in the technical guidance page https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance.

The Priority Medical Devices for COVID-19, as well as the respective catalogue and technical specifications and a surge calculator to assist in planning for care provisions including the priority medical devices for Covid-19 which can be found at https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/covid-19-critical-items.

As we continue to learn more and our global understanding of the virology of covid-19 continues to evolve, In Vitro Diagnostics and medical equipment facilitating laboratory testing will be essential to identifying cases, taking proactive measures and reducing the impact of the disease until further measures can be achieved.

The WHO has created an emergency use listing that is updated each week to expand capability which can be found at https://www.who.int/diagnostics_laboratory/EUL/en/. Additionally, the WHO is leading an effort to facilitate a functioning global supply chain during the pandemic via a public-private collaboration. Further information can be found at https://www.weforum.org/projects/pandemic-supply-chain-network-pscn regarding this effort.

The International Federation of Medical and Biological Engineers' Clinical Engineering Division (IFMBE-CED) has also worked to consolidate Covid-19 guidance from clinical engineers and healthcare technology management professionals globally via their Covid-19 Resource Center that can be found at https://ced.ifmbe.org/blog/covid19-resources.html. Additionally, I was honored to work with healthcare technology management professionals globally and partake in the Global CE Covid-19 Day hosted by IFMBE-CED on April 9, 2020.

The link to the recording of the presentation can be found at https://youtu.be/oVi4XFcJLBE. I will continue to provide additional information regarding Covid-19 in the WHO Medical Devices Newsletter and blogs for IFMBE-CED which can be found at https://ced.ifmbe.org/blog.html.

Thank you for all you are doing on the front line to implement, innovate and maintain medical devices and technology during this dynamic time. The world, more than ever, needs clinical engineer's technical knowledge, entrepreneurial and innovative spirit, know-how and empathy to ensure the wellbeing of patients around the globe.

Please stay safe, remember your PPE and wash your hands!

Regards,

Adriana Velazquez

Date of publication April 13, 2020

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PATIENT SAFETY RECOMMENDATIONS FOR COVID-19 EPIDEMIC OUTBREAK

Lessons from the Italian Experience

By Micaela La Regina, Michela Tanzini, Francesco Venneri, Giulio Toccafondi, Vittorio Fineschi, Peter Lachman, Luca Arnoldo, Ilaria Bacci, Alessandra De Palma, Mariarosaria Di Tommaso, Andrea Fagiolini, Marco Feri, Raffaele La Regina, Antonino Morabito, Stefano Parmigiani, Mario Plebani, Elisa Romano, Chiara Seghieri, Pierfrancesco Tricarico, Giorgio Tulli, Riccardo Tartaglia.

International Society For Quality In Health Care

Version – 1.1 (30 March 2020)

SUMMARY

INTRODUCTION

On the basis of reports and questions forwarded to the Clinical Risk Managers of the Italian Network for Health Safety (INSH) from physicians working on the front line, a series of recommendations have been developed referring to documents and papers published by national institutions (ISS) and Italian and international scientific societies and journals. We have arranged the process to describe organising the work system according to the SEIPS Human Factors approach (1).

1. Assess the work system:
    a. Team and organisational culture and communication
    b. Environment
    c. Tasks required and skills to complete tasks
    d. Equipment for patient care and to protect staff
    e. The people needed to provide care
    f. The patients who will receive care
2. Develop reliable pathways of care.
3. Measure the outcomes of care.

ISQua is honoured to publish these recommendations with our partners in Italy. The document is work in progress and will be subject to updates by all professionals on a continuing basis. We appreciate and welcome the contribution of all those involved in COVID- 19, both providers of care and patients who have received care: (e-mail info@insafetyhealthcare.it).

1. GENERAL RECOMMENDATIONS FOR THE WORK SYSTEM

Building the Team including communication and team culture

1. Emergency taskforce should be promptly activated with a clear chain of command, roles and responsibilities, reliable information sharing tools and proactive approach.
2. Check frequently every day the communications sent by your institutions. Read carefully and respect them. Alternatively, print and make such communication available in the ward and share such information during handovers.
3. Clinical risk management units can support dissemination of documents, guidelines issued by the national institutions for supporting the emergency management, relatively for measures of prevention to be taken. Knowledge about Coronavirus transmission and spreading and clinical characteristics of related disease (COVID-19) are constantly evolving, so that indications for clinical practice change frequently, i.e. case or suspicion definition, criteria for making swabs, etc.
4. The clinical risk management units must keep contact with front line workers and provide support. The reporting of adverse events must occur within the task-force activity and be primarily related to the core activities in time of the pandemic. Secondly, the reporting of Adverse Events should be encouraged in order to maintain the underpinning safety climate in order to prompt corrective and improvement actions. Consider quick reporting tools such as confidential IM or audio-messages (e.g. WhatsApp, WeChat, Telegram, Line etc.)
5. The clinical risk management units should also receive evidence of good practice so this can be disseminated.

Tasks to be undertaken and skills required

1. Organise brief educational training on the correct use of medical and protective devices targeted to all healthcare workers and develop video tutorials to be available on the healthcare trust website.
2. Hold refresher courses on hand-hygiene, the prevention of VAP (Ventilator Associated Pneumonia) and CLABSI (Central Line Associated Bacterial Infection) bundles and the SEPSIS bundle for early sepsis recognition and management to all healthcare workers (2), but in particular to the staff not in the frontline of the emergency who could be called as replacements.
3. Organise early support of expert doctors/nurses with young or colleagues from other specialties who may be called upon to replace them to properly educate them
4. Do not forget appropriate instructions for environment disinfection (detergents, contact time, frequency) to cleaners (3).

Equipment needed to protect staff

1. Contact and droplet precautions can be used in routine patient care of patients with suspected or confirmed COVID-19 (4).
2. Contact and airborne precautions are recommended when performing aerosol generating procedures (AGPS), including intubation and bronchoscopy (4).
3. Prevent biosafety precautions shortage by extended use and limited re-use of full-face shields and disposable facial filtering masks (5), by identifying a priority order to the different wards and by supply of reusable tyvek suits. Store such devices in a locked or secured area and distribute to staff appropriately (5).

The infection spreads so quickly that a depletion of reserve medical supplies is almost unavoidable.

Equipment needed to treat patients

1. Give suspected or confirmed patients a surgical mask to put on, at their first contact with healthcare services (6).
2. In the dedicated care areas for patients with COVID-19, ensure that:
   a. haemo-gas analyzers
   b. pulse oximeters
   c. oxygen therapy
   d. ventilator therapy equipment e.
   e. suction pumps.

   are available and well-functioning (7).

Environment

1. Strictly apply, without exceptions, the indications for disinfection of environments and tools (sodium hypochlorite at 0.5% or 70% ethyl alcohol solution) (8). It is not yet well known how long the virus resists in the environment, but it is inactivated by solutions based on hypochlorite and alcohol.
2. Prevent germicide deficiency by using galenic preparations.
3. Keep in mind that the creation of dedicated hospitals may divert from the emergencies /emergencies network. Evaluate carefully the fallout of the timing of treatment decisions for time-dependent diseases. Consider the use of underused or quiescent equipped hospitals to meet this need.4. Unless activity is suspended, in the outpatient (public or private) clinics:
   a. avoid gatherings in waiting rooms (recommend people wait outside, respecting the distance of at least 1m between seats);
   b. inform symptomatic subjects with fever and / or cough and / or dyspnea (shortness of breath) not to go to clinics;
   c. disseminate hygiene and health standards recommendations in the waiting room.

Patients

1. Reduce hospital admissions, routine outpatient clinic appointments and routine surgical procedures and regulate hospital visits. Even in absence of strong evidence, it would be a good practice for authorized family members to enter the wards wearing medical masks, due to patients' frailty.

   In the full-blown epidemic phase:
   a. consider all patients with flu-like symptoms who access hospitals as potentially affected until proven otherwise (2 negative swabs at least 48-72h apart);
   b. create separate unclean/clean paths, even with the help of external mobile structures (i.e. tents).
2. Contacts of positive patients must follow the instructions provided by those who carry out epidemiological investigation and be clinically evaluated in the locally designated sites, only if symptomatic.
3. Use a screening interview to identify suspected cases before admission to the examination room in case of infection symptoms or to healthcare services for other reasons (i.e. surgery, coronary angioplasty, labour and delivery, etc.)
   a. If the criteria of case or suspicion are met, refer the patient for evaluation, according to local procedures.
   b. General practitioners will provide their patients with useful information by social networks, email or other tools and keep them updated.

2. RECOMMENDATIONS FOR DIAGNOSIS

1. The adequate specimen for Real Time-Polymerase Chain Reaction (RT-PCR) testing is nasopharyngeal

and oropharyngeal sampling. Prefer lower respiratory tract (LRT; expectorated sputum, endotracheal aspirate, or bronchoalveolar lavage) when readily available (for example, in mechanically ventilated patients). Quality of RT-PCR testing is a crucial issue. Both pre-analytical and analytical variables should be carefully considered, and a validation process should be performed according to ISO 15189 (3 protocols). (9)

2. Many of the most common symptoms of novel coronavirus disease (COVID-19) are like those of common flu or cold. So, it is also suggested knowing which common symptoms of flu or cold are not symptoms of COVID-19. COVID-19 infection seems to rarely cause a runny nose. Rhinorrhea ("runny nose") is not a symptom of COVID-19 and nasal congestion ("stuffy nose) is reported only by 4.8% of patients (10).
3. The most common COVID-19 symptoms are: fever (88%), dry-cough (68%), fatigue (38%), thick sputum production (34%), shortness of breath (19%), arthro-myalgia (15%), sore throat (14%), headache (13.6%), chills (11%), nausea/vomiting (5%), nasal congestion (4.8%), diarrhoea (3.7%). Data from a series of 55,924 laboratory confirmed cases of COVID-19 in China in the period up to February 2020 (11).
4. Beware of patients with gastrointestinal symptoms. Nausea / vomiting and / or diarrhea can be present in about 9% of cases. These symptoms have so far been one of the most frequent causes of omission or diagnostic delays (11).
5. Unexplained hyposmia, anosmia and dysgeusia could be other symptoms of COVID-19. This issue is currently under investigation (12).
6. Vital signs measurements (do not forget respiratory rate, please) and blood gas analysis in room air, if SpO2 <94%, at triage or as soon as possible, are essential to correctly assess patients coming to the emergency room (13, 14).
7. Do not rely only on PO2 <60 for the diagnosis of respiratory failure, always calculate the PaO2/ FiO2 ratio (P/F ratio), especially in young subjects.
8. Define a "COVID-19 profile" for the rapid order entry of blood tests, including the following tests: blood count, C-RP, creatinine, electrolytes, blood glucose, albumin, AST ALT, LDH, bilirubin, pneumococcal and legionella urinary agents, PT-INR, troponin and procalcitonin.
9. Chest X-rays have limited sensitivity in early stages of COVID-19 pneumonia. CT scan is more sensitive but raises logistical problems. If ultrasounds competencies are available, use chest US, but disinfect US probes after contact with every COVID-19 suspected patient (15).
10. Monolateral lung infiltrates do not exclude COVID-19. They have been described in 25% of cases (15).
11. The most common reported laboratory abnormalities in COVID-19 patients are: Lymphopenia (35-75%), increased C-RP (75-93%), LDH (27-92%), ESR (up to 85% of cases), hypoalbuminemia (50-98%) and anemia (41-50%). Data from a systematic revision of literature (16).
12. The following negative prognostic factors have been reported: leukocytosis, neutrophilia, increased procalcitonin, LDH, AST, ALT, total bilirubin, creatinine, troponin, d-dimer, PT and hypoalbuminemia, lymphopenia. Even thrombocytopenia is associated with severe disease (16, 17). Severe lymphopenia and lymphocytes count fall during the first 4 days since hospital admissions have been associated with a higher mortality. Increased white blood cell count, neutrophil count and procalcitonin could reflect bacterial superinfection, while increased d-dimer and PT a diffuse intravascular coagulation (DIC), reported in up to 75% of patients who died (16).
13. History of smoking, respiratory failure, maximum body temperature on admission 37.3°C, albuminemia<4 mg/dl would be risk factors for disease progression (severe or critical disease/death). esults from a multivariate analysis on a small sample (OR ranging from 7 to 15) (18).
14. Do not forget other respiratory infections (legionella, pneumococcus, mycoplasma, chlamydia, other respiratory viruses) even if during epidemics, so look for other pathogens and consider antibiotics. During epidemics it is important to avoid availability bias that means diagnose all infections due to epidemic agents.

WHO recommends investigating other pathogens, as co-infections have been reported (2).

15. Use disease severity stratification for the choice of the treatment setting (home, ordinary, sub-intensive or intensive care unit). WHO distinguishes 6 clinical syndromes associated with COVID-19: uncomplicated disease, mild pneumonia, severe pneumonia, ARDS, sepsis and septic shock. Patients with uncomplicated upper respiratory tract viral infection, may have non-specific symptoms such as fever, cough, sore throat, nasal congestion, malaise, headache, muscle pain or malaise. These patients do not have any signs of dehydration, sepsis or shortness of breath and can be treated at home (2).
16. Pay attention to elderly people and immunocompromised subjects as they can present vague and/or atypical symptoms (2).
17. Immediately notify the Public Health Officials of COVID-19 positive patients (use infectious disease notification forms) (19).

3. RECOMMENDATIONS FOR HOSPITAL TREATMENT

1. Before prescribing antiviral drugs, verify drug-drug and drug-disease interactions, pay particular attention to oral anticoagulants that could be substituted by low molecular weight heparin. Current antiviral therapy schemes include drugs such as lopinavir / ritonavir, chloroquine or hydroxychloroquine, darunavir, cobicistat, tocilizumab, remdesivir (14,20) which present interactions with antibiotics, antiarrhythmics, statins, anti-angina, etc. (Table 1, 2, 3, 4).
2. Angiotensin-converting enzyme (ACE) inhibitors and angiotensin II receptor blockers (ARBs) are safe and should not be discontinued during Coronavirus epidemics (21).
3. There is no proof that ibuprofen can aggravate COVID-19 clinical picture and the European Medicines Agency is monitoring this issue (22).
4. Start oxygen therapy at 5 L/min and titrate flow rates to reach SpO2 ≥90% in non-pregnant adults and SpO2 ≥92-95 % in pregnant patients (2).
5. High-flow nasal oxygen (HFNO) or non-invasive ventilation (NIV, mainly c-PAP) should only be used in selected patients with hypoxemia, respiratory failure (P/F next to 300 for HFNO and 250-300 for NIV), but with alerts and with preserved ventilator dynamics. Monitor closely for clinical deterioration (7, 23).
6. Do not prolong HFNO or NIV for over 2 hours in the case of failure to improve (HFNO: respiratory rate ≥24/min, NIV: respiratory rate ≥28/min and/or worsening P/F for both) (7, 23). High flow nasal cannulas and non-invasive ventilation are not recommended in viral pandemics, based on studies conducted in influenza and MERS (2).
7. Avoid nebulisation therapies for the potential spread of bacteria. Nebulisers generate aerosol particles that can carry bacteria and viruses deep into the lung. The risk of infection transmission may increase with nebulisers as they can generate a high volume of respiratory aerosols that may be propelled over a longer distance than in natural dispersion pattern. Nevertheless, the larger particles may cause cough in both patients' and bystanders' and increase the risk of spreading the disease. Nebulisers in patients with pandemic COVID-19 infection have the potential to transmit potentially viable COVID-19 to susceptible bystander hosts (24).
8. Administer intravenous fluids only if needed and avoid steroids, unless for other indications. Excessive fluid administration could aggravate oxygenation and be dangerous, especially in settings where mechanical ventilation is not readily available. Steroids were not associated with benefits, but rather with damage in the 2003 SARS epidemic and a delay in virus clearance in Middle-Eastern Respiratory Syndrome (MERS) of 2012 (2).
9. Assess thromboembolism and bleeding risk of every patient and provide appropriate thromboprophylaxis. Consider that recovery times and therefore hypo mobility of a subject with COVID-19 are long (at least 15 days in mild forms and up to 6 weeks in severe / critical ones) and diffuse intravascular coagulation (DIC) can complicate the course (2,15).

10. The Respiratory rate, peripheral oxygen saturation (SpO2) and arterial blood gas analysis results must be monitored closely during hospital stay due to insidious presentation of severe hypoxemia in this disease. Intra-arterial radial catheters insertion is to be considered to reduce arterial punctures, even outside ICU.
11. Also monitor white blood cells, lymphocytes and platelets count, LDH, procalcitonin and d-dimer are considered alarm flags (13, 15, 17).
12. Be aware of an eventual development of severe form +/- 7 days after symptom onset (13).
13. If a patient reports a SpO2 ≤90% in free air or ≤92% in conventional oxygen therapy and/or presents ≥30 acts/min and/or severe respiratory distress, intensive care therapist consultation must be required (25).
14. Use biosafety precautions when handling oxygen therapy devices (23); cover the patient's face with a surgical mask during HFNO or C-PAP (23); to reduce the risk of aerosolization, possibly use a dual or single circuit non-invasive ventilator with an integrated expiratory valve and a helmet that allows to insert a filter as interface (7).

4. THE ETHICS OF TREATMENT DECISIONS

This is a complex issue which will be decided upon in the local setting as per previous ethical frameworks. We recommend that the ethical decision-making process be developed in anticipation of making complex decisions, rather than in reaction to the need to decide.

With regard to management of the patient affected by COVID-19 in intensive care, we offer a number of references which will assist in developing the local ethical guidelines. (19, 25, 26, 27). Other important publications (not included among references): These provide recommendations that can assist in developing local, though may be context specific.

Giacomo Grasselli, Antonio Pesenti, Maurizio Cecconi. Critical Care Utilization for the COVID- 19 Outbreak in Lombardy, Italy Early Experience and Forecast During an Emergency Response. JAMA published online March 2020 https://jamanetwork.com/journals/jama/fullarticle/2763188

Robert D. Truog, Christine Mitchell and George Q. Daley, Robert D. Truog., Christine Mitchell, George Q. Daley. The Toughest Triage — Allocating Ventilators in a Pandemic This article was published on March 23, 2020, at NEJM.org. https://www.nejm.org/doi/pdf/10.1056/NEJMp2005689?listPDF=true

Ethical Framework for Health Care Institutions Responding to Novel Coronavirus SARS-CoV- 2 (COVID-19) Guidelines for Institutional Ethics Services Responding to COVID-19 Managing Uncertainty, Safeguarding Communities, Guiding Practice Hastings Institute https://www.thehastingscenter.org/wpcontent/uploads/HastingsCenterCovidFramework20 20.pdf

5. RECOMMENDATIONS FOR SURGERY

These recommendations apply to the medical staff of the operating blocks in case COVID-19. Patients with COVID-19 may need to undergo emergency and/or emergency surgery. The following recommendations should be observed (29, 30, 31):

COVID-19 patient positive asymptomatic

1. Surgical team wearing disposable masks, caps and gloves correctly. Anesthesiologist and assistant nurse: FFP2 masks.
2. Patients must wear a medical mask until I.O.T. (oro-tracheal intubation).
3. Airway protection of the patient also intubated with TNT drapes compatible with anesthesiologist assistance.

Symptomatic or having few or minor symptoms positive COVID-19 patient

1. Surgical team wears Personal Protective Equipment (PPE) and FFP2 or FFP3 masks.
2. Anesthesiologist and nurses assigned to direct assistance: FFP2 / FFP3 masks and PPE.
3. Patients must wear a medical mask for the entire time of surgery and / or after the IOT procedure for airway protection with compatible TNT drapes.

Patient COVID-19 sick and in invasive airway management.

1. All professionals must wear PPE and FFP2 / FFP3. While staying in the operating room it is recommended to

utilise laminar flow according to current legislation and post-intervention sanitisation for at least 1 hour.

Team working and organisation

Surgical teams in order to stay healthy and maintain continuity of care should divide into teams of senior and junior doctors and work for a 2-week period. After the 2 weeks, teams will come in to release the other. This will allow easier replacement of team members should they fall ill and potential containment of the virus to smaller staff numbers and an ability to maintain some service provision and clinical care.

6. RECOMMENDATIONS RELATED TO PREGNANT WOMEN

1. Reduce access of pregnant women to prenatal care, limiting only to high-risk cases (32). There is no evidence of an increased risk of unfavourable maternal or foetal outcomes in the case of COVID-19. However, evidence relating to influenza and SARS-COV1 must induce to consider the pregnant woman as a high-risk patient.
2. Infants born to mothers with confirmed COVID-19 should be considered as suspects. As such, these infants should be isolated from others (33).
3. Separation (i.e. in an individual room) of the infant from the mother with COVID-19 confirmed or suspected, until the precautions based on the transmission risk of the mother are suspended. The decision should be discussed carefully between the caring team and the mother, evaluating risk and benefits of this choice, including the protective potential of colostrum, breast milk and feeding time. (32,33).
4. The discharge of mothers after childbirth must follow the recommendations for discharge of COVID-19 or suspected patients (32).
5. In the case of a woman with suspected SARS-CoV-2 infection or with COVID-19, according to her clinical conditions and desire, breastfeeding should be started and / or maintained directly on the breast or with expressed breast milk (33). If mother and child must be temporarily separated because of mother clinical conditions, one should help the mother to maintain milk production through manual or mechanical/ electric expressing (33). In a limited series reported to date, the presence of the virus in the breast milk of infected women has not been reported, but anti-SARS-cov2 antibodies have been found (31). So breast milk would be protective.
6. A mother with confirmed COVID-19 or ongoing swab samples because symptomatic should take all possible precautions to avoid spreading the virus to the baby, including washing hands before touching the baby and wearing a face mask, if possible. during breast-feeding. If using a manual or electric breast pump, the mother must wash her hands before touching the breast pump or parts of the bottle. If possible, have another person administer the milk to the baby (33). It is not yet known whether COVID-19 can be transmitted through breast milk. At present, the main concern is not whether the virus can be transmitted through breast milk, but rather whether an infected mother can transmit the virus through respiratory droplets during breastfeeding (32).
7. For assisting the delivery of women with confirmed or suspected COVID-19, staff must use the safety precautions provided for non-pregnant patients (33).
8. Pregnant women with suspected or confirmed SARS-COV2 infection should be treated with supportive therapies, however taking into account the physiological characteristics of pregnancy (2).
9. The use of experimental therapeutic agents outside of a research study should be guided by an individual risk-benefit analysis based on the potential benefit to the mother and the safety of the foetus, with the consultation of an obstetrician specialist and an ethics committee (2).
10. The decision to proceed to a pre-term birth is based on many factors: gestational age, maternal conditions and foetal stability and requires a collegial evaluation by obstetric, neonatal and intensive care specialists (depending on the mother's condition) (2).
11. Positivity in itself to Coronavirus is not an indication for a caesarean section which in these patients should only be performed based on other obstetric or medical indications (33).

12. In COVID-19 pregnant women, it is useful to be very cautious in inducing maturity of the lung by means of corticosteroids, since these drugs seem to worsen the course of the infection. If possible, evaluate each case with a neonatologist.

7. RECOMMENDATIONS RELATED TO PEDIATRIC PATIENTS

Keep in mind that:

1. To date there is a paucity of information regarding COVID-19 in children.
2. Children and infants are affected and with milder forms (X-ray more often negative; CT more sensitive) (34, 35).
3. A small series of children with COVID-19 has shown a greater prevalence of peripheral halo (halo-sign) lung consolidations on CT (35).
4. The criteria for the definition of Acute Respiratory Distress Syndrome (ARDS) and septic shock, the guidelines for the management of sepsis and septic shock and the use of non- invasive ventilation in children are different from those of adults (2).
5. Children desaturate more easily during intubation; therefore, it is important to pre- oxygenate with 100% O2 with a mask with a reservoir before intubating (2).
6. A rectal swab may be useful in children to determine the timing of the termination of quarantine. Some authors have used the cycle threshold values of the serial rectal and nasopharyngeal swab tests to indicate viral load. Interestingly, the measurements have indicated that viral shedding from the gastrointestinal system could be greater and last longer than the respiratory tract (36, 37).

8. RECOMMENDATIONS RELATED TO HOSPITAL DISCHARGE

1. The patient with fever without respiratory failure (normal EGA and walking test) and normal chest x-ray, <70 years and without risk factors (lung disease, diabetes mellitus and/ or heart disease) can be discharged from the emergency room (14, 20) with indication of home isolation, waiting to run the swab sampling or its result.

   The discharge physician:
   - obtains a telephone number to contact the patient for swab sampling and / or to communicate the result;
   - provides information on how to access the pad (where and when).

   If the swab test does not take place in the emergency department, but is performed elsewhere to another area or hospital, it is strictly suggested to use systems to avoid the loss of information. The facility / service running the buffer
   - must report the result as soon as it is available to the patient and, if positive, to the Public Health Department for establishing active surveillance.

2. At the end of the hospitalisation, write clearly on the discharge letter:
   - CLINICALLY CURED patient (patient with clinical symptoms resolution, but still positive for swab) (38)

   or
   - CURED patient (patient who, in addition to resolving the symptoms, is negative in two consecutive swabs, carried out at least 24 hours apart) (38).

   or
   - CLINICALLY CURED PATIENT: write clearly on the discharge letter the indication to be observed at the home quarantine until the swab is negative on two determinations after 24 hours and the execution methods of the control buffer.

   Although there is no clear supported evidence, it is considered appropriate to suggest patient retesting no earlier than 7 days and, if negative, confirm the negativity after at least 24 hours (38).

   Or DISABLED PATIENT, roommate of patient with positive swab or whose result is not yet known:
   - Write clearly the indication of home isolation on the discharge letter (up to 14 days from contact with the infected person) and indication to call the appropriate number (in Italy 112) if symptoms appear;
   - Assure a telephone number to communicate buffer result;

- Communicate swab results as soon as available to the patient and, if positive, to public health trusts, in order to establish active surveillance (38).

9. RECOMMENDATION RELATED TO HOME ISOLATION

1. Provide prevention measures and explain them to patients in home isolation also by using designs, charts or pictures.
2. Give also clear indications on alarm symptoms:
   a. promote information
   b. diffusion of telephone numbers to call in case of occurrence of symptoms
   c. Arrangements for support e.g. shopping
3. Provide call centres, online chats, FAQs and video tutorials to consult when there is doubt.

10. RECOMMENDATIONS RELATED TO PERSONS IN QUARANTINE (39)

1. Information represents the key success factor; quarantined persons must be constantly informed and updated on the epidemic progress.
2. It is necessary to provide food and other materials and any necessary drugs without making people feel abandoned or alone.
3. The quarantine period should be short, and the duration should not be modified except in extreme circumstances.
4. Most of the side effects derive from the freedom restriction imposition; voluntary quarantine is associated with less stress and fewer long-term complications; therefore, it is necessary to explain clearly the reasons for such suggested behaviours.
5. Public health officials should stress the selfless choice of self-isolation.

Quarantined healthcare workers can be helpful in producing useful documents or other materials while at home for their colleagues. They could contribute by making suggestions and stay in touch with social media.

11. RECOMMENDATIONS RELATED TO ONCOLOGIC AND IMMUNOSUPPRESSED PATIENTS

1. Do not indiscriminately discontinue antineoplastic or immunosuppressive therapies. (40-42).
2. In cancer patients, consider the possibility of postponing the treatment cycle on a case-by-case basis (40).
3. Immunosuppressant withdrawal is indicated if symptoms suggestive of infection appear (41); in this case it is good practice to inform the physician responsible for the treatment promptly.
4. Steroids can be continued, but with caution (41).
5. New immunosuppressant prescriptions or dose increases are not recommended during an epidemic (42).
6. Consider the switch from parenteral drugs to others that can be administered at home (e.g. subcutaneously) to reduce access to outpatient clinics (41).
7. Ensure non-deferred outpatient visits and postpone visits for long-term follow-up, after remote evaluation (telephone, email, etc.) (40, 41).
8. Do not allow visitors in therapy rooms and allow the presence of a maximum of one visitor per patient in hospital stays (40).

Please refer also to General Recommendations (section 1) for other indications relating to outpatient clinics.

12. MORTUARY/MORGUE OPERATING PROCEDURES

Management of the deceased body with suspect, probable or confirmed COVID-19 respiratory infection. The proposed procedure is aimed at the safe management of the phases of acceptance, handling, custody, and discharge of the body with suspected, probable or confirmed diagnosis of COVID-19 (43). The objective has been pursued by drawing up the following recommendations:

1. The acceptance and handling of the body must be done by personnel equipped wearing the recommended PPE;
2. The body must be positioned on a sanitised metal stretcher for custody and subsequent investigations.
3. At the end of the investigations, the body must be placed in the coffin with the clothes and wrapped in a sheet soaked in disinfectant solution.

4. If the corpse is required to remain in the mortuary is necessary, pending or at the conclusion of the investigations, the same must take place inside a special closed body bag and dedicated refrigerated room.
5. At the end of the handling and transport operations, all the equipment used must be subjected to sanitisation.

Recommendations for autopsy investigation in cases of suspect, probable or confirmed COVID-19. For the safe and effective performance of HG3 (Hazard Group 3) autopsy investigations, is required:

- generic risk assessment and adoption of universal standard precautions;
- knowledge of possible pathological findings that can be highlighted;
- the definition of SOP (Standard Operating Procedures) for the management of autopsies with high biological risk.

1. The use of universal precautions effectively protects against most risks related to SARS- CoV-2 infection. Professionals have a duty to carry out risk assessment for each case in order to prevent actions that could put operators at risk (44).
2. At the end of the autopsy investigations, the body must be positioned in a body bag and transported in a refrigerated room.
3. Disinfect the outside of the body bag with a hospital disinfectant applied according to the manufacturer's recommendations. It is also recommended in this phase the use of suitable PPE by each operator involved in the movement and exit phases of the body.

Disinfection of autopsy rooms

In addition, following an autopsy on a subject with suspect or confirmed COVID-19, the following recommendations for disinfection of autopsy rooms should be applied (45):

1. keep ventilation systems active during cleaning;
2. wear disposable gloves when cleaning and handling cleaning or disinfectant solutions;
3. dispose of gloves after cleaning; do not wash or reuse the gloves in any case;
4. use eye protection, such as a visor or goggles, if splashing is expected;
5. if necessary, use respiratory protection based on the type of detergent or disinfectant;
6. wear a long-sleeved waterproof device to protect skin and clothing;
7. use disinfectants with indications of efficacy against human coronaviruses;
8. clean the surfaces and apply the disinfectant ensuring an adequate contact time for effective disinfection;
9. comply with the safety precautions and warnings indicated on the product label (for example, allow adequate ventilation in restricted areas and ensure correct disposal of the unused product or used containers);
10. avoid product application methods that cause the production of splashes or aerosols.

Regarding environmental disinfection, the available evidence has shown that coronaviruses are effectively inactivated by adequate sanitisation procedures that include the use of common hospital disinfectants, such as sodium hypochlorite (0.1% -0.5%), ethanol (62- 71%) or hydrogen peroxide (0.5%). There is currently no evidence to support a greater environmental survival or a lower sensitivity of SARS-CoV-2 to the aforementioned disinfectants.

1. Hard and non-porous surfaces can be cleaned and disinfected as previously described.
2. Handle with gloves and disinfect properly after use, equipment such as cameras, telephones and keyboards, as well as all objects that remain in the autopsy room.
3. Cleaning activities must be supervised and periodically checked to ensure that correct procedures are followed. Sanitation personnel must be properly trained and equipped with suitable PPE.
4. After cleaning and removing the PPE, wash the hands immediately. Avoid touching the face with gloved or unwashed hands.
5. Environmental disinfection must include cleaning with water and detergent soap on all vertical and horizontal surfaces, followed by disinfection with hospital disinfectants effective against SARS-CoV-2.

6. For environmental decontamination, it is necessary to use dedicated or disposable equipment. Reusable equipment must be decontaminated after use with a chlorine-based disinfectant. The use of special trolleys is strongly recommended, different from those used for cleaning common areas.
7. The instruments used for autopsies should be autoclaved or treated through chemical sterilisers.

13. PSYCHOLOGICAL SAFETY OF STAFF AND MENTAL WELLBEING OF PATIENTS

Psychological safety of staff (46, 47, 48, 49)

1. Create a healthy work, ethos and environment during crises and also to have systems in place to deal with subsequent distress and disorder.
2. Organisations which have the foresight to prepare their staff to deal with trauma might consider using interventions such as PFA (Psychological First Aid is a humane, supportive response to a fellow human being who is suffering and who may need support).
3. Consider that factors negatively affecting the psychological well-being of staff are:
   - concerns over the contracting the illness
   - concerns for safety of their family
   - witnessing the death of colleagues
   - isolation from family and colleagues
   - sense of being underappreciated
   - extended length of epidemic
4. Reduce mental health stigma. The best ways of reducing stigma were believed to be raising awareness of mental health issues and telling people that it's quite normal to feel that way and have those feelings;
5. Educate healthcare workers who are exposed to trauma about the effects of cumulative stress. The training should be delivered either online 'because they can do it at their own convenience' or via educational leaflets 'rather than finding the time to spend on a day course'. The education about psychological trauma may lead to better understanding, better recognition of symptoms in oneself and in others, less judgement, and therefore reduced stigma, and that positive relationships with others in the workplace can have a positive impact on psychology.
6. Maintain teamwork and effective leadership while at the same time providing individuals the opportunity to provide input into the decisions that affect their lives. Staff often experience severe emotional stress during viral outbreaks. It is often the nursing staff who feels the greatest level of stress due to their constant contact with sick patients, who may not be improving despite the nursing staff's best efforts. Physicians usually cope somewhat better with this situation because they are in a position to make treatment decisions and are less directly involved in implementing patient care.
7. Be receptive to suggestions from nursing staff and support personnel. Input is empowerment and provides a sense that these critical staff retain some control over their situation. If suggestions are not acted on, clear explanations as to why they were not should be provided and alternatives should be explored.
8. Administration needs to be supportive of staff and not be seen as pedantic and overly controlling.

In cases where staff and support personnel did not feel appreciated or listened to, there was a high degree of dissatisfaction and an increased occurrence of absenteeism and staff strikes, which further reduced personnel in an already-strained system.

9. Take care of yourself and your loved ones. Healthcare providers are not invulnerable to experiencing their own emotional distress during outbreaks, and this distress can be compounded by caring for sick and distressed patients.
10. Make sure your basic needs are met, including: eating, drinking, and sleeping; take a break when you need one; check in with loved ones; practice the strategies to reduce distress listed above; and monitor yourself for stress reactions too.
11. Make efforts to ensure that your office and/or organisation has a viable plan to monitor the course of the outbreak and take rapid and appropriate action if needed.

Mental well-being of Patients (50)

1. Medical and mental health clinicians are likely to encounter patients who are experiencing various levels of emotional distress about the outbreak and its impact on them, their families, and their communities. We must consider that COVID-19 patients have long hospital stays and in the early stages they will experience the anguish of having an aggravation of the disease with the possibility of being intubated. Furthermore, the limited staff available will not be able to guarantee them continuous assistance and their relatives as well.
2. Providers should acknowledge uncertainty about emerging diseases and help patients understand that there is often an emotional component to potential health concerns.
3. Providers should be cognisant that the symptoms might extend beyond classical mental health symptoms to include relational struggles, somatic, academic, or vocational issues.
4. Every person, including mental health providers, can either react in fear, anger, or despair and regress, or can choose resilience and play as an active part of the solution.

In addition, providers should consider the following recommendations for promoting patients' mental wellbeing during emerging infectious disease outbreaks:

Be informed: Obtain the latest information about the outbreak from reliable public health resources in order to provide accurate information to your patients.

Educate: Healthcare providers are on the front lines of medical intervention and in a position to influence patient behaviours for protecting individual, family, and public health. Psycho-education is of utmost importance in the aftermath of disasters. Patient education plays a critical role in both containing the disease and mitigating emotional distress during outbreaks. Depending on the nature of the outbreak, this can range from education about basic hygiene such as hand-washing and cough etiquette to more complex medical recommendations for prevention, diagnosis, and treatment.

5. Let patients know what you, your office, or your organisation is doing to reduce the risk of exposure.
6. Correct misinformation. In this age of social media, misinformation can spread quickly and easily, causing unnecessary alarm. If patients present you with inaccurate information related to the outbreak, correct their misconceptions and direct them to vetted public health resources.
7. Limit media exposure. The excess media exposure to coverage of stressful events can result in negative mental health outcomes. Use trusted media outlets to gather the information you need, then turn them off— and advise your patients to do the same.
8. Anticipate and counsel about stress reactions. Emotional distress is a common mental condition in the context of uncertain and potentially life- threatening situations, such as COVID-19 epidemic. A good first step for mitigating your patients' stress is to acknowledge that it exists and help normalise it ("I see that you're stressed, and that's understandable. Many people are feeling this way right now.").
9. Teach patients to recognise the signs of distress, including worry, fear, insomnia, difficulty concentrating, interpersonal problems, avoiding certain situations at work or in daily living, unexplained physical symptoms, and increased use of alcohol or tobacco. This will help them become more aware of the state of their mental health and head off distress before it becomes harder to manage.
10. Discuss strategies to reduce distress, which can include:
    - Being prepared (developing a personal/ family preparedness plan for the outbreak).
    - Taking everyday preventive measures (e.g., frequent handwashing).
    - Maintaining a healthy diet and exercise regimen.
    - Talking to loved ones about worries and concerns.
    - Engaging in hobbies and activities you enjoy to improve your mood.
    - If a patient is experiencing severe emotional distress or has a diagnosable mental illness, refer for specialized mental health care.

14. MEASURES (51,52,53)

It is important that we measure the impact of our actions. We include some measures that may be of use.

Outcome measures

Outcome measures should be collected in order to support the monitoring of effective provider (hospital) epidemic/pandemic response including the capacity to adequately treat patients with other common severe conditions like heart attacks, strokes, trauma, COPD in order to assure that the health of the public is protected to the fullest extent possible:

1. Hospitalisation rate for COVID-19 (indirect outcome measure of the territory).
2. In-hospital Mortality rate of patients hospitalized for COVID-19.
3. Average Length of Stay of COVID-19 patients.
4. Percentage of COVID-19 patients admitted to ICU.
5. In-hospital mortality rate of NO-COVID-19 patients hospitalised for AMI.
6. In-hospital mortality rate of NO-COVID-19 patients hospitalized for Stroke.
7. In-hospital mortality rate of NO-COVID-19 patients hospitalized for COPD.
8. Percentage of NO-COVID-19 hospitalized patients that acquired COVID during the hospitalisation.
9. COVID-19 infection rate among staff / Number of tests performed to hospital staff (as process measure)
10. Survival rates

Where possible indicators 1-7 should be stratified by age groups. Additionally, the proposed outcome measures should be used and interpreted with great caution if used to benchmarking care quality between providers. In this case, consistent data definitions should be adopted and measures from 1 to 7 should be adjusted for potential confounding factors (i.e. patient case mix) in order to draw meaningful and correct comparisons among providers of Mortality rate.

Length of stay measures

1. Length of Stay
2. Average length of stay in ICU of infected
3. Average length of stay in hospital

Process Measures (some examples)

1. Percentage of infected individuals admitted to ICU
2. Percentage of people with comorbidities
3. Percentage of staff with and without correct equipment
4. Number of patients not treated in appropriate level of care
5. Percentage staff trained to use equipment

Balancing measures

1. Staff infection rate
2. Staff mortality rate
3. Staff well being
4. Illness and sickness rates
5. Mental illness

Patient profiles to consider

- Age
- Gender
- Ethnicity
- Comorbidity
- Region
- Contacts

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16. APPENDIX - MEDICATIONS

TABLE 1. Chloroquine and hydroxy-chloroquine: main Italian drug interactions

DRUGS	INTERACTIONS
Chloroquine	Antacids based on aluminum, calcium and magnesium and kaolin can reduce their absorption. In association with: • Corticosteroids accentuation of any myopathies or cardiomyopathies • Phenylbutazone can induce exfoliative dermatitis • Isoniazid, Amiodarone, Carbamazepine, Phenytoin, Phenothiazide, Ketoconazole and MAO inhibitors (Mono-Amino-Oxidase Inhibitors) risk of hepatotoxicity • Mefloquine and bupropion risk of convulsions • Metronidazole possible dystonic reactions • Penicillamine serious haematological or renal adverse events • Pyrimetamine / sulfadoxineskin reactions **Effects of chloroquine on other drugs:** • Ampicillin reduced absorption (administer at least 2 hours after chloroquine) • Class IA and III antiarrhythmics, Tricyclic antidepressants, Antipsychotics increased risk of ventricular arrhythmia • Antiepileptic antagonism on anticonvulsant effects • Cyclosporine increase in plasma concentration • Digoxin increase in plasma concentration and relative toxicity • Methotrexate potentiation of the action • Neostigmine and Pyridostigmine antagonism of the effects • Vaccines antibody response reduction ONLY with rabies vaccine
Hydroxy- chloroquine	In association with: • Phenylbutazone can induce exfoliative dermatitis • Isoniazid, Amiodarone, Carbamazepine, Phenytoin, Phenothiazide, Ketoconazole and MAO inhibitors (Mono-Amino-Oxidase Inhibitors) can cause hepatoxicity **Effects of hydroxychloroquine on other drugs** • Anti-epileptics antagonism on anticonvulsant effects • Cyclosporine increased plasma concentrations • Digoxin increased plasma concentration and relative toxicity • Insulin and Antidiabetics potentiation of hypo-glycemic effects

TABLE 2. LOPINAVIR/RITONAVIR: Main Italian interactions and recommendations

Co-administered Drug	Mechanism of interaction	Clinical Recommendations
RETROVIRAL AGENTS: Nucleoside reverse transcriptase inhibitors (NRTIs), Non-nucleoside reverse transcriptase inhibitors (NNRTIs), HIV CCR5 - antagonist, Integrase inhibitor, Inhibitors of HIV protease		Specialist advice, dose adjustment is not required in most cases. Co- administration with other HIV protease inhibitors (PIs), according to current guidelines, is not recommended.
Antacids		No contraindications
Alpha antagonists		
ALFUZOSIN	Increased concentration (CYP3A inhibition)	Contraindicated (hypotension)
Analgesic Drugs		
FENTANYL	Increased concentration (CYP3A inhibition)	Close monitoring (risk of respiratory
Antianginal Drugs		
RANOLAZINE	Increased concentration (CYP3A inhibition)	Contraindicated
Co-administered Drug	Mechanism of interaction	Clinical Recommendations
Antiarrhythmics		
AMIODARONE, DRONEDARONE	Increased concentration (CYP3A inhibition)	Contraindicated (arrhythmia)
DIGOXIN	Increased concentration (P-gp inhibition)	Plasma level monitoring
BEPRIDIL, SYSTEMIC LIDOCAINE, QUINIDINE	Increased concentration	Plasma level monitoring
Antibiotics		
CLARITHROMYCIN	Moderate increase of under-curve area (CYP3A inhibition)	Dose reduction in kidney failure (CrCL<30 ml/min); attention in patients with impaired liver and kidney function
Antineoplastics		Specialist Advice
Anticoagulants		
WARFARIN	CYP2C9 induction	INR monitoring
RIVAROXABAN	AUC: ↑153%, Cmax: ↑55% (CYP3A and P-gp inhibition)	Contraindicated (bleeding)
VORAPAXAR	Increased concentration (CYP3A inhibition)	Contraindicated
Antiepileptic		
PHENYTOIN	Concentrazioni diminuite (induzione del CYP2C9 e del CYP2C19)	Plasma level monitoring
CARBAMAZEPINE, PHENOBARBITAL	Increased Carbamazepine concentration (CYP3A inhibition); reduced Lopinavir concentration (CYP3A induction)	Plasma level monitoring

Co-administered Drug	Mechanism of interaction	Clinical Recommendations
Antidepressants and anxiolytics		
TRAZODONE	AUC:↑2,4 times	Dose reduction
Antifungals		
KETOCONAZOLE	Increased concentration (CYP3A inhibition)	Dose reduction
Co-administered Drug	Mechanism of interaction	Clinical Recommendations
Anti-gout		
COLCHICINE	AUC: ↑3-times; Cmax: ↑1,8-times (CYP3A and/or P-gp inhibition)	Contraindicated
Antihistamines		
ASTEMIZOLE, TERFENADINE	Increased concentration (CYP3A inhibition)	Contraindicated (severe arrhythmias)
Anti-Infectives		
Fusidic Acid	Increased concentration (CYP3A inhibition)	Contraindicated (rhabdomyolysis)
Anti-mycobacterial agents		Specialist Advice
Benzodiazepines		
MIDAZOLAM	Oral administration: AUC: ↑13-times parenteral administration: AUC: ↑4-times (CYP3A inhibition)	Oral administration contraindicated; close monitoring for parenteral administration
Beta2 agonists		
SALMETEROL	Increased concentration (CYP3A inhibition)	Contraindicated (severe cardiovascular event and arrhythmias)
Calcium Channel Blockers		
FELODIPINE, NIFEDIPINE, NICARDIPINE		
Steroids		
DEXAMETHASONE	Reduction of Lopinavir concentrations (CYP3A induction)	Clinical monitoring of anti- viral activity
Phosphodiesterase inhibitors AVANAFIL, SILDENAFIL	Increased concentration (CYP3A inhibition)	Contraindicated
Ergot Alkaloids		
DIHYDROERGOTAMINE AND OTHERS	Increased concentration (CYP3A inhibition)	Contraindicated
Intestinal Prokinetics		
CISAPRIDE	Increased concentration (CYP3A inhibition)	Contraindicated
Direct anti-HCV agents	Increased plasma concentration (combined mechanisms)	Contraindicated
HCV protease inhibitors		Contraindicated

Co-administered Drug	Mechanism of interaction	Clinical Recommendations
Immuno-suppressers		
CICLOSPORINE	Increased concentration (CYP3A inhibition)	Plasma level monitoring
Statins		Contraindicated; fluvastatin and pravastatin tolerated
Opioids		
METHADONE	Decrease in concentration	Plasma level monitoring
Contraceptives		
Ethinylestradiol	Decrease in concentration	Use additional contraceptive methods
Hormone Replacement Therapy (HRT)		
Levothyroxine	Potential interactions not well documented	TSH monitoring during the first month from the beginning and / or from the end of the treatment

TABLE 3. DARUNAVIR/COBICISTAT: Main Italian interactions and recommendations

Co-administered Drug	Interaction mechanism	Clinical Recommendations
Anti-retroviral agents (HIV)		
Inhibitors of the strand transfer of ' integrase, inhibitors nucleoside / nucleotide HIV reverse transcriptase inhibitors (NRTIs)		Specialist advice, no dose adjustment necessary, except for Emtricitabine / tenofovir alafenamide
Non- nucleoside / nucleotide inhibitors of HIV reverse transcriptase (NNRTI)		Specialist advice, non- recommended co-administration RILPIVIRINE, the increase of which is not considered relevant, is an exception
CCR5 A ntagonists		No dose adjustment necessary
MAVAVIROC	Increased concentration (CYP3A inhibition)	Specialist advice for dose adjustment
Al / M or calcium carbonate- based antacids		No dose adjustment
Alpha antagonists		
ALFUZOSIN	Increased concentration (CYP3A inhibition)	Contraindicated (hypotension)
Anaesthetic		
AL FENTANYL	Increased concentration (inhibition of CYP3A4)	Dose reduction and monitoring (respiratory depression risk)
Antianginal/tymic antiaries		
AMIODARONE, DRONEDARONE CHINIDINA, BEPRIDILE, IVRABRADINA, RANOLAZINA	Increased concentration (inhibition of CYP3A and/or CYP2D6)	contraindicated
DYSOPYRAMID, FLECAINIDE, SYSTEMIC LIDOCAINE, MEXILETINE, PROPAPHENONE	Increased concentration (inhibition of CYP3A and/or CYP2D6)	Caution and monitoring
digoxin	Increased concentration (P- glycoprotein inhibition)	Dose titration and accurate monitoring of drug concentration
Antibiotics		
Clarithromycin	Increased AUC (CYP3A inhibition)	Caution dose adjustment in patients with renal impairment CrCL <30 ml / min
Anticoagulants		
WARFARIN	Theoretical mechanism of alteration of plasma concentrations	INR monitoring
APIXABAN, EDOXABAN, RIVAROXABAN	Increased plasma concentrations (inhibition of CYP3A & P-gp)	contraindicated
DAPIGATRAN; ticagrelor	Increased plasma concentrations (inhibition of CYP3A & P-gp)	contraindicated
Anticonvulsants		
clonazepam	Increased concentration (CYP3A inhibition)	Clinical monitoring

Co-administered Drug	Interaction mechanism	Clinical Recommendations
CARBAMAZEPINA, FENOBARBITALE, FENITOINA	Reduced concentrations of darunavir and/or cobicistat (CYP3A induction).	Contraindicated
Antidepressants and anxiolytics		
ST. JOHN'S GRASS	Reduction of darunavir and / or cobicistat concentrations (CYP3A induction).	contraindicated
PAROXETINE, SERTR ALINA, AMITRIPTILINA, DESIPRAMINA, IMIPRAMINA, NORTRIPTILINA, TRAZODONE	Increased plasma concentrations (CYP2D6 and/or inhibition CYP3A)	Dosage reduction and clinical monitoring
Antidiabetic		
METFORMIN	Increased plasma concentration	Dosage reduction and clinical monitoring
Antiemetics		
DOMPERIDONE	Not studied	contraindicated
Anti-fungals		
CLOTRIMAZOLO, FLUCONAZOLO, ITRACONAZOLO, ISAVUCONAZOLO, POSACONAZOLO	Increased concentration (inhibition of CYP3A &/or P- gp)	Caution, clinical monitoring and dosing Voriconazole contraindicated
Anti-gout		
colchicine	Increased concentration (inhibition of P- gp and/or CYP3A4)	Dosage reduction, contraindicated in the presence of hepatic or renal impairment
H2 receptor antagonists		No dose adjustment necessary
Antimycobacterials		Specialized evaluation, tendentially contraindicated
Anti-psychotics / neuroleptics		
PERFENAZINA, RISPERIDONE, TIORIDAZINA	Increased plasma concentrations (inhibition of CYP3A, CYP2D6 and/or P- gp)	Dose reduction and clinical monitoring
LURASIDONE, PIMOZIDE, SERTINDOLO, QUETIAPINA		Contraindicated
Anti-cancer	Theoretical mechanism of concentration increase (CYP3A inhibition)	Specialist evaluation, extreme caution
Beta2 agonists		
SALMETEROL	Increased concentration (CYP3A inhibition)	Contraindicated (serious cardiovascular adverse events, arrhythmias)
Beta blockers		
CARVEDILOL, METOPROLOL, TIMOLOL	Plasma concentrations increased (CYP3A inhibition)	Dose reduction and clinical monitoring

Co-administered Drug	Interaction mechanism	Clinical Recommendations
Calcium antagonists		
AMLODIPINA, DILTIAZEM, FELODIPINA, NIFEDIPINA, NICARDIPINA, VERAPAMIL	Increased concentration (inhibition of CYP3A and / or CYP2D6)	Dose reduction and clinical monitoring
Corticosteroids		
dexamethasone	Reduction of Darunavir and / or cobicistat concentrations (CYP3A induction)	Caution
Proton pump inhibitors		No dose adjustment
Inhibitors of phosphodiesterase		
TADALAFIL, SILDENAFIL	Increased concentration (CYP3A inhibition)	Contraindicated
Antivirals direct action against HCV (inhibitors NS3-4A protease)	Increased plasma concentrations (combination of mechanisms)	Contraindicated
Endothelial receptor antagonists (Bosentan)	Increased concentration (theoretical consideration)	Contraindicated
Immunosuppressant		
CYCLOSPORINE	Increased concentration (CYP3A inhibition)	Monitoring of drug levels
everolimus		contraindicated
Narcotics, Opioids		
METHADONE	Increased concentration (theoretical consideration)	Monitoring of drug levels
Buprenorphine / naloxone	Increased concentration (theoretical consideration)	Clinical monitoring
FENTANYL, OXYCODONE, TRAMADOL	Increased concentration (theoretical consideration)	Clinical monitoring
Opioid antagonists		
NALOXEGOL	Not studied	contraindicated
Sedatives / hypnotics		
BUSPIRONE, CLORAZEPAM, DIAZEPAM, ESTAZOLAM, FLURAZEPAM, ZOLPIDEM	Increased concentration (CYP3A inhibition)	Caution, dose reduction and clinical monitoring
MIDAZOLAM (PARENTERAL)		Only in intensive care.
MIDAZOLAM (ORAL)		contraindicated
Urological drugs		
FESOTERODINA, SOLIFENACINA	Not studied	Caution, dose reduction and clinical monitoring
DAPOXETINE	Not studied	Contraindicated
Contraceptives		
	Alteration of plasma concentrations	Use additional methods of contraception
drospirenone		Monitoring for possible hypokalaemia

TABLE 4. Serious adverse effects

	Lopinavir / Ritonavir	Darunavir / cobicistat	Chloroquine	Hydroxychloroquine	Tolicizumab
Serious adverse effects	Hypersensitivity reaction, angioedema Stevens-Johnson syndrome / Toxic epidermal necrolysis / Erythema multiforme QT prolongation & Torsade de Pointes AV block, PR prolongation Hyperglycaemia, hypertriglyceridemia Renal failure Anemia, leukopenia, neutropenia Pancreatitis Hepatotoxicity	Hepatotoxicity Anorexia, hyper- cholesterol-aemia hyper- triglyceridemia Renal failure Stevens- Johnson syndrome rarely	QT prolongation & Torsades de Pointes Reduction in seizure threshold Anaphylaxis or anaphylactoid reaction Neuromuscula r impairment Neuropsychiat ric disorders (potential to increase delirium) Pancytopenia, neutropenia, thrombocytop enia, aplastic anemia Hepatitis	Hypoglycemia QT prolongation Cardio- myopathy Muscle asthenia Retinal or visual field alterations Skin reactions	Interstitial pneumonia Infections Leukopenia, neutropenia hypo-fibrinogenaemia Upper respiratory infections Herpes simplex and zoster Oral ulcerations Complicated diverticulitis Hepatotoxicity
Common adverse reactions	Nausea / vomiting, diarrhoea Insomnia, anxiety	Nausea / vomiting, diarrhoea Insomnia, anxiety Headache Rash Muscle Pain	Nausea / vomiting, diarrhoea, abdominal pain Visual disturbance, headache Extrapyramida l symptoms	Nausea / vomiting, diarrhoea, abdominal pain Visual disturbance, headache Skin rash, itching Extra-pyramidal symptoms	Hypertension Headache Skin reactions Conjunctivitis Hyper-cholesterolemia Abdominal pain, gastritis Cough, dyspnoea
Contra-indicated in:	Cardiac disease ischemic heart disease, cardiomyopathy, structural heart disease, QT prolongation Liver disease	Liver failure (class C Child- Pugh) Haemophilia	Porphyria G6PD deficiency Epilepsy Heart failure Recent myocardial infarction	Porphyria Retinopathy Maculopathies Children <6a <31 Kg	Administration of alive or attenuated vaccines
Monitor	Transaminases	Kidney function	Serial complete blood count QT interval	Blood count, glycemia, QT interval	Cholesterol, blood count, transaminases

Date of publication April 15, 2020

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ITALIAN CLINICAL ENGINEER EXPERIENCE DURING COVID-19

Transcript of March 24, 2020 Webinar (on behalf of AIIC & IFMBE/CED)

Health Technology Alliance TownHall (HIMSS, AAMI and ACCE)

By Umberto Nocco,
Vice-president of AIIC and Director of the Clinical Engineering Department, in charge of evaluation, acquisition and maintenance of medical equipment. A.S.S.T. dei Sette Laghi, Varese, Italy

Umberto Nocco: It's a pleasure to be here and to share with you some of the things we've been dealing with for the past month, actually, because it hasn't been longer than that. Lombardy is the region in the northern part of Italy where I live in. It's been one of the most struck from the virus inside our state. Basically, data shown today shows that we have some 30,000 cases among the 70,000 gross numbers throughout Italy. This happened basically in three weeks. Patient one, as we call him, was found positive on February 21st. Since then, we add an exponential incremental ratio of known patients basically based in kind of a defined area throughout the region. But later on, the outbreak expanded over the entire nation.

The point is that the rest of Italy aside Lombardy seeing cases after two weeks from the start in our region, so that at least they had the time to get ready to some extent before the outbreak reaches them. Of course, we all wish it doesn't happen, but it's an option, of course, that this might end up having quite a number of cases.

Just to give you an idea, the difference between Lombardy and Rome, for example, although I'm saying they did a great job, they had the time one week, not very much, to remodel a closed hospital to accept COVID-19–positive patients only. While in our region due to the birth and the continuous flow of patients to the hospitals, we had to work day by day and try to find out the solution to have them inside our hospitals.

From an HTM point of view, I would like to outline three major problems:

1. Machine availability plus space inside the hospitals (e.g., ICU beds).
2. Organizational issues.
3. Acquisition problems for devices.

One of the main problems we had to cope with was that the need for ventilated beds, not only did we use ICU beds which were more or less full because of standard patients. We were just running normal routine, and we are normally running at 95% better in Lombardy and I think that more or less the same number throughout Italy, but we had to define new areas where positive patients were to be placed.

The more patients, the more ICU beds were needed. Those that could create new ICU beds out of nowhere

did so, while other suffered the way even and they had to figure out a place where to put them, whether it be a normal ward, or some hospitals are starting to put tents outside the hospital at least to do the first screening when a patient comes in with the ambulance or with their car or however they get to the hospital.

This means that the major issue about acquiring technology is basically on four to five types of assets. I'm talking about continuous positive airway pressure systems, ventilators, monitors, infusion systems, and beds being the last and the easier to describe and with difficulties to be found on the market and to be acquired. Although, in the end, we ended up using normal ward beds even if we are to handle intensive care patients because, in some places throughout our region, we are basically a war zone. It's really whatever you have available, that's fine for the patient.

ITALY: THE MOST IMPORTANT DEVICES NEEDED

Umberto Nocco: The point is that if you get the continuous positive airway pressure system, they are the first line because patients come in with some sort of breathing problems. You might use noninvasive ventilation but usually requires a mechanical ventilator which is precious because we don't have a lot of them. We immediately swapped to continuous positive airway pressure systems.

These can be used outside the ICU, especially if you already have training personnel like in lung department or other specialties or medical departments. But you have to be aware that you are risking a lot more aerosol spreading outside the system rather than with the invasive ventilators. We have come to the point where we are making basically our own gas blenders because vendors can't keep up with the need we have.

When it comes to ventilators, if you ask an anesthesiologist, he will ask for the top quality of the product. The point is that we had so many patients that we have become greedy rather than specific, if you see what I mean. We had to acquire devices really fast. The typical call we used to make a couple of weeks ago was calling the vendor and saying, "How many ventilators do you have in stock that can you bring me, say, tomorrow?"

What we had to consider especially devices that could run without compressed air since we don't usually have that in ward. If you end up installing ICU beds in what yesterday used to be normal wards, of course, you don't have all the facility you may have in an ICU as usually defined. Of course, I don't know how many of you are familiar with the Italian way of setting up at hospitals. We usually don't have a room for the patient regardless of his type of treatment that goes from the ICU to the general ward before he goes home. We have specific areas of the hospital dedicated to a different level of intensity of care we have to give to the patients.

The next kind of asset we need to acquire really fast and in good big numbers were monitors and monitoring systems. They are, of course, important for an ICU but also for patients who are taking care in normal wards. General conditions that we want to monitor are oxygen saturation, which is probably the best for a meter to look at, together with CO2, to figure out whether the lungs are working correctly. But they asked for monitors rather than simple telemetry systems because they want to be able to view the monitor without going too close to the patient. So they avoid getting dressed up with protection clothes and breathing all the aerosols, which is, of course, one of the major issues.

As far as I figured out in this past three weeks, you don't need a high-level monitoring. You don't need a lot of parameters. Basically, basic parameters: pressure, of course, invasive pressures because the more the patient becomes bad and more ill, the more you may need to have some invasive pressure, and plus CO2 monitoring unless you have it on the ventilator, of course, because you need to be really aware of the condition of the oxygen exchange in the lungs.

The point is that we needed a lot. In my hospital, we have in standard conditions, some 50 intensive care beds. We've come up to almost a hundred. We basically doubled the number of ICU beds in the hospital to handle this kind of patients and you have to be aware that the hospital I work in, it's not one of the most involved in the outbreak. We have a lot of cases but not as many as in other parts of the region.

The last thing is the infusion systems, both syringe and IV lines. The thing is you never know how many you need. At least, that's what happened to me. If you talk to different anesthesiologists, they may ask you for different numbers. I wouldn't be able to say the correct number,

but probably a gross number is something around four pumps per patient, but the problem is always the same.

We're talking about 20, 30 beds at the time, so numbers go up real, real fast. In Italy, at least, we don't have a sort of organization where we have stocks of medical devices that can be used by hospitals without too much effort. I mean we had to buy all the devices to get them running inside the hospitals. Of course, the more you get into it, the more requests come up from clinicians because, then basically, you need to put up a COVID-positive, as we call it, patients and a non-COVID patients ICU.

There are really two different ICUs for different kinds of patients. Hopefully, once this empties, the COVID-positive, while the other doesn't, but then everything is doubled up. So, you need two more ultrasound machines, more point-of-care diagnostics, and many other devices. For example, the emergency ward requires for extra ultrasound machine to do first screening of the patient's, portable x-rays because they're easy to handle. They give you a good shot at the beginning, and then, they're really easier to assess rather than CT scans.

ITALY: WHAT SUPPLIES ARE RUNNING OUT

Umberto Nocco: One of the problems we are starting to face right now, and we are talking about right now and in the past two or three days, is the problem about spare parts. I don't have data on this, but one thing I must say is that probably ventilators run more steadily, if you see what I mean, because they're running on the same patient for a long time, so they suffer less failure if compared with the time when you have a higher patient turnover in the ICUs. So basically, technology is more stable, but then you need a lot more oxygen cells because they fail more often, probably it is due to the higher oxygen concentration used.

And also one of the other problems is the consumption of oxygen. I don't have calculations handy, but lump figures say that we kind of doubled up, or maybe more than that, the oxygen used in the hospital. And so you need to increase the capability of the tanks, of the oxygen tanks. And also you need to be sure that you give an extra boost to the oxygen in the flow because continuous pressure airways support system use very high flows. And when you have many of them connected to the same pipe, you might end up figuring out that you're not really giving the patient the wanted flow of oxygen because everybody's sucking up from the same reservoir. So basically that's what it is.

ITALY: TACKLING ORGANIZATIONAL ISSUES

Umberto Nocco: At the beginning of the outbreak we had to divide production lines, especially in the ERs, sorry for my poor English, and I hope you understand what I mean. Basically you need to define which wards and which ICUs, if you have them, you want to put positive patients in and which wards you want to put non-positive patients in.

I know it's a stupid point of view, but the thing is that normal patients will show up anyway. So if you have a contagious disease ward, which is usually designed also with regard to air flux and isolation of the rooms, then you're quite ahead. But at least in Italy, those are really a few and usually they don't have so many beds as needed in this kind of an outbreak. So you need to use a general ward, which is usually not designed to handle this kind of situation.

You need to set it up with monitors, continuous pressure airway support system, point of care diagnostics, personnel, which we're really running short of personnel, and protection devices. These can be set up in advance. Of course, if you know where to put patients, where you're really staying there.

And this process division has to, at least we experienced, you have to figure it out also in the emergency ward, especially if you need to have basis for clean patients because unfortunately, as I said before, strokes, trauma still happen. Although we experienced a significant decrease, especially after lockdown, it seems like patients don't have strokes anymore. We're kind of asking, “Why?” But there are fewer cases that have come up to the hospital, luckily.

Of course, you have to have completely different spaces for known or suspect positive patients and known positive patients. This basically is like having two emergency departments inside the same hospital. Also from an asset point of view, so you need to have the space, and you need to have the technology to make it run.

Another thing is about biomeds and biomedical equipment technicians and as hospital technology management people who kind of walk around the hospital just to have everything set. We need to be alert. Of course, this is easy to say, but it's hard to handle. But one thing is that you

may need to define where to go and especially when it's worth or needed. By this, what I mean, this is mainly to prevent exposure to the virus, to the biomeds, and to your people in your organization, plus, to reduce the use of the protection clothing and devices, which are always short.

And so this might not be liked by the personnel, at least it is not liked in Italy, they don't like to attach cables, but sometimes some really easy basic line maintenance probably should be given out by nurses and people who can do that inside the ward without biomeds and people from the health technology department going inside a kind of positive area, which has all kind of problems.

ITALY: THE CHALLENGE OF ACQUIRING DEVICES

Umberto Nocco: Last, but it's still a major problem, probably it's more local because it's probably it's more related to the way we acquire devices in Italy. I won't get into the details related to public tenders, which probably don't apply to the U.S. market, but to some extent we faced a kind of saturation of the capability to produce devices, which is probably typical of medical device market, which is not usually accustomed to producing by the hour in great numbers, if you see what I mean.

So, we were the first, and so we were able to use stocks, and we were able to acquire some numbers of devices at the beginning of the outbreak. But after a short time, we started experiencing a longer and longer time to hospital, as they call it, for ordered goods. Orders given today are scheduled to be given to the hospital by the mid of April. So that's way too long. We need the devices before that. And we also experience lower quality due to a certain, probably to the speed on the production line, details that are not present on the devices, things that are missing, things that probably are not assembled very well and stuff like that.

Last thing, is how many devices do I need? Basically, it's another way of putting the question I started with. We had hospitals where more was never enough, still today, and hospitals where you had the feeling that you were doing something wrong in acquiring all that kind of technology because it didn't seem like needing more devices and beds and somebody else might have a need rather than you.

The problem is that you never know. You never know what's going on tomorrow. Also, all these nice curves of patients that we see every day, we're not really sure they're correct. So we don't know what will be happening in the hospital tomorrow, how many cases we have at home, and they're are not even aware that they have COVID-19, and they might end up in a hospital in a couple of days. So it's really hard to find the balance when you have to decide how many devices, which type, what you want them to do, and how you want the thing run.

Received April 20, 2020, accepted April 21, 2020, date of publication April 22, 2020

THE CHINESE EXPERIENCE - FIGHTING AGAINST COVID-19, SHANXI MEDICAL ENGINEERS

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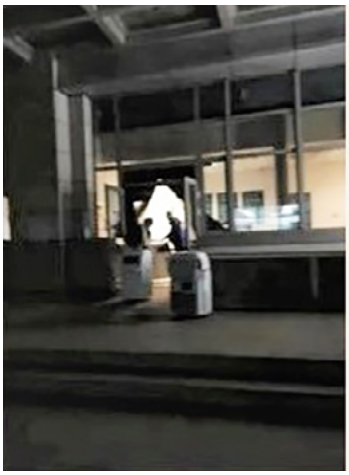
ABSTRACT

The world has witnessed as the COVID-19 pandemic has been raging wildly across China and the world. Although it is a war without gunpowder smoke, it is nevertheless extremely fierce. Countless medical and other front-line staff are fighting under grave conditions while facing the death of their patients and the need to protect themselves against the virus. However, against these gigantic challenges, the healthcare team stays firm in their beliefs and with the long-term vision of winning the war for their patients and families. In order to win this battle faster, in addition to the doctors, there are also a large number of clinical/medical engineers fighting on the front line! This group of unsung heroes wrote application letters asking to join the battle and take on assignments at the front line early on. They have kept working at their assignments 7 × 24. These clinical engineers appreciate the urgency of racing against time to expedite the commissioning and installation of new and relocated medical equipment at their hospitals. In the face of the epidemic, as always, they have remained at their stations in hospitals and have become the "patron saints" of medical equipment. Although there is a risk of infection, they do not hesitate. It is their commitment in the face of exhaustion that ensures the normal and safe operation of the equipment. It is their untiring belief that together we will wipe out this disease, unite as one, and overcome any challenges. In the end, victory will belong to us all!

SHANXI BETHUNE HOSPITAL

Faced with the severe situation of a pneumonia epidemic from the novel coronavirus, it has become very important to triage tasks and employ workarounds to deal with the limited supply of protective gear with priority given to medical personnel and ensure that rescue and resuscitation equipment is in place and ready when critically needed. All the staff of the Medical Equipment and Materials Management (CE) program of Bethune Hospital in Shanxi province held fast to their posts and mobilized to search for resources and solutions day and night.

"We have only one idea, no matter how great the pressure, we must do our best to ensure that protective and disinfection materials are kept in stock and all diagnosis and treatment equipment operates normally," said their manager.



In order to prevent the spread of the epidemic and ensure the safe use of available and much needed medical equipment, relevant resources were consulted and new protocols were organized. This included the "Guidelines for Disinfection of Medical Equipment (I) and (II)" links that were developed to guide clinical and medical departments (CE personnel) on how to clean and disinfect medical equipment scientifically and reasonably.

This epidemic knows no boundaries, is merciless, and everyone is impacted to some degree. The Hubei Medical Aid Team from Bethune Hospital in Shanxi has continuously rushed to help meet the CE needs at the front lines in Hubei. Members play a vanguard and exemplary role. Our Chinese CEs, like Jin Yue actively practice at the front line of this war. On February 4, he went with the Shanxi Provincial Emergency Medical Rescue Team to the epicenter of the virus in Wuhan. This is an example of a dedicated medical worker and a model for all healthcare workers.

Our office has prepared a travel inventory for the team members going to Hubei many times. This includes protective clothing, head covers, various masks, goggles, and other decontamination products, to ensure the safety of the medical team members as they work.

SHANXI PROVINCIAL PEOPLE'S HOSPITAL

To establish an isolation ward as soon as possible, it was vital to speed up the progress and shorten construction time. This required the general staff of the engineering department of Shanxi People's Hospital to work overtime dismantling the old DR and install the new computed tomography (CT) scanner for testing for novel coronavirus. This is shown in the following photos.

In order to cope with the new coronavirus pneumonia epidemic, Shanxi Provincial People's Hospital used a GE 16-slice CT for the examination of patients showing symptoms such as fever. However, the CT had to be set up and operated by trained personnel who must enter the computer room. This led to close contact between

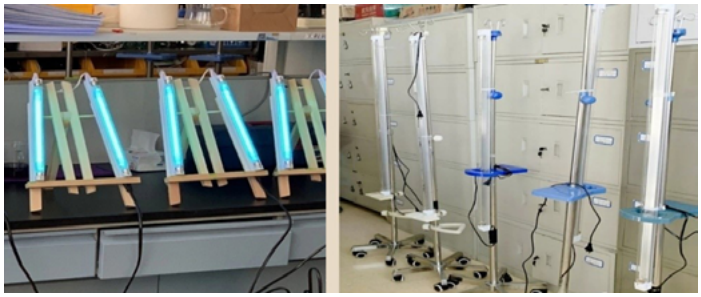
the operator and the patient and increased the possibility of operator infection. To solve this problem, the engineers of Shanxi People's Hospital carefully studied the environment and equipment structure, reviewed the operating circuits, jointly brainstormed ideas, designed the required additional interconnecting circuits, searched for and purchased the materials needed, and came up with a custom-built built it in-house solution.

With the aim of not affecting the function of the CT equipment, the rack control panel was moved to the external operation room so that the operators could safely position themselves outside the CT room and avoid close contact with patients. This greatly reduced the risk of infection.

SHANXI CHILDREN'S HOSPITAL

With the continuous spread of the virus, the demand for disinfection equipment in hospitals has increased greatly. In order to meet this demand, the medical engineering (CE) team of Shanxi Children's Hospital designed and manufactured 60 sets of ultraviolet disinfection lamps of differing specifications using existing materials in combination with professional characteristics and first-line operation specifications. This will better meet the needs of clinical departments during the epidemic and is shown in the photos below.

At present, the first batch of disinfection lamps have been distributed to dozens of key prevention and control departments such as emergency and respiration departments and comprehensive and clinical examination areas. After they are built and installed, the hospital will be better prepared to carry out disinfection work in a 3000㎡ medical area space while simultaneously providing strong assurance against possible coronavirus infection and strengthening the fight against the epidemic. Ultraviolet lamps can effectively disinfect the surface of objects by exposing them to light radiation. They can be reused and can be mobilized and moved between rooms and patient consultation areas.



This is the disinfection method recommended by the prevention and control guidelines issued by the National Health and Safety Commission. Engineers carried out ultraviolet intensity testing in strict accordance with medical ultraviolet disinfection requirements and formulated usage specifications to more comprehensively ensure the protection and safety of patients, family members, and medical personnel.

SHANXI COAL CENTRAL HOSPITAL

The epidemic situation is merciless, people everywhere are impacted, and sadly some succumb to the disease. In the face of this grave situation, Shanxi Coal Central Hospital, as the protection department during the epidemic, has volunteered to safeguard the hospital's protection gear and materials. For many years CEs have been making continuous and silent contributions to improve patient care. In order to ensure that temporarily assigned on-the-job front-line medical personnel are protected in place, the material support department checked inventory and issued protective gear and materials in a fixed amount every day. It also allocated the necessary equipment for the fever clinic and emergency department in the hospital. In addition to moving needed equipment between locations,

the medical maintenance department also serves as the competent on-site technical service support staff as shown in the photos below. They are at the dangerous forefront of transportation, installation, commissioning, and training of air purification disinfectors that are urgently needed in fever clinics, respiratory medicine departments, emergency departments, clinical departments, and CT rooms.

The Clinical/Medical Engineering Committee of Shanxi

Medical Association issued a "Proposal for Donations to Fight Novel Coronavirus Pneumonia Together" which received a positive response from Shanxi medical workers. Everyone actively participated in the charity fundraising activities and have made a modest contribution to the final victory in the fight against this disease.

Medical equipment plays an important role in the di-

agnosis and treatment processes. In order to strengthen the prevention and control work of medical institutions throughout the province, the management and the use of medical equipment must be more efficient during the prevention and control of a pneumonia epidemic from the novel coronavirus. This especially applies to the safe use, cleaning, and disinfection and control of large medical, first aid, and life support equipment. The Medical Engineering Branch of Shanxi Medical Association referred to the cleaning and disinfection plans of Philips, GE, and Murray for medical equipment during the epidemic. The Organization of Shanxi Province Medical Equipment Management Quality Control Center, Shanxi Medical Association Medical Engineering Professional Committee and Hospital Infection Experts conducted research, formulated, and demonstrated various cleaning and disinfection work plans (trial runs) to guide medical facilities in the diagnosis and treatment safety of medical equipment throughout the province and ensure the safety of medical personnel, patients and their families. Examples of protocols are attached below.

At present, director Zhang Jin leads all clinical/medical

engineers in Shanxi in collaboration to help concentrate manpower, perform their extraordinary duties, provide solid backing for front-line clinical medical personnel, build up the cornerstone of epidemic prevention, and improve the required logistics support during these abnormal times. Under the guidance of medical engineers, we firmly believe that in the face of the epidemic, we will be able to overcome this difficulty through concerted and collaborative efforts. Come on, Wuhan! Come on, Shanxi! Come on, China!

Received February 2, 2020, accepted March 27, 2020, date of publication April 17, 2020

EMERGENCY RELOCATION OF A CARDIO-SURGICAL HEALTH FACILITY DUE TO WAR

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ABSTRACT

This article seeks to share our experience on the consequences of a poorly managed conflict and its impact on a healthcare institution. We further try to talk about what it takes to relocate, especially such a vital sector like cardiac surgery amid the socio-economic and socio-political context in which the hospital happens to be situated. Bearing in mind that the promptness of a patient's recovery in a healthcare facility depends immensely on how accurate the engineers were during the design and construction phase how precise international standards are implemented in the various engineering sectors of the hospital is of capital importance. Following the Cameroonian mindset, wherein division of labor and meritocracy are usually far fetch realities, it is therefore of prime importance to choose experienced and qualified contractors, architects, project managers to take part in the implementation of healthcare projects. The process of relocating either temporarily or permanently some health services from a crisis-stricken zone to a safer environment also demands a lot of tactfulness in decision making as well as personnel involvement. All personnel from the various sectors being relocated must work closely with the team leader such that all necessary equipment, consumables, surgical materials are put together to simplify logistics and even safeguard the logistical process.

Keywords – *Healthcare, Outreach, Crisis, International standards, Facilities, Emergency*

INTRODUCTION

The St. Elizabeth Catholic General Hospital Cardiac Center Shisong is a hospital founded in 1936 as a dispensary by the Tertiary Sisters of St. Francis. The Tertiary Sisters of Saint Francis are a Roman Catholic Religious Congregation of Pontifical Right with motherhouse in Brixen, South Tyrol – Italy and General Administration in Rome – Italy. The hospital was recognized by the Cameroon Government in 1952. The hospital has several departments amongst which the Cardiac Center is our point of interest in this article. The Cardiac Center Shisong is a state-of-the-art hospital constructed on a surface area of 12,500 m^2 in a remote area of Kumbo, Bui Division, North West Region – Cameroon between 2005 and 2009. It was officially inaugurated on November 19th, 2009 by the Cameroon minister of public health. This was done in the presence of the Italian ambassador to Cameroon amongst other top-ranking personalities. Following this inaugural ceremony, the Cardiac Center was recognized

as a National Referral Center for cardiovascular diseases in Cameroon. On November 4th, 2015, following Presidential Decree № 2015/493, the Cardiac Center Shisong was recognized as a "Public Utility." This hospital is the end product of a fruitful collaboration between 3 main partners (Non-Governmental Organization) which are: "Tertiary Sister of St Francis" (Cameroon), "Bambini Cardiopatici nel Mondo" Onlus (Italy), "Cuore Fratello" Onlus (Italy). These 3 partners signed an MoU in June 2010 to define management, responsibilities, and ownership of the Cardiac Center.

RESPONSIBILITIES BEFORE INAUGURATION

Table 1 summarizes some responsibilities of the 3 partners before inauguration.

TABLE 1. Responsibilities of the Various Partners before Inauguration

Tertiary Sisters of St. Francis	Cuore Fratello Onlus	Bambini Cardiopartici Nel Mondo Onlus
Selection of patients to be operated upon in Milan	Accommodation of patients and staff who travel to Milan	Training of chosen staff
Staff recruitment before sending to Milan for training	Technical assistance to site engineers	Carry out surgical interventions
Construction of new infrastructure to accommodate the new Hospital	Provision of medical, electrical and mechanical equipment	Provision of some medical equipment and surgical materials
Management	Sponsorship of surgical procedures for underprivileged patients	

Table 2 summarizes some responsibilities of the 3 partners after inauguration.

The following day after the inauguration ceremony, the first cardiac surgery was performed in the new infrastructure which was very successful.

TABLE 2. Responsibilities of the Various Partners after Inauguration

Tertiary Sisters of St. Francis	Cuore Fratello Onlus	Bambini Cardiopartici Nel Mondo Onlus
Selection of patients who cannot be operated upon in Shisong due to the complexity of the surgical intervention	Accommodation of patients and staff who travel to Milan	Training of chosen staff
Staff recruitment and management, selection of those needing supplementary training in their respective fields. Organization with foreign partners for possible training	Technical assistance to site engineers and help desk function. Connection with potential suppliers of spare parts. Follow up purchase and dispatch to Shisong.	Carry out surgical interventions in Shisong. Collaboration with other foreign healthcare practitioners for possible organization of pediatric surgical missions in Shisong
Facility management of the infrastructure	Donation of medical, electrical and mechanical equipment	Donation of some medical equipment and surgical materials
Management of hospital activities	Sponsorship of surgical procedures for underprivileged patients	

PRESENTATION OF CARDIAC CENTER SHISONG HEALTH FACILITY

1. Total bed capacity is 86 with 13 Intensive Care Unit (ICU) beds included
2. An outpatient department
3. Well-equipped ICU
4. Electrophysiology and hemodynamic (angiograph)
5. Two well-equipped operating theaters in which heart surgeries can go on simultaneously
6. Blood bank service
7. Pharmacy and procurement
8. Technical department

METHODS

In November 2016, social unrest broke up in the 2 English speaking regions of Cameroon (North West and South West regions). The Cardiac Center Shisong happens to be situated in one of these regions that is the North West region. The crisis which initially started as a non-violent protest in which teachers and lawyers were demanding reforms of the educational and judicial sector, and were molested and chased from the streets. Some youths took upon themselves to retaliate and fight for their rights, a situation which transformed into violent and deadly confrontations. From thence, an extremist part of the population became radicalized and transformed the protest into a fight for independence (cessation).

The number of extremists grew and we started to observe a wide proliferation of arms of all sorts. There was chaos all over the Anglophone regions as the confrontation between separatist fighters and the military became deadlier, leading to the massive internal displacement of citizens. It was after the October 7th, 2018 presidential election that the confrontations gained grounds generally speaking (although some localities had already experienced severe and deadly confrontations). People fled from their homes into bushes with the hope of returning after a few days. They then fled from their hideouts into neighboring villages until some found themselves in neighboring countries while others settled in the French-speaking regions of the country. This situation forced many companies and hospitals to shut down. Some were even reduced to ashes.

The Cardiac Center Shisong, fortunately, was not reduced to ashes but suffered from a long period of inactivity. Some patients who were hospitalized just before the situation aggravated were stranded and couldn't return to their homes and some patients who had been booked for cardiac surgeries ended up dying. Due to the low patient turnouts, the hospital administration was forced to send about 75% of staff on technical leave.

ACTIVITIES PERFORMED BY THE CENTER BEFORE OCTOBER 7TH, 2018

Table 3 shows medical activities performed between November 2009 and October 2018.

TABLE 3. Various Activities Performed Over 10 Years

ACTIVITY	NUMBER
Consultations	74,655
Echocardiograms	24,000
Diagnostic and interventional catheterization	515
Cardiac pacemaker	185
Open-heart surgeries	769

SOME TECHNICAL FACILITIES FOUND AT THE CARDIAC CENTER SHISONG

Table 4 groups some of the biomedical, electrical and mechanical equipment found in the hospital.

TABLE 4. Various Activities Performed Over 10 Years

DESIGNATION	QUANTITY
Electricity generators (700 kVA, 900 A, 3 phases)	2
Voltage stabilizer (650kVA, 3phases, regulates between −35% and +15% of nominal voltage)	1
Voltage transformers 10KV–400V (630 kVA 3 phases)	2
Vacuum pumps for centralized suctioning (7 kW)	3
Medical oxygen production plant (6m3/h)	1
Syringe pumps	30
Infusion pumps	25
Patient ventilators	8
Multi-parameter patient monitors	18
Anesthetic machines	4
Coagulation analyzers	3
Blood gas analyzers	4
Chemistry analyzer	1
Portable ultrasound machines	3
Mobile ultrasound machines	2
Defibrillators	5
Surgeon's headlamp	1
Auto-transfusion pumps	2
Intra-aortic balloon pump	1
Heating/cooling machines	5
Air compressors (11 kW, 3 phase, 108 m3/h)	3

DESIGNATION	QUANTITY
Sternum saws	2
Electrosurgical units	4
Weighing scales	3
Measuring tapes	3
Blood warmers	3
Drug refrigerators	6
Extracorporeal circulation machines SIII	2
Mobile suction machine	1
Infusion stands	20
Drug trolleys	15
Electrocardiograph machines	2
Transesophageal probe	1
Oxygen flow meters	45
Negatoscopes	15
Patient's bedside tables	48

SOME IMPACTS OF THE CRISIS ON THE CARDIAC CENTER

1. The growing cost of preventive maintenance due to prolonged shutdown of equipment.
2. Worries about the state of equipment containing internal batteries which had not been charged.
3. A long blackout period or lack of electricity leading to the possible deterioration of rechargeable batteries in equipment. In the event of a fault on the grid, workers from the electricity supply company would not be able to intervene unless a period of ceasefire was announced.
4. Increased expenditure on fuel for the electricity generators.
5. Travelling for distances of about 100 km during violent confrontations in search of fuel for electricity generators. This led to the rationing of the electricity supply. In a bid to economize fuel, the electricity generator would work for only 4 hours a day.
6. A growing number of patients on the waiting list needing prompt surgical interventions.
7. Expiration of drugs, surgical materials, valves, patches, and other consumables.
8. Loss of manual dexterity of the personnel due to the long period of technical leave.

It was following some of these points that studies were made to create an outreach program for the cardio-surgical unit of the hospital in a safer city. The challenges were numerous for this project to go operational and we had to keep in mind that not all pieces of machinery were to be transferred out from the Cardiac Center as surgical activities could resume in the Cardiac Center whenever the crisis was resolved.

There was a lot of discussion mostly between the surgeon and the technical coordinator seeking the most appropriate model of implantation to be adopted. Our first worry was the city in which we were to settle in. We had to choose between Yaounde, Douala, and Bafoussam. The criteria which guided our choice of city were:

1. The climatic condition of the city (temperature and humidity).
2. Level of pollution.
3. Population density.
4. Security and safety in association with urban disorder.

After carefully deliberating on these points, we realized that Yaounde, the capital of Cameroon, was the most suitable. We were convinced that our proximity to decision-makers (ministries, insurance companies, and Non-governmental Organizations) could increase our chances of integration and reaffirming our place in the healthcare sector. The next challenging task was to find either an appropriate piece of land to construct new facilities to accommodate the services or to collaborate with an existing hospital or clinic. Due to the unavailability of enough funds, the second option was chosen to raise another problem of which hospital to work with. This was very challenging knowing that we were to choose among close to 20 renowned government, private, and confessional hospitals.

1. Criteria for Choosing a Partnering Hospital
2. The close proximity to the center of the city.
3. An institution with lesser administrative latency.

4. An institution with similar religious perspectives.
5. An institution who puts patients' recovery as the main priority.
6. An institution with similar hygienic standards.
7. An institution in which workers and administrators are completely apolitical.

After visiting several health institutions both state and privately owned, our choice was made on a private clinic considering the above-mentioned criteria. It should be noted that Cardiac Center Shisong is the only center in Central African Sub-region where routine open-heart surgeries are performed. We have in Cameroon, the Douala General Hospital who also does open-heart surgeries, but patients are grouped and wait for foreign specialists to come once or twice a year for surgeries.

We had several challenges to kick-start activities in the chosen healthcare institution and we expected to meet these challenges knowing that hospitals not performing such levels of surgical interventions would not invest in upgrading facilities.

CHALLENGES ENCOUNTERED HINDERING THE SMOOTH TAKE OFF OF SURGERIES IN THE CHOSEN CLINIC

1. There were 2 split-type air conditioners in the operating theater. Contrary to the conventional air-handling units with high-level filter management of air pressure in the rooms, we had a completely closed operating theater with no possibility of renewing the air. Among the 2 air conditioners, none was cooling to our satisfaction.
2. There was only 2 outlets for oxygen in the theater. The operating theater had no anesthetic pendant nor enough outlets for medical oxygen. We needed at least 3 outlets for our machines.
3. Piping for medical air in the operating theater was absent. Medical air (air containing 21% oxygen) is needed by the anesthetic machine and heart-lung machine.
4. There was an absence of piping for the anesthetic gas scavenging system in the operating theater.
5. Only 3 electrical sockets were present in the operating theater. Mindful of the number of appliances connected during heart surgeries and even general surgeries to a lesser extent, it was unworkable to have only 3 electrical sockets. We also noticed electricity distributors were being used with little knowledge about their electrical rating.
6. There was the presence of a very tight and poorly ventilated 2-bed ICU. We also had a slit-type air conditioner with no possibility of air renewal.
7. There was a poor disposition of oxygen cylinders and supply networks. The health facility was supplied with medical oxygen from a two-cylinder ramp. Knowing very well the role and importance of oxygen in heart surgery and hospitals with emergency units, we wondered how the patients survive during the process of replacing empty cylinders. Furthermore, the distribution network was composed of only one pressure reducer situated beside the ramp. It was reducing the pressure from 145 bar to 4.5 bar. Meaning that there wasn't any second stage reduction.
8. A centralized vacuum system was absent. We found only 3 mobile suction machines available in the hospital.
9. A medical gas alarm system was absent. We witnessed instances where oxygen ran out and no one knew about it.

With all these challenges in mind, discussions were scheduled with the CEO of the clinic. The aim is to present all the listed challenges hindering a smooth take-off and to propose recommendations according to international standards which would be taken into consideration while upgrading the facility. Bearing in mind the complexity of the task and huge financial constraints involved and the fact that all investments were to be borne by the CEO of the clinic alone, we were obliged to reshape or soften our recommendations while still trying to align with international standards.

RECOMMENDATIONS TO BE IMPLEMENTED WHILE UPGRADING THE HEALTHCARE FACILITY TO ACCOMMODATE THE CARDIO-SURGICAL SERVICE

1. Due to financial constraints, we asked that the air conditioners in the operating theater be repaired and

cleaned rather than purchasing an air-handling unit. This issue was to be reviewed after the first year of collaboration.

2. More oxygen sockets were to be added to the operating theater.
3. Installation of new pipeline for medical air in the operating theater.
4. Installation of piping and scavenging system for anesthetic gas from the machine in the operating theater.
5. To foster a continuous supply of oxygen to the hospital, we recommended the installation of at least 2 ramps with 2 cylinders each, having an automatic switchover between both ramps. This new system should be linked to a medical gas alarm system to indicate ramp discharge, low, and high pressures. We also asked that a second stage pressure reducer be installed.
6. The purchase of more mobile suction machines to serve in the operating theater as well as in the ICU.
7. Owing to the very limited space in the existing ICU, we asked for a new location to be provided. The CEO instead promised to construct a new building to accommodate the ICU as he was about to embark on an extension project of his clinic.
8. Increase the number of electrical sockets in the operating theater and reevaluate the power rating of the UPS to make sure that it matches our demand of 15 kVA.
9. Review of the earthing system.

RECOMMENDATIONS FOR THE IMPLEMENTATION DURING THE CONSTRUCTION OF THE NEW ICU

The ICU was to be constructed on a 35-square meter piece of land (7 m length and 5 m width). After careful analyses, we decided to design the room such that it could contain 3 adult patients' beds and 2 infants' or neonates' beds with warmers for a total of 5 head beds altogether.

1. Each bed should have 12 electrical sockets. All sockets including those in the operating theater were to be protected following the NFC 15 – 100. More specifically, the earthing system was to be the IT system.
2. The installation of 2 oxygen sockets per bed and one socket of medical air per bed.
3. The installation of rails on the wall for hanging medical fixtures and equipment.
4. The installation of an air-handling unit comprising recommended levels of air filtration (F5, F6, F9, and absolute filter) including the management of room pressure, temperature, and humidity.
5. The provision of a sluice room.
6. The installation of 2 small drawers on the wall for each bed.
7. The installation of a washbasin with a tap that has a lever mechanism or PIR sensor.

LIMITATION OBSERVED IN THE CONSTRUCTION OF THE ICU

After handing over the recommendations for the construction of the ICU to the hospital's CEO and project coordinator, we were told that the entrepreneur was up to the task and would deliver the goods based on the recommendations.

One month after the kick-off of the project, a site visit was scheduled to understand the level of progress and to validate the implementation of our recommendations. To our greatest dismay, we had the following lapses which were immediately corrected while some other lapses were discovered in the course of using the facility.

1. There was a small number of electrical sockets (4) installed per patient bed contrary to the recommendations.
2. There was no provision for a sluice room. Nurses were asked to move completely out of the zone housing the ICU to empty waste.
3. There was a poor installation of water collectors on the roof. During rainfall, some walls were completely soaked leading to the proliferation of fungal growth.
4. There was poor anchorage of bedside cupboard/drawer on the wall which broke when syringe pumps or patient monitors were placed on them.
5. There was the poor demarcation of sterile zones, hence communication of construction site with the ICU.
6. There was the poor implementation of the oxygen distribution system which lead to frequent ruptures in the oxygen supply to the various services.

7. Contrary to requests, a split-type air conditioner was installed in the ICU.

CHALLENGES OR LIMITATIONS TO A SMOOTH TAKE OFF FOR THE CARDIAC CENTER

While working closely with the partnering clinic, we faced many challenges that could equally delay if not addressed, the smooth take-off of surgical activities. They were:

1. The means of transporting required equipment, me-di-cations and consumables from Shisong to Yaounde amid the prevailing crisis. Many truck drivers were reluctant to travel to the area for fear of being killed or seeing their vehicle burned.
2. Regrouping all displaced workers who were to take part in the outreach activity.
3. Compilation of a list of needs (consumables, materials, and equipment) from the various sectors involved in heart surgery.
4. Negotiating and obtaining a balanced MoU between both institutions.
5. Discussion by the Cardiac Center administrator with staff to arrive at an optimum working condition in Yaounde.
6. The main technical coordinator, not being in Shisong, found a lot of difficulties in selecting medical equipment, spare parts, packaging, labelling, and transporting out of the hospital for onward transmission to Yaounde.
7. Establishing a list of medications and surgical con-sumables based on a predefined list of pathologies to be handled.

INFRASTRUCTURE AVAILABLE FOR THE OUTREACH ACTIVITY

1. Bed capacity:

TABLE 5. Personnel Chosen To Take Part in the Outreach Program

DESIGNATION	NUMBER
Administrator	1
Cardiac surgeon	1
Anesthesiologist	2
Cardiologist	1
Pharmacist	1
Biomedical engineer	1
ICU nurse	6
Perfusionist	2

- ICU = 3 adult and 2 infant beds.
- Pre-surgical ward = 2 beds.
- Post-surgical ward = 2 beds.

2. An operating theater.

TABLE 6. Equipment Taken for the Outreach Program

DESIGNATION	QUANTITY
Syringe pumps	16
Infusion pumps	15
Patient ventilator	3
Multi-parameter patient monitor	9
Anesthetic machine	1
Coagulation analyzer	1
Blood gas analyzer	1
Chemistry analyzer	1
Portable ultrasound machine	2
Defibrillator	2
Surgeon's headlamp	1
Auto-transfusion machine	1
Heating/cooling machine	1
Air compressor	1
Sternum saw	2
Electrosurgical unit	2
Weighing scale	1
Measuring tape	1
Blood warmer	1
Drug fridge	2
Extracorporeal circulation machine SIII	1
Extracorporeal circulation machine S5	1
Mobile suction machine	4

DESIGNATION	QUANTITY
Infusion stand	6
Drug trolley	4
Electrocardiograph	2
Transesophageal probe	1
Oxygen flow meter	5
Negatoscope	1
Patient's bedside table	3

3. An office for pre-surgical consultation and post-surgical follow up.

TABLE 7. Timeline

DATE	ACTIVITIES
October - November 21st, 2016	Anglophone lawyers and teachers began protesting. Gradual transformation of peaceful protest into violent confrontations after this date.
September 20th, – October 14th, 2018	Separatists groups ordered the complete lockdown of both North West and South West region in view of upcoming campaigns for the presidential election, including the day of elections and post-electoral activities.
October – November 7th, 2018	Discussions and underground works between the cardiac surgeon and technical coordinator concerning the possibilities of reviving surgical activities in a safer location.
November 17th, 2018	After sharing our thoughts with the hospital administrator, we performed the first site visit to the health facility which was our first choice.
November 20th, 2018	Sharing of an elaborated report of the visit with the Cardiac Center administration and cardiac surgeon. This report brought forward the state of the partnering healthcare facility, improvements to be made in the facility, how long it would take to upgrade before the kick-off of cardiac surgeries and the list of equipment not available within the healthcare facility but needed to be transported from Shisong. The target is begin surgeries within the second week of January 2019.
November 20th, – December 12th, 2018	Review of upgrading tasks to be accomplished at the Jordan Medical Services, review of the hospital's layout to understand and reorganize work flow. Proposal of a second healthcare facility as second choice. Sharing of idea to relocate with the several partners of the Cardiac Center Shisong including the Cameroon Ministry of Public Health.
December 12th, 2018	Second visit to our first choice partnering institution to see the level of work progress, organized meetings with the contractors responsible for executing the recommendations given the constructing a new ICU block. Equally paid a first and second site visits to a healthcare institution which was our second choice and was equally under renovation and restructuring.
November 2018 – January 2019	Sharing of an idea to relocate with the several partners of the Cardiac Center Shisong including the Cameroon Ministry of Public Health.
December 29th, 2018	Discussions after sharing reports of the last interventions. A decision was taken to collaborate with the Jordan Medical Services. Upgrading work was to last for 5 months.
January – February 2019	Prepared the list of various equipment, accessories, spare parts, and consumables to be transported from Cardiac Center Shisong to Yaounde.
March 2019	Third site visit to the clinic to follow up on the work progress and implementation of recommendations. In the course of the evaluation meeting, there was a change of location for the ICU. A new building was being erected to serve this purpose, more recommendations were given for this ICU block. Commissioning scheduled for mid-May. Preparation of storage space to safely pack all materials and equipment from Shisong. Investigations to understand the best moment to transport materials safely out of the hospital in Shisong.
March 2019	Holding of Technical Committee meeting (hospital's board of directors) to designate management and to elaborate a model/ draft of the MoU between both healthcare facilities.
March – April 2019	Dismounting, packaging, and transportation of listed equipment, accessories, spare parts, medical as well as technical consumables, drugs, and surgical materials to Bamenda using an ambulance before onward transmission to Yaounde given that there were more security threats on the stretch of road Kumbo – Bamenda than Bamenda – Yaounde.
Mid - April 2019	After grouping close to 95% of the materials in Bamenda, we organized and transported them to the clinic in Yaounde. Received them in Yaounde and packed in the already previewed storage space.
April 27th, – May 8th, 2019	Commissioning of the new ICU and upgraded operating theater amid some adjustments and finishing touches to be made. Reception of remaining materials required to complete the list of items used to perform cardio-surgical activities. Unpacking, assembling, cleaning and testing of all equipment before sending them to their various locations.
May 18th, – June 6th, 2019	Signing of an MoU and the kick-off of first surgical mission with a total of 9 patients with cardiomyopathies operated upon.

4. Due to limited space in the hospital, the room for magnetic resonance imaging was used as an extended storage facility.
5. The point of care was performed in the ICU.
6. The blood bank hosted by the clinic.

THE CLINIC'S LABORATORY WAS RESPONSIBLE FOR ALL TESTS.LIST OF DIFFERENT PERSONNEL CHOSEN TO TAKE PART IN THE OUTREACH PROGRAM

Some of the personnel chosen to take part in the outreach program are detailed in Table 5.

LIST OF MEDICAL EQUIPMENT, FIXTURES, AND OTHER APPLIANCES SUCCESSFULLY TRANSFERRED FROM SHISONG TO YAOUNDE

Table 6 lists some of the equipment taken for the outreach program.

TIMELINE OF ACTIVITIES

Table 7 presents a visual timeline of activities leading to relocation or creation of outreach.

RECOMMENDATIONS

1. Diversification of production units is of key importance. This means that for a given healthcare institution performing open-heart surgeries, it won't be good to concentrate all investments in one city or town. They should divide the investment and implant of another healthcare unit in another town. Also recommended in bilingual countries like Cameroon or countries with 2 distinct groups of people or races, not locating both structures in the towns belonging to the same group of people or race.
2. When the relocating health facility is discussing with the partnering hospital, it will be good to take part in sharing the cost of renovation or upgrading work if any. This is because the partnering hospital may not have enough funds to put in place all the facilities necessary to carry out safe surgical interventions according to international standards or may simply be ignorant about international standards and by so doing not see the need to invest and implement all recommendations. To this effect, the relocating hospital once made aware of the importance of having all recommendations implemented, may decide to assist financially and later include in the MoU the terms to recover the investment.
3. The neutrality of the hospital trying to relocate must be made known to all conflicting parties or the different groups of activists engaged in the war. This neutral position is very important to the safety of materials when transporting them out of the war zone.
4. Before organizing any transport activity in the war zone, a good investigation must be carried out to understand the safest periods. This is to avoid being caught up in a cross fire during transportation leading to death or destruction of goods.
5. The implementation of the heads all of units involved in heart surgery for instance will go a long way to avoid forgetting important materials needed during the process knowing that transportation within the crisis hit zone becomes risky.
6. While planning and organizing the workflow in a chosen healthcare facility, emphasis must equally be paid on the reduction to near zero the transmission of nosocomial infections. This is because, a surgical procedure can be performed perfectly with the required instruments, equipment, and consumables, but because attention was not paid to the sterility of instruments and air, the patient, later on, develops severe complications or bacterial infections. This situation may couple with the patient's long stay in the ICU to produce bed sores aggravating the condition and even leading to death.
7. For those who want to relocate to a city where stable electrical supply is still a farfetched reality, care must be taken so that uninterruptible power supplies are installed, stand-by electricity generators installed, and a proper grounding system implemented.
8. The availability of enough medical oxygen for continuous activities is also very important knowing that the life of a cardiac patient in the operating theater and ICU depends primarily on it.
9. When both institutions meet to discuss the model of partnership, it is advisable to strive at maintaining

autonomy in management. That is, personnel management, medical supplies, and billing must remain under the control and supervision of the visiting hospital or relocated healthcare institution.

10. For none profit-making healthcare institutions, a frank and sincere discussion should be held with all potential benefactors including the government for possible sponsorship. This assistance can go a long way to even acquire new or refurbished machines which cannot be easily displaced from the crisis-hit zone like an angiograph or computed tomography scanner. These are vital and supportive equipment used for pre-surgical diagnosis of the coronaries for instance, (in most aging patients above 45 years or younger patients presenting a higher risk factor of having coronary stenosis). Also, the angiograph can also be used in correcting some cardiopathies within the scope of minimally invasive procedures. If these discussions held before starting upgrading or renovating works, the problem of limited space can be handled by transforming the operating theater into a hybrid operating room.

TABLE 8. Achievement Over 10 Months

SURGICAL MISSIONS	PERIODS	NUMBER OF SURGERIES
First surgical mission	May 18th – June 2nd 2019	9
Second surgical mission	July 16th – 28th 2019	8
Third surgical mission	September 23rd – October 8th 2019	8
Fourth surgical mission	November 12th – 18th 2019	**5**
Fifth surgical mission	December 6th – 15th 2019	**7**
Sixth surgical mission	January 17th – February 4th 2020	**7**

FIGURE 1 & 2. The staff at work in the operating theater during open-heart surgery.

FIGURE 3 & 4. Staff at work in the ICU.

RESULTS

A glance through the results obtained after the creation of the outreach program may not be very encouraging vis-à-vis our capacity, but for those patients who survived through the period during which we were inactive, it is a success (Table 8). Irrespective of the several limitations encountered along the line with the construction of an ICU within a short time, the threats to burn down equipment and consumables during their transportation out of the crisis-hit zone, we were able to perform successful open surgeries. The creating of this outreach program has given hope to some Cameroonians and beyond for a better life and health condition.

DISCUSSION

After the kick-off of surgical activities, notwithstanding the successes recorded, the Technical Department continued working hand-in-glove with the different sectors involved trying to know their level of satisfaction. We also sought to know those areas which needed improvement either by adding equipment to ameliorate working conditions or speeding up patients' recovery. In this line we were able to change the noisier and space-consuming mobile vacuum/suction pumps to a miniature less noisy, wall-mounted vacuum regulator using compressed air to generate a negative pressure (Venturi effect). Although while implementing this solution we created another problem (that of increase in the demand of compressed air), we have been working on possible fundraising to purchase a bigger air compressor to cover the entire needs during surgical missions.

The absence of an air-handling unit in both the operating theater and ICU has been one of our major setbacks in patient recovery and infection control. To that effect, while seeking funds to handle this issue, we intensified the use of an antiseptic spray for in-depth sterilization and antiseptic solution for cleaning of surfaces.

CONCLUSION

The prompt and speedy recovery of patients after heart surgery are the driving forces that keep energizing medical and paramedical personnel to continue working harder to attain better results. These driving forces are also responsible for the quest to brainstorm and come up with lasting solutions which when implemented per international standards would step up the level of healthcare offered in the outreach setting. Mindful of the fact that the term outreach here does not mean working at the minimum level prescribed by standards, we are determined to put more efforts such that surgeries shall be performed under safer conditions and that the right health technologies are utilized. The hospital administration is working closely with some benefactors who have opted to offer some equipment in a bit to meet up with the standard working conditions and patients' safety.

We are also determined to work closely with all parties concerned if asked to do so, towards the resolution of the pending conflict which has dispersed a majority of patients who were already living in a precarious situation before the escalation of peaceful protest into armed conflict.