Conceptual Framework for the Adoption of Innovative Health Technologies In Response to Health Emergencies

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Introduction: Rapid developments in healthcare technology can significantly improve the quality, availability, and immediacy of care in health emergency events; however, without a cohesive framework to conceptualize the interplay between emerging technologies, we risk creating silos, ignoring applications, and reducing interoperability between innovations.
Method: This framework was developed after reviewing the current literature regarding new technologies in healthcare assessment and delivery, discussing relevant innovations with experts, and analyzing global market trends in emerging health technology capabilities.
Results: Innovative health technologies deployed in disaster settings can be grouped by their relevance to (1) Disease and Injury Surveillance and Detection, (2) Population Protection, (3) Responder Protection, and (4) Disease and Injury Management. The first category encompasses technologies that help characterize the severity and scope of an event at its onset, utilizing a network of wearable devices, sensors, remote infectious disease sampling, and other tools. Once an incident occurs, technologies aimed at Population Protection are necessary to preserve the well-being of unaffected citizens. Scaled-up on-demand manufacturing for prophylactic medical countermeasures and needle-free delivery mechanisms for pre-treatments against CBRN threats will be paramount. Healthcare and emergency responders require additional support before and during incident response, especially just-in-time training through virtual and augmented reality, biometric monitoring, next-generation personal protective equipment, and enhanced communications capabilities. Finally, delivering care to patients in healthcare emergencies will require optimized allocation of scarce resources based upon acuity and survivability. Effective healthcare service delivery can be bolstered using Telehealth, autonomous patient transport, drone delivery, robotic and haptically guided care delivery, and decision support tools.
Conclusion: To effectively manage the successful adoption and implementation of innovative tools applicable to health emergencies, areas of impact and utility should be comprehensively categorized. This framework guides emergency managers, policymakers, and innovators alike to understand how individual developments coalesce in the larger context of disaster prevention, response, and recovery.

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Development of a Logistics System for Disaster Medical Container Operations Using Drones and GIS

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Introduction: To quickly operate a temporary hospital using disaster medical containers in the event of a large-scale disaster, dozens of large trailers must be quickly brought to the disaster site. This study aims to establish a logistic system for transporting and installing containers using drones and GIS.
Method: By linking drones and GIS, a theoretical model was created to quickly determine routes and installation sites for large trailers transporting medical containers from candidate routes simulated in advance by taking into account hazard maps and road conditions.
Results: Using this system, it is possible to

(1) Establish whether the roads planned to be passed through are passable.

By narrowing down candidate routes through preliminary simulations that overlay hazard maps and roads that are passable for large trailers, it is possible to narrow down the routes that need to be confirmed. Immediately after a disaster, a drone can be used to confirm road damage, flooding, landslides, etc., and map them on the GIS to determine the extent to which they are passable.

(2) Identify locations that take into account demand and safety.

Locations that are close to the disaster area, safe, and in demand for medical care can be determined and identified based on the population mesh and the damage situation.
Conclusion: GIS and drones have a high affinity and are used in various ways. However, there is still no linkage between GIS and drones adapted to medical care and logistics at disaster sites in Japan. This system is indispensable to comprehensively determine the safety and demand of roads and installation sites.

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Effects of an Early Detection System for Barotrauma During Hyperbaric Oxygen Therapy

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Introduction: Although hyperbaric oxygen therapy is required in disasters or emergency situations, barotrauma, which is the most common complication, continues to occur. If barotrauma occurs during hyperbaric oxygen treatment, treatment is stopped, and there is no proper preventive method for this. Therefore, the authors evaluated the degree of barotrauma prevention by applying a tympanometry-based anti-barotrauma device (ABT).
Method: The candidates of the clinical trial are adults between the ages of 18 and 65 who correspond to academic indications for hyperbaric oxygen therapy. In a prospective parallel design, the candidates were placed in the test group and control group. Simple randomization and one-sided blinding were applied. The medical staff directly observed the severity of middle ear barotrauma through a video otoscope. The number of treatment interruptions and completions along with findings from the otoscope observation (Grade 0~5) such as level of ear pain (pain scale value) were collected at three university hospitals.

Results: When ABT was applied, it was possible to prevent barotrauma earlier than the traditional medical observation. However, since the application of ABT requires the patient's voluntary cooperation, it is difficult to prevent barotrauma if a patient has reduced consciousness or is unable to follow the instructions of the medical staff.
Conclusion: Applying ABT is an appropriate method for early detection of barotrauma. However, in order to be applicable to patients with reduced consciousness or difficulty in cooperation, an automatic intrinsic pressure reduction system should be developed.

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Machine Learning Prediction for Supplemental Oxygen Requirement in Patients with COVID-19

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Introduction: The coronavirus disease (COVID-19) poses an urgent threat to global public health and is characterized by rapid disease progression even in mild cases. In this study, we investigated whether machine learning can be used to predict which patients will have a deteriorated condition and require oxygenation in asymptomatic or mild cases of COVID-19.
Method: This single-center, retrospective, observational study included COVID-19 patients admitted to the hospital from February 1, 2020, to May 31, 2020, and who were either asymptomatic or presented with mild symptoms and did not require oxygen support on admission. Data on patient characteristics and vital signs were collected upon admission. We used seven machine learning algorithms, assessed their capability to predict exacerbation, and analyzed important influencing features using the best algorithm.
Results: In total, 210 patients were included in the study. Among them, 43 (19%) required oxygen therapy. Of all the models, the logistic regression model had the highest accuracy and precision. Logistic regression analysis showed that the model had an accuracy of 0.900, precision of 0.893, and recall of 0.605. The most important parameter for predictive capability was SpO2, followed by age, respiratory rate, and systolic blood pressure.
Conclusion: In this study, we developed a machine learning model that can be used as a triage tool by clinicians to detect high-risk patients and disease progression earlier. Prospective validation studies are needed to verify the application of the tool in clinical practice.

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An Innovative Mobile Hospital for the Management of a Massive Flow of Victims.

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Introduction: In order to deal with disastrous situations needing massive healthcare support, a new tool, financed by FEDER European funds (Interreg POCTEFA program) has been designed: the multipurpose mobile hospital Europe Occitanie (UMPEO). It is a projectable, foldable, versatile and autonomous truck with an interchangeable function from advanced medical post to operational command center, for acute events involving mass gathering or during multiple victims disasters. This study aims to show the usefulness of this structure during the COVID-19 health crisis.
Method: The UMPEO is a shelter deployable in an emergency ward or intensive care unit, mobilizable in one hour, projectable by truck and autonomous for the first two hours. A descriptive, transversal, European study was carried out to describe its use in the cross-border countries of the Pyrenees (France, Spain and Andorra). When applicable, demographic data were gathered and/or a satisfaction questionnaire was given to the caregivers involved.
Results: Between September 8, 2020 andFebruary 25, 2021, UMPEO was mobilized as a COVID-19 testing center, emergency department, vaccination center or as a command center at a political summit. Thus, 1322 screening tests were carried out over the screening three weeks deployment and 91% of the volunteers considered the screening operation useful. Used as a hospitalization ward, UMPEO was able to accommodate 266 patients over a period of four weeks. Eight hundred people were able to benefit from two doses of vaccines during the six weeks of the mobile vaccination campaign.
Conclusion: This tool, initially designed to be used in the event of a catastrophic event of an accidental or terrorist type or as a help station during mass gathering, has been diverted without any modification of its structure to meet the challenges of the global health crisis and provide a solution adapted to the population of countries bordering the Pyrenees.

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