

Taiwan's experience in managing COVID-19 and the impact on medical students: an ounce of prevention is worth a pound of cure

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Abstract

In the past several months, the globe was overwhelmed by the novel coronavirus (COVID-19) pandemic. As rising number of documented cases and mortality toll continued to be reported, it is imperative to reexamine the current healthcare system as well as consider the repercussion on medical society. The condition in Taiwan, although expected critical regarding close intertwine with epicenter, was relatively stable thus far given multiple efforts paid, suggesting the experiences here may serve as a reference for other countries. The aim of this article was to illustrate the aggravation of COVID-19 status and how Taiwan corresponded to the crisis. First, national team production and name-based allocation, followed by map-directed and online pre-order system, ensured the public to obtain enough surgical masks. Second, constant advocacy of the quarantine policies and personal hygiene, in conjunction with regular press conference by officials, accomplished message transparency and citizens' literacy upon the situation. Third, establishment of the traffic control bundle successfully antagonized nosocomial infection and prevented subsequent clusters. Forth, biomedical research not only propelled the elucidation of the COVID-19 pathogenesis but also facilitated the development of potential medications. Furthermore, the impact on medical education was delineated. Reorganization of training curriculum, distance learning, and the practice of virtual meeting reshaped the landscape of clinical training. In conclusion, through conscientious appraisal on how we confronted COVID-19 will the community be better prepared for the next pandemic.

Key words: *COVID-19, pandemic, Taiwan, public health, medical student, Asian Medical Student Association.*

Introduction

In December 2019, a cluster of cases sustaining pneumonia of unknown causes occurred in Wuhan, Hubei province, Mainland China¹. These patients were characterized by their shared exposure to venison and raw seafood. Although local government fleetly lockdown the Huanan wholesale market and further sanitized such area, the outbreak of a novel coronavirus became inevitable². After sequencing the viral genome, the culprit pathogen was demonstrated to harbor similar yet not identical genetic landscape with either severe acute respiratory syndrome coronavirus (SARS-CoV) or Middle East Respiratory Syndrome (MERS-CoV)³. Domestic patient count skyrocketing, China filed the first mortality report, a 61-year-old gentleman, on January 11th, 2020, followed by the summary of clinical vignettes among those firstly affected as well as epidemiological statistics⁴. Thailand also diagnosed the premier case of the novel coronavirus on January 13th, 2020. World Health Organization (WHO) eventually declared “*Public Health Emergency of Global Concern*” on January 30th, 2020, and later officially named the disease COVID-19⁵. On March 12th, 2020, COVID-19 was recognized as pandemic⁶, and human-to-human transmission was affirmed⁷.

Over the next two months, due to airline travel, cruise trip, and cargo transportation, the total diagnosed cases of COVID-19 reached a quarter million, with more than 13,000 affected individuals unfortunately expired at the end of March 2020. Despite the fact that vast majority of the deceased were the elderly, obese, with smoking history, immunocompromised, or

with significant cardiopulmonary underlying illness⁸, a great quantity of middle-aged citizens who contributed to the central working power were designated as probable or certain cases and thereby obligated for 14-day isolation. Conjunctionally, city was blocked, migration ceased, boutique closed, and society distanced. The pandemic gradually teared the global village apart. The aim of this article is both to revisit the policies administered in Taiwan and further to illustrate the impact on medical students both upon curriculum arrangement and clinical participation.

Condition in Taiwan

On Taiwanese perspective, considering the geographic proximity to the initial epicenter of COVID-19 as well as previous experience of managing SARS-CoV⁹, vigilance arose in both public and private sectors at the very beginning, followed by aggressive actions to curb the COVID-19 spreading in a timely manner (**Table 1**). Political factor aside, our government implemented rigorous measures to restrict the pouring of citizens from across the strait, attempting to withhold the infection. Till now, the performance of Taiwan Central Epidemic Command Center (CECC) was above average and well-recognized by international society. The climb of cumulative cases has yet beyond control (**Fig. 1**) and the total number was among the fewest in Asian Medical Student Association chapters (**Fig. 2**). Minimal community spread and least nosocomial contagion bought our medical facilities and logistic industries more time to expand hospital capacity and avoid society breakdown. The aim of this review is to summarize the policies by Taiwanese government for apprehension of COVID-19 and illustrate the impact upon medical students (**Fig. 3**).

Figure 1. Timeline of policies implemented by Taiwan government (until March, 2020).



Figure 2. Statistics of confirmed cases and mortality tolls among 17 Asian Medical Student Association (AMSA) chapters (until 12th week of 2020).

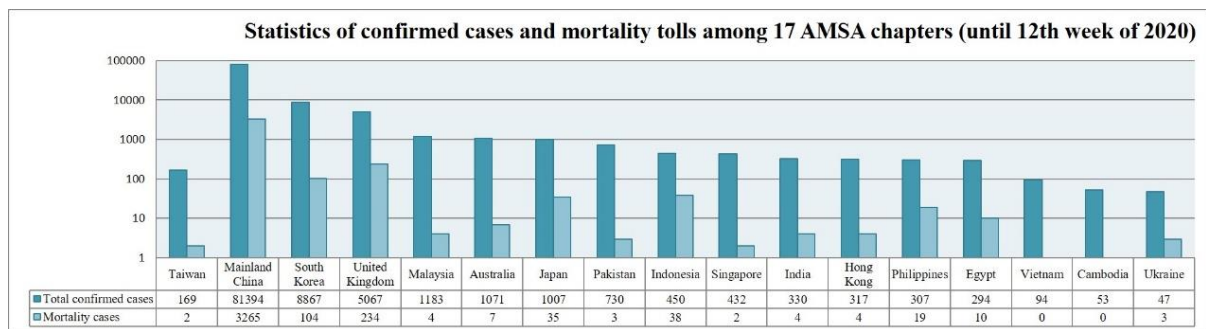
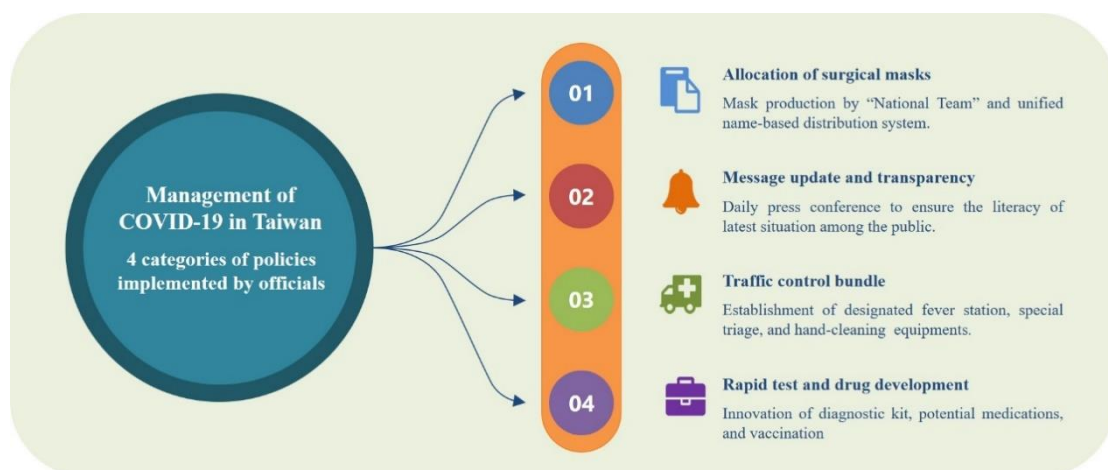


Figure 3. Graphic summary of COVID-19 management in Taiwan.



Allocation of surgical mask

Maintaining adequate number of surgical masks both augmented the blockade of infection and carried implication to

stabilize public sentiment. Because of infectious meningitis in Tainan around 1920s and SARS nationwide in 2003, Taiwanese culture is traditionally compatible with the donning of masks even in usual times. Before the COVID-19 outbreak, daily production of mask in Taiwan was 1.88 million

pieces on average. To guarantee adequate domiciliary reserves, President of Executive Yuan forbade the export of surgical mask, albeit controversies over ethical consideration from opposition parties, on January 24th, 2020. Additionally, multiple giant enterprises, including Foxconn, Hiwin Technologies, and Taiwan Takisawa Company, *etc*, volunteered to join the “national team”, expediting the industrial manufacture. Influx of soldiers’ assistance, lucrative funding up to 180 million new Taiwanese dollars (NTD) (*5.95 million US dollars*) for expropriated factory, and 24/7 shift accelerated the assembly line. Until middle March, 13 million adult masks plus 5.5 million pediatric masks were provided per day.

To track the circulation of goods, on January 31st, 2020, CECC issued for unified allocation of surgical masks by central government¹⁰. Setting the price at 7 NTD per piece and restricted to purchase at most three pieces per day per person, a panic-buying spree, nonetheless, ensued. In response, 6 days later the mask rationing plan was executed. Citizens were requested to present their National Health Insurance card at contracted pharmacies or any 220 township public health centers around the island before one could acclaim the weekly ration thereof. However, due to the differences in population density and urban-rural gap, a considerable amount of time was spent on queueing for limited products in certain area, whereas other stores still housed abundant masks at stock. Correspondingly, Minister of State without Portfolio designed Taiwan Mask Map to direct people toward appropriate emporium in real-time via global positioning system. Furthermore, on March 12th, 2020, refined mask distribution system commenced. Incorporating internet network and logistic business, residents could pre-order surgical masks via eMASK application online and received the merchandise about one week later at local convenience stores (ibon, FamiPort, Life-ET, OK Go). These policies

together accomplished both steady and fair supply of surgical masks in the society.

Message update and transparency

Risk and outbreak communication was gradually instituted in the post-SARS era¹¹. Since the first several patients of COVID-19 were reported in the island, CECC has been holding press conference regularly, if not daily, to update the citizens on the statistics of new documented cases and advocating the prophylactic measures on disease control in additional to strengthening personal hygiene. Medias were free to raise any relevant questions, which would be answered by the professional panel directly and simultaneously be broadcasted nationwide. In addition, the authority filmed a sequence of brief television advertisements with doctors at local clinic, celebrities, Dean of medical college, and the vice president Professor Chien-Jen Chen. The purpose of these clips was to underscore different aspects of the preventive program, including the correct procedure of hand washing, proper timing to wear surgical mask, appropriate way to cleanse the environment, and urging the public to replace hatred with support toward the quarantined individuals.

Besides, to endorse the accurate streaming of information and to subdue fictitious message, the executive officials on February 25th, 2020, promptly passed 《Prevention and Bailout for Infectious Pneumonia Special Act》. Those who either fabricated or disseminated any rumors on purpose would be fined at the maximum of 3 million NTD or be sentenced up to 3 years in prison. Meanwhile, National Communications Commission ordered the social network website to delete false comments on COVID-19 and block the culprit IP address, if necessary, so as to aware users of the authentic situation. Securing the openness and transparency of the COVID-19 updates

Table 1. Timeline of policies implemented by Taiwan government (until March, 2020).

Date (2020)	Policy	Purpose
January 20 th	Found CECC*	For unified command
January 24 th	Prohibit mask export	To ensure sufficient supply
January 31 st	Unified mask allocation	For fair distribution
February 6 th	Mask rationing plan	To achieve general allocation
February 6 th	Postpone hospital accreditation	To advocate for concentration on disease control
February 20 th	Homemade Remdesivir ready	To facilitate pharmaceutical development
February 23 rd	Ban medical personnel from traveling abroad [†]	To affirm adequate manpower
February 25 th	Special Act legislation	To punish fictitious news and budget industry bailout
February 29 th	Demand medical students to temporarily leave X hospital [‡]	To avoid further nosocomial infection
March 12 th	Name-based mask distribution system 2.0	Online mask pre-order
March 17 th	Prohibit teachers & students from traveling abroad [†]	For prevention of in-campus transmission
March 20 th	Raise global travel advisory to Level III [§] ,	To discourage cross-border migration

*CECC: Central Epidemic Command Center. [†]Unless otherwise approved. [‡]X was used due to anonymity. [§]Must avoid all unnecessary travels.

paved the way for the establishment of citizen-governor trust as well as the diminishment of widespread restlessness.

Traffic control bundle

From the beginning of the COVID-19 epidemic, CECC conjointly with Ministry of Foreign Affairs and Mainland Affairs Council together determined travel advisory alert of other countries based on their

respective condition. According to Taiwan legislation, Level I exercises normal precautions and no specific requirement for incoming travelers is necessitated. Level II calls for reinforced safeguarding and all arriving travels from these countries were subject to self-health management for 2 weeks. Level III exhorts the nationals to cancel all nonessential travels. Otherwise, 14 days of home quarantine must be observed upon returning. Until March 20th, 2020, CECC had raised travel alert to Level III on all countries universally in order to

consolidate plausible supervision. Plus, foreigners have been restricted from entering the island. Each airport in Taiwan was equipped with infrared laser thermometer to routinely and rigorously assess body temperature of all incoming traveler at border for years¹², which also helped identifying potential spreader of COVID-19 at the earliest possible timing. Upon entrance, the contact phone number, however time-consuming, would be rechecked by officials. On the other hand, toll-free hotline “1922” for disease reporting and consultation commenced operation since 2003. Most calls inquired for influenza vaccine, measles, tuberculosis, and acquired immunodeficiency disease before the COVID-19. Now “1922” was primarily responsible for the coordination of medical assistance toward those affected travelers. Comprehensive actions on the prevention of communicating disease have been carried out at the border.

Besides, meticulous circulation planning was performed in hospitals. Since SARS-CoV epidemic in Taiwan, Yen *et al* introduced traffic control bundle (TCB), aiming to distinguish clean from contaminated individuals and items¹³ (*to reviewer: Duplication of the message from the cited reference might be redundant here*). In addition to personal protective equipment (PPE), negative pressure isolation room, and barrier nursing station¹⁴, TCB was proven to be a prerequisite element for overcoming this unprecedented crisis. At designated fever station outside emergency department entrance, febrile subjects were specially triaged and completely separated from other patients as well as healthcare workers. Transition area was created at the waiting zone among individuals with different risk of infection¹⁵. Increased number of hand-washing facilities (*i.e.* faucets or checkpoint alcohol dispensers) was also set up, and zone of risk between contaminated or clean were unequivocally defined. By TCB, likelihood of nosocomial infection rate significantly declined during SARS, MERS, and Ebola outbreak^{16,17}. Incidence

of ventilator associated pneumonia and central line infection in intensive care unit was also significantly reduced^{18,19}. Recently, enhanced TCB approach was introduced. With expanded buffer zone, quarantine ward for the accommodation of patients with atypical symptoms, and fortified PPE, Taiwan effectively impede the transmission cycle to date²⁰. Hospital capacity (over 1000 negative pressure isolation room, currently 70% full) was still ample for contemporary condition. These experiences were instructive for our country to manage COVID-19 and provided a feasible protocol for rest of the world to consider.

Biomedical and pharmaceutical preparedness

Taiwan is renowned for its aptitude in biomedical research and pharmaceutical development. Technique of reverse transcription polymerase chain reaction to inspect the presence of COVID-19 was readily available in the island, and simple kit for rapid diagnostic test was collectively established by Academic Sinica (AS), with United States, European Union, and Czech Academy of Sciences. The goal to shorten the testing time down to 15 minutes was attempted. Although the apparatus was in place, the scope of individuals to be assessed varied from nation to nation. South Korea decided to undergo mass testing, although some argued that pronounced false negative rate might bring about mendacious sense of security in the public and thereby hampered further infection control. Conversely, Taiwan currently chose to permit testing only for those with upper respiratory symptoms or fever and had travel/exposure history, cluster event, otherwise untreatable pneumonia, or special occupation. *e.g.* medical staffs or workers in nursing facility, in accordance to the WHO interim guidance of COVID-19 surveillance²¹.

Pro tem, significant efforts have been devoted to appreciate the behavior of the novel coronavirus as well as to spot potential therapeutic target. The pathophysiology and transmission dynamics were reviewed elsewhere^{22,23,24,25}. A wide range of medications was repurposed for treating COVID-19²⁶. Specifically, the efficacy of favipiravir (T-705), Nitazoxanide, Nafamostat, and panciclovir were equivocal, whereas Remdesivir (GS-5734) and chloroquine were among the first to be proven effective *against* the novel coronavirus²⁷. Proudly, in two weeks AS synthesized homemade Remdesivir 100 mg with purity reaching 97% after crystallization. Further anecdotal reports and expert consensus shed light on the combined therapeutics with Hydroxychloroquine (600 mg QD) and Azithromycin (loading 500 mg QD on day 1, then maintained with 250 mg QD)²⁸. Future research would be needed to accurately discover a drug specific to COVID-19.

Influences on medical students

The COVID-19 pandemic is closely intertwined with medical students. On February 23rd, 2020, in spite of bitter dispute upon legitimacy, CECC firmly banned all medical practitioners (including doctors, nurses, pharmacists, physical therapists, occupational therapists, laboratory technicians, nutritionists, *etc*) from travelling abroad unless otherwise approved²⁹ so as to warrant sufficient medical labor. Hospital accreditation was also adjourned for 1 year. Additionally, as escalating number of cases confirmed, with some of which among personnel inside campus, New Taipei City government, followed by CECC, announced travel constraint upon whole teachers and students in high school and under on March 17th, 2020^{29,30}. Elimination of global interactions was believed to be indispensable for combating the outbreak.

On the other side, fifth (clerkship) and sixth grade (sub-internship) of medical students in Taiwan are required to observe in the hospital. Since the first case of patient-nurse transmission of COVID-19 in X hospital on February 29th, 2020, the authority asked all medical trainees to return to their respective universities²⁹. Clinical apprentice was substituted with distance learning and virtual presentation. Other hospitals and medical universities were also concerned about nosocomial spreading, thereby disagreed any gathering with more than 100 people in enclosed environment or 250 people outside. Some gathered clerks and reallocated them to specific ward for minimizing contagious sources and better trace for the origin of nosocomial infection if present. Plus, morning meeting took place as video conferences, grand round put off, and seminars postponed. Eventually, Asian Medical Student Conference 2020 was also cancelled due to disease outbreak, and the Asian Medical Students' Exchange Program would not be resumed until next January³¹. These adaptive measurements are mandatory in this unprecedented situation, whilst might also change the mode of medical education both for now and even for the upcoming future.

As a matter of fact, alteration in the form of physician cultivation usually came after a major health crisis by which the suboptimal aspects of capacity building were illuminated. For instance, after 2003 SARS-CoV outbreak in Taiwan, it was notable that the general medical training was rather insufficient. After the pandemic subsided, Ministry of Health and Welfare at that time drafted the "post graduate year (PGY) doctor" proposal before residency for naïve licensed personnel^{32,33}. The purposes were to solidify the knowledge on the independent management of general diseases and to compensate for the consequences of premature specification in career planning³⁴. In 2019, the training length of PGY program was extended from a year

to two. Currently, the officials are considering further reformation of the present agenda, such as curriculum rearrangement to add in more training on public health and infection control. It is foreseeable that the medical education would remain dynamic and echo the clinical demand.

Future perspective

The evolution of COVID-19 pandemic is rapid, and it is still enigmatic when the crisis will regress. As Ms. President Ing-Wen Tsai of Taiwan addressed that “we are in the same boat³⁵,” multi-disciplinary involvement became vital to tackle the situation. Medical schools and teaching hospitals in the island cooperated to develop vaccination, novel medications, as well as intellectual platform to monitor the clinical conditions of individuals under quarantine, track exposure history, and automatically issue corresponding alert. Besides, shortcoming of the present healthcare system and medical training curriculum will be reviewed after this emergent condition to better prepare for future disease outbreak. We also learned the conundrum that during critical time, admeasurement of scarce medical apparatus such as ventilator could be a heart-breaking challenge³⁶. Strengthening the public health system is an urgent necessity³⁷. Incorporation of the artificial intelligence and big data library for future infection control, epidemiological statistics, and to realize individualized therapeutic arrangement, albeit still in its infancy, enlightened a new avenue to advance our medical capacity and capability.

Conclusion

The global impact of COVID-19 tsunami is profound. Confirmed cases exceeded medical capacities in several coun-

tries, and death toll continued to accumulate. Thus far, the outbreak in Taiwan was fortunately amendable, and the measures authority put in action could be reproducible should future public health crisis be encountered (Figure 3). Allocation system of surgical mask distribution, transparency of present-day information, traffic control bundle inside the hospital, and pharmaceutical logistics are the cornerstones to overcome the pandemic. Transformation of medical training and the influence on medical students were also approached. Lesson learned in this human tragedy is devastated, but it will eventually enhance our public health scheme and medical competence.

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Conflict of Interest

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