

COVID-19 Research Led by HSSR

Background

COVID-19 first emerged in November 2019 in the city of Wuhan, Hubei province, China and has spread rapidly in multiple countries worldwide. On 11th March 2020, the World Health Organization declared the COVID-19 outbreak a pandemic, in light of the alarming levels of spread throughout the world.

In Singapore, the first case of COVID-19 was confirmed on 23rd January 2020. On 7th February, the Singapore Government escalated the national Disease Outbreak Response System Condition (DORSCON) to orange.

To inform current and future policy decisions locally and even globally, our faculty in the Programme in Health Services & Systems Research (HSSR) is leading research projects on the COVID-19 disease outbreak through multiple dimensions.

Health System-Wide Modelling of COVID-19 Outbreak in Singapore

Lead PI: Professor Marcus ONG



As the COVID-19 outbreak unfolds, it will lead to health system-wide consequences. These can be direct consequences experienced by COVID-19 patients; and indirect ones faced by non-COVID-19 patients due to downstream effects of policy responses, particularly due to re-prioritization of existing services and opportunity costs.

Therefore, our overall goal is to minimize the impact of the evolving COVID-19 disease outbreak on Singapore health systems' outcomes by advising policy through whole-system modelling using existing data and novel modelling methods leading to measured policy responses.

Building upon local data, preliminary studies and prior experience of the investigators, we have set three specific aims: 1) Build computer simulation models to: 1a) evaluate impact of policies on health systems estimating overall mortality, morbidity and service utilization; 1b) understand high infectious disease dynamics at higher resolution for more precise policy decisions. 2) Assess actual health services utilization attributable to COVID-19 and non-COVID-19 conditions through analysing disease registries. Qualitative data from patients and other stakeholders will enrich this data. Costs of care will also be assessed capitalizing on routine data sources. 3) Evaluate policy experiments, through conventional and probabilistic sensitivity analyses in three potential scenarios i.e. 3a) COVID-19 remains under control; 3b) difficult to control with local clusters and 3c) full-blown local epidemic.

Work Stream 1: The Effectiveness of Public Health Interventions against COVID-19: Lessons from the Singapore Experience

Work Stream Leads: Professor David Bruce MATCHAR and Assistant Professor John P. ANSAH



In dealing with community spread of COVID-19, three active interventions have been attempted or advocated i.e. containment, mitigation, and uninhibited spread (herd immunity). Given the exponential growth in the number of COVID-19 cases globally, there are international interests to learn from best practices that have shown to work in controlling community spread.

We conducted a counterfactual analysis, using the case of Singapore, which was initially relatively successful in suppressing community spread of COVID-19, to expose what the trajectory of COVID-19 infection might have been in Singapore had the government not focused on containment, rather on mitigation or uninhibited spread. In addition, the impact of the specific scenarios on return to normalcy were explored. We developed a model to estimate the number of COVID-19 infection cases and deaths in Singapore, under different public health interventions compared to the containment interventions implemented in Singapore.

Our studies showed that early public health measures in the context of targeted, aggressive containment e.g. swift and effective contact tracing and quarantine was likely responsible for suppressing the number of COVID-19 infections in Singapore.

Work Stream 2: Healthcare Resource Planning Model for COVID-19

Work Stream Lead: Assistant Professor Sean LAM



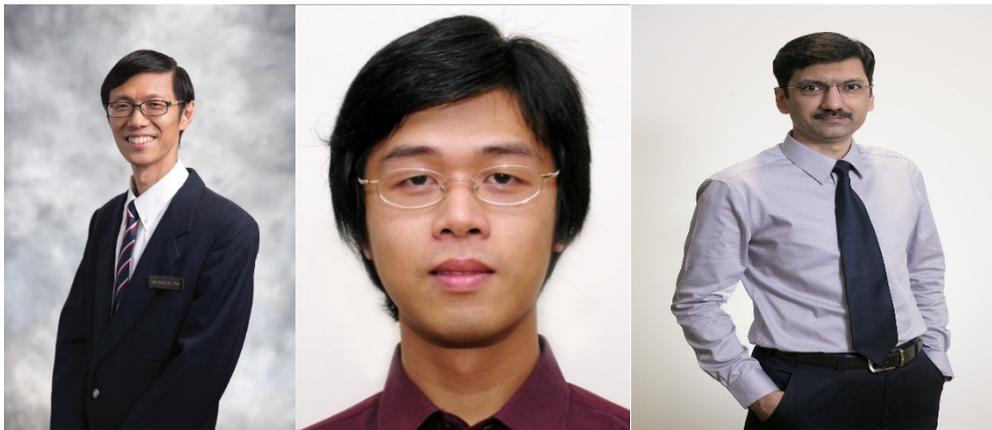
In a fast evolving COVID-19 pandemic situation with many unknowns, the demand projections for healthcare resources are fraught with uncertainties, particularly when potential hotspots cannot be identified *a priori* to guide resource modelling efforts. Such was the case in Singapore as most of the earlier demand projections were based on importation and secondary local transmission models in the community. Despite the proliferation of such demand projections with robust sensitivity analysis, there is a need to develop rapid resource planning models that can efficiently take into consideration the dynamic evolution of new outbreaks that are often less predictable in the initial phases. Mathematical modeling and simulation captures both the behavior of the system (dynamic complexity) and structure (causal relationship) in a cost-effective virtualized platform. This study aims to develop a fast deployable

and adaptable dynamic simulation model that can describe the response that health systems should embrace in consideration of the dynamic evolution of the COVID-19 pandemic. The model will enable the estimation of healthcare resources needed to deal with rapidly evolving outbreak scenarios as it

allows for the fast adaptation of new structural and behavioral assumptions on both the demand and supply scenarios. Alternative demand scenarios, either due to unexpected resurgence for COVID-19 or future pandemics, can be readily integrated and alternative policy interventions can be rigorously evaluated to guide healthcare resource management.

Work Stream 3: Impact of COVID-19 Outbreak on the Workflow of Emergency Department and Patient Outcomes

Work Stream Leads: Professor Marcus ONG, Associate Professor LIU Nan and Assistant Professor Fahad SIDDIQUI



The COVID-19 pandemic exerted major constraints to provide quality care, particularly to those requiring urgent care in the Emergency Department (ED). All the routine processes in the ED have been affected due to the activation of infection control measures. Consequently, the chain of care in the hospital was slowed down leading to longer waiting times, an extended stay in ED, and beyond. A shortage of ED, intensive care unit (ICU), and inpatient beds, for the patients requiring inpatient care of various levels, was experienced. In Work Stream 3, we will examine, in detail, the impact of COVID-19 on ED workflow and investigate the delays in healthcare provision and their impact on health outcomes at ED, by comparing the data of pre-COVID-19 and COVID-19 periods. The insights obtained from our research will aid in the redesigning of the ED workflow, enabling it to rapidly adapt to an outbreak scenario. This adaptability will contribute towards the continued provision of need-appropriate quality care to patients even during an outbreak. Moreover, our results, obtained through analyses and modelling, will provide critical information to support other Work Streams in the project.

Work Stream 4: Understanding the Impact of COVID-19 Pandemic on Healthcare Utilization, Health Outcomes and Unmet Needs in Medically Vulnerable Patients: A Mixed-Methods Study

Work Stream Leads: Assistant Professor Sungwon YOON, Associate Professor Angelique CHAN and Assistant Professor Rahul MALHOTRA



The COVID-19 pandemic has placed a tremendous strain on healthcare system in Singapore. As the pandemic continues to evolve, hospitals have postponed routine elective services and reduced healthcare

workforce attending to non-COVID-19 related needs. This may make it difficult to maintain continuity in the provision of healthcare to medically vulnerable population such as chronically ill patients and functionally impaired older adults. It is therefore vital to address the needs of medically vulnerable population to mitigate potential undesirable outcomes and prevent exacerbation of existing morbidity.

This study aims to understand the impact of COVID-19 pandemic on healthcare utilisation and health outcomes in medically vulnerable patients and their unmet needs through multi-stakeholder interviews and questionnaire. Participants will be recruited from Singapore General Hospital, the Transitions in Health, Employment, Social engagement and Inter-Generational transfers in Singapore Study (THE SIGNS Study) cohort and other relevant healthcare and government institutions. Findings will inform the evaluation of current policies and strategies to optimise and improve healthcare delivery, patient outcomes and population health in the current COVID-19 pandemic and for future public health emergencies.

Work Stream 5: Economic Impact of COVID-19 on a Tertiary Singapore Hospital

Work Stream Leads: Professor Nicholas GRAVES and Assistant Professor Elaine LUM



In response to the DORSCON escalation, severe measures were implemented in Singapore General Hospital, the largest public acute-care hospital in Singapore, commensurate with similar strong responses in other hospitals in Singapore. These included changes to general infection control practices, special measures for the treatment of suspected and infected cases, staff surveillance, self-declaration and screening protocols, and business contingency measures such as management of beds and elective admissions,

working in split teams, and restriction of staff leave and travel.

Prevention measures for an outbreak comes with a price to the hospitals, and developing accurate data on the cost of an outbreak is difficult. Attempts to count the cost need to account for not only actual expenditures on additional supplies and labour, but also opportunity costs from missed revenue due to ward closure, cancelled elective appointments and loss of man-hours. The study objective is to accurately quantify the associated economic costs to hospitals and health services so that the current policy response can be evaluated and potentially improved in the short term. The information generated will help to guide policy responses for future outbreaks in Singapore and internationally.

Citizens' Compliance Behaviours to COVID-19 Preventive Measures in Singapore

Lead PI: Assistant Professor Semra OZDEMIR

Co-I: Professor Eric Andrew FINKELSTEIN



The containment of the current COVID-19 pandemic is largely dependent on the support and compliance of citizens to the preventative measures that their governments recommend and implement. Measures could be informal, such as frequent hand-washing, or mandated, such as social distancing. To identify factors associated with uptake of COVID-19 preventive behaviours, we surveyed 1,000 individuals from the general population on which strategies they have adopted and their perceptions of the COVID-19 pandemic in Singapore. We hypothesise that adoption

of preventive behaviours increases in tandem with higher perceived levels of COVID-19 risk and perceived effectiveness of a strategy. Our study also looks at the public support for policies that are deployed by the government in the face of outbreaks of varying severity. We designed hypothetical outbreak scenarios varying in the extent of infectiousness, morbidity and fatality, then provided a list of policies that were increasingly restrictive. Participants were asked to choose which policies they supported under each outbreak scenario. Our hypothesis is that support for prevention policies will be greater as per each disease's infectiousness and fatality rate, and that support for more restrictive policies will increase with the severity of the outbreak.

Psychological Impact of the COVID-19 Pandemic in Singapore

Lead PI: Professor Ecosse LAMOUREUX



Locally, Professor Lamoureux is the PI of the population-based study investigating the knowledge, attitude, and practice about COVID-19 and the circuit breaker response; and the associated personal, psychological, and economic impact in elderly Singaporeans of varying socioeconomic status [R1714/37/2020]. Internationally, Prof Lamoureux collaborated on a cluster RCT evaluating the effectiveness of a peer-to-peer live streaming social media intervention that encourages regular physical activity and relaxation of accommodation (near focusing) on anxiety syndrome and digital eye strain among children during the COVID-19 home schooling period in the Guangdong Province, Southern China [NCT04309097]. This paper is now being considered for publication in the Lancet journal.

Lead PI: Assistant Professor Sharon Cohan SUNG



Assistant Professor Sharon Sung is involved in several collaborative projects related to the psychological impact of the COVID-19 pandemic, including a randomised controlled trial of an online resilience training intervention to prevent depression and posttraumatic stress among paramedics working during the outbreak. Paramedics working on the frontlines are one of the most important emergency response resources to effectively manage the spread of the COVID-19 virus. However, frontline emergency workers are regularly exposed to high stress working conditions, which increases their risk for developing stress-related problems such as depression, anxiety, and post-traumatic stress disorder. These can negatively impact their overall well-being and reduce the effectiveness of response to the current pandemic. In order to better

support our paramedics in coping with the COVID-19 outbreak, it is essential to provide them with timely support to enhance resilience and to prevent negative stress-related outcomes. A new internet-delivered resilience training programme specifically designed for use with paramedics may be helpful for those working during the COVID-19 epidemic in Singapore. Asst Prof Sung and team are conducting a randomised controlled trial to examine the impact of the resilience training programme compared to an existing package of online educational materials. The primary efficacy outcome will be severity of depression symptoms. Secondary outcomes will be posttraumatic stress, resilience, anxiety, general psychological distress, burnout, work engagement, and health-related quality of life. Economic outcomes will be the cost and incremental cost effectiveness of the resilience training programme. Outcomes will be assessed after the intervention period and at 6-month follow-up. If successful, this trial will be the first to demonstrate the effectiveness of a low-cost resilience training programme for paramedics working under epidemic conditions that can be easily adapted for future disease outbreaks and other frontline healthcare workers.

Lead PI: Assistant Professor Sungwon YOON

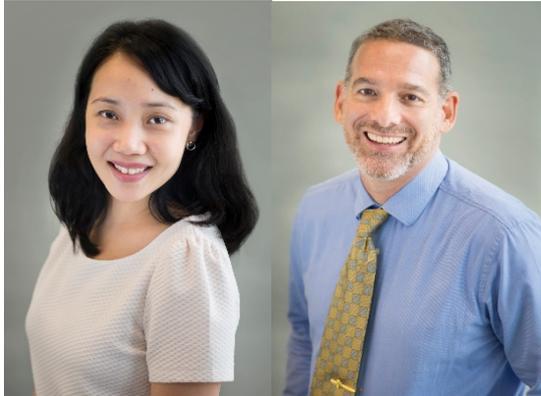


In Singapore, with the increasing number of confirmed COVID-19 cases, public healthcare systems have been stretched to the maximum and this often comes at a hidden cost to the resilience and morale of front-line healthcare workers. These healthcare workers are among the most vulnerable to infection and are at an exceptionally high risk for being stigmatised. Although psychoeducation programmes have been implemented, they are primarily based on a one-off involvement without much consideration given to ongoing monitoring, evaluation and impact assessment. This study aims to assess the experience of and needs for psychosocial support among front-line healthcare workers involved in the response to the COVID-19 pandemic in Singapore. The study will generate valuable data that can inform the

development of a personalised and adaptive mobile application with features that mitigate burnout and acute stress and promote adaptation to a public health emergency.

Lead PI: Assistant Professor Irene TEO

Co-I: Professor Eric Andrew FINKELSTEIN



The COVID-19 pandemic has brought unprecedented challenges to healthcare workers worldwide. Past experiences of disease outbreaks in Singapore and the literature indicate that healthcare workers report signs of psychological morbidity during and in the aftermath of the crises. These include high levels of burnout, anxiety, depression and stress reactions. Given the expected long-term nature of the COVID-19 effects, the psychological health of healthcare workers will be important to continually assess and monitor. Dr. Irene Teo, Clinical Psychologist and Assistant Professor in

HSSR, Duke-NUS, together with clinician PI Dr. Tan Hiang Khoon from Singapore General Hospital and the National Cancer Centre Singapore are leading a prospective study entitled, *Psychological Outcomes of Healthcare workers during the COVID-19 outbreak (POHS-C)* to follow healthcare workers within the SingHealth cluster. Doctors, nurses, allied health professionals, administrative and operations staff are invited to participate to examine changes in psychological morbidity and identify risk and protective factors. Participants complete online surveys every 4 weeks until Singapore returns to DORSCON green. This study is ongoing and over 1600 healthcare workers have signed up to date.

Lead PI: Professor Tazeen Hasan JAFAR



This is a systematic review among the general population, healthcare professionals, and high-risk patients. The project is led by a 2nd year Duke-NUS medical student Monica Palanichamy Kala and supervised by Prof Tazeen Jafar. We have registered our protocol online and aim to finish the project by 30th July, 2020. The results will provide solid evidence for identifying risk factors for the psychological impact of COVID-19 and help countries around the world to design and implement effective psychological interventions.

Impact of COVID-19 Outbreak on non-COVID-19 Patients/Vulnerables in Singapore

Lead PIs: Assistant Professor Rahul MALHOTRA



Family caregivers are a vulnerable population group, as they are already known to have worse health and healthcare seeking behaviour than non-caregivers. Asst Prof Malhotra is leveraging upon his ongoing longitudinal study, Caregiving Transitions among Family Caregivers of Elderly Singaporeans (TraCE), to collect data on how the COVID-19 epidemic in Singapore has affected the use of healthcare and intermediate- and long-term care (ILTC) services of the study participants (N=580). Specifically, he is assessing the impact of the COVID-19 epidemic on the use of healthcare services for chronic and acute health conditions among older adults with (or without) functional limitations and their primary family caregivers (or future caregivers), and

on the use of intermediate- and long-term care (ILTC) services (such as home care or day care) by older adults with functional limitations. The self-perceived change in health status or in care provision subsequent to any change in healthcare or ILTC use due to the COVID-19 epidemic is also being assessed.

Lead PI: Assistant Professor Chetna MALHOTRA

Co-I: Professor Eric Andrew FINKELSTEIN



COVID-19 has affected how patients with advanced serious illnesses such as cancer, heart failure and dementia, are experiencing their last year and months of life. These patients are not only at risk of experiencing high morbidity and mortality directly due to COVID-19, but also indirectly due to delays in seeking healthcare, social isolation and anxiety due to the COVID-19 outbreak. We are using data from three ongoing cohort studies at Lien Centre for Palliative Care with patients with advanced cancer (n=600), advanced heart failure (n=250) and advanced

dementia (n=185) to assess the impact of COVID-19 outbreak on healthcare seeking behaviours and end of life outcomes among patients, and the pathways that mediate these outcomes. Results will inform us about the direct and indirect, and negative and positive consequences of COVID-19 outbreak on end of life care outcomes in Singapore.

Lead PI: Professor Tazeen Hasan JAFAR



Professor Tazeen, Duke-NUS and Dr Terrence Kee, SGH are the Principal Investigators of this project, which aims to understand psychological impact, knowledge, attitudes, and emotional responses of kidney transplant recipients and their living kidney donors during the COVID-19 pandemic. Our results will generate important clinical and public health implications informing patient care and designing effective intervention programs for vulnerable patients.

COVID-19 Outbreak Overseas

Lead PIs: Associate Professor Bibhas CHAKRABORTY and Assistant Professor Palash GHOSH



In India, a huge country of about 1.3 billion people, the total number of confirmed COVID-19 cases surpassed 37,000 as of 3 May 2020, and is currently growing very fast. While the majority of prior research focused on the number of cases in the entire country, we chose to analyse data from each Indian state separately and make 30-day predictions, recognizing the enormous size and diversity of the country and hoping that state-wide predictions would help the state governments better channelize their limited healthcare resources. Since predictions from any

one model can potentially be misleading, we built three growth models, e.g. the logistic, the exponential, and the susceptible-infectious-susceptible (SIS) models, and finally developed a data-driven ensemble of predictions from various models using functions of the model-free maximum daily infection-rate (DIR) over the last two weeks (a measure of recent trend) as weights. We also jointly interpreted the results, and categorized the states as ‘severe’, ‘moderate’ or ‘controlled’. We found that, seven states (i.e. Maharashtra, Delhi, Gujarat, Madhya Pradesh, Andhra Pradesh, Uttar Pradesh and West Bengal) turned out to be in the severe category, which may be at least partially attributed to poor compliance to a nation-wide lock-down. These states need to immediately ramp up the preventive measures in order to combat the pandemic before it gets out of hand.