



PROGRAMME IN  
**HEALTH  
SERVICES &  
SYSTEMS  
RESEARCH**

# DIRECTOR'S MESSAGE

**W**elcome to the Programme in Health Service & Systems Research (HSSR).

Established in 2008, HSSR is one of the five founding signature research programmes in the Duke-NUS Medical School. It leads world-class health services research, education, and training for healthcare professionals, scientists, policy-makers, and students.

Our research focuses on the organization and delivery of health and social services in the context of an ageing population. It is undertaken to investigate whether services are effective, appropriate, scalable and economically sustainable. We work closely with multiple stakeholders including government, regional health systems, and social service organizations to facilitate and advance a holistic research agenda. In Singapore, we collaborate closely with Singapore Health Services, Ministry of Health, Ministry of Home Affairs, A\*STAR, and etc. Globally, we have undertaken research projects in Bangladesh, Cambodia, Vietnam, Indonesia, Sri Lanka, Thailand, and etc.

Besides cutting-edge research, HSSR faculty are highly engaged in education. HSSR offers PhD-IBM-HSSR Programme to groom graduate students to health services research professionals. Recently we developed a Graduate Certificate Programme in Health Services Innovation and will offer four graduate modules to healthcare professionals from October 2020 onwards. With this programme we seek to engage a new generation of disruptive innovators who will improve the performance of health services.

If you are interested in our research, education and training, please feel free to contact us.



Professor  
**Marcus ONG**  
*HSSR Programme Director*

## EDITORS

Dr Katherine Wang  
Mr Mohammad Faris Bin Mohd Ibrahim  
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**H**ealthcare providers globally and in Singapore are focusing on population-level health outcomes, value for money and integrating services across social, primary and acute sectors. While person-centred care will always be important, there is a need to demonstrate that high performing health systems are meeting the challenges of populations.

The Programme in Health Services & Systems Research (HSSR) in Duke-NUS Medical School has been a leader in the study of health systems and services for the population in Singapore and beyond. Key goals have been to show whether services are effective, appropriate, scalable and economically sustainable.

We facilitate and advance a multi-disciplinary research agenda by actively engaging the government, regional health systems and social service organizations. Our research methods include implementation science, health economics, decision science, survey/qualitative research, quantitative medicine, epidemiology, and data science.



## VISION

*To improve the performance of health systems for the population in Singapore and beyond through cutting-edge, pragmatic health services and systems research*

## MISSION

*Advance the state of the science in health services and systems research*

*Promote capacity for healthcare professionals to do and use health services research*

*Generate improvements in health outcomes and quality of life from new studies and the implementation of best practice*

*Promote the efficient use of healthcare resources*

*Provide education and training for health services professionals and academics in health services and systems research and related fields*

# PROGRAMME OVERVIEW

# COVID-19

# RESEARCH

**C** 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:

- evaluate impact of policies on health systems estimating overall mortality, morbidity and service utilization;
- 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.

- COVID-19 remains under control;
- difficult to control with local clusters and
- full-blown local epidemic.

## Work Stream 1

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

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 Leads:



Professor  
**David Bruce MATCHAR**



Assistant Professor  
**John P. ANSAH**

## Work Stream 2

### Healthcare Resource Planning Model for COVID-19

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 Lead:



Assistant Professor  
**Sean LAM**

### Work Stream 3

#### Impact of COVID-19 Outbreak on the Workflow of Emergency Department and Patient Outcomes

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 Leads:



Professor **Marcus ONG**



Associate Professor **LIU Nan**



Assistant Professor  
**Fahad SIDDIQUI**

### 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

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 Leads:



Assistant Professor  
**Sungwon YOON**



Associate Professor  
**Angelique CHAN**



Assistant Professor  
**Rahul MALHOTRA**

### Work Stream 5

#### Economic Impact of COVID-19 on a Tertiary Singapore Hospital

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.

Work Stream Leads:



Professor  
**Nicholas GRAVES**



Assistant Professor  
**Elaine LUM**

## CITIZENS' COMPLIANCE BEHAVIOURS TO COVID-19 PREVENTIVE MEASURES IN SINGAPORE

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.



Lead PI: Assistant Professor  
**Semra OZDEMIR**



Co-I: Professor  
**Eric Andrew FINKELSTEIN**

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  
**Sharon Cohan SUNG**

## PSYCHOLOGICAL IMPACT OF THE COVID-19 PANDEMIC IN SINGAPORE

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: Professor  
**Ecosse LAMOUREUX**

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  
**Sungwon YOON**

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:* Assistant Professor  
**Irene TEO**



*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:* Assistant Professor  
**Chetna MALHOTRA**



*Co-I:* Professor  
**Eric Andrew FINKELSTEIN**

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.



*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 programmes for vulnerable patients.



*Lead PI:* Professor  
**Tazeen Hasan JAFAR**

## IMPACT OF COVID-19 OUTBREAK ON NON-COVID-19 PATIENTS/VULNERABLES IN SINGAPORE

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  
**Rahul MALHOTRA**

## COVID-19 OUTBREAK OVERSEAS

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.

*Lead PIs:*



Associate Professor  
**Bibhas CHAKRABORTY**



Assistant Professor  
**Palash GHOSH**

# RESEARCH AREAS



## IMPLEMENTATION SCIENCE



Professor  
**Marcus ONG**

Prof Ong is a Senior Consultant, Director of Research, and Clinician Scientist, at the Department of Emergency Medicine in Singapore General Hospital. He is also the Director of Health Services Research Center (HSRC), Singapore Health Services; Professor and Director, Health Services and Systems Research (HSSR), Duke-NUS Medical School. Prof Ong also serves as Medical Director, Unit for Prehospital Emergency Care (UPEC) and Senior Consultant, Ministry of Health, Hospital Services Division. He is also Chairman, Pan Asian Resuscitation Outcomes Study (PAROS).

Prof Ong has obtained more than S\$47 million in research grants for his studies, which include geospatial diseases mapping, clinical drug trials, resuscitation and cardiovascular sciences, pre-hospital emergency care, and biomedical engineering. He is the Principal Investigator for an international, multi-centre cohort study of out-of-hospital cardiac arrest across the Asia-Pacific. This clinical research network has published more than 36 articles in peer-reviewed journals since 2009. In total, Prof Ong has published more than 250 articles in international and local journals, such as Journal of the American Medical Association, Lancet, American Journal of Medicine, Critical Care Medicine, Resuscitation, Annals of Emergency Medicine, and etc.

In 2014, Prof Ong started a Data Science team at SingHealth Health Services Research Centre (HSRC) and was appointed Head of Data Science at SingHealth. He is the SingHealth Co-Principal Investigator of the AI Singapore Grand Challenge addressing diabetes, hypertension and hyperlipidemia. He is considered a leading proponent of Data Science in Healthcare in Singapore. He is also a Scientific Advisor for Global Healthcare, a start-up company providing medical cooling solutions and TIIM Healthcare, an AI start-up.

### Research Interests

- Health Services Research
- AI in Healthcare
- Implementation Science
- Geospatial Modelling
- Big Data Analytics
- Physiological Data Modelling

### Research Highlight

➤ Prof Ong's research studies focus predominantly on pre-hospital emergency care, medical devices, data science and health services research. His research has addressed acute issues such as out-of-hospital cardiac arrest (OHCA), acute myocardial infarction, overcrowding in emergency departments (ED), environmental health, resource allocation and deployment of emergency medical services (EMS), etc. He is a leading researcher in Health Services Research and use of Data Science in Healthcare.

In Singapore, the survival rate of OHCA has improved over the years from 11.6% to 23.4% between 2011-2016, owing to research into several PEC interventions such as telephone cardiopulmonary resuscitation (CPR), firebike first responders, community CPR training and first responder Apps on a national level. Results from such research were translated into national policies and the interventions implemented as standard of care. At the international level, Prof Ong's OHCA research network, the Pan-Asian Resuscitation Outcomes Study, has increased research capacity and improved the EMS systems of participating low-middle income countries through training workshops, development and provision of research and interventional tools and packages, etc. Apart from his extensive work in OHCA, using geospatial mapping and system status management techniques, Prof Ong's studies have aided the Singapore Civil Defence Force in implementing dynamic deployment strategies for their ambulance service to better meet increasing population's demand for prehospital emergency care. Prof Ong has also patented inventions using Heart Rate Variability for risk prediction of acutely ill patients and cooling solutions for therapeutic hypothermia for OHCA patients and for management of heat injuries. Heart Rate Variability is currently being developed into bedside triage devices that can help in risk stratification of critically ill patients for triaging of patients in the ED for better resource allocation.



Professor

**Tazeen Hasan JAFAR**

Dr Tazeen H. Jafar is a global health leader and expert with a focus on implementation research in hypertension, cardiovascular disease, and chronic kidney disease.

Dr Jafar is Professor of Health Services and Systems Research at Duke-NUS Medical School, Visiting Consultant Renal Medicine at Singapore General Hospital, Visiting Professor of Medicine, Aga Khan University, Pakistan, Adjunct Professor of Nephrology, Tufts Medical Center, Boston, MA, and Research Professor at Duke Global Health Institute, Durham, NC, USA.

Professor Jafar has been leading innovative, impactful, research funded by Wellcome Trust and MRC in non-communicable diseases for over 15 years. She is the chief principal investigator of the multi-country COBRA-BPS (Control of Blood Pressure and Risk Attenuation-Bangladesh, Pakistan, Sri Lanka) trial published in the *New England Journal of Medicine*.

Prof Jafar is the PI of the Singapore National Ministry of Health funded SingHypertension cluster RCT- for improving management of hypertension in public sector polyclinics in Singapore. She is also the co-theme PI on A\*STAR funded "Diabetes Clinic of the Future" project in Singapore.

Prof Jafar is a Board member of the MRC Global Health Board, and serves on several national and international research funding panels and advisory boards. Prof Jafar mentors several trainees and junior faculty. She is also a practicing nephrologist.

**Research Highlight**

➤ Professor Tazeen H. Jafar led the multi-country Control of Blood Pressure and Risk Attenuation-Bangladesh, Pakistan, Sri Lanka (COBRA-BPS) Study and found that a multicomponent intervention, tailored to the rural setting, delivered through the existing public healthcare infrastructure significantly reduced systolic and diastolic BP, and improved BP control and some aspects of self-reported health compared to usual care in adults with hypertension. The intervention also appeared to lower cardiovascular mortality - all at an annual cost of less than US\$11 per patient. The public health implications of the findings are significant. A low-cost programme like COBRA-BPS could be adapted and scaled up in many other settings globally expected to achieve a substantial reduction in deaths and disability from cardiovascular and kidney disease. (*New England Journal of Medicine* 2020)



Assistant Professor

**Elaine LUM**

Dr Lum is an Assistant Professor, Health Services & Systems Research Programme, Duke-NUS Medical School. She is also an Advanced Practice Pharmacist (Australia) and a Visiting Clinical Fellow with the School of Clinical Sciences, Queensland University of Technology, Australia.

Dr Lum's areas of knowledge and interest include medication management, quality and safety of health systems and practitioners, health services research, and implementation science. Other research interests include digital health, decision-making, and designing for behaviour change. Her work is focused on enabling equity of access to health and healthcare through translational and empirical research, as well as education and training of healthcare professionals.

She is interested in projects that enable people to have health and/or to access a minimum standard of appropriate healthcare, wherever they live and whatever their capacity to pay. She believes in the value and power of collaborating with people of integrity who dare to do things differently and fail fast, in order to bring about game-changing practices and innovations for better patient care.

**Research Interests**

- Implementation Science
- Medication Management
- Antibiotic Use and Antimicrobial Resistance
- Digital Health
- Decision-Making



Assistant Professor  
**Irene TEO**

Dr Irene Teo is an Assistant Professor at the Lien Centre for Palliative Care and the Signature Programme in Health Services and Systems Research, Duke-NUS. Her background is in clinical health psychology and she is trained as a researcher and clinician. Asst Prof Teo's research and clinical interests include coping and adjustment to emotional distress and disease symptoms (e.g. pain, fatigue) in the areas of oncology. She joined Duke-NUS Medical School in 2015 and has focused her time in development of psychosocial interventions aimed at alleviating distress for patients and their families. She is a recipient of several small grants including that from the Singapore National Medical Research Council and Singapore Cancer Society.

## HEALTH ECONOMICS



Professor  
**Nicholas GRAVES**

Prof Graves is the Deputy Director of the Programme in Health Services & Systems Research at Duke-NUS and the SingHealth Duke-NUS Health Services Research Institute. His areas of knowledge include health economics, health services research, decision making and cost-effectiveness. He is interested in projects that show high and low-value care, as well as the processes around implementing new policies.

His major focus is on showing how health services can be improved at low cost, or even improved with cost savings. He enjoys collaborating with clinicians who wish to improve the performance of health services.

Prof Graves has made contributions of international significance, publishing over 250 articles in top-ranking peer reviewed journals such as JAMA, BMJ, AIDS, Health Economics, Clinical Infectious Diseases, Lancet Infectious Diseases, The Journal of Infectious Diseases and Emerging Infectious Diseases.

**Research Highlight**

➤ Prof Graves is currently working on projects about the economic value of innovations in hospital-based services such as programmes to reduce risk of healthcare acquired infections, different approaches to testing cardiology outpatients and alternate treatment approaches for treating complex coronary artery disease. He is leading a qualitative study on why doctors believe non-beneficial treatments happen at the end of life. He is collaborating across all clusters to quantify the economic costs of chronic wounds to Singapore. And there are other projects on screening for paediatric genetic diseases, whether selective termination of resuscitation prehospital is a feasible and cost-effective policy and a project on inappropriate nephrotoxic Non-Steroidal Anti-Inflammatory Drug in Diabetics, Elderly and Renal impairment. He is developing a Graduate Certificate Programme in Health Services Innovation to be launched at Duke-NUS in 2020/21.



Professor  
**Eric Andrew  
FINKELSTEIN**

Dr Finkelstein is a Professor of the Programme in Health Services & Systems Research and the Executive Director of the Lien Centre for Palliative Care at the Duke-NUS Medical School. He also holds appointments at NUS School of Public Health and Duke University Global Health Institute. His research focuses on the economic causes and consequences of health behaviours, with a primary emphasis on the use of traditional and behavioural economic incentives to influence those behaviours in ways to improve health outcomes. Recent research also focuses on studies to better understand the complicated decisions that revolve around end of life care. He has published over 200 manuscripts and 2 books in these areas, and also successfully commercialised an Obesity Cost Calculator for employers and insurers. Based on google scholar, he has an h-index of 62 and his publications have been cited over 50,000 times, including in the landmark Supreme Court decision upholding the U.S. Affordable Care Act (aka Obamacare). He was included in the list of the World's Most Highly Cited Researchers three years in a row by Thomson Reuters and Clarivate Analytics.

#### Research Interests

- His main areas of health economics research include:
  1. Health Technology Assessments and Cost-effectiveness Analyses
  2. Behavioural Trials of Public Health Interventions, including economic incentives
  3. Preference Assessments using state-of-the-art techniques

The health technology assessment research applies economic evaluation frameworks to both clinical and public health interventions. Recent examples include burden of illness studies for migraine and asthma in Singapore, cost-effectiveness evaluations of weight loss medications, new treatments for diabetic retinopathy, and a community hypertension trial in Nepal. The behavioural trials aim to evaluate the effectiveness of strategies to improve public health. Through a series of trials, Prof Finkelstein's team tested different types of incentives to improve physical activity and weight loss, and most recently developed an on-line grocery to test a series of pricing and information strategies aimed to improve diet quality. Their preference work uses discrete choice experiments and other methods to understand the value of new technologies and the extent consumers are willing to trade off various features, both positive and negative, of an intervention. Studies focus on trade-offs between efficacy, safety, and costs but a special emphasis focuses on preferences for end of life care and the extent to which people are willing to trade off quality for quantity of life.



Assistant Professor  
**Semra OZDEMIR**

Dr Ozdemir is an Assistant Professor at Lien Centre for Palliative Care and the Programme in Health Services and Systems Research, Duke-NUS. She obtained her PhD degree in Public Health and Economics from the University of North Carolina in Chapel Hill, USA. Her main research areas are medical decision making and health economics. She is interested in understanding preferences for health services and technologies and the decision-making process between patients, family caregivers and physicians, especially in decisions related to advanced serious illnesses. Her research also focuses on developing interventions and decision aids to help individuals make decisions that align with their preferences and treatment goals. She has developed numerous discrete-choice experiment surveys in a variety of therapeutic areas, and has been developing and testing patient decision aids for elderly patients with end-stage kidney disease.

#### Research Interests

- Medical decision making, health economics, stated-preference methods, patient decision aids, shared decision making, and end-of-life and palliative care.

## DECISION SCIENCE



Professor  
**David Bruce  
MATCHAR**

Prof David B. Matchar, MD, is the Inaugural Director of the Programme in Health Services and Systems Research (HSSR) (2008-2018). He is also Professor of Medicine at Duke University in the United States. He received his AB in Statistics from Princeton University. After completing his MD degree and residency training, he served as fellow in the Department of Internal Medicine at Duke.

Prof Matchar has worked in clinical research for over 35 years; his work primarily relates to stroke and other chronically disabling neurological disorders, as well as clinical and public policy analysis. He served as Director of the Duke Center for Clinical Health Policy Research and established the Duke Evidence-based Practice Center, which was responsible for analysis in support of coverage policy for the US Centers for Medicare and Medicaid Services, as well as guidelines for medical professional societies.

In August 2009, Prof Matchar was awarded the prestigious STaR Investigator Award by the Singapore Ministry of Health's (MOH) National Medical Research Council (NMRC), for developing a systems model to address crucial strategic and operational challenges presented by a rapidly ageing population. He is the Principal Investigator of several other MOH HSR grants related to stroke, falls, population segmentation, transitional care and practice improvement. He is currently PI of a EHO-Kobe unded project to develop a toolkit to promote NCD care in Cambodia.

While the content of Prof Matchar's research spans the range of clinical medicine, the essential nature of his work has involved integration of researchers from multiple disciplines under a common conceptual framework, to address important and complex healthcare issues. His overarching goal has been to promote the use of best evidence to support clinical and public policy decision making.

#### Research Highlight

- The SAFE intervention is a meticulously defined falls prevention programme based on established principles of tailoring, progressing and focus on balance. Prof Matchar's research team performed a randomized trial and demonstrated that individuals who had experienced a fall and had no more than one major medical illnesses (i.e., the pre-frail) not only achieved a benefit from the SAFE programme in terms of reduced risk of falls and injurious falls, it reduced healthcare costs, particularly those due to falls. The question remains: how can such a programme be implemented in the broader community? In response to this question, Prof Matchar's team submitted a proposal to MOH/NIC and was awarded a grant titled "Steps to Avoid Falls in the Elderly: Translating Research into Practice" in 2019. The objective is to explore various means of providing this programme in the community specifically, community-based centres, existing rehabilitation programmes, and at home in a way that will remain effective but will also make financial sense and is socially acceptable. In addition, they are collaborating with ETH-Zurich on a NSF-funded project to use innovative technologies to predict risk of falls and fractures and thus identify ideal candidates for intensive prevention efforts.



Assistant Professor  
**John P. ANSAH**

Dr Ansa is an Assistant Professor of the Programme in Health Services and Systems Research, Duke-NUS and a faculty fellow at Residential College 4, National University of Singapore. He has a PhD degree in Systems Science methodology of System Dynamics, and has 10 years' experience in the application of simulation modelling to complex health policy issues. Asst Prof Ansa's research uses computational modelling—with systems thinking and System Dynamics methodology as the foundation—coupled with the active involvement of stakeholders to better understand complex health systems issues to inform policy and interventions to improve health outcomes. His research interests lie broadly in the area of health systems improvement—to address strategic and operational health and social care challenges – and the evaluation of health system-wide impacts of complex health and social care interventions. Current projects includes long-term care needs, resilience and hip fracture recovery trajectories among the elderly, patients flow in the emergency department, enhanced primary care for an ageing society and human resources for health.

## SURVEY/QUALITATIVE RESEARCH



Associate Professor  
**Angelique CHAN**

Dr Angelique Chan holds joint tenure appointments as Associate Professor in the Programme in Health Services and Systems Research, Duke-NUS Medical School, and in the Department of Sociology at the National University of Singapore. She currently serves as the Executive Director of the Centre for Ageing Research and Education at Duke-NUS Medical School.

She has developed and nurtured a strong research portfolio in ageing research. This portfolio contains projects that are multidisciplinary and focus on the following themes - epidemiology of ageing, social determinants of health, caregiving, long-term care and the evaluation of programmes providing health services to the community. She has led several major projects on ageing in Singapore including large-scale longitudinal national surveys that have led to recommendations in policy research and public policy making. Her research work has been featured in both local and international new channels (The BBC, The Straits Times, Today, Bloomberg, Channel News Asia, etc).

Her international work includes working with partners from Australia, Hong Kong, Japan, United Kingdom, and United States of America to build and enhance capacity for research on ageing in Singapore. She has performed consultancy work for government organisations such as the Singapore Ministry of Social and Family Development, the Singapore Ministry of Health, the United Nations, Temasek Foundation, the World Bank and the Asian Development Bank.

She is also a board member of the Milken Institute Board of Academic and Policy Advisors for the Centre for the Future of Ageing; Deputy Chair of the Asia Pacific Rim Universities Ageing Hub; board member of the Next Age Institute (NUS); board member of the Temasek Polytechnic School for Humanities and Social Sciences; member, Singapore Medical Complaints Council; member, Health Cluster, Faculty of Arts and Social Sciences, NUS.

### Research Highlight

- A paper by A/Prof Chan's research team produced useful findings to examine various dimensions of health and population-level projections for Singapore. Expounding on familial support and living arrangements of the elderly in Singapore, the paper addressed rising concerns on the social isolation and associated health risks of elderly Singaporeans who live alone (*International Journal of Epidemiology*, August 2019).



Assistant Professor  
**Rahul MALHOTRA**

Dr Malhotra is an Assistant Professor at the Programme in Health Services and Systems Research (HSSR) and Head of Research at the Centre for Ageing Research and Education (CARE) at Duke-NUS Medical School. A physician and public health researcher, his research focuses on the vulnerability – i.e., increased risk of adverse outcomes – associated with ageing. His current funded research projects include (1) a longitudinal study of older Singaporean-family caregiver dyads (TRaCE) that aims to assess the patterns, correlates and consequences of changes in caregiving-related outcomes over time, (2) a national longitudinal survey of older Singaporeans (THE SIGNS Study) that aims to study the predictors and outcomes of change in physical, psychological and social health of older adults, and (3) a pharmacy health services research project (PROMISE) that aims to provide the evidence base for patient-centred prescription medication labels. He has authored or co-authored over 140 peer-reviewed papers in the geriatrics and gerontology, medical and public health literature.

### Research Interests

- Dr Malhotra's research agenda focuses on the development of an evidence base that enables understanding, measurement and alleviation of vulnerability (i.e., increased risk of adverse outcomes), resulting from physical, psychological, social and health service factors, among older adults and their caregivers in Singapore and other Asian countries. His current areas of research, contributing to his research agenda are:
  1. Impact of caregiving on informal family caregivers and formal caregivers, including foreign domestic workers and older care recipients.
  2. Correlates and outcomes of psychosocial health of older persons.
  3. Health communication and Health literacy.
  4. Measurement, and utilization, of health expectancy for spatial and temporal comparisons of health.
  5. Development, and/or validation, of scales assessing physical, psychological or social constructs among older Asians or their caregivers.

### Research Highlights

- **Caregiving**  
Dr Malhotra found empirical evidence for the supportive role of foreign domestic workers – they eased the impact of care provision on family caregivers. His systematic review of published studies from Singapore on caregiving-related outcomes highlighted gaps in the local literature and the need for longitudinal studies studying both negative and positive aspects of caregiving.
- **Psychosocial Health of Older Persons**  
Dr Malhotra has contributed to research establishing the link between low social network and depression, and loneliness and mortality. His work linking life-course socioeconomic status and obesity among older Singaporeans, whose findings contrasted with those reported from Western nations, highlighted the importance of the setting or context in life-course studies.
- **Health Communication and Health Literacy**  
Dr Malhotra's work has demonstrated the utility of bilingual prescription medication labels (PMLs) – he found that the understanding of PMLs among older Singaporeans was enhanced when bilingual, versus the usual English-only, PMLs were used. His work also established the link between inadequate health literacy and medication non-adherence.
- **Health Expectancy**  
Dr Malhotra's work has provided estimates for the duration of remaining life older Singaporeans can expect to live in various health states (such as with and without activity limitations). Using longitudinal data from his surveys, he has provided these estimates for older adult sub-groups defined by gender, ethnicity, education, body mass category, and sensory impairment.
- **Scale Development and/or Validation**  
Dr Malhotra has established the validity, in the local context, of well-known scales used to assess caregiving-related outcomes, and in the process, developed their shorter versions (modified-Caregiver Reaction Assessment [m-CRA]; Short-Positive Aspects of Caregiving [S-PAC]). The shorter versions are now employed in several caregiving studies, in Singapore as well as internationally.



Assistant Professor  
**Chetna MALHOTRA**

Dr Malhotra is an Assistant Professor at the Lien Centre for Palliative Care and the Programme in Health Services and Systems Research, Duke-NUS. She is a physician specializing in Community Medicine and Public Health. Her work focuses on conducting health services research in the area of palliative and end-of-life care for patients with advanced serious illnesses including those with advanced cancer, heart failure, renal failure and dementia, with the goal of improving delivery of palliative care services to these populations. Specific areas of interest in the context of end-of-life research include: (1) understanding and meeting care preferences of patients and their caregivers, for example through advance care planning, (2) medical decision making, (3) patient-physician communication and (4) end-of-life suffering. She has experience leading survey-research studies, cohort studies, trials and qualitative research, and has authored or co-authored more than 60 peer reviewed publications in medical literature.

She is currently leading several research projects:

- Panel Study Investigating Status of Cognitively Impaired Elderly in Singapore (PISCES)  
This study is funded by the Ministry of Health's Health Services Research Grant. It is a multi-centred cohort study of caregivers of patients with advanced dementia to assess patients' end-of-life care, health care utilisation, cost, quality of life, decision making and suffering during the last year of life.
- Communication quality between physicians and cancer patients in Singapore  
This study assesses the preferences for communication and perception of quality of communication among advanced cancer patients with their physicians.
- Impact of advance care planning on care for patients with advanced heart failure: A randomized controlled trial  
This is a 2-arm randomized controlled trial to assess the effectiveness of advance care planning in meeting patient's end of life care preferences.

She is co-investigator on several projects (selected):

- Costs and Medical Care of Patients with Advanced Serious Illness in Singapore (COMPASS) Study  
This is a cohort study of 600 patients with advanced cancers to assess their health care utilisation, cost, and quality of life during the last year of their life.
- Singapore cohort of patients with advanced heart failure (SCOPAH)  
This is a cohort study of 250 patients with advanced heart failure to better understand the relationship between patient preferences, healthcare access, utilisation, costs, and quality of life and to identify strategies to improve the end of life experience for these patients.



Assistant Professor  
**Sharon Cohan SUNG**

Dr Sharon Sung is an Assistant Professor at the Signature Programme in Health Services and Systems Research, Duke-NUS, Senior Clinical Psychologist, Department of Developmental Psychiatry, Institute of Mental Health and Senior Clinical Psychologist, Department of Psychological Medicine, KK Women's and Children's Hospital.

Asst Prof Sung earned her M.S. and Ph.D. degrees from the San Diego State University/ University of California San Diego Joint Doctoral Program in Clinical Psychology. She received specialty training in cognitive behavioral therapy at Columbia University Medical Center and the American Institute of Cognitive Therapy in New York City. Prior to moving to Singapore, she held faculty positions at Albert Einstein College of Medicine and Harvard Medical School.

Her research is focused on improving the identification and treatment of patients with mood and anxiety disorders. She has published numerous peer reviewed articles, editorials and book chapters, as well as a practitioner guide entitled *10-Minute CBT: Integrating Cognitive Behavioral Strategies Into Your Practice*. Recent NMRC-funded projects include a study to improve screening for panic disorder in the Department of Emergency Medicine, Singapore General Hospital and a multi-site randomised controlled trial to evaluate a stepped care intervention for emergency medicine patients with panic-related anxiety.



Assistant Professor  
**Sungwon YOON**

Dr Sungwon Yoon is an Assistant Professor at the Programme in Health Services & Systems Research, Duke-NUS. She is a public health researcher and behavioral scientist. Her main research interest lies in understanding individual and population health behavior which may have public health significance. Through this research, she hopes to utilize the findings to inform health policy planning and evaluation.

She has extensive experience in qualitative and mixed research methodologies used in a variety of fieldwork settings. Her current research projects include assessment of post-screening behavior for chronic conditions (diabetes, hypertension and hyperlipidemia), risk perceptions and health-seeking behaviors in individuals with pre-diabetes, personalized behavioral intervention using mobile technology for chronic disease self-care, health services research pertaining to cancer and end of life care, primary care based integrated community care team intervention, medication adherence, and global health governance.

She was a Korea Government Fellow at London School of Economics and Political Science (LSE). She was trained as a medical sociologist at Seoul National University and Ewha Womans University in Korea and subsequently completed a second doctorate in public health at London School of Hygiene and Tropical Medicine (LSHTM) in the United Kingdom.

#### Research Interests

- Population health and health-seeking behavior, implementation science, qualitative and mixed methods research, chronic disease management (diabetes, heart disease, cancer) and end-of-life care, and global health.

## QUANTITATIVE MEDICINE



Professor  
**CHEUNG  
Yin Bun**

Dr Cheung Yin Bun is a Professor at Duke-NUS Medical School, Singapore, and Adjunct Professor at Tampere University, Finland. Prior to joining Duke-NUS in 2012, he served as a biostatistician at the National Cancer Center Singapore, a senior lecturer at the London School of Hygiene & Tropical Medicine, and Chief Scientific Officer at the Singapore Clinical Research Institute.

He received his degrees in social science, medical demography, statistics and paediatric epidemiology from institutions in Hong Kong, Singapore, and the United Kingdom. He has broad interest in the studies of child health, statistical methodology, and health and quality of life outcomes.

As of 2020, he is the Principal Investigator of a study to improve statistical methodology for analysis of recurrent events in vaccine research (funded by the National Medical Research Council, Singapore), and the Co-Principal Investigator of a cluster randomized trial to evaluate the impact of periodic mass administration of azithromycin to infants in a high-mortality setting (funded by the Bill & Melinda Gates Foundation).

He is the author of *Statistical Analysis of Human Growth and Development* (CRC Press, 2014) and co-author of *Survival Analysis: A Practical Approach* (Wiley, 2006). He is the developer of the *Singapore Caregiver Quality of Life Scale*.

### Research Highlight

- Design and analysis of studies of vaccines and pharmaceutical preventive measures against infectious diseases

Recent developments in vaccines and pharmaceutical prevention measures often involve conditions that can recur, such as acute gastroenteritis, malaria and pneumonia, as opposed to diseases that can only occur once in a lifetime. In a series of research projects funded by the National Medical Research Council, Professor Cheung and his team have been investigating efficient and robust approaches to study design and statistical analysis of recurrent events, covering individual and cluster randomized trials, case-control studies and within-unit comparative methods. These developments have been motivated by and applied to studies of child health in low-income countries.

- Quantification of patients' and caregivers' quality of life and health utility

Professor Cheung and his team develop and evaluate methods and measurement scales to quantify patients' and caregivers' quality of life and health utility, with focus on suitability and usability in Asian and clinical settings. Some recent achievements include the development of the *Singapore Caregiver Quality of Life Scale* and its short forms and sample size determination formula for EQ-5D-5L value set studies. These developments have been motivated by and applied to studies of patients with palliative or long-term care needs and their caregivers.



Associate Professor  
**Bibhas  
CHAKRABORTY**

Dr Chakraborty is a tenured Associate Professor at the Centre for Quantitative Medicine and the Signature Programme in Health Services & Systems Research at Duke-NUS Medical School. Previously, he served as the Director of the Centre for Quantitative Medicine, and as the Founding Co-director of the PhD programme in Quantitative Biology and Medicine (QBM) at Duke-NUS.

He is the recipient of the prestigious Calderone Research Prize for Junior Faculty from Columbia University's Mailman School of Public Health in 2011, and the Young Researcher Award from the International Indian Statistical Association (IISA) in 2017. He has served as the Principal Investigator of research grants funded by the Ministry of Education (MOE), Singapore, as well as the National Institutes of Health (NIH), USA, in addition to being a co-investigator on numerous grants from various funding agencies.

### Research Interest

- A/Prof Chakraborty's research in Quantitative Medicine involves developing novel statistical methods and associated study designs to facilitate data-driven precision health in a time-varying setting, often known as dynamic treatment regimens or adaptive interventions. Once developed, these treatment regimens can serve as decision support systems for clinicians and other healthcare providers, and are particularly appealing in the context of chronic disease management. He has authored the first textbook on this cutting-edge topic. He also has expertise in modern clinical trial designs, including sequential multiple-assignment randomized trial (SMART) design for dynamic treatment regimens, various kinds of adaptive design, as well as full and fractional factorial designs in the context of multi-phase optimization strategy (MOST) for developing multi-component interventions. More recently, he has got deeply interested into the domain of mobile/digital health, in particular the development of just-in-time adaptive interventions (JITAs) and the micro-randomized trials (MRTs), and also the analysis of big electronic health records data. The above research areas employ tools from artificial intelligence, including reinforcement learning and other forms of machine learning. His research has been funded by grants from the Ministry of Education (MOE), Singapore, as well as the National Institutes of Health (NIH), USA.



Assistant  
Professor  
**Jin LIU**

Dr Jin Liu is an Assistant Professor at the Centre for Quantitative Medicine and the Signature Programme in Health Services and Systems Research, Duke-NUS Medical School. His research interest is primarily focused on the development of novel statistical methodologies for big data in genetics, which includes large-scale genome-wide association studies and integration of multi-omics analysis.

Asst Prof Jin Liu has been involved in several research projects on genetics/genomic studies and currently serves as the Principal Investigator for statistical genetics research at Duke-NUS which provides him experience on organising research teams, communicating with collaborators, solidifying realistic research plans and delivering research results in a timely manner.

Dr Liu has developed quite a few statistical methodologies in integrative analysis of multiple cancer studies. He is particularly interested in developing novel penalized regression methods to integrate the multiple-platform data in genomic studies. Dr Liu also has broad interests over other areas, e.g. statistical computing, mixed models and empirical Bayes. Dr Liu had been involved with several National Institutes of Health funded research projects on genomic studies and currently serves as the biostatistician for genetics research at Duke-NUS, which provide him some experience on organising research teams, communicating with collaborators, solidifying realistic research plans, and delivering research results in a timely manner.

### Research Highlight

- Dr Liu's recent work includes statistical methods integrating functional annotations, statistical methods leveraging regulatory information, methods used to make causal inference using genetic summary statistics, and single-cell data analysis. For example, in the project "Novel methods to jointly analyse pleiotropic genetic effects on multiple traits" (MOE2016-T2-2-029), his team investigated the joint analysis of multiple traits to explore the genetic structure among them and also explored the effects of functional annotations on multiple traits. They proposed LLR as a new statistical approach to prioritizing risk variants using the pleiotropy across multiple related studies. The development of the EM-path algorithm allows LLR to efficiently handle the analysis of large-scale genomic data. These merits make LLR an attractive and effective tool for the integrative analysis of multiple GWAS data. In addition, they presented a statistical approach, LSM, to integrate genic category annotations and a large amount of tissue-specific functional annotations with GWAS data. LSM can not only improve the statistical power in the identification of risk SNPs but also infer relevant tissue-specific functional annotations to the phenotype, offering new insights to explore the genetic architecture of complex traits or diseases.

## EPIDEMIOLOGY



Professor  
**KOH Woon  
Puay**

Dr Koh is a Professor at Duke-NUS Medical School and Joint-Professor at the Saw Swee Hock School of Public Health at the National University of Singapore. She received her MBBS (Honours) from NUS, her PhD in immunology from the University of Sydney, Australia, and postdoctoral training in epidemiology from the University of Southern California in USA.

Prof Koh is the Principal Investigator of the Singapore Chinese Health Study, a 63,257-strong cohort of middle-aged and elderly Chinese Singaporeans established for the long-term study of dietary and environmental determinants of chronic diseases common among Singaporeans. She has co-authored over 350 scientific papers on diet, lifestyle and genes in relation to risk of diseases such as cancer, cardiovascular diseases, diabetes, gout, osteoporosis, osteoarthritis and tuberculosis disease. She has received over \$18 million dollars in research funding from NIH (USA) and NMRC (Singapore), and is a recipient of the Ministry of Health NMRC Clinician Scientist Award (Senior Investigator) (2014-2019), the Duke-NUS Dean's Excellence Awards in Research (2016) and Leadership (2018), and the National Day Public Administration Medal (Bronze) (2019).

Besides research, her other passion is in mentoring, and she is the Director of the Centre for Clinician-Scientist Development (CCSD) in Duke-NUS, a centre established to consolidate support and nurture clinician-scientists, spanning from graduating Duke-NUS students to aspiring clinician-researchers across the SingHealth Duke-NUS Academic Medical Centre.

### Research Highlight

Being a population health scientist, Prof Koh's research interest and expertise is in unravelling the epidemiology of chronic diseases of importance to Singapore and the world at large, such as cancer, cardio-metabolic, musculoskeletal and neurodegenerative diseases. Being medically qualified in Singapore, and having had PhD training in experimental research and postdoctoral training in epidemiology, Prof Koh seeks to integrate biology, medicine and epidemiology in etiological studies of the aforementioned chronic diseases. Her research incorporates her knowledge in clinical medicine and training in laboratory science with epidemiologic methods to unravel putative mechanistic pathways in disease etiology. Beyond establishing associations between exposures and risk of disease, her research uses molecular and genetic tools to identify modifiable factors (such as lifestyle factors) that could be applicable to disease prevention, or biomarkers (including but not limited to genetic markers) that could be developed for early detection or screening of disease. In addition to bringing benefit to the scientific community, she also aims to translate her research into public health outcomes by providing evidence for the foundation of public health education and policy in Singapore and the world at large.



Professor  
**Ecosse  
LAMOUREUX**

Professor Lamoureux holds a tenured appointment with the Duke-NUS Medical School (Health Services and System Research Department) and professorial appointments with the National University of Singapore and the University of Melbourne. He is the Director of the Population Health and Clinical Epidemiology Platform at the Singapore Eye Research Institute (SERI). His research programme focuses on sensory impairment in the elderly; and the prevention, intervention, and outcomes research associated with eye diseases; aging; and diabetes microvascular complications. His research includes the implementation of novel RCTs; population-based epidemiological studies; new prevention and treatment models for vision impairment and eye care; adherence to management of eye diseases; and patient-centred outcomes. Importantly, his work has produced novel computer adaptive testing systems (a form of AI technology) to optimally assess the impact of eye diseases and associated treatment efficacies. To date, his overall research activities have attracted over SG\$40 million in competitive grant

funding in Australia (Australian NHMRC, Australian ARC) and Singapore (Singapore NMRC). In addition, he has been awarded numerous fellowships such as the Australian NHMRC Career Fellowships, and the Singapore Clinician Scientist Award. He has over 400 publications in top international journals, and his international standing is supported by numerous invited oral presentations at international and regional conferences.

### Research Highlight

Professor Lamoureux is recognized locally and internationally for his research in population health; epidemiology; patient-centred outcomes; development of patient-reported outcome measures using modern psychometric theory, item banking, and computer adaptive testing; and quality of life outcomes in the elderly and underprivileged community groups. His current population-based and epidemiological cohort is a contemporary patient-centric study of the old and very old elderly individuals in Singapore with a specific focus on sensory impairment, sarcopenia, osteoporosis, frailty (physical and cognitive) and multimorbidity. He is also currently developing several item banks and computer adaptive testing systems for major eye conditions and diabetes.



Professor  
**Truls OSTBYE**

Professor Ostbye is Vice Chair (Research) in the Department of Family Medicine and Community Health at Duke University. He is a chronic disease epidemiologist and public health researcher with a special interest in obesity and diseases of the elderly. He has led various health and longitudinal studies on chronic diseases across populations including those Pacific Islanders in New Zealand and elderly Canadians (Canadian Study of Health and Aging) as well as numerous global health projects in Sri Lanka.

In Singapore, his current research includes studies of health and lifestyles of the elderly, physical, mental and social facets of caregiving as well as studies of disease prevention in both the clinical setting and the community.



Professor  
**Julian  
THUMBOO**

Professor Julian Thumboo was the Head, Department of Rheumatology and Immunology, Singapore General Hospital. He graduated from the National University of Singapore and subsequently trained in Rheumatology in Singapore and at the Mayo Clinic.

His clinical and research interests in Systemic Lupus Erythematosus, Osteoarthritis, Health Services Research and Patient Reported Outcomes have led to over 260 publications in peer reviewed journals. Professor Thumboo serves as Research Director for the Singapore General Hospital and Director of Health Services Research in the SingHealth Regional Health System & SGH.

He was the founding Director of the SingHealth Health Services Research Centre and founding Co-Director of the SingHealth Duke-NUS Health Services Research Institute, and was previously Vice Chair for Research for the Medicine Academic Clinical Programme.

In addition to patient care and administrative duties, Professor Thumboo has also served on the editorial boards and as a reviewer for regional and international medical journals. He has been an invited speaker at regional and international scientific conferences, and is involved in undergraduate and postgraduate teaching.



Professor  
**WANG Jie Jin**

Dr Wang Jie Jin is a Professor of Epidemiology and Deputy Director, Centre for Clinician-Scientist Development (CCSD), Duke-NUS Medical School. She was an Associate Professor (2007-2011) and Professor (2012-2018), University of Sydney and a Senior Research Fellow, National Health and Medical Research Council (NHMRC), Australia (2005-2015).

Prof Wang conducted epidemiological research in visual impairment and its two common causes in older people: age-related macular degeneration (AMD) and age-related cataract. She was a key investigator of the Blue Mountains Eye Study, a population-based cohort study of 15 years. She led a clinic-based cohort study of 2000 cataract surgical patients to clarify a long-term debate over the possible adverse effect of cataract surgery on AMD risk, documented the associations of visual impairment with poor survival and correction of visual impairment with better survival among older people in two cohorts. She led investigation of joint contribution of modifiable factors and genetic susceptibility to risks of AMD and age-related cataract.

Prof Wang was the primary supervisor of 9 PhD and 4 Masters awardees. She is a co-author of 617 research reports, 19 reviews and 6 book chapters (H index 71). She served as a member of NHMRC Project Grant Review Panels (2011-2014) and the Editor-in-Chief, *Ophthalmic Epidemiology* (2011-2016).



Assistant  
Professor  
**Fahad  
SIDDIQUI**

Dr Siddiqui is an ex-clinician from Sukkur, Pakistan. He did his MBBS in 1997, from Bolan Medical College, Quetta, and MSc in Epidemiology and Biostatistics in 2003 from Aga Khan University, Karachi, Pakistan and MSc in Public Health from Curtin University, Perth, Australia in 2006. His research interests include clinical epidemiology, evidence-based medicine, evidence synthesis and public health.

From 1998 to 2008, he worked in the departments of community medicine, paediatrics and cardiothoracic surgery of Aga Khan University, Karachi Pakistan. In 2009, he joined the Singapore Clinical Research Institute (SCRI) and Duke-NUS Medical School Singapore at various positions. In 2016, he joined the Centre for Global Child Health Hospital for Sick Children, Toronto, Canada. Dr Siddiqui is a Cochrane Trainer of Cochrane Singapore and also the Managing Editor of the Nutrition Group of Campbell Collaboration.

He resumed working at Duke-NUS in March 2020 as an Assistant Professor and took up the responsibility to carry the research forward at Prehospital and Emergency Care Research Centre (PERC) under the leadership of Professor Marcus Ong.

## DATA SCIENCE



Associate  
Professor  
**LIU Nan**

Dr Liu is an Associate Professor at Centre for Quantitative Medicine and Programme in Health Services and Systems Research, Duke-NUS Medicine School. His research focuses on health services research, emergency and prehospital care, cardiology, medical informatics, and health innovation. Dr Liu has been awarded research grants from National Medical Research Council, National Health Innovation Centre, and SingHealth Foundation. He received many international and national awards, including Meritorious Paper Award from Computers in Biology and Medicine journal, Best Abstract Award from European Emergency Medical Services Congress, Grand Prize from Singapore Tech-Factor Challenge, and Paul Dudley White International Scholar Award from American Heart Association. Dr Liu is serving as an Academic Editor for four international peer-reviewed journals, including Computers in Biology and Medicine (Elsevier), Medicine (Lippincott Williams & Wilkins), PLOS ONE, and IEEE Access. He is also a regular reviewer for more than 60 international journals. Dr Liu is currently the Chairman of IEEE Engineering in Medicine and Biology Society (EMBS) Singapore Chapter.

### Research Interests

- Educated in electrical and computer engineering with a focus on artificial intelligence, A/Prof Liu is actively working on advanced computational and intelligent solutions to improve patient care. His research focus is primarily leveraging artificial intelligence, machine learning, and data science to solve real-world problems in clinical areas such as prehospital and emergency care, critical care medicine, cardiology, and population health. He investigates and develops novel technical solutions with large-scale electronic health records data mining, health data science and analytics, physiological signal analysis, and smart sensor technology. Moreover, his research acknowledges the importance of clinical translation through commercialization of innovative biomedical engineering technologies.



Assistant  
Professor  
**Sean LAM**

Dr Lam has a PhD and Master's in Industrial and Systems Engineering, Operations and Business Analytics from the National University of Singapore. He is currently the Head of Data Science in the SingHealth Duke-NUS Academic Medical Centre, overseeing a team of data scientists for the enhancement of patient care and outcomes through health services research. Dr Lam is also an Assistant Professor at the Signature Programme in Health Services and Systems Research, Duke-NUS. He has more than 20 international publications, and won numerous local and international awards.

### Research Interests

- Asst Prof Lam has contributed to the areas of data science and artificial intelligence research with particular applications in health services research, healthcare operations research, transportation, supply chain, energy and defence. Specific areas of interest in health services research include emergency medicine, prehospital emergency care, respiratory medicine, chronic kidney disease, diabetes, glaucoma, disease registries, data science infrastructure, diagnostic radiology, inpatient bed management, surgical and emergency department resource optimization and NLP for unstructured medical notes. His generic interest areas are in the resolution of epidemiological, quality/ service improvement and translational health services research problems leveraging on real-world data coupled with applied optimization and simulation techniques, statistical theory and machine learning (reinforcement and supervised/unsupervised learning).

# EDUCATION

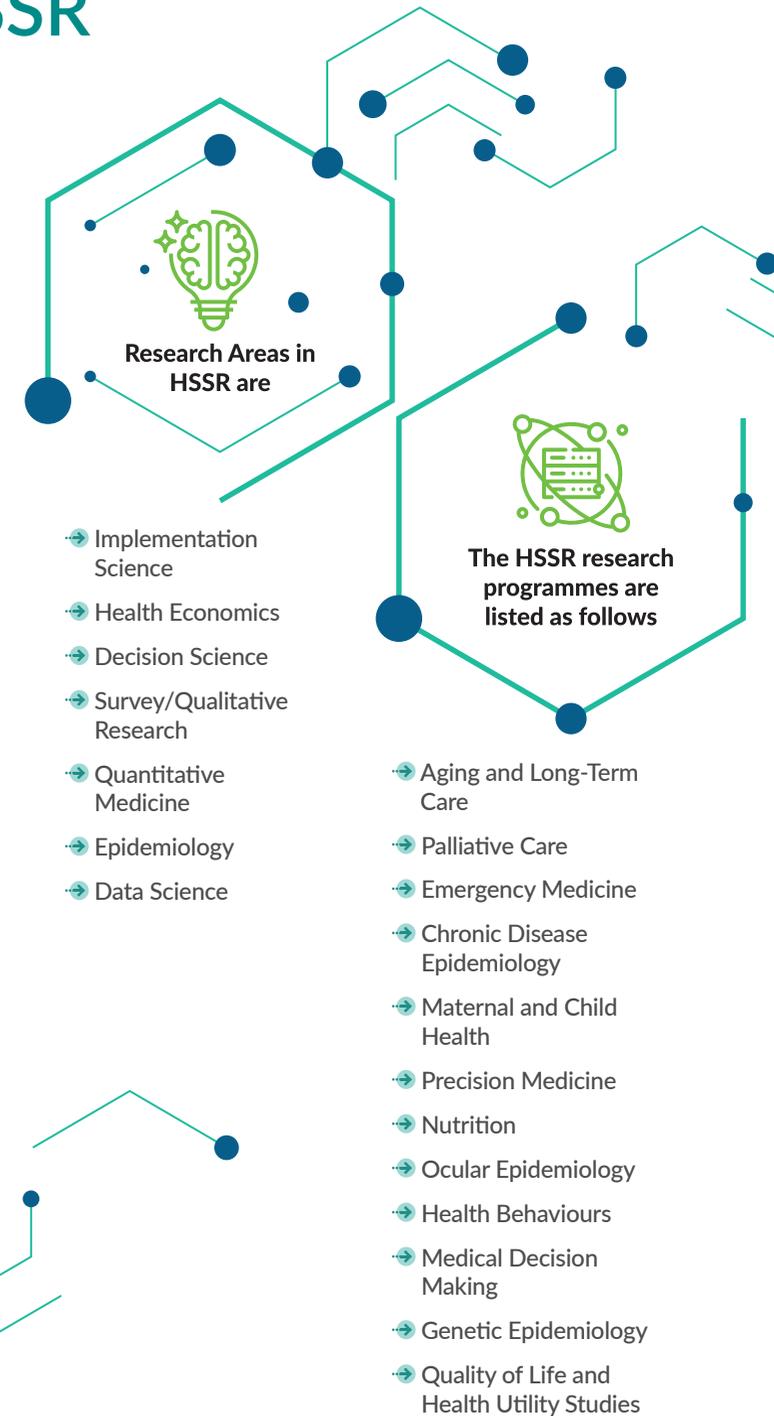


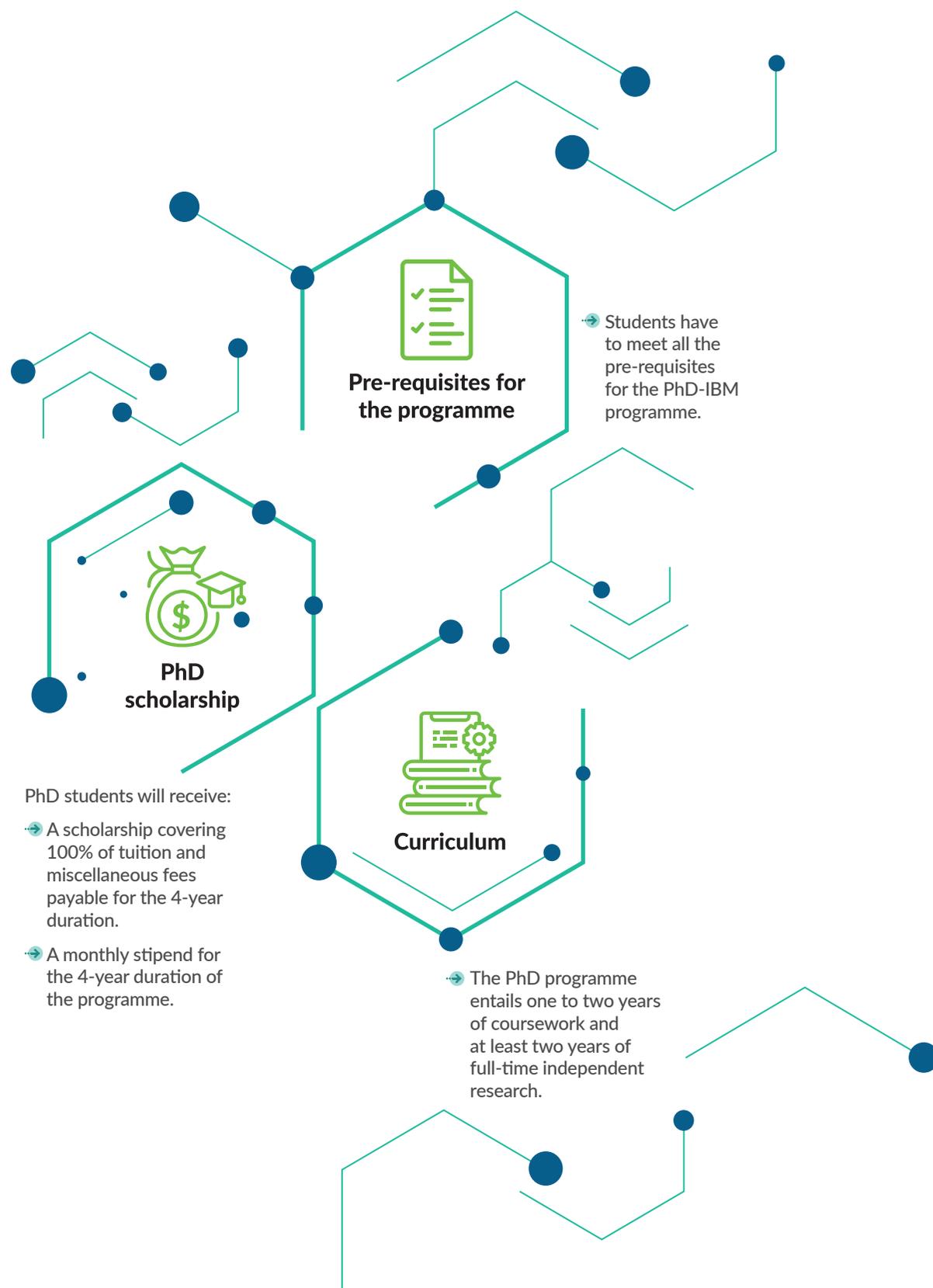
## PHD-IBM-HSSR

The PhD Programme in Integrated Biology and Medicine at Duke-NUS has a thriving track on Health Services and Systems Research (PhD-IBM-HSSR). We seek motivated applicants.

The PhD-IBM-HSSR programme is for students with an undergraduate or a master's degree in social sciences, epidemiology, public health, economics, psychology, sociology or quantitative methods including data science applications (or any related field) who want to advance their understanding of health services research. Students in our PhD programme focus on the creation of new and innovative knowledge in the field of health services research.

Graduates of the programme use their acquired substantive and methodological skills in a wide range of work settings, including academic institutions, non-profit organizations and government bodies to shape health services research.





**Year 1**

PhD students who opt for HSSR track at the beginning of their PhD are exempted from the course "Molecules to Medicine". These students can instead take our core course on Health Services and Systems Research (GMS6950) in their Semester 1. PhD students who opt for HSSR track in Semester 2 or later will take GMS6950 in their Year 2.

PhD students will conduct three 6-week rotations with HSSR faculty mentors in Semester 1. Mentors for these rotations are regular-ranked HSSR faculty who are approved PhD mentors. These rotations are structured to provide students with first-hand exposure to specific disciplines and research programmes within HSSR in which they may choose to conduct their research. At the end of these rotations, students commit to a thesis mentor.

During the second semester, students continue with their coursework and/or begin primary research under the supervision of their thesis mentor.

**Year 2**

At the start of the second year, students work towards developing their thesis projects. Students may or may not continue with their formal coursework.

In the first semester of their Year 2, all PhD students take a qualifying examination or preliminary exam. Students defend a mock proposal and are evaluated on their knowledge in the given HSSR discipline and their ability to pursue hypothesis-based research.

**Years 3 & 4 – Research and Thesis**

After the qualifying exam, remainder of the PhD training consists of the execution of the thesis project and participation in seminars. The thesis mentor will guide the student and act as chair of the student's thesis advisory committee. Success of the thesis is judged by publication or anticipated publication of two first authored papers, emphasis being on quality rather than quantity.

**Curriculum Requirement Credit**

**Year 1**

**Semester 1**

GMS6950 "Health Services & Systems Research"	4
HSSR Laboratory Rotation 1	2
HSSR Laboratory Rotation 2	2
HSSR Laboratory Rotation 3	2

**Semester 2 onwards**

GMS6900 "Student Research Seminars" (6 semesters)	3
<i>(Optional) PhD-QBM seminars</i>	
Elective Courses (Decided by student & mentor and approved by Course Coordinator)	28
Additional modular credits of 6000 level	12
Additional modular credits of 5000 level or higher	16
Thesis & Research	19

**Total 60**

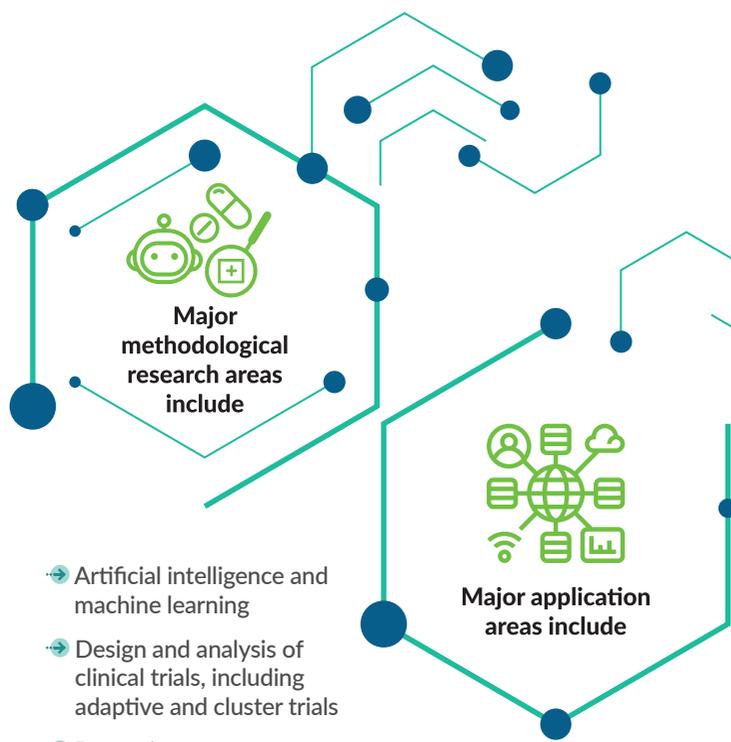
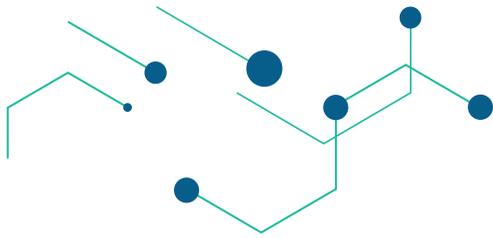
**Contact**

If you are interested in the PhD Programme, please feel free to contact the following faculty:

a) Prof Nicholas Graves  
n.graves@duke-nus.edu.sg

b) Asst Prof Chetna Malhotra  
chetna.malhotra@duke-nus.edu.sg

# PHD-QBM-BHDS



PhD students will receive:

- A scholarship covering 100% of tuition and fees.
- A monthly stipend.
- There is no service obligation (no bond).



→ The degree will take on average 4 to 5 years to complete. In years 1 and 2, students will complete a core set of study modules, an elective module, and a biomedical research internship. In year 2, students will also work towards developing their thesis projects and take a qualifying examination, which includes submission and defence of a research proposal. The remainder of the PhD training consists of the execution of the thesis project, culminating with the development of a written thesis and a successful oral dissertation defence. In addition, students will participate in a journal club in the first semester of every year.

**T**he PhD Programme in Quantitative Biology and Medicine with concentration in Biostatistics and Health Data Science (PhD-QBM-BHDS) aims to:

- Advance health and biomedical sciences through the development and application of innovative statistical and data science methods.
- Train quantitative scientists who will master specialized areas in biostatistics and data science and their applications in health and biomedical research.

The PhD-QBM-BHDS programme is for students who have an undergraduate or a master's degree in a quantitative discipline such as statistics, data science, engineering, demography and epidemiology. Students in our programme will develop innovative statistical and data science solutions and apply them to solve real-life problems in health and biomedical sciences.

- Major methodological research areas include**
- Artificial intelligence and machine learning
  - Design and analysis of clinical trials, including adaptive and cluster trials
  - Dynamic treatment regime
  - Diagnostic medicine
  - High dimensional "omics" data
  - Pleiotropy studies
  - Recurrent events in cohort and case-control studies
  - Time-to-event analysis
  - Quantification of quality of life and subjective health outcomes
- Major application areas include**
- Big data analytics in healthcare
  - Clinical trials in chronic diseases
  - Emergency medicine
  - Genetic epidemiology
  - Quality of life in chronic diseases and palliative care
  - Medical devices
  - Vaccines and infectious diseases

## Curriculum Requirement Credit

Curriculum Requirement	Credit
GMS6801 Study Designs in Clinical and Population Health Research	4
GMS6802 Core Concepts in Biostatistics	4
GMS6821 R-Programming	Non-credit
GMS6850 Core Concepts in Bioinformatics	4
GMS6802 Analysis of Complex Biomedical Data	4
GMS6804 Biomedical Research Internship	4
Elective module, course code 5000 level or higher	4
GMS6800 Integrated Biostatistics and Bioinformatics Journal Club	1×4
Thesis Research	32

**Total 60**

## Contact

If you are interested in the PhD Programme in Quantitative Biology and Medicine (QBM), please contact Prof CHEUNG Yin Bun ([yinbun.cheung@duke-nus.edu.sg](mailto:yinbun.cheung@duke-nus.edu.sg)).

# GRADUATE CERTIFICATE PROGRAMME IN HEALTH SERVICES INNOVATION

Healthcare professionals require the skills and confidence to prosecute health services research to inform innovation among services. Clinical staff and service managers face challenges that will not go away. They must respond to population growth and aging, increasing prevalence of chronic diseases, which are costly to manage under current configurations of services, and they must reduce waste and inefficiency.

Innovation to improve the performance of health services is increasingly relevant, yet delivering this innovation requires new knowledge and some prospects to collaborate with existing Health Services Research groups.

The Graduate Certificate Programme in Health Services Innovation was approved by the Ministry of Education (MOE) in February 2020 to build capacity for innovation, build relationships with researchers and increase pressure for the promotion of high value services.

The specific objectives of the Graduate Certificate Programme are:

- i) To build a sustainable training programme in health services innovation;
- ii) To increase among Singaporean HCPs the skills and confidence for health services research;
- iii) To train a workforce to identify opportunities for improvement, measure and improve patient outcomes, demonstrate and improve value for money, and implement evidence into practice sustainably.

## Modules

The Graduate Certificate Programme will offer the following four new modules:

### Implementation Science (4 modular credit)

This module is designed to introduce health care professionals to the principles of translating evidence for better services into a clinical setting. Participants will learn processes and factors associated with successful integration of evidence-based interventions within a particular setting, assess whether the core components of the original intervention were faithfully transported to the real-world setting and gain new knowledge about the adaptation of the implemented intervention to the local context.

On successful completion of this module, students will be able to:

- Design interventions based on community, patient, clinician and organizational inputs to translate findings into clinical practice, policy and public health.
- Design evaluations of interventions that translate evidence into practice.
- Develop better proposals.
- Develop a design for a research implementation and/or a dissemination and evaluation project.

### Research Methods for Health Services Research (4 modular credit)

This is about the current practice of health services research. It will include a discussion of the reproducibility crisis. The sources of data that are commonly used to address research questions are reviewed and critiqued. Different approaches to assess causality and associations are taught. An introduction to qualitative research methods is provided and participants are taught about systematic reviews and meta analyses.

Upon completion of the module, students should be able to:

- Describe the reproducibility crisis and debate contemporary issues relevant to the conduct of health services research.

- Understand the requirements for good survey design, the importance of patient reported outcome measures. The advantages and disadvantages of using disease registries and other routinely collected data.

- Understand the different approaches to assessing causality used in health services research.

- Apply the methods of qualitative research and understand the value of these approaches to Health Services Research.

- Design and conduct a systematic review and simple meta analyses.

### Health Technology Assessment, Economic Evaluation and Decision Making (4 modular credit)

Health technology assessment is a well-established tool used when decisions need to be made quickly. Often there is no time for new data collection or a dedicated research effort. It is an exercise in synthesizing current evidence and responding appropriately. Economic evaluation has its foundations in welfare economics and offers a theory based approach to informing choice and trade-offs given resources are scarce. Often, new data are required or a more formal research approach is used. Various modelling approaches are used to complete economic evaluations.

Upon completion of the module, students should be able to:

- Complete their own health technology assessment project and understand the rationale and methods for doing one.

- Understand the principles of welfare economics, market failures and how they apply to the supply of health care services.

- Be able to read and interpret a published cost-effectiveness study, able to collaborate with a health economist for a new study.

- Understand the scientific paradigms of decision making and how they come into conflict with traditional scientific approaches.

- Have awareness of other approaches for decision making such as dynamic

system modelling and multi criterion approaches.

### Healthcare + Data Science (4 modular credit)

This module exposes students to the foundation concepts, case studies and applications, some mathematics behind data science models and algorithms. There will also be practical sessions for model development, training, validation and tests. Students will acquire new knowledge of data science techniques. The new knowledge from this course will enable predictions to be made about likely diagnoses, prognoses of health conditions and risks of adverse events.

There will also be a mini-project and healthcare case studies to demonstrate the applicability of data science as a key enabler for improving the delivery of health services.

Upon completion, students should be able to:

- Understand the value and application of data science for the future of health services.

- Develop the ability to independently conduct health data science projects.

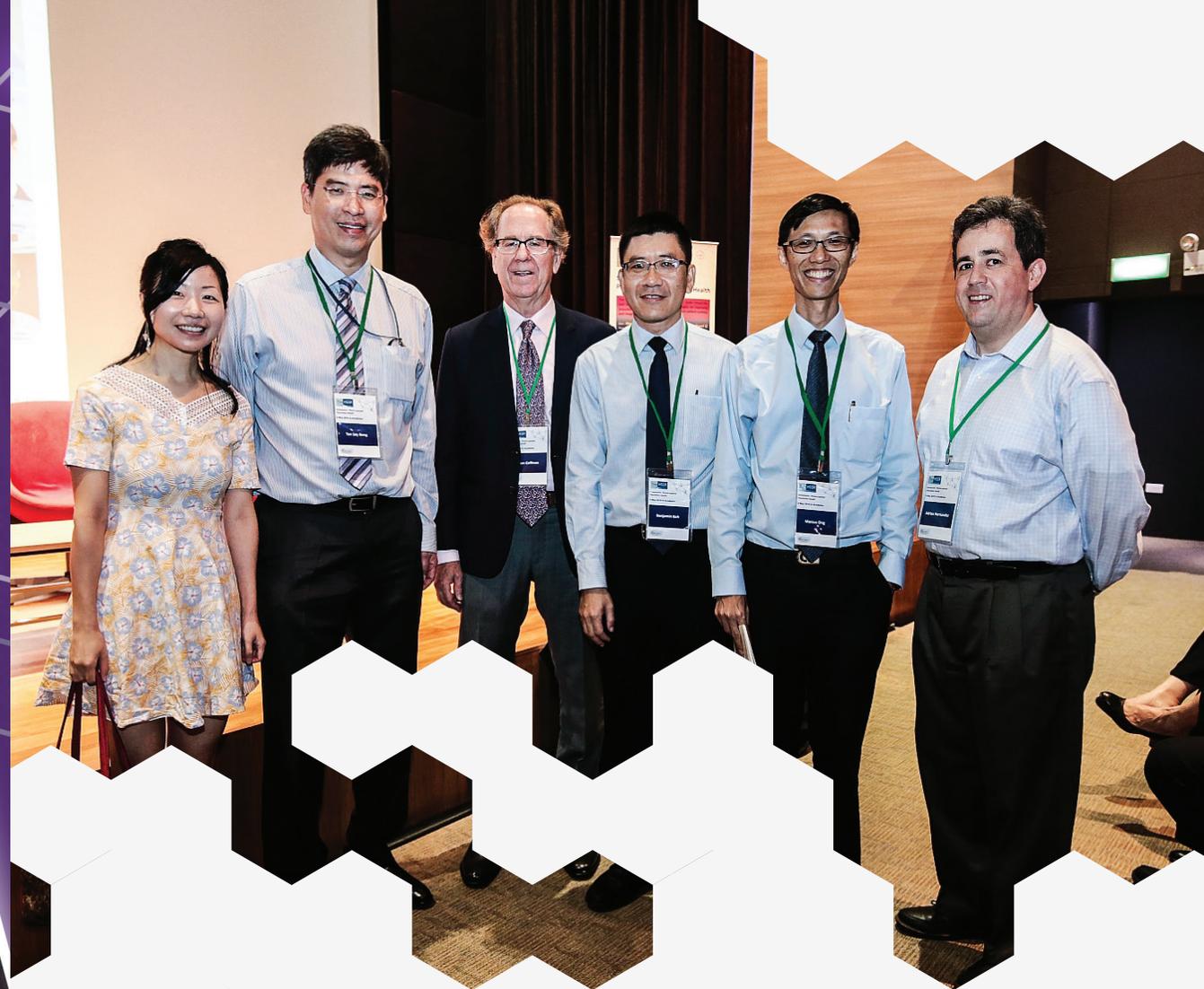
## Eligibility

We are recruiting a cohort of doctors, nurses, allied health and professional staff from the institutions of SingHealth. To be eligible, you need a Bachelor's Degree in a Health, Information Technology or a Management discipline. Work experience instead of a Bachelor's Degree can be considered on a case-by-case basis. The goal is to help develop future clinical and non-clinical leaders to drive innovation, engage in research and redesign services. We seek enthusiastic participants willing to join a high performing cohort and have impact on health services. The programme will be open to external applicants in the future.

## Contact

If you are interested in the Graduate Certificate Programme, please feel free to contact Prof Nicholas Graves ([n.graves@duke-nus.edu.sg](mailto:n.graves@duke-nus.edu.sg)).

# EVENTS



— SYMPOSIUM: —

## PERSON-CENTRED POPULATION HEALTH

6 May 2019

Over 300 participants comprising of clinicians, researchers, policy makers and educators from various organizations and institutes across Singapore, including the Ministry of Health (MOH), Duke-NUS Medical School and SingHealth, convened at Academia for the HSSR symposium “Person-Centred Population Health”. The symposium was jointly organised by Duke-NUS Medical School, Duke University and SingHealth. Experts from MOH, SingHealth, Duke University, Duke Kunshan University, NTU and Duke-NUS shared their insights through talks on how population health can be defined and measured as well as showcased strategies that have been undertaken in Singapore and elsewhere to improve population health and care integration.

The symposium commenced with a welcome address by Prof Thomas Coffman, Dean, Duke-NUS. He mentioned that the theme of the symposium “Person-Centred Population Health” is timely and important as 1 out of 5 Singaporeans will be above the age of 65 by 2030, and the move towards personalised care will help to provide the patients with better integration in the community.



## Panel Discussion: Person-Centred Population Health

Moderator:  
Prof Julian Thumboo (SingHealth)

Discussants:  
Dr Benjamin Koh (MOH)  
Prof Adrian Hernandez (Duke University)  
A/Prof Josip Car (NTU)  
Prof Marcus Ong (Duke-NUS)



During a panel discussion involving Prof Julian Thumboo (SingHealth), Dr Benjamin Koh (MOH), Prof Adrian Hernandez (Duke University), A/Prof Josip Car (NTU) and Prof Marcus Ong (Duke-NUS), the speakers responded to questions from the audience and shared about their experiences and challenges, as well as unique solutions to resolve them.

Prof Tazeen Jafar and Prof Eric Finkelstein from HSSR, Duke-NUS spoke about chronic disease prevention and management while Dr Agnes Koong (SingHealth), A/Prof Janet Bettger (Duke) and Dr Daphne Khoo (MOH) spoke about complexity of care in the community, and implementation science involved in accelerating evidence into public health and healthcare at scale. Prof David Matchar (Duke-NUS), Dr Low Lian Leng (SingHealth), Prof Marcus Ong (Duke-NUS) and Dr Kelvin Bryan Tan (MOH) spoke about how data and data science can be put into practice to assess and improve population health. A/Prof Yan Lijing (Duke Kunshan), A/Prof Ng Yee Sien (SingHealth), Asst Prof Chetna Malhotra talked about aging, and care at the end of life. Prof Cheung Yin Bun and Asst Prof Rahul Malhotra (Duke-NUS) shared with the participants on tools for measuring population health.

It was an exciting symposium and many of the participants from within and outside of the SingHealth Duke-NUS Academic Medical Centre had an enriching experience through a day of knowledge sharing from various stakeholders.

Dr Benjamin Koh, Deputy Secretary (Development), MOH, shared with the audience on how MOH set up the Regional Health Systems (RHS) for integrating care across the care continuum with the aim of improving population health. Dr Koh also shared on MOH major priorities in population health planning, and how MOH data can be used to formulate a more targeted population health strategy.



Prof Adrian Hernandez, Vice Dean, Clinical Research, Duke University, focused on the opportunities and challenges for developing evolutionary to revolutionary healthcare while catalyzing biomedical advances that lead to improved health. He also shared with the participants new models that Duke University is using to enable a learning health system.





## WORKSHOP: PLUS DATA SCIENCE

8-12 Jul 2019 & 3-7 Feb 2020

About 120 healthcare professionals attended the “Plus Data Science Workshop” organised by Duke-NUS Programme in Health Services & Systems Research (HSSR) and SingHealth Health Services Research Centre (HSRC) on 8-12 July 2019. The 5-day workshop was facilitated by 6 Duke University faculty members. It focused on machine learning for clinical practice.

The workshop commenced with a Welcome Address by Prof Marcus Ong, Director of both Duke-NUS HSSR and SingHealth HSRC. He shared that the workshop was a joint initiative between Duke-NUS, SingHealth, and Duke University. He briefly introduced the 6 Duke University faculty members (i.e. Prof Lawrence Carin, Asst Prof David Carlson, Asst Prof Ricardo Henao, Dr Johnny Sigman, Dr Tim Dunn and Dr Matthew Engelhard). Prof Lawrence Carin, Vice Provost for Research, Duke University, gave an Opening Remark. He spoke about the increasing importance of data science particularly in healthcare, and how the applications of machine learning tools have a growing impact in the clinical setting.

Over the course of the 5-day workshop, participants learned about a different area of machine learning each day.

### Day 1

Asst Prof David Carlson gave an introduction on the concept of Deep Learning and shared many interesting examples of its applications including image recognition via the ImageNet Challenge. Asst Prof Ricardo Henao then worked participants through the case study of using machine learning to make predictions from electronic health records. Dr Johnny Sigman wrapped up the first day by briefly introducing the concept of “TensorFlow” to the participants.



### Day 2

Dr Tim Dunn lectured on some important applications of Deep Learning in image analyses and spoke about Convolutional Neural Networks (CNNs) which have greatly showed capabilities beyond human performance for image analyses. Dr Matthew Engelhard then shared with participants on the applications of CNNs to health such as detection of diabetic retinopathy and segmentation of biomedical images. Dr Johnny Sigman ended the second day by sharing how TensorFlow is used for image classification with CNNs.

### Day 3

Prof Lawrence Carin spoke about the basics of “Natural Language Processing” (NLP) and its applications such as text translation, automatic text synthesis, automatic image captioning, etc. Asst Prof David Carlson shared some applications of machine learning in neuroscience, as well as in electronic health records and psychiatric assessment.

### Day 4

Asst Prof Ricardo Henao introduced Generative Adversarial Network (GAN) and spoke about the different perspectives of GAN as well as shared its applications such as survival analysis and imputation of missing data.



### Day 5

Prof Lawrence Carin summed up the workshop by speaking about Reinforcement Learning for sequential decision-making, with applications to sepsis management and closed-loop blood glucose control (i.e. artificial pancreas).

The daily lectures were followed by hands-on sessions where participants got to work on case studies and code in Python. Case studies such as using machine learning to make predictions from electronic health records and methods for object detection in images were all highly applicable in the clinical setting, allowing participants to greatly appreciate the usefulness of data science in solving real problems.

It was an exciting week for the participants who learned how the substantial and rapidly-improving ability of artificial intelligence can be used to make effective predictions based on clinical data, to improve patient care. 7 months later, HSSR organized a second run of the 5-day workshop with local customisation which was also very well received by healthcare professionals.



### Things to consider

- Quality Improvement versus research
- QI objective address need of local situation
- Research seeks to address problems that will provide generalizable results
- QI can be considered research if
  - 1) the tested intervention involves a deviation from established practices
  - 2) individual patients are subject
  - 3) randomization or blinding is conducted
  - 4) Participants are subjected to additional risks/burdens beyond usual practice.

## WORKSHOP:

# IMPLEMENTATION SCIENCE

7-9 May 2019

Implementation Science seeks to understand the processes and factors that are associated with successful integration of evidence-based interventions within a particular setting, with the aim of improving healthcare. Around 50 healthcare professionals attended the 3-day "Implementation Science Workshop" organized by the Programme in Health Services & Systems Research (HSSR) on 7-9 May 2019. It was a joint effort between Duke-NUS, Duke University, and SingHealth. Participants were immersed in the new field of Implementation Science through didactic lectures and small group discussions. Both basic topics (e.g. introduction, significance, frameworks and outcomes of Implementation Science) and practical topics (e.g. stakeholder engagement, sustainability and policy implications) have been well covered. To help participants implement what they learnt in the workshop, they were asked to work on a project in which they were trying to implement an intervention or service before the workshop, which was discussed during the small group discussion. As a workshop follow-up, participants were offered the opportunity to be matched with a mentor in applying Implementation Science to their projects.

# CONTACTS



**Katherine Wang, PhD, PMP**  
Associate Director

[katherine.wang@duke-nus.edu.sg](mailto:katherine.wang@duke-nus.edu.sg)

Katherine obtained her PhD degree in Biology from New York University (NYU), USA in Jan 2010. She published first-authored papers in peer-reviewed journals. She worked at A\*STAR and NUS for over 6 years, where she accumulated substantial experience in research, administration, and project management. Since she joined Duke-NUS in October 2016, she has played important roles in the successful development of multiple new programmes including the PhD Programme in Clinical Sciences (PhD-CS), the Pre-hospital & Emergency Research Centre (PERC), the Graduate Certificate Programme in Health Services Innovation (GCP-HSI), and Women-in-Science (WinS) Network.

She is currently leading the administrative functions for 3 departments i.e. the Programme in Health Services & Systems Research (HSSR), the Centre for Quantitative Medicine (CQM), and PERC. She also organised multiple academic events e.g. international symposiums and workshops which were well received by healthcare professionals.



**Geraldine Koh, MSc**  
Senior Executive

[geraldine.koh@duke-nus.edu.sg](mailto:geraldine.koh@duke-nus.edu.sg)

Geraldine obtained her Master degree in Business Analytics from National University of Singapore (NUS), in Aug 2019. Prior to that, she worked at the research office in NIE for 3 years, where she has gained valuable experiences and skills in finance, research administration and project management. Her current portfolio involves providing support in the areas of data management and analytics as well as research and general administration for the department.



**Mohammad Faris Bin Mohd Ibrahim, BSc**  
Executive

[mohd.faris@duke-nus.edu.sg](mailto:mohd.faris@duke-nus.edu.sg)

Faris obtained his Bachelor's degree in Chemistry from National University of Singapore (NUS) in July 2017. He worked at SingHealth for almost 2 years, where he gained good experience in clinical project coordination and research administration.

Faris joined HSSR, Duke-NUS in May 2019. He is responsible for the day-to-day operations and administrative functions in HSSR. He provides oversight in the areas of grant management, events management, finance and procurement processes, and office management. His work also includes writing HSSR reports as well as constantly updating the HSSR website.





**DukeNUS**  
Medical School

Health Services &  
Systems Research

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