



# Evaluating Variable Importance to OHCA Outcome Prediction: An Interpretable Machine Learning Approach

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# Outline of Proposal

- ▶ Introduction
- ▶ Aims/Hypotheses
- ▶ Methods
- ▶ Significance

# Introduction



- Understanding factor impact on OHCA outcomes can help improve medical interventions and public health policies.
- Existing evidence for Pan-Asian communities is mostly generated from regression analyses of PAROS data.
- Statistically significant association is not equivalent to strong impact on the probability of developing an outcome.

# Introduction

Al-Dury et al. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*  
(2020) 28:60  
<https://doi.org/10.1186/s13049-020-00742-9>

Scandinavian Journal of Trauma,  
Resuscitation and Emergency Medicine



ORIGINAL RESEARCH

Open Access

## Identifying the relative importance of predictors of survival in out of hospital cardiac arrest: a machine learning study



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- A recent work trained a machine learning (ML) model for OHCA outcome, and quantified **relative** variable important based on the ML model.
- Unable to assess if a factor is important to the outcome.
- How confident are we on findings from a single ML model?
- How do findings based on a ML model connect with existing evidence from regression analyses?

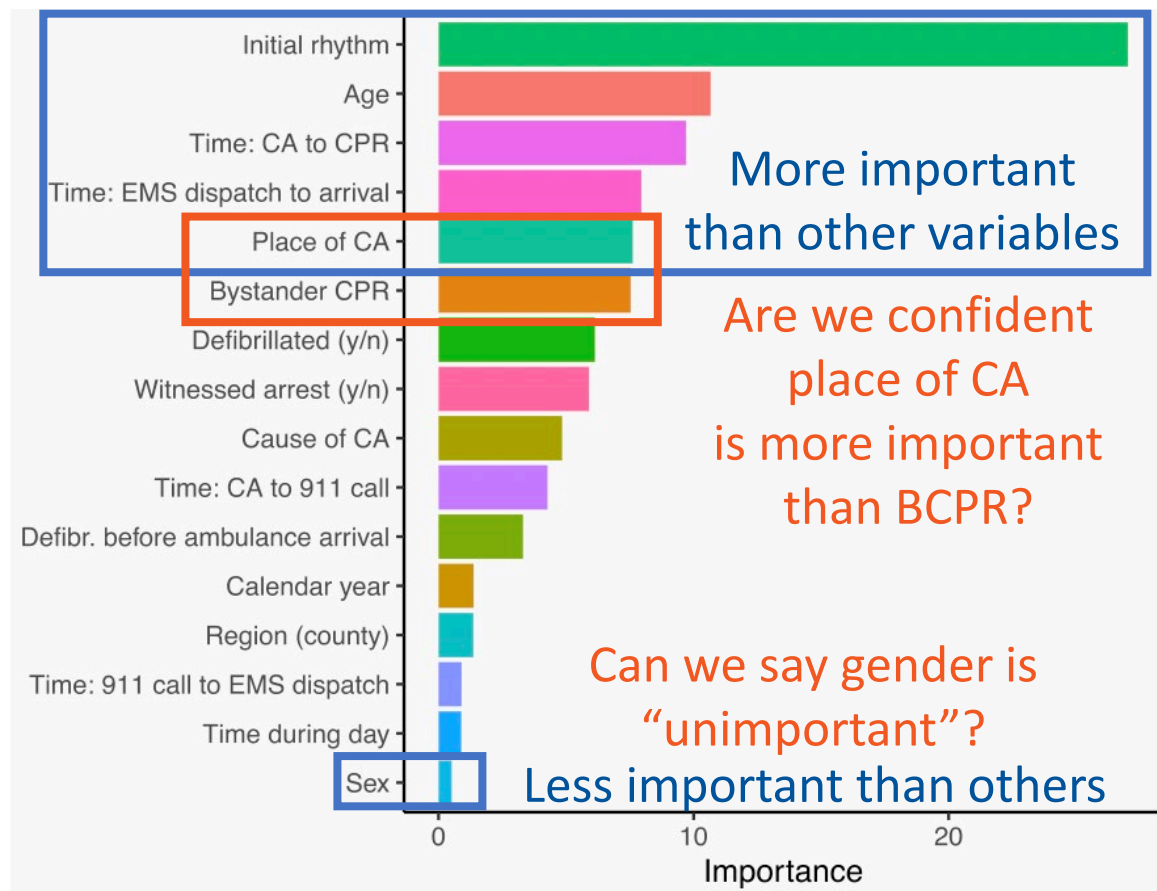
# Aims/ Hypothesis

- To assess variable importance to prediction of OHCA outcomes in Pan-Asian communities using an interpretable machine learning (IML) approach.
- Specifically, we aim to:
  - Provide robust estimates of variable importance not biased towards any single model.
  - Assess significance of overall variable importance with statistical evidence.
  - Evaluate variable importance with respect to regression models to avoid practical gap.

# Methods

- Small effect sizes can become statistically significant in a regression analysis of a large sample.
- IML methods assess variable importance directly based on the impact on predicted probabilities, based on **the best model** trained from data.

## Variable importance based on a random forest (RF)



Al-Dury et al (2020)

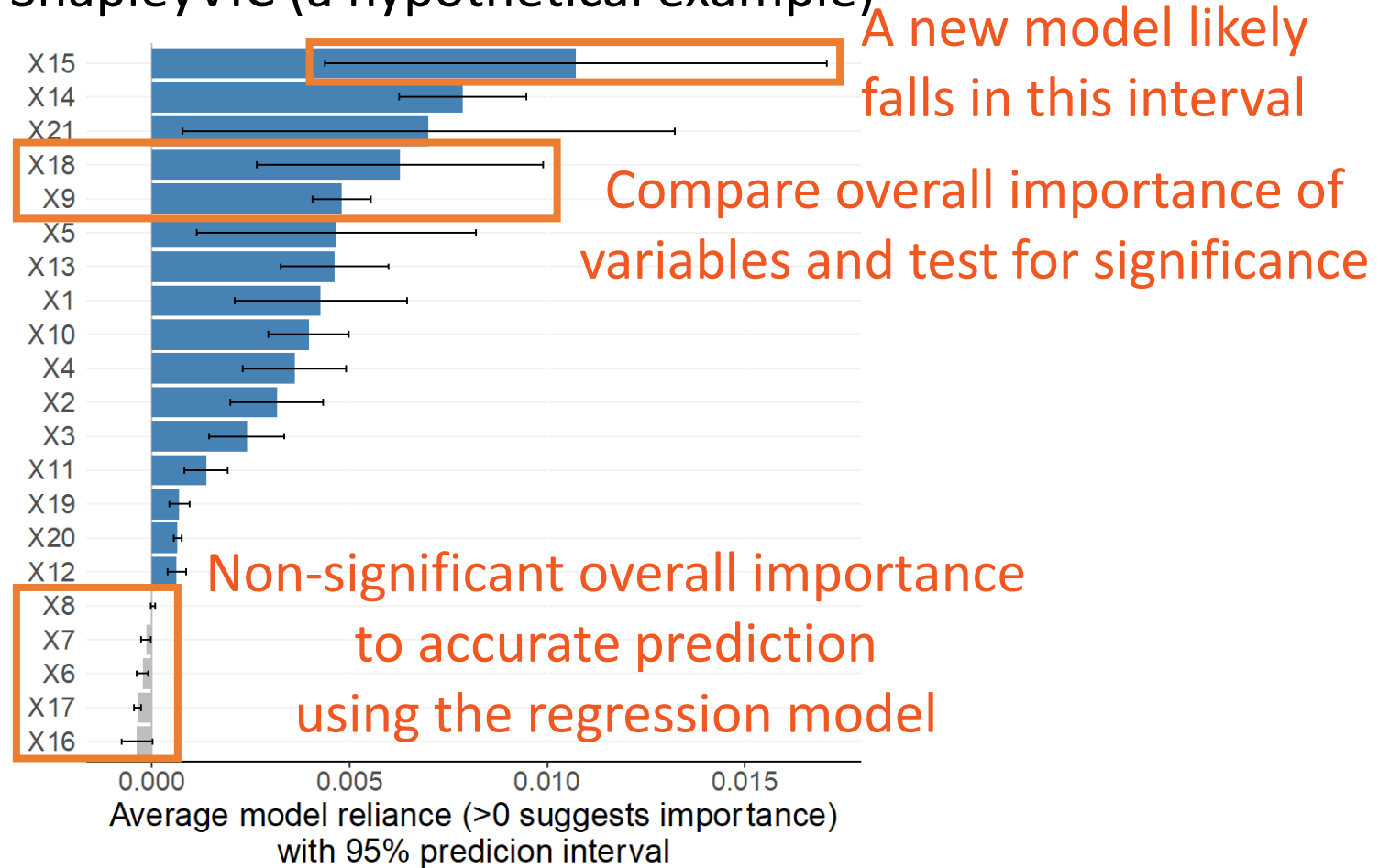
# Methods

- We will use the recently developed **Shapley variable importance cloud (ShapleyVIC)** to overcome these limitations.
- In practice, prediction models only need to be **good enough** to be useful.
- ShapleyVIC assesses variable importance from **a group of “good models”**:
  - Performs a meta-analysis of variable importance across “good models” for improved robustness.
  - Quantifies uncertainty in overall variable importance for rigorous statistical inference.
  - Directly assesses variable importance to regression models for straightforward interpretation and practical implication.

# Methods



Overall variable importance assessed using ShapleyVIC (a hypothetical example)





# Methods

- We will conduct retrospective analyses of the PAROS 2 dataset, excluding pediatric victims (aged below 18 years) or OHCA cases without resuscitation.
- Outcomes of interest include survival to hospital discharge, survival with good neurological outcomes.
- We will include factors in the dataset that have been previously investigated for relationship with OHCA outcomes.
- We will perform stratified analyses to investigate and discuss the differences across Pan-Asian communities.




# Significance

- Provide statistical evidence for current perceptions on factor importance to OHCA outcomes, which may resolve conflicts in existing findings, e.g., on gender of OHCA patients.
- Provide robust data-driven evidence on variable importance to OHCA outcomes across Pan-Asian communities to better inform medical and public health interventions.



Thank you



# "The Asian EMS personnel preparedness and response to OHCA during the COVID 19 Pandemic"

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# Outline of Proposal

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# Introduction

- Emergency Medical Services personnel play a vital role in patient outcomes and are often the first healthcare providers to make contact with COVID-19 patients (Gibson et. al, 2020)
- The CDC has provided an Interim guidance for EMS professionals amid the COVID-19 pandemic
- AHA also released a guideline in resuscitation during the pandemic.





# Aims/ Hypothesis

## Objective

To determine the preparedness and response of EMS Personnel in OHCA during the COVID 19 Pandemic.

## Specific Objectives:

1. To determine the knowledge and practice of EMS personnel in basic and advance life support in responding to OHCA during the COVID 19 pandemic.
2. To determine the knowledge and practice of EMS personnel in the proper safety measures in responding to OHCA during the COVID 19 pandemic.
3. To determine the attitudes of EMS personnel in their response to OHCA during the COVID 19 pandemic



# Methods

- Descriptive study
- Structured, content validated questionnaire distributed to the EMS personnel of participating countries in Asia
- Purposive sampling
- Study Period: March 2022 – November 2022
- Inclusion: EMS personnel including the first responders, EMTs, Paramedics and physicians who were actively responding to OHCA during the COVID 19 Pandemic
- Exclusion: EMS personnel not involved in responding to OHCA during the COVID 19 pandemic.



## SPECIAL REPORT

2022 Interim Guidance to Health Care Providers for Basic and Advanced Cardiac Life Support in Adults, Children, and Neonates With Suspected or Confirmed COVID-19: From the Emergency Cardiovascular Care Committee and Get With The Guidelines-Resuscitation Adult and Pediatric Task Forces of the American Heart Association in Collaboration With the American Academy of Pediatrics, American Association for Respiratory Care, the Society of Critical Care Anesthesiologists, and American Society of Anesthesiologists



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# Significance

- Determining the preparedness/response of the EMS personnel in OHCA during the COVID 19 pandemic.
- Assess the needs and improvement needed by the EMS personnel.
- Outcomes of this study will be the basis for augmenting the training, physical and emotional/mental needs of the EMS personnel during times of pandemic.



**Salamat po!**

A map of the Asia-Pacific region, including parts of Europe, Africa, and Australia. Several countries and regions are highlighted in a light red color, indicating the focus of the PAROS studies. These include Turkey, Japan, South Korea, the Philippines, Indonesia, and parts of Australia and New Zealand. Labels for the Black Sea, Arabian Sea, Bay of Bengal, and East China Sea are visible on the map.

# Summary: PAROS Studies Update



**Published !**

Resuscitation. 2022 Feb;171:80-89. doi: 10.1016/j.resuscitation.2021.12.032.

**International multi-center real world implementation trial to increase out-of-hospital cardiac arrest survival with a dispatcher-assisted cardio-pulmonary resuscitation package (Pan-Asian resuscitation outcomes study phase 2)**

Marcus Eng Hock Ong, Sang Do Shin, Patrick Chow-In Ko, Xinyi Lin, Matthew Huei-Ming Ma, Hyun Wook Ryoo, Kwanhathai Darin Wong, Jirapong Supasaowapak, Chih-Hao Lin, Chan-Wei Kuo, Ramana Rao, Wenwei Cai, Faith Joan Gaerlan, Munawar Khursheed, Do Ngoc Son, Karim Sarah, Mazen El Sayed, Saad Al Qahtani, Hideharu Tanaka

# Proposals Withdrawn

- due to timeline and lack of progress/ request by PI



Study Title	Date of Approval	First Author	Status updates_2022	Topic Status
Time Interval between Collapse and Return of Spontaneous Circulation between Various Outcomes in OHCA	June 2014	Dr Andrew Ho	Withdrawn 2021	Open to all
Epidemiology of OHCA between developing and developed countries	Aug 2016	Dr Takahiro Hara	Withdrawn 2021	Open to all
The Outcomes of Traumatic or Injured OHCA and Ventricular Fibrillation	Aug 2016	Dr Patrick Ko Dr Yen-Pin Chen, Dr Sot Shih-Hung Liu	Withdrawn 2021	Open to all
Gender difference in out-of-hospital cardiac arrest survival by region in Asian countries	Feb 2018	Dr Lee Sun Young	Request to withdrawn 2021	Open to all
Percutaneous coronary intervention provision and outcomes among cardiogenic OHCA in Asian countries	July 2017	Dr Takashi Tagami	To be withdrawn	Open to all

# Study Updates



Study Title	Approval	First Author	Status updates_2022
Predictive performance of Termination-Of-Resuscitation (TOR) rules in Asia: Are They Accurate Enough?	April 2014	Dr Huang Yu-Sheng Dr Chiang Wen-Chu	Submitted an extension of the study to include PAROS 2 data
Factors Influencing Bystander Cardiopulmonary Resuscitation and the Related Outcomes across PAROS Communities	Nov 2015	Dr Jonathan Lu	Data analysis completed and manuscript under preparation. Pending abstract submission to AHA ReSS 2022 and manuscript to Resuscitation.
Resuscitation Academy (RA) 10-Step Implementations in the Pan-Asian Resuscitation Outcomes Study (PAROS) group	Aug 2016	Dr Marcus Ong	Ongoing
Environmental exposure as a risk factor for out-of-hospital cardiac arrest	Feb 2018	Dr Andrew Ho	Manuscript completed, clearing NEA for submission

Study Title	Approval	First Author	Status updates_2022
Interaction effect of bystander CPR on the association between time from call to first rhythm analysis and shockable presenting rhythm after out-of-hospital cardiac arrest	Feb 2018	Dr Jeong Ho Park	Ongoing
The effect of initial ECG rhythm on the association between bystander cardio-pulmonary resuscitation (CPR) and outcomes after out-of-hospital cardiac arrest (OHCA)	Feb 2018	Dr Jung Eujene	
Basic versus Advanced Life Support in Out-of-Hospital Cardiac Arrest: A Retrospective Study of the Pan-Asian Resuscitation Outcomes Study (PAROS) Registry Population	Feb 2018	Dr Mazen El-Sayed	
Utstein Factors and Outcomes in Traumatic Out-of-Hospital Cardiac Arrests	Feb 2018	Dr Chia Yih Chong Michael	Manuscript completed, “Characteristics and outcomes of traumatic cardiac arrests in the Pan Asian Resuscitation Outcomes Study”. Manuscript submitted to a few journals but were rejected. Still trying.





Study Title	Approval	First Author	Status updates_2022
Pre-hospital Advanced Airway and Survival Outcomes after Paediatric Out-of-Hospital Cardiac Arrests.	Feb 2018	Dr Tham Lai Peng	Manuscript submitted and pending review.
The impact of early coronary angiography on clinical outcomes in out-of-hospital cardiac arrest	Feb 2018	Dr Lim Shir Lynn	Published in J Clin Med. 2021. Early coronary angiography is associated with improved 30-day outcomes among patients with OHCA
Monitoring the brain after cardiac arrest	Feb 2018	Dr Lim Shir Lynn	Compiling data. Data analysis should be completed by Q3 2022.
Variability of a first responder dispatch after out-of-hospital cardiac arrest among Asian countries	Jun 2019	Dr Sattha Riyapan	Ongoing
Emergency department factors and outcomes of adult and paediatric out-of-hospital arrests in Pan-Asian Countries	Jun 2019	Dr Gene Ong	
Development and Validation of a Predictive Model for Early Neuro-Prognostication after OHCA	Jun 2019	Dr Liu Nan	Analysis ongoing

Study Title	Approval	First Author	Status updates_2022
Comprehensive Prehospital Intervention for Heat Wave Victims	Jun 2019	Prof Marcus Ong, Dr Gayathri Nadarajan, Dr Ramana Rao, Dr Keshav Reddy	Nadarajan GD, Rao GR, Reddy K, Gimkala A, Janumpally R, Ang Y, Woo CTZ, Neo TH, Wong XY, Ong MEH. Characteristics of Prehospital Heat Illness Cases During the Annual Heat Wave Period in Telangana, India. Prehosp Disaster Med. 2021 Aug;36(4):385-392. doi: 10.1017/S1049023X21000583. Epub 2021 Jul 9. PMID: 34238399.
Protocol development for Video-Call based DACPR	Jun 2019	Dr Tae Han Kim	
Gender Disparities Among Recipients of Bystander CPR and AED in Pan-Asian Communities	Oct 2019	Dr Liu nan	Published. <a href="https://www.sciencedirect.com/science/article/pii/S2589537022000232">https://www.sciencedirect.com/science/article/pii/S2589537022000232</a>
Development and Validation of the Pan-Asian ROSC After Cardiac Arrest (PA-RACA) Score	Aug 2020	Dr Liu Nan	Manuscript under review
Use Artificial Intelligence and Deep Learning to Predict Clinical Outcomes for Out-of-Hospital Cardiac Arrest Patients	Aug 2020	Dr Liu Nan	Analysis ongoing



Study Title	Approval	First Author	Status updates_2022
Outcomes of OHCA patients stratified by mode of transport to the ED in Asia	Aug 2020	Dr Ivan Chua	
Descriptive comparison of OHCA survival and predictors amongst the geriatric age group in Asia	Aug 2020	Dr Gayathri	
Proposal for GRA Assessment Tool study	Aug 2020	Dr Gayathri	
Adult OHCA during COVID-19	Aug 2020	Dr Lim Shir Lynn	Data collection in progress
Paediatric OHCA during COVID-19	Aug 2020	Dr Kenneth Doya G. Nonesa	
Early vs Late Endotracheal Intubation among Out-of-Hospital Cardiac Arrest Patients in Pan-Asian Countries in the time of COVID-19 Pandemic	Aug 2020	Dr Daniel Unno H. Hiquiana	Study submitted to DOH CERC February 2022 for Closure  Early versus Late Endotracheal Intubation among Out-of-Hospital Cardiac Arrest Patients in SPMC in the time of COVID-19 Pandemic
Temporal trends of non-shockable out-of-hospital cardiac arrest in Asia	Dec 2020	Dr Lim Shir Lynn	Data from Singapore obtained. Analysis is ongoing



Study Title	Approval	First Author	Status updates_2022
Trends of DA-CPR and bystander CPR rates in OHCA patients between intervention groups (basic, comprehensive, control) of DA-CPR Resuscitation Package	2021	Ng Wei Lin	
# The Validation and Development of Termination-of-Resuscitation (TOR) rules in Patients Following Out-of-Hospital Cardiac Arrest (OHCA) in Asia Countries	2021	Hsu, Shu-Hsien, Chiang Wen-Chu	
Universal Termination of Resuscitation (TOR) rules and health economic outcomes if TOR is applied to the Out-of-Hospital Cardiac Arrest (OHCA) patients in Asia	2021	Gayathri Devi Nadarajan	
Pre-hospital airway for out-of-hospital cardiac arrest	2021	Hansol Chang	
Developing a Time-Adaptive Prediction Model for Out-of-Hospital Cardiac Arrest: using PARSOS data	2021	Ji woong Kim, Won Chul Cha, Hansol Chang	



<b>Study Title</b>	<b>Approval</b>	<b>First Author</b>	<b>Status updates_2022</b>
Universal termination of resuscitation (TOR) rule predicts neurologically favorable outcome in Asian countries	2021	Kentaro Kajino	Analysis in progress
Association between drug administration and outcome after out-of-hospital cardiac arrest	2021	Tatsuya Kaito, Hideharu Tanaka	In progress
Association between advanced airway management and outcome after out-of-hospital cardiac arrest - propensity score analysis	2021	Koshi Nakagawa, Hideharu Tanaka	Ongoing
Verification of the effect of introducing DA-CPR comprehensive package – a regression discontinuity design	2021	Koshi Nakagawa, Hideharu Tanaka	Ongoing



Thank you