



Prehospital prediction **Of** severe injury in road traffic injuries

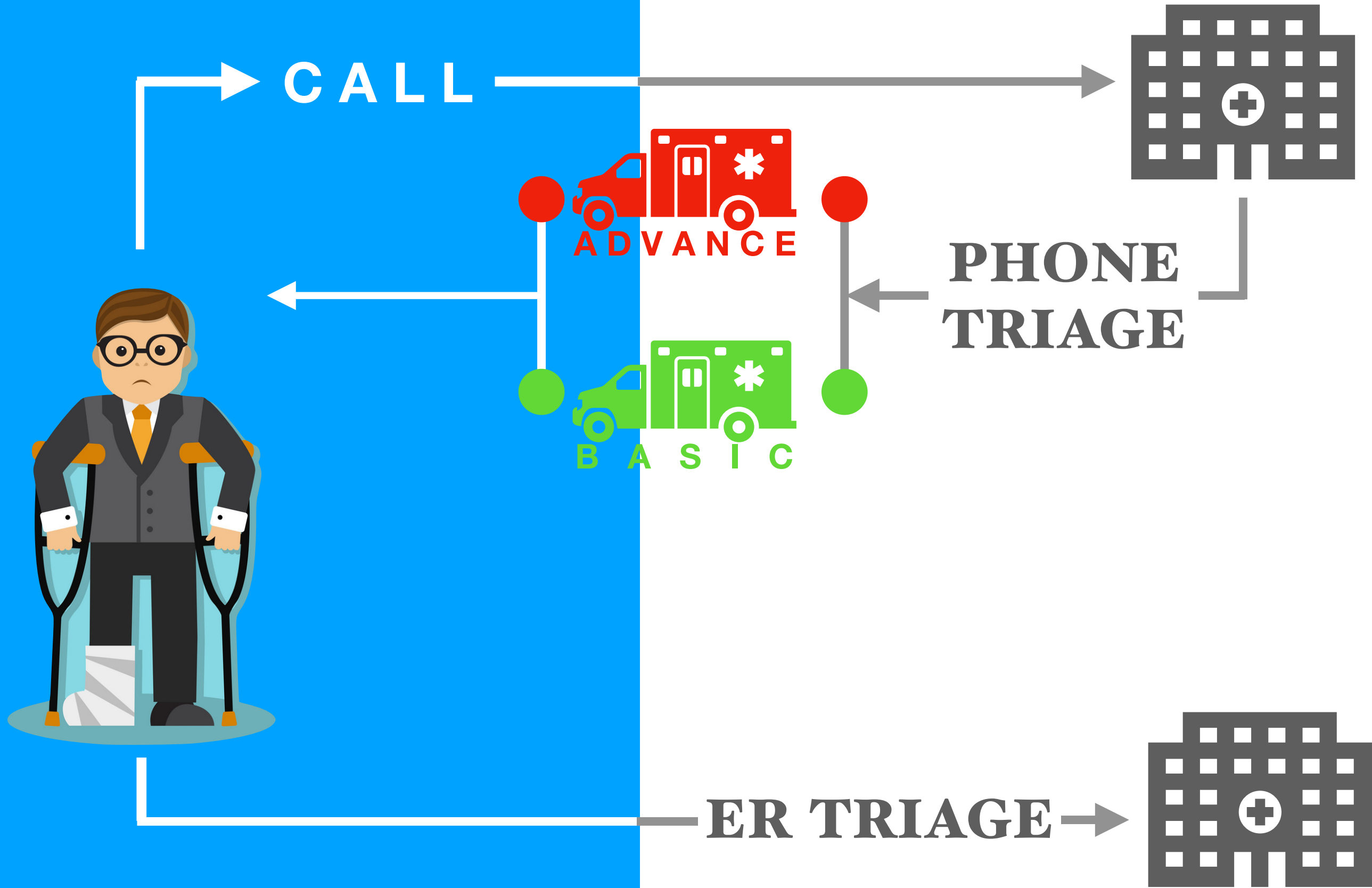
Pongsakorn Atiksawedparit, M.D.

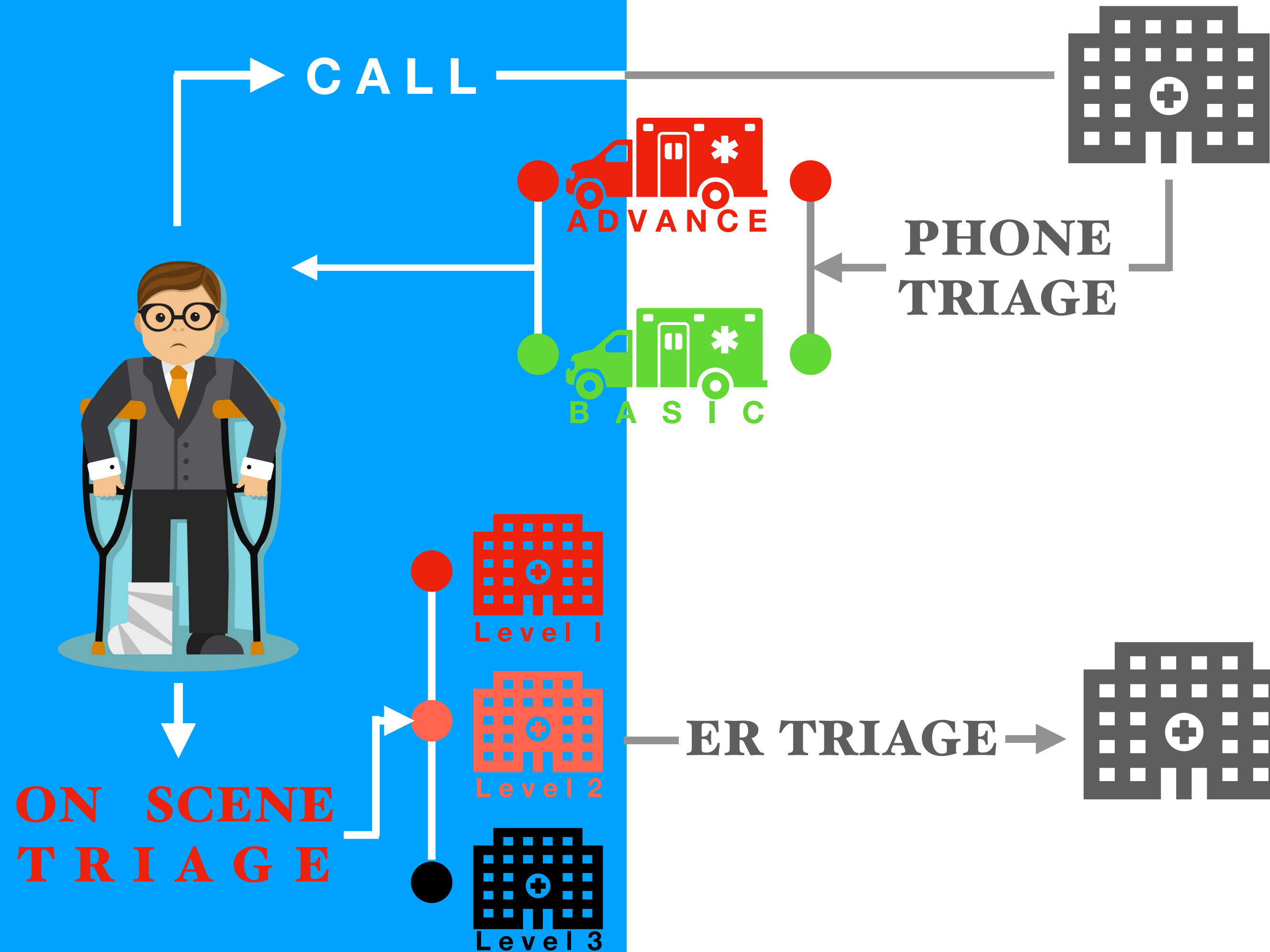
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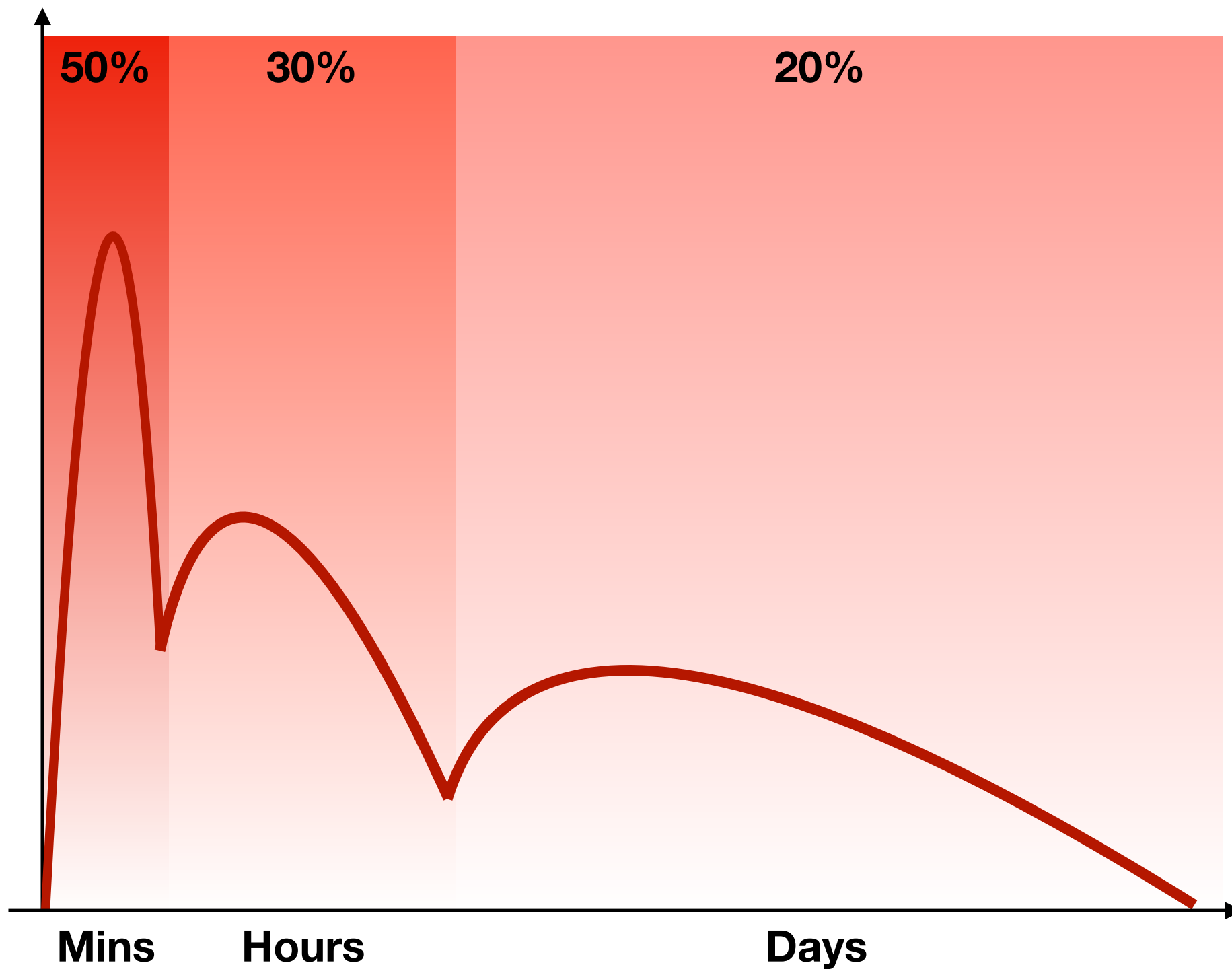




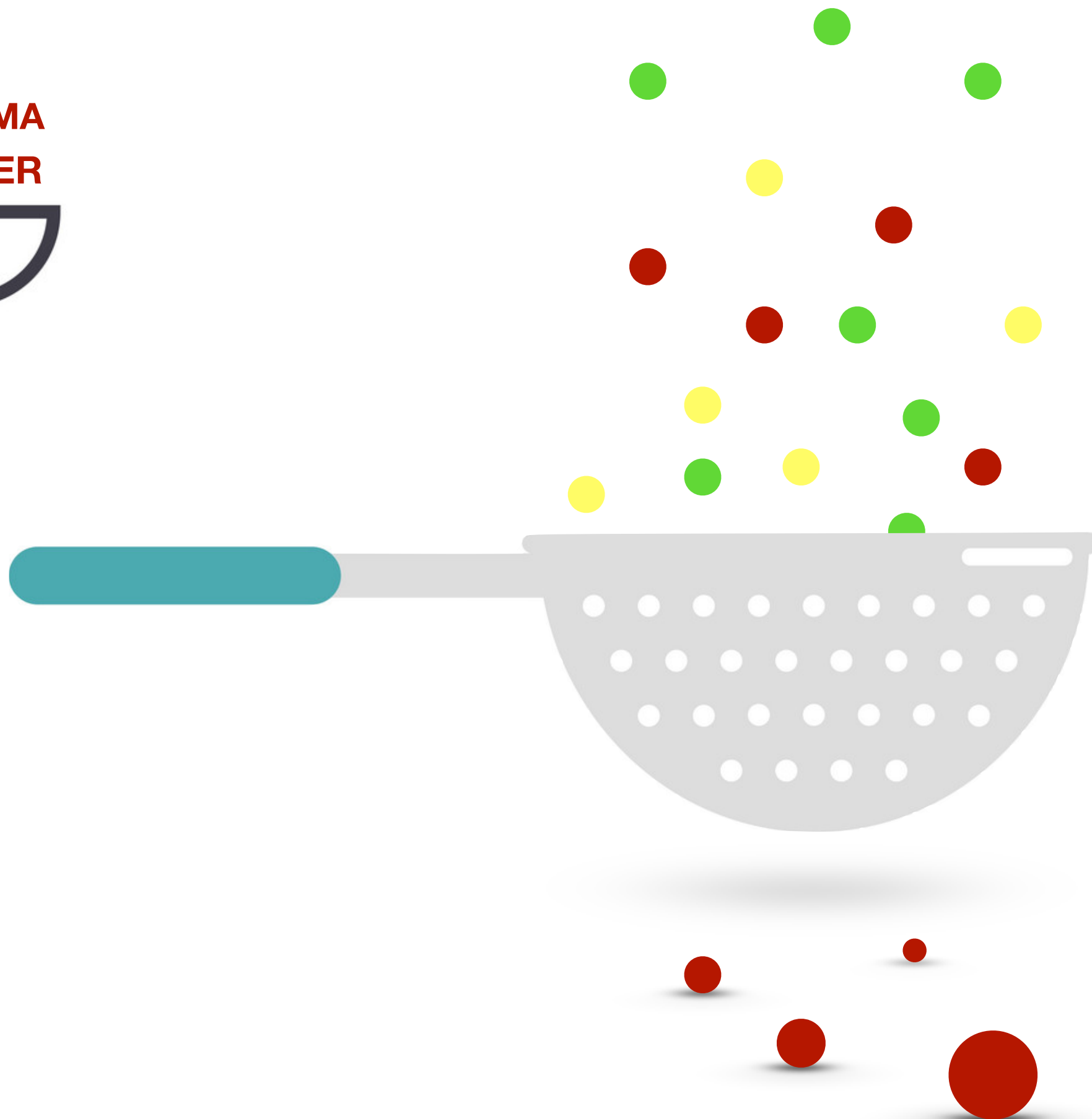
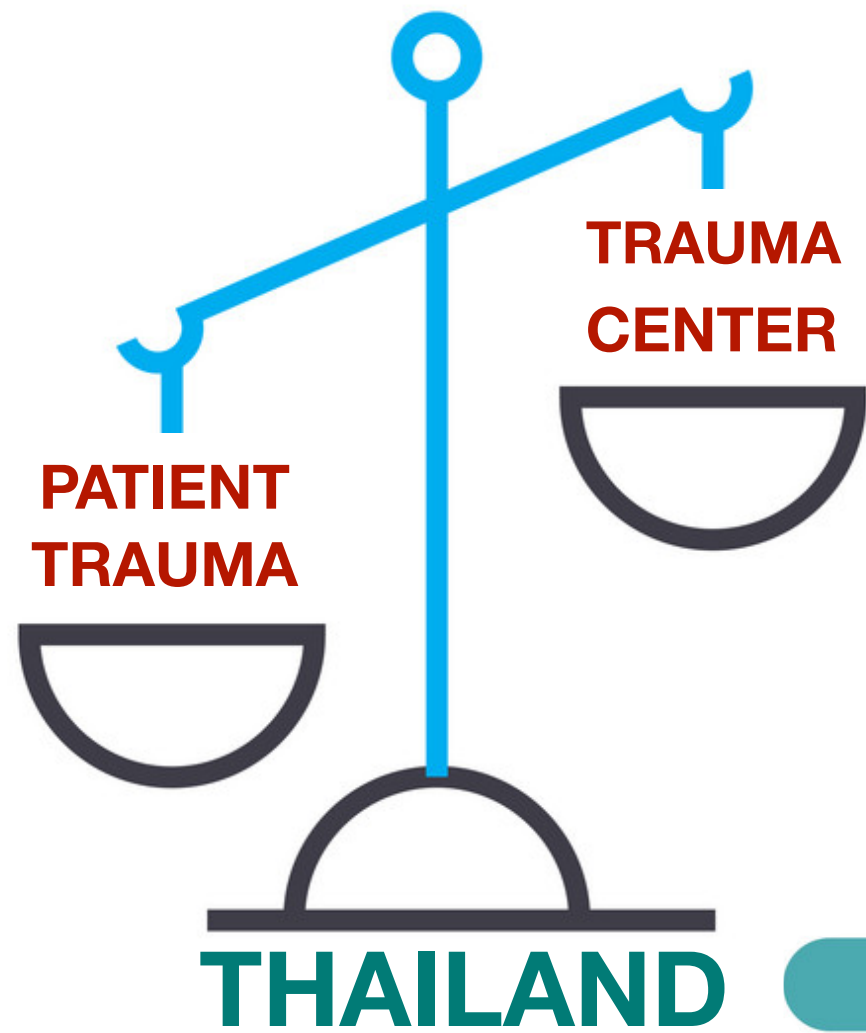
EMS Requests



63%
Injury related death in Thailand, 2012



- Prehospital care
- **Transportation to appropriate hospital**



❖ — Systematic review — ❖

Models	Predictors							AUC of ROC
	Subjects	Outcomes	Physiology	Age	ISS	Crash characteristics	EMS operation	
RTS	General	Death	• SBP, RR, GCS	-	-	-		0.69 to 0.86
TRISS	General	Death	• SBP, RR, GCS	Yes	Yes	-		
TRISS liked	General	Death	• SBP • BMR	Yes	Yes	-		
Triage decision scheme	General	SI	• SBP, RR, GCS	Yes	-	Yes		
Newgard, 2002	Children	SI	GCS	-	-	• Restrain devices • Intrusion		
Scheetz, 2007	General	SI	-	-	-	• Extrication • Direction of collision • Numbers of victim		
Scheetz, 2009	General	SI	-	Yes	-	• Direction of collision • Number of victim		
Kashani, 2005	General	SI	-	-	-	• Restrain devices • Crash cause • Crash location		
Ayoung-chee, 2013	General	SI				• Ejection • Intrusion		

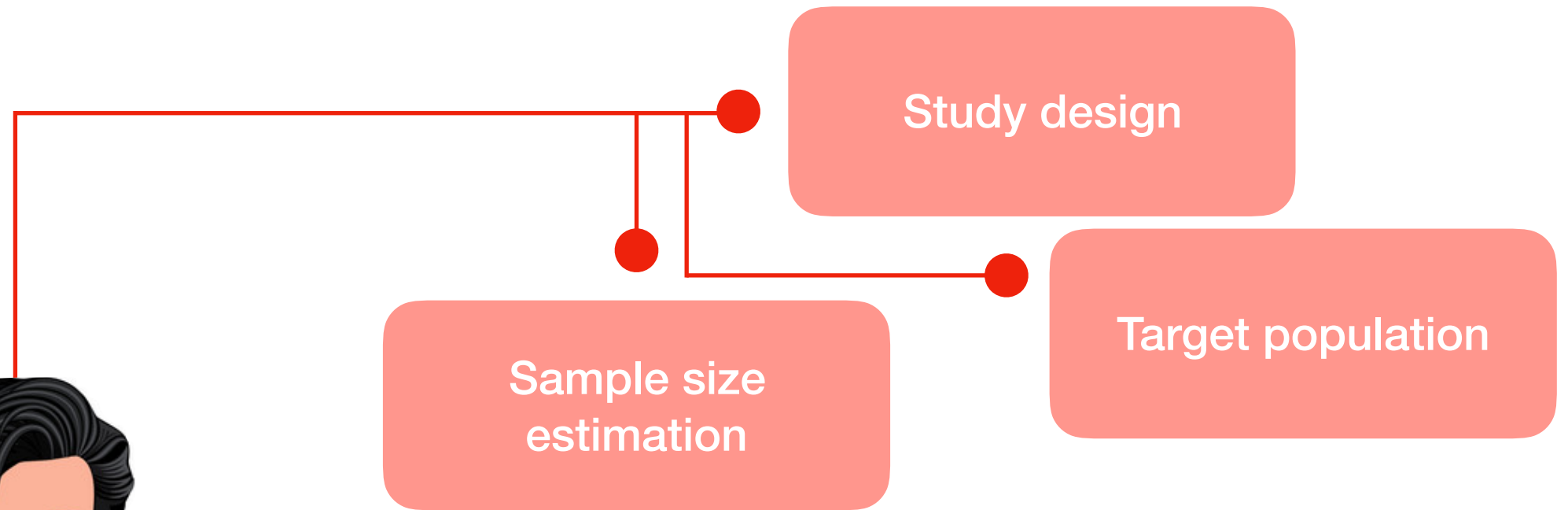
To improve the model;

- Considering other important predictors
- Applying appropriate statistical method
- Including adequate sample size

❖ – Objectives – ❖

To develop, internally and externally validate a risk stratification model of death and SI in RTI patients for transportation to TC

— ❖ — **METHODS** — ❖ —





Multi-center cross sectional study

Criteria for selection study provinces

- High density of RTI cases treated by advanced life support (ALS) response unit
- Having emergency physician (EP) as medical director
- Having EMS information system

Inclusion criteria

1. Age 15 years old or older
2. RTI patients who were operated by ALS response unit under DC and transported to hospital

Exclusion criteria

1. Had at least one sign of irreversible death as the following criteria:
 1. Decapitation
 2. Incineration (Burning of whole body completely)
 3. Separation or destruction of heart or brain
 4. Rigor mortis (presence of the stiffness of joint and muscle of dead body)
 5. Lividity (presence of the bluish appearance on skin of dependent part of dead body)
2. Denied EMS treatment or transportation to hospital

Pooled prevalence of SI: 12.7%

**Estimation
of
proportion**

**IV fluid vs outcomes
ITEMS, 2012**

**2 proportions
Comparison**

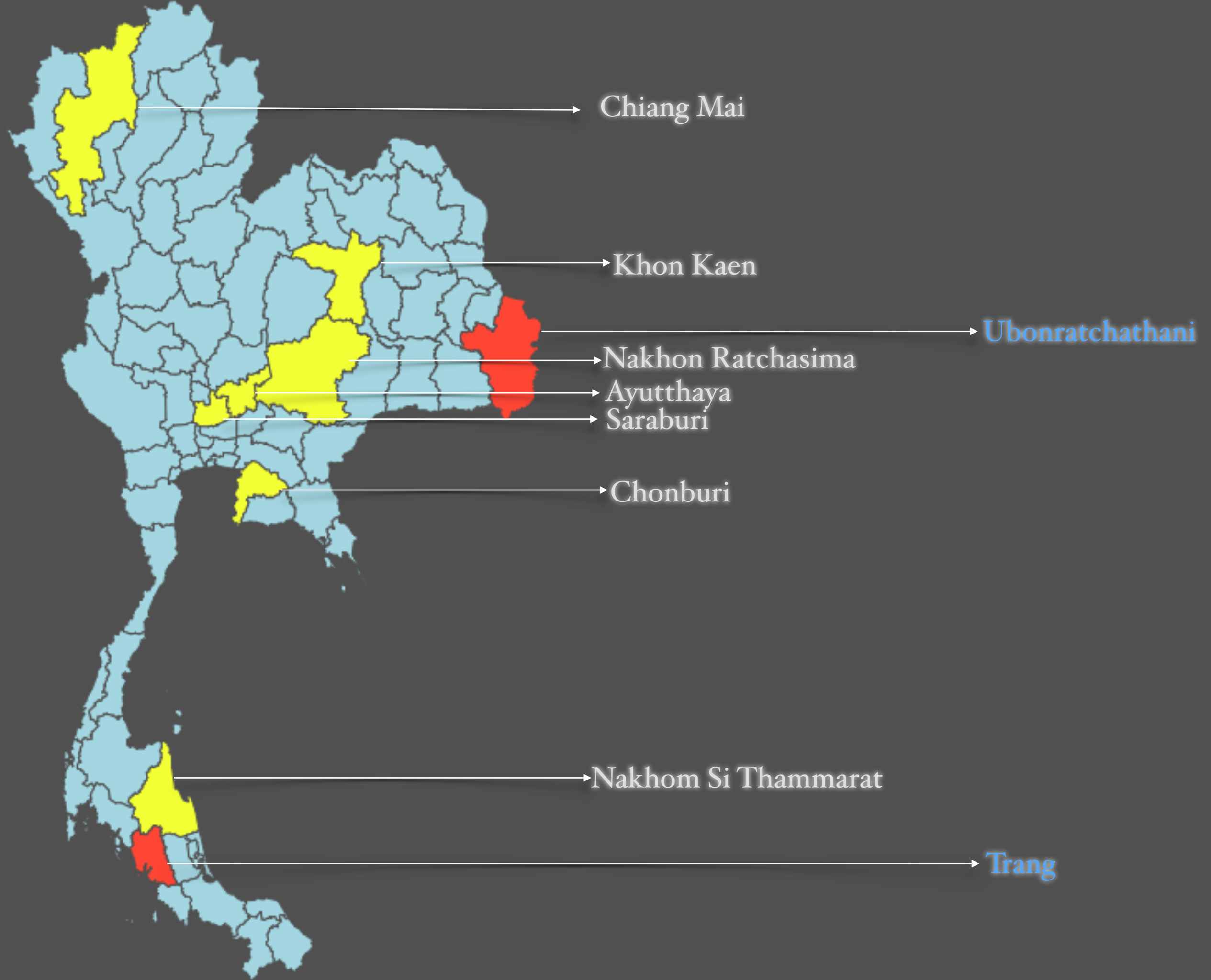
**Valid
Construction
of logistic
regression
model**

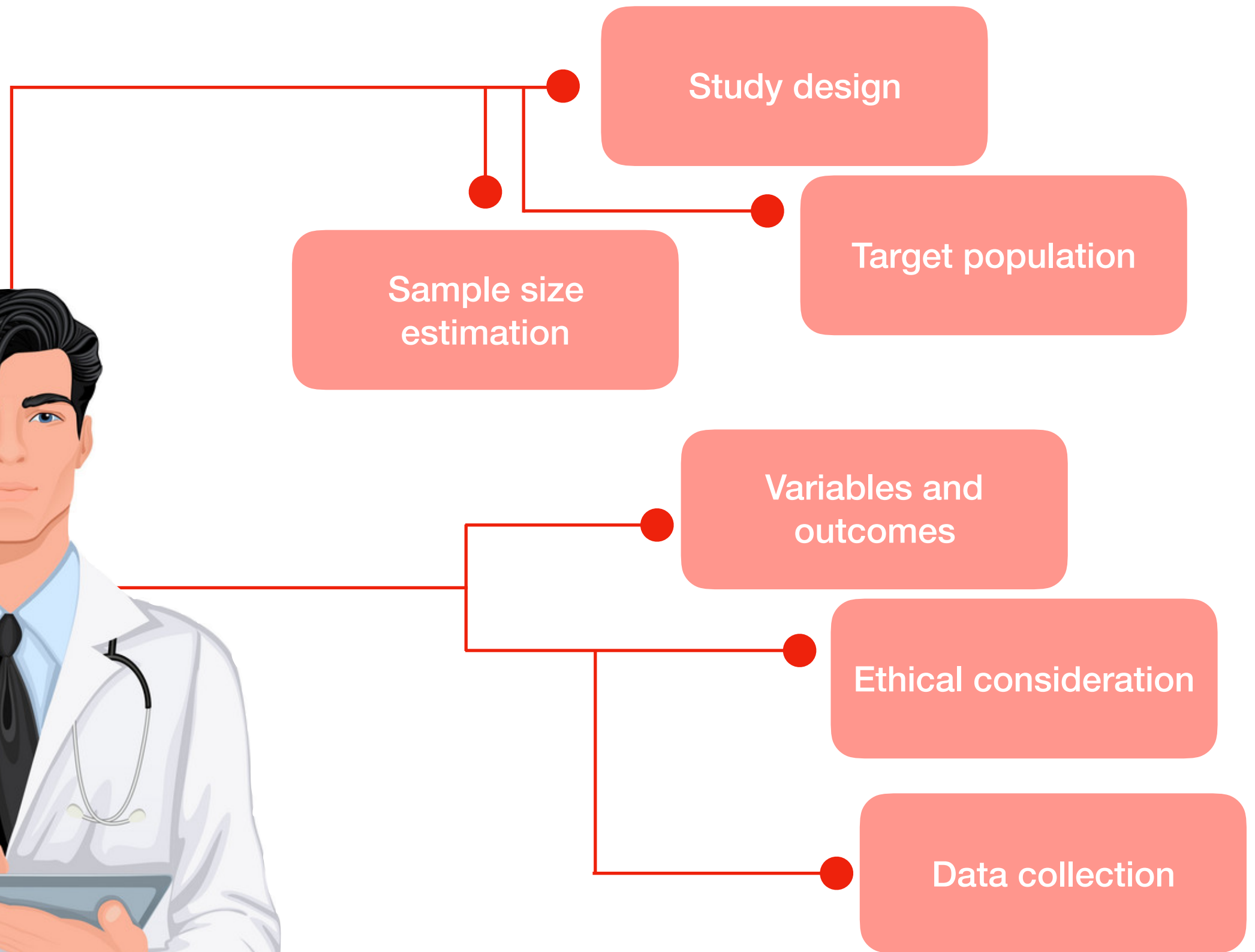
6,133
5,111 + 1,022

10-20 outcomes / 1 dummy

Phase	Thailand (2012)			sample size
	Regions	No. of DCs	ALS operation	
Derivation	Middle*	21	7,230 (16.4%)	838
	North	17	10,674 (24.3%)	1242
	NE	20	18,864 (42.9%)	2193
	South	14	5,065 (11.5%)	588
	East	4	2,173 (4.9%)	250
	Total	76	44,006	5,111
External validation	NE	-	-	-
	South	-	-	-
	Total	-	-	1,022

Phase	Thailand (2012)			sample size	Studied DCs (2012)		
	Regions	No. of DCs	ALS operation		No. of DCs	Provinces	ALS operations
Derivation	Middle*	21	7,230 (16.4%)	838	2	Saraburi	413
						Ayutthaya	415
	North	17	10,674 (24.3%)	1242	1	Chiang Mai	3,200
	NE	20	18,864 (42.9%)	2193	2	Nakhon Ratchasima	1,503
						Khon Kaen	734
	South	14	5,065 (11.5%)	588	1	Nakhon Si Thammarat	259
	East	4	2,173 (4.9%)	250	1	Chonburi	1,063
	Total	76	44,006	5,111	9		7,587
External validation	NE	-	-	-	1	Ubon Ratchathani	1,085
	South	-	-	-	1	Trang	585
	Total	-	-	1,022	-		1,670

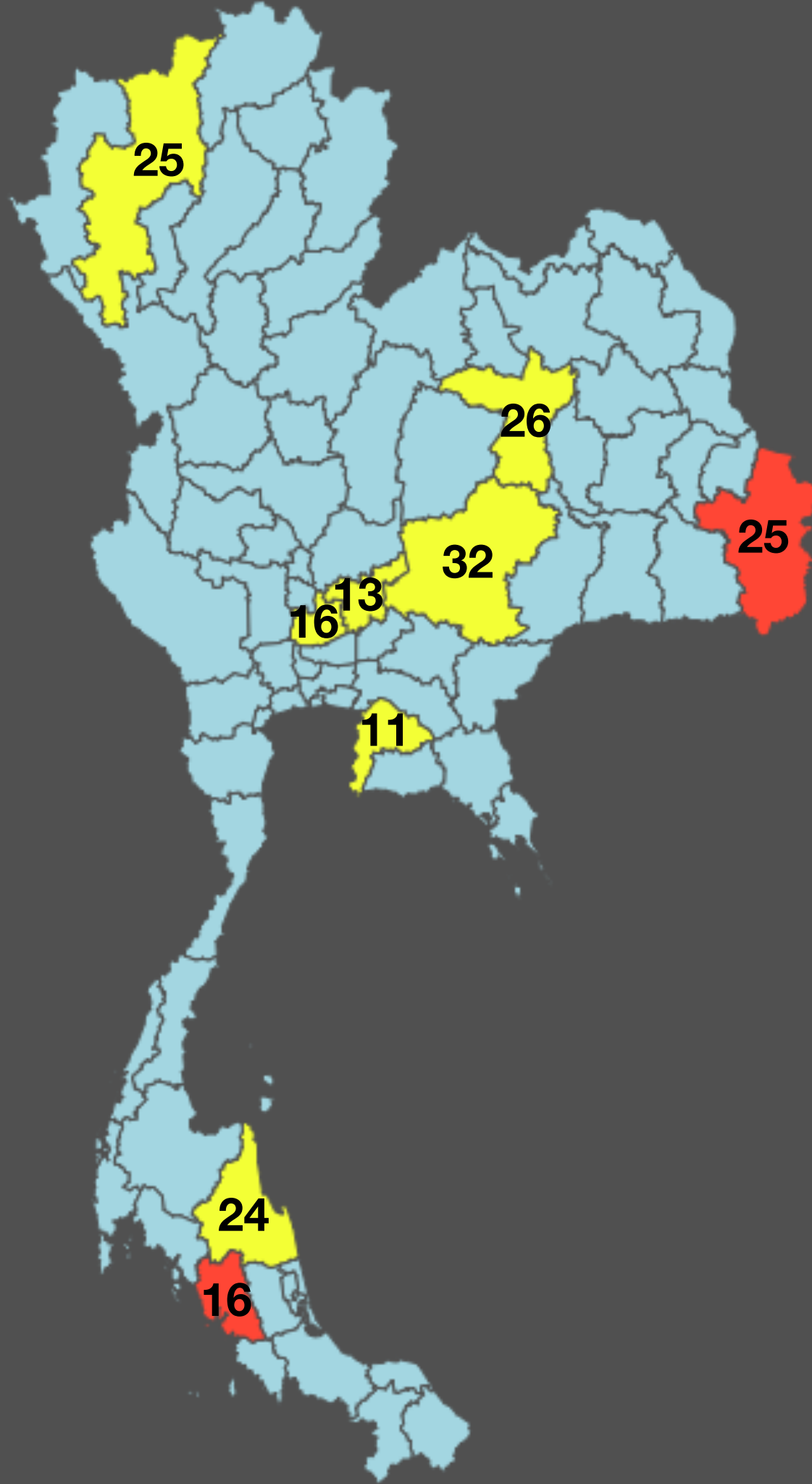




Systematic review

Domains	Variables
Demographics	Age (Years)
	Sex
	BMI (kg/m ²)
Crash characteristics	Types of road users
	Total number of victims
EMS operation	Response time (mins)
	On-scene time (mins)
	Transportation time (mins)
	Distance from base to scene (kms)
	Distance from scene to hospital (kms)
	Intravenous fluid administration
	Respiratory supports

Domains	Variables
Mechanism of injury	Burn
	Blunt
	Penetrating
Physiological	SBP (mmHg)
	DBP (mmHg)
	MAP (mmHg)
	Pulse (times/min)
	Respiratory rate (beaths/min)
	GCS
Environmental	Place of incidence
	Time of incidence
Risk behavior	Alcohol consumption
Outcomes	SI (NISS > 15)
	Death in 48 hours



- Initial meeting between PI and collaborative sites
- The first site visits were set to all 9 studied sites (188 hospital).
 - Aimed to inform studied DCs and all hospital under network of DC about;
 - research protocol
 - Data collection
 - Variables and outcomes
 - using AIS 2007 update 2009 dictionary



Drunk
Head Injury
No Relative
Observational study

Waiving for signed
informed consent form

Trained EMS personal:

Basic emergency medical technician (EMT-B), intermediate emergency medical technician (EMT-I), prehospital nurse or doctor

On scene

1. Demographic domain
2. Crash characteristics domain
3. Mechanism of injury domain
4. Environmental domain
5. Risk behaviour domain

EMS operation form and Medical records

1. EMS operation domain
2. Physiological domain
3. Death in 48 hours
4. Injury related diagnosis

CRFs

Study sites

1. checked correctness and completeness of data
2. mailed to DMU

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Basic emergency medical technician (EMT-B), intermediate emergency medical technician (EMT-I), prehospital nurse or doctor

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EMS operation form

1. EMS operation domain
2. Physiological domain
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Study sites

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DMU at Ramathibodi Hospital

1. Re-evaluated by PI
 - Unclear/missing data
 - Inquired to sites to complete CRFs
2. Double data entering and subsequent validation between 2 data set before sent to database (EPIDATA V.3)
3. Cleaning and checking by PI

I.5
years for data collection

7,456 subjects

No. Of enrolled subjects
VS
Possible cases from ITEMS database

Follow the missing cases

Site visits for self data collection
and
Corrected the errors

5-6 provinces/month

Proved the CRFs at Ramathibodi hospital

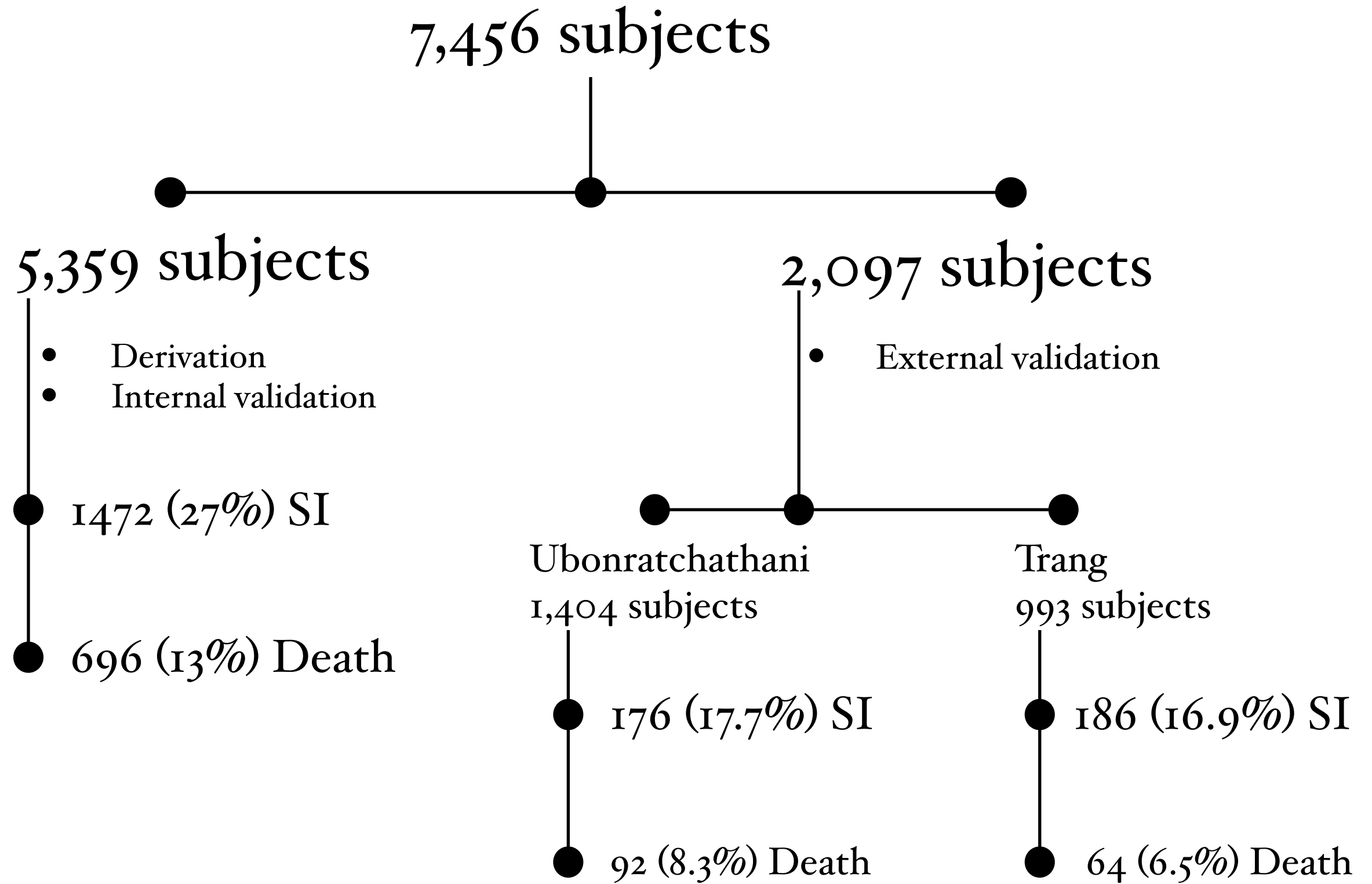
ANALYSIS

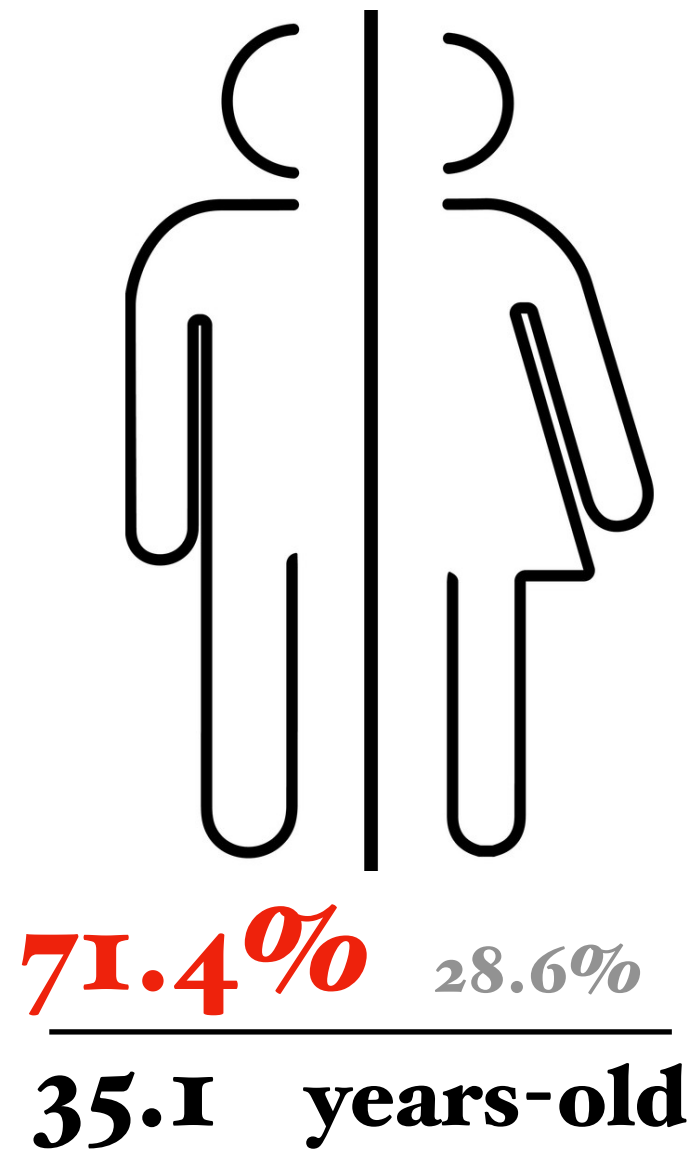
&

RESULTS

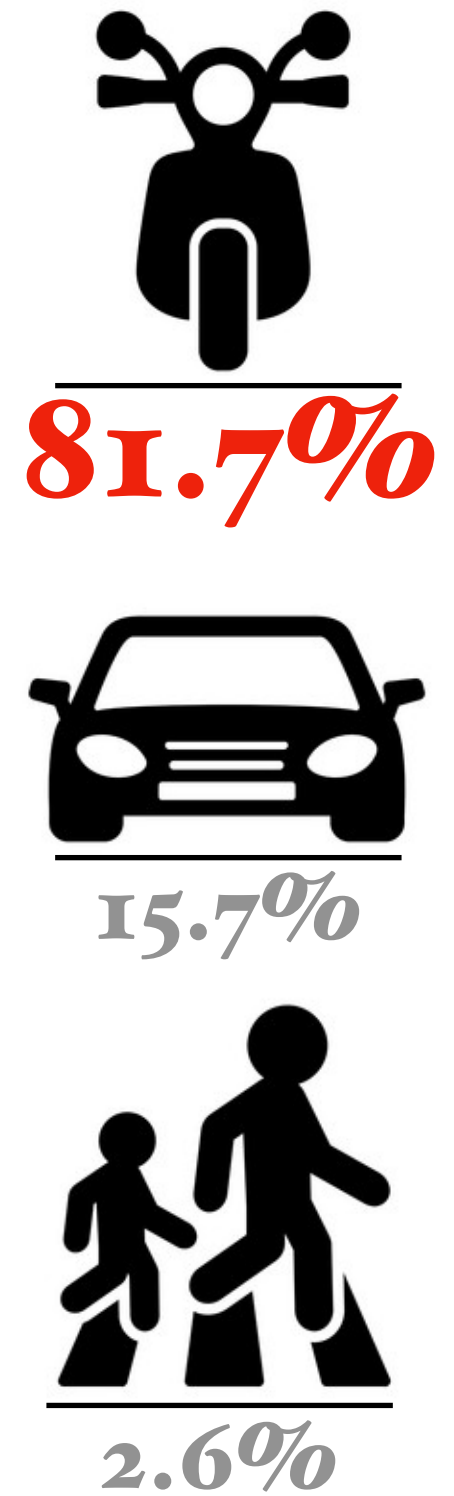
Steps	Planning	Estimates
Dealing with missing data	Multiple imputation	FMI and RVI
Data description	Types and distributions	
Model derivation	Logistic regression model	Coefficients
	Under MI condition	Calibration: HL Chi2, O/E ratio, calibration plot
		Discrimination: C statistics
Internal validation	Bootstrapping	Bootstrap corrected discrimination/ calibration coefficient
External validation	Constructing model	Calibration: HL Chi2, O/E ratio, calibration plot
		Discrimination: C statistics
		Model recalibration

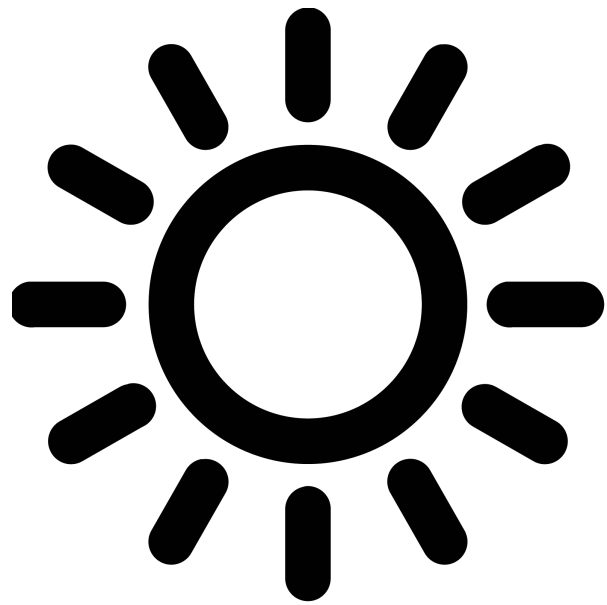
————— ✿ ——— Characteristics ——— ✿ ———





1 victims





53.3%

26%

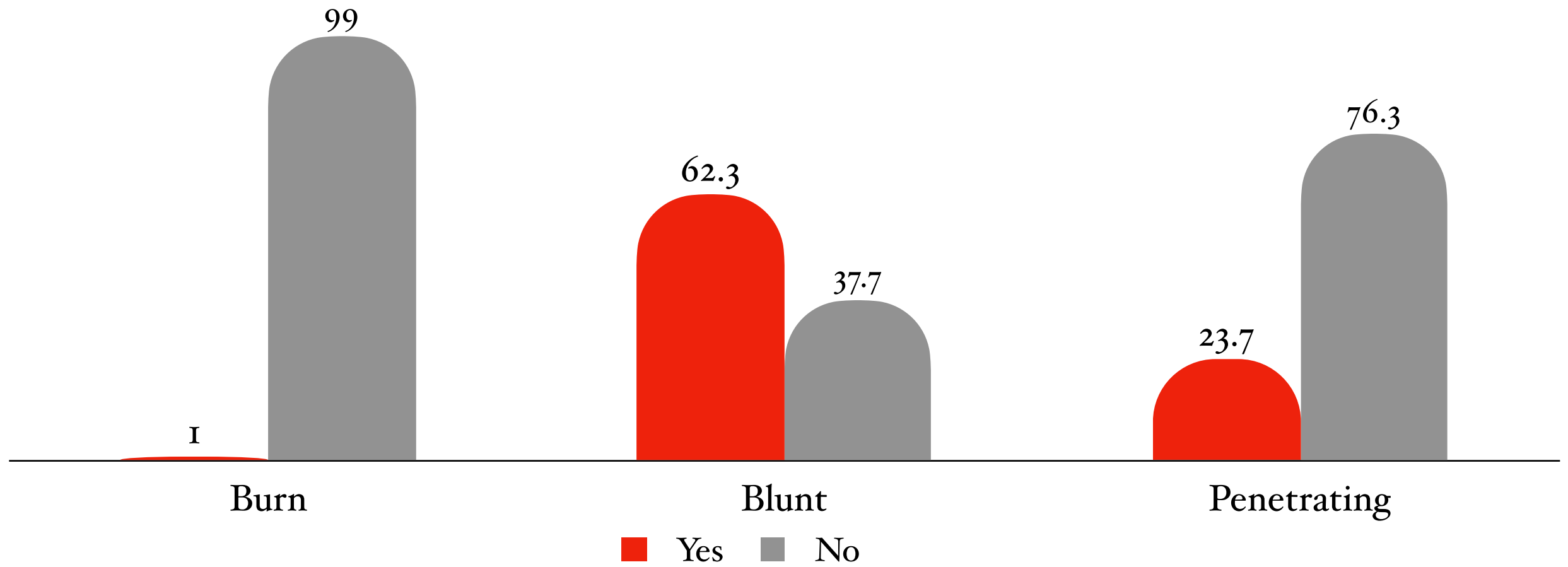


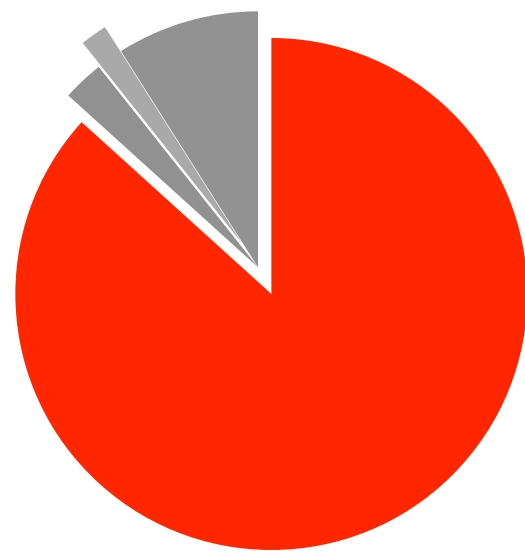
94.4%

High way



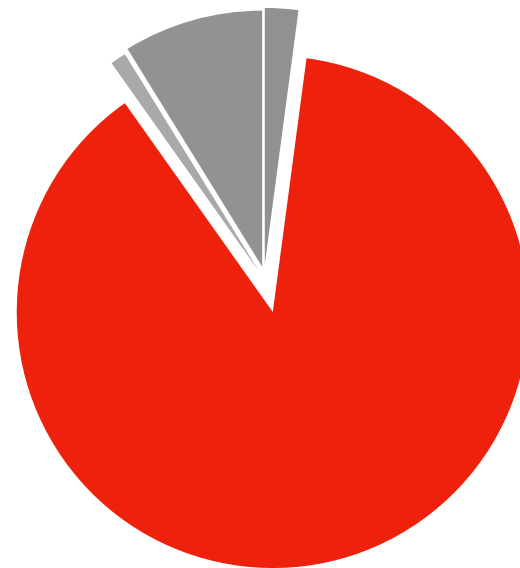
100





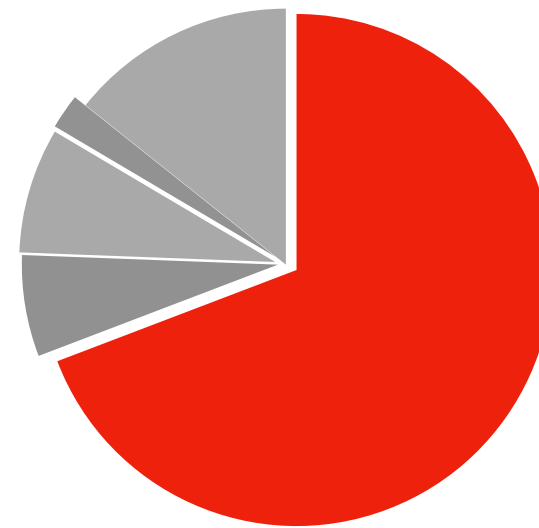
Blood pressure

86.8%



Respiratory

88%



GCS

69.2%



Pulse

22.5%



Increase



Normal



Decrease



47.6%
IV fluid



43.6%
Assisted ventilation



● — **7 mins** — **5 mins** — **6 mins** — ●

● — **4 kms** — ● — **5 kms** — ●

———— ✿ — Multiple imputation — ✿ —————

Multiple imputation

Factors	Observed	% missing	Imputed	FMI	RVI	Original dataset	Imputed dataset
Weight	7417	0.53	40	0.0089	0.0045	62.3 (11.9)	62.3 (11.9)
Height	7429	0.37	28	<0.001	<0.001	164.24 (7.2)	164.24 (7.2)
RR	7444	0.17	13	<0.001	<0.001	19.19 (6.5)	19.19 (6.5)
Alcohol	6535	12.36	922	0.3968	0.3226	27.9%	29.1%

————— ✿ ————— Derivation ————— ✿ —————

Death

Predictors	Coefficients	95%CI
Intercept	-6.763	(-7.437, -6.089)
Age	0.017	(0.009, 0.025)
Blunt injury		
Yes	0.835	(0.523, 1.147)
No		
RR 4 groups		
<6	1.024	(0.573, 1.476)
6-9	1.016	(0.371, 1.661)
>29	1.080	(0.537, 1.623)
10-29	0	
SBP 4 groups		
<50	2.266	(1.822, 2.710)
50-75	1.666	(1.107, 2.225)
76-89	1.258	(0.751, 1.765)
>89	0	
GCS 5 groups		
3	2.654	(2.079, 3.230)
4-5	2.646	(1.970, 3.322)
6-8	1.591	(1.017, 2.165)
9-12	1.357	(0.773, 1.940)
13-15	0	
Time of incidence		
Day	0.314	(0.037, 0.591)
Night	0	
Airway management		
Assisted ventilation	1.212	(0.468, 1.957)
Open/clear airway	0.408	(-0.267, 1.083)
No supplement	0	
IV fluid administration		
YES	0.656	(0.124, 1.189)
No	0	

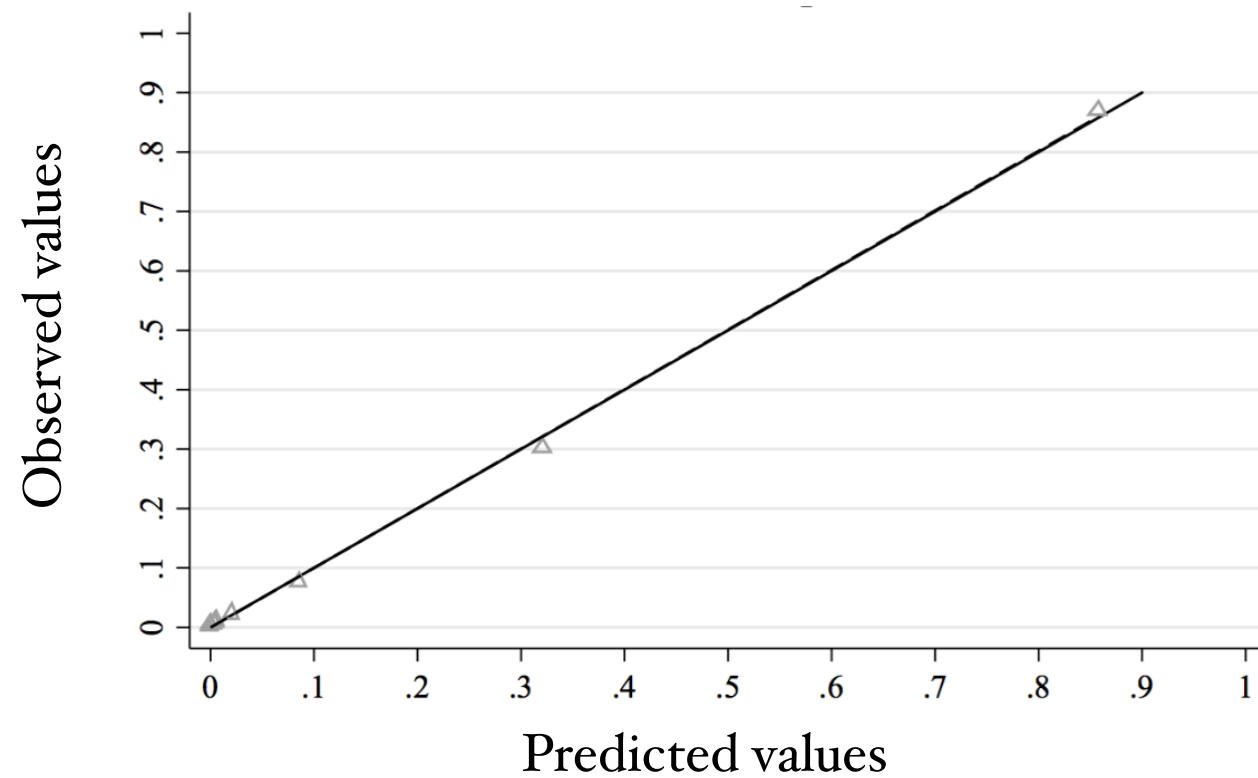
Severe injury

Predictors	Coefficients	(95%CI)
Intercept	-3.934	(-4.201, -3.677)
Age 2 groups		
>55 years	0.351	(0.105, 0.597)
<= 55 years	0	
Blunt injury		
Yes	0.699	(0.512, 0.884)
No	0	
SBP 4 groups		
>50	0.701	(0.245, 1.156)
50-75	0.790	(0.24, 1.339)
76-89	0.581	(0.152, 1.009)
>89	0	
RR 3 groups		
<10	0.208	(-0.223, 0.638)
>29	0.646	(0.175, 1.115)
10-29	0	
GCS 5 group		
3	2.250	(1.867, 2.633)
4-5	2.553	(1.988, 3.117)
6-8	1.476	(1.162, 1.789)
9-12	1.137	(0.858, 1.414)
13-15	0	
Type of road user		
Pedestrian	0.780	(0.263, 1.296)
4 or more wheels	0.079	(-0.15, 0.307)
Bicycle or motorcycle	0	
Response time ≤ 8 minutes		
>8	0.189	(0.011, 0.365)
≤8	0	
Airway management		
Assisted ventilation	1.219	(0.844, 1.594)
Open/clear airway	0.671	(0.403, 0.939)
No supplement	0	
IV fluid administration		
YES	1.213	(0.971, 1.455)
No	0	

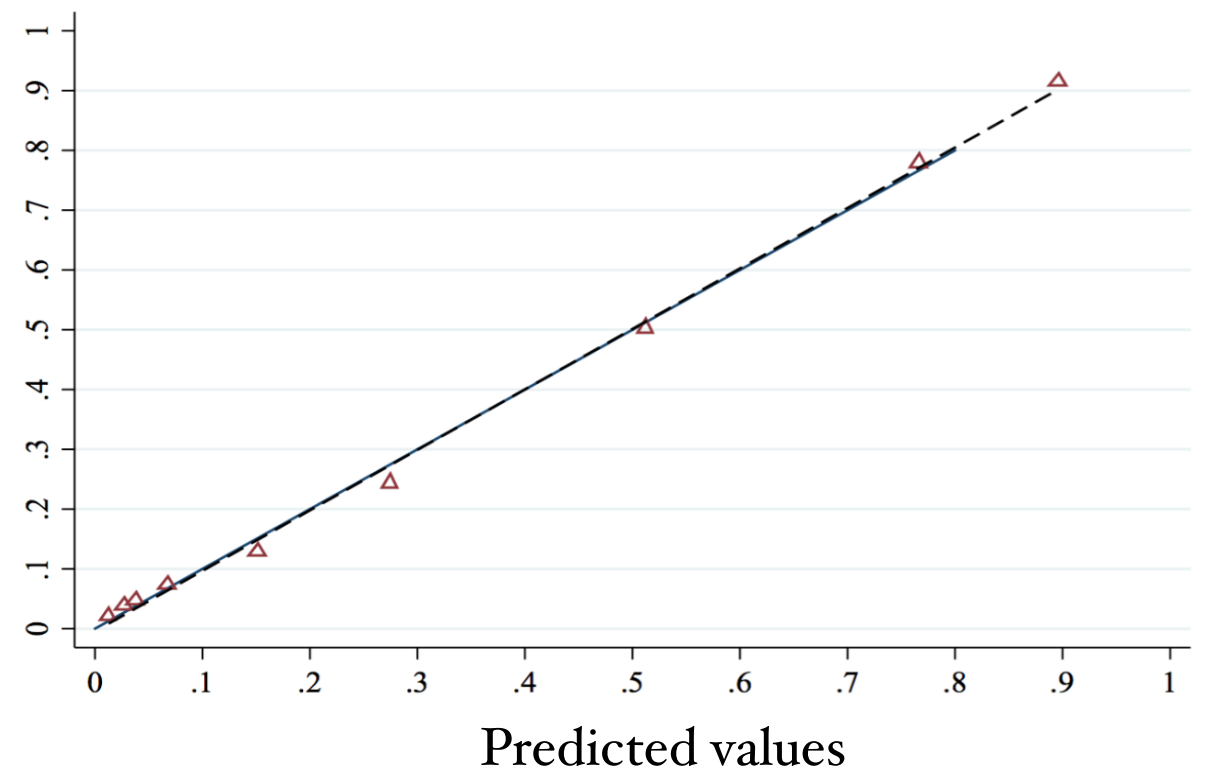
Performances of derived model

Predictor	Phases	Provinces	Mode	Calibration			Discrimination	
				HL Chi ²	df	<i>P</i>	O/E (IQR)	C statistic (95% CI)
Death	Derivation			9.82	8	0.28	1.00 (0.50, 1.15)	0.966 (0.960, 0.971)
SI	Derivation			13.8	8	0.09	0.99 (0.95, 1.05)	0.913 (0.905, 0.922)

Calibration plot of derived model



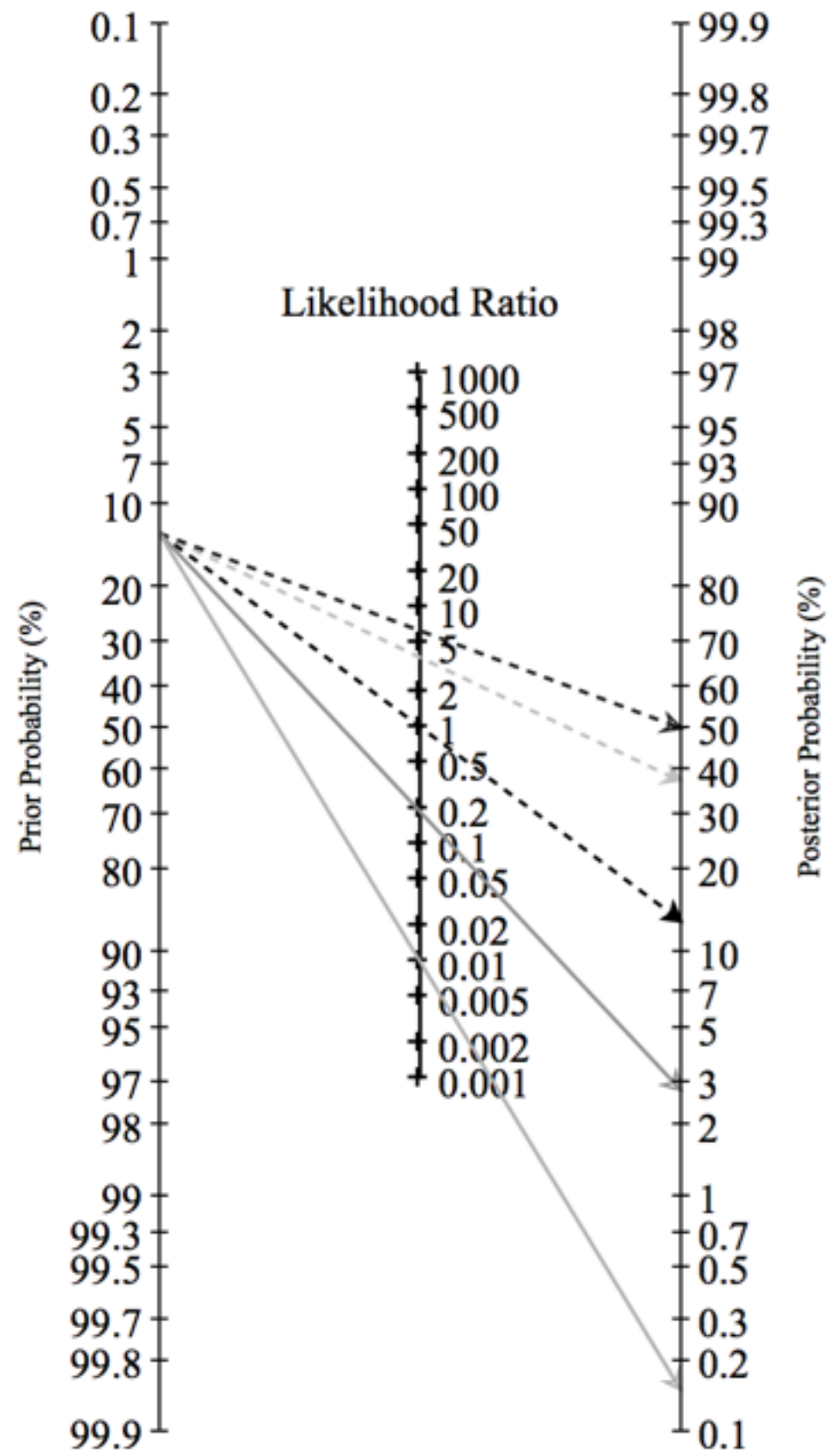
Death



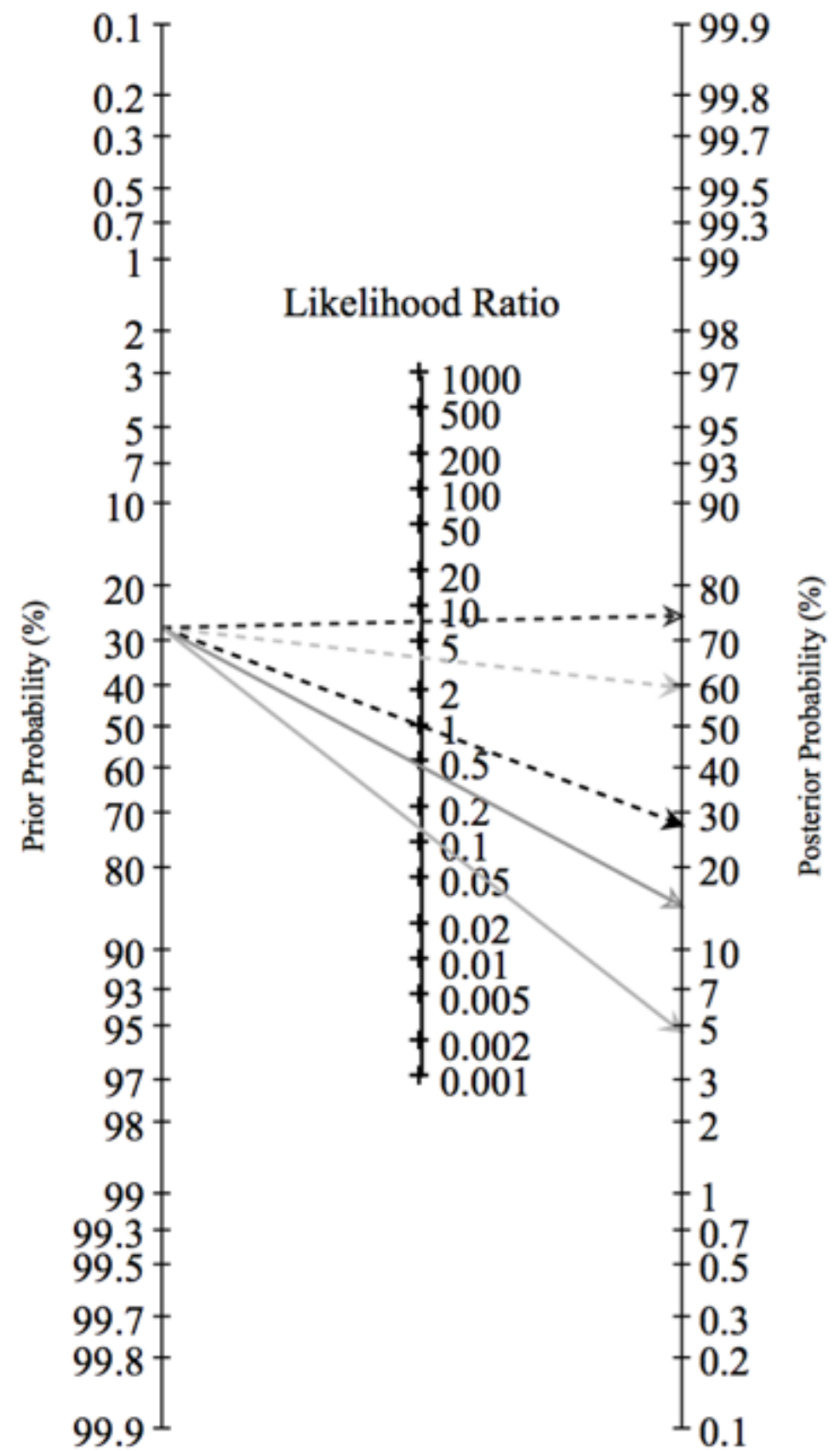
Severe injury

Risk groups for clinical implementation

Outcome	Score	Risk groups	Yes	No	%Sensitivity (95% CI)	%Specificity (95% CI)	LR+ (95% CI)	%Post-test probability
Death	<-4.265	Low	8	3211	100	0	1	12.9
	-4.265 to -2.223	Moderate	46	889	85.2 (72.9, 93.4)	78.3 (77, 79.6)	3.9 (3.5, 4.4)	37
	>-2.223	High	642	563	98.8 (97.6, 99.5)	85.10 (83.9, 86.2)	6.6 (6.1, 7.1)	49.7
SI	<-1.834	Low	144	2949	100	0	1	27.5
	-1.834 to -0.372	Moderate	231	562	61.6 (56.5, 66.5)	84 (82.7, 85.2)	3.9 (3.5, 4.3)	59.4
	>-0.372	High	1097	376	88.4 (86.5, 90.1)	88.7 (87.6, 89.7)	7.8 (7.1, 8.6)	74.8



Death



Severe injury

————— ✿ ——— Internal validation ——— ✿ —————

Internal validation: Bootstrapping

Performances		Death	Severe injury
		Value (95% CI)	Value (95% CI)
Calibration	D origin	0.933 (0.922, 0.944)	0.827 (0.810, 0.844)
	D boot	0.933 (0.910, 0.950)	0.826 (0.825, 0.826)
	D bias	-0.0000945 (-0.017317, 0.0225068)	0.0009 (-0.0239, 0.0281)
	BS corrected D	0.933	0.826
	Percent D error	-0.01%	0.11%
Discrimination	C origin	0.966 (0.960, 0.971)	0.913 (0.905, 0.922)
	C boot	0.966 (0.955, 0.975)	0.913 (0.912, 0.913)
	C bias	0.0000027 (-0.0000177, 0.0000182)	0.0004 (-0.0005, 0.000002)
	BS corrected C	0.966	0.913
	Percent C error	0.00%	0.05%

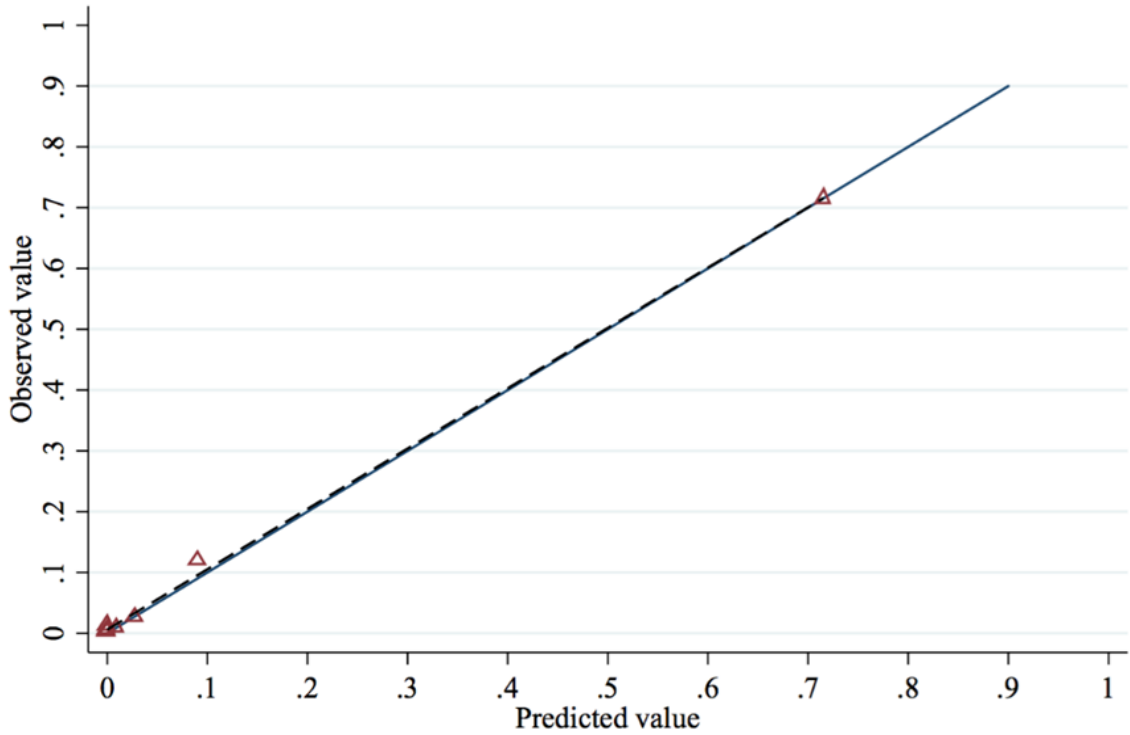
———— ✿ ——— External validation ——— ✿ ———

Performances of external validation

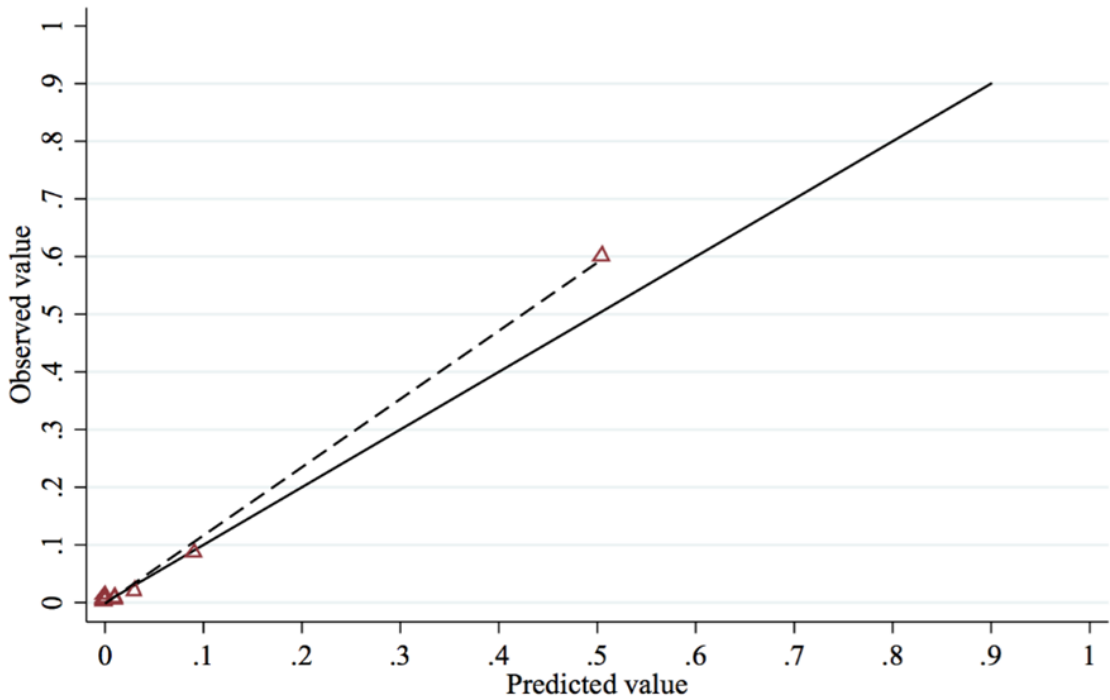
Predictor	Phases	Provinces	Mo	Calibration			Discrimination	
				HL Chi²	df	P	O/E (IQR)	C statistic (95% CI)
Death	Derivation			9.82	8	0.28	1.00 (0.50, 1.15)	0.966 (0.960, 0.971)
	External Validation	Ubonratchathani	Mo	4.23	8	0.84	1.00 (0.76, 1.22)	0.980 (0.970, 0.990)
		Trang	Mo	7.66	8	0.47	1.05 (0.42, 1.89)	0.948 (0.921, 0.975)
SI	Derivation			13.8	8	0.09	0.99 (0.95, 1.05)	0.913 (0.905, 0.922)
	External Validation	Ubonratchathani	Mo	28.7	8	<0.001	1.00 (0.71, 1.03)	0.909 (0.885, 0.932)
		Trang	Mo	21.0	8	0.007	0.99 (0.78, 1.04)	0.896 (0.871, 0.922)

Death

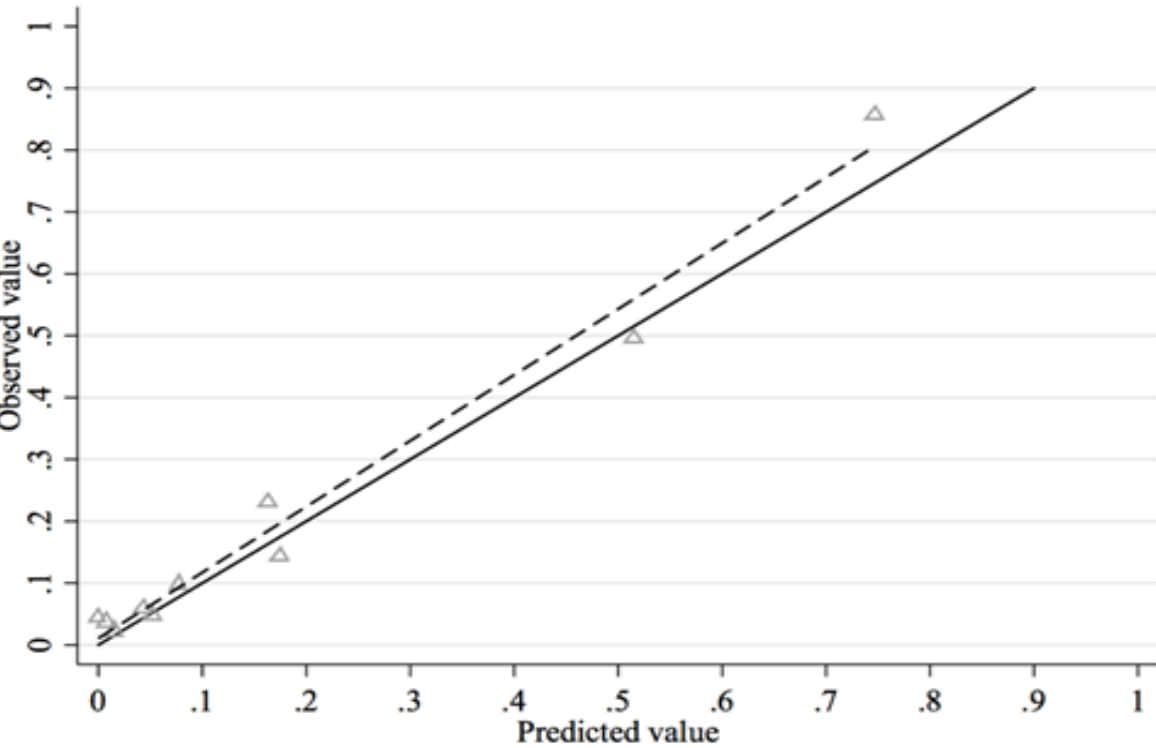
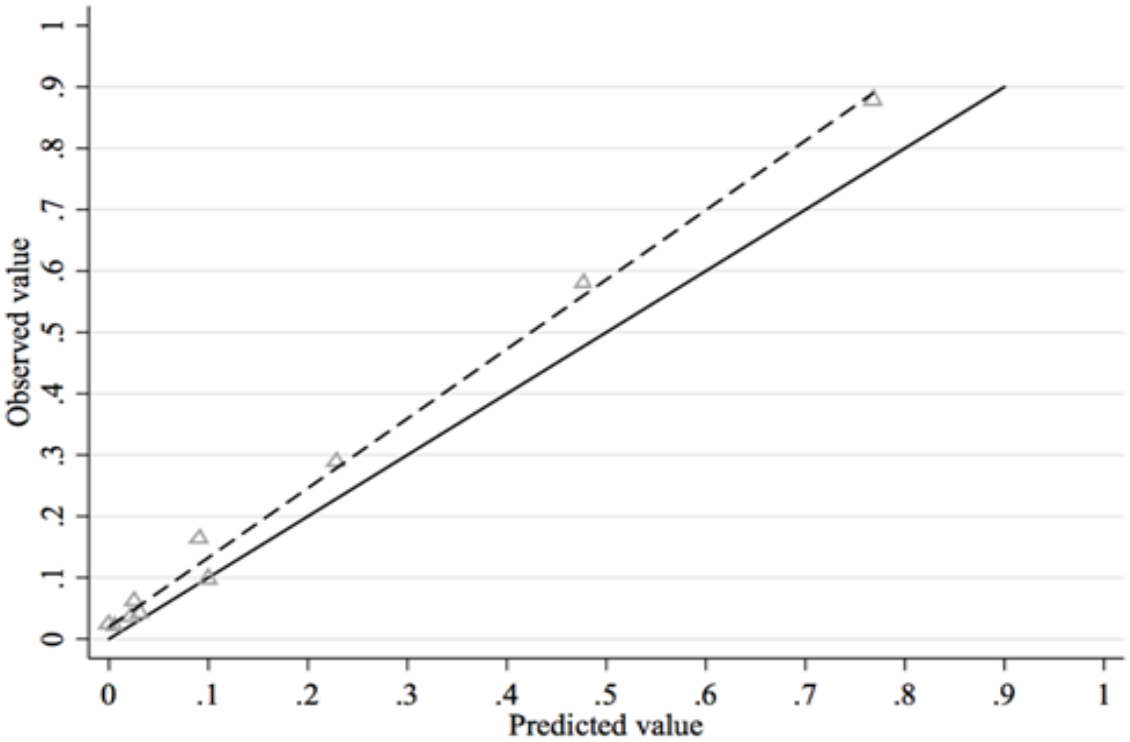
Ubonratchathani



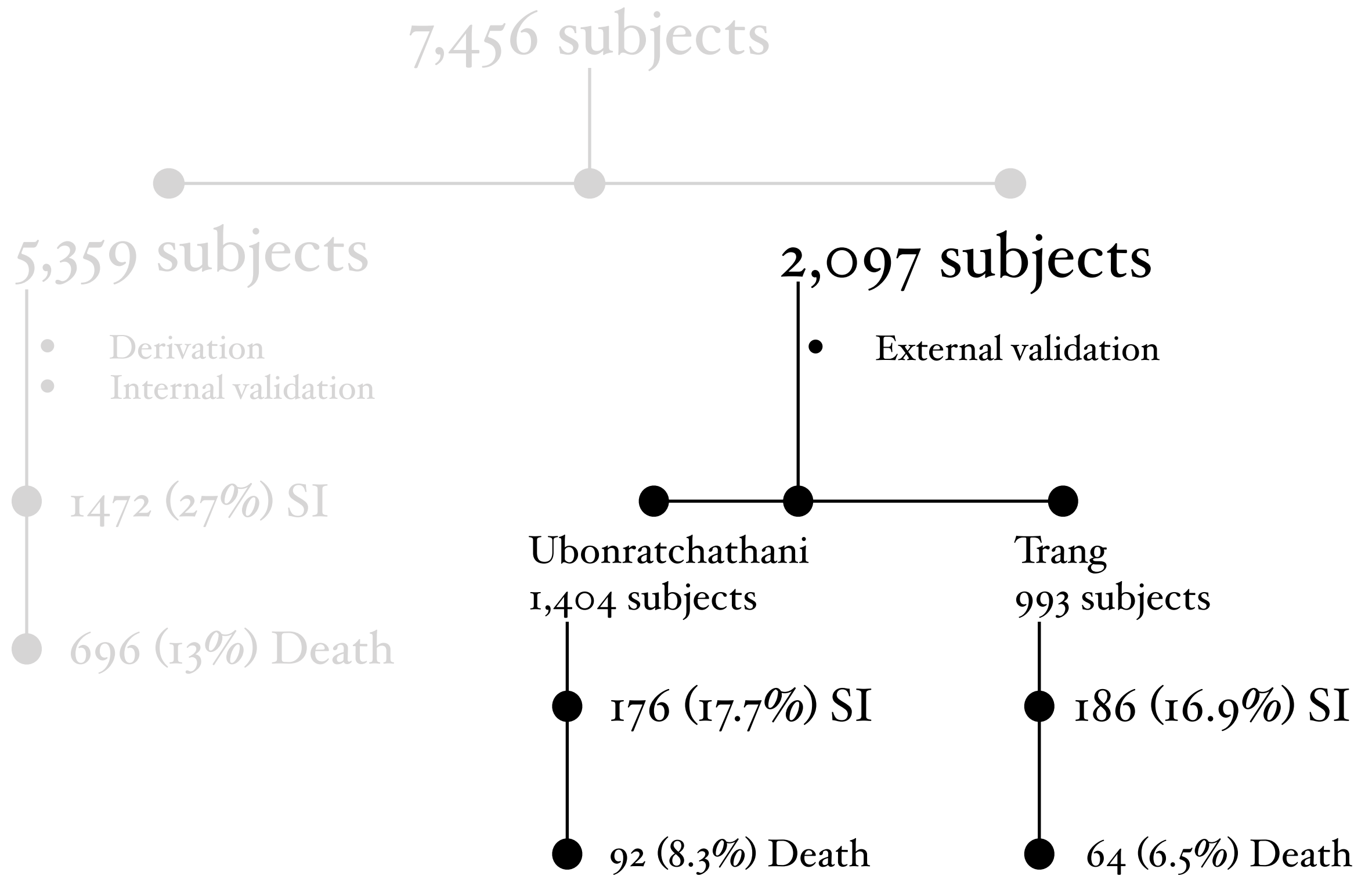
Trang



SI



————— ❖ — Recalibration — ❖ —————



Trang

Recalibration of the intercept

Death

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Intercept	(-0.591)+(-6.763)	(-7.437, -6.089)
Age	0.017	(0.009, 0.025)
Blunt injury		
Yes	0.835	(0.523, 1.147)
No		
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No supplement	0	
IV fluid administration		
YES	0.656	(0.124, 1.189)
No	0	

Trang

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Intercept	(-0.293)+(-3.934)	(-4.201, -3.677)
Age 2 groups		
>55 years	0.351	(0.105, 0.597)
<= 55 years	0	
Blunt injury		
Yes	0.699	(0.512, 0.884)
No	0	
SBP 4 groups		
>50	0.701	(0.245, 1.156)
50-75	0.790	(0.24, 1.339)
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Ubonratchathani

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Bicycle or motorcycle	0	
Response time ≤ 8 minutes		
>8	0.189	(0.011, 0.365)
≤8	0	
Airway management		
Assisted ventilation	1.219	(0.844, 1.594)
Open/clear airway	0.671	(0.403, 0.939)
No supplement	0	
IV fluid administration		
YES	1.213	(0.971, 1.455)
No	0	

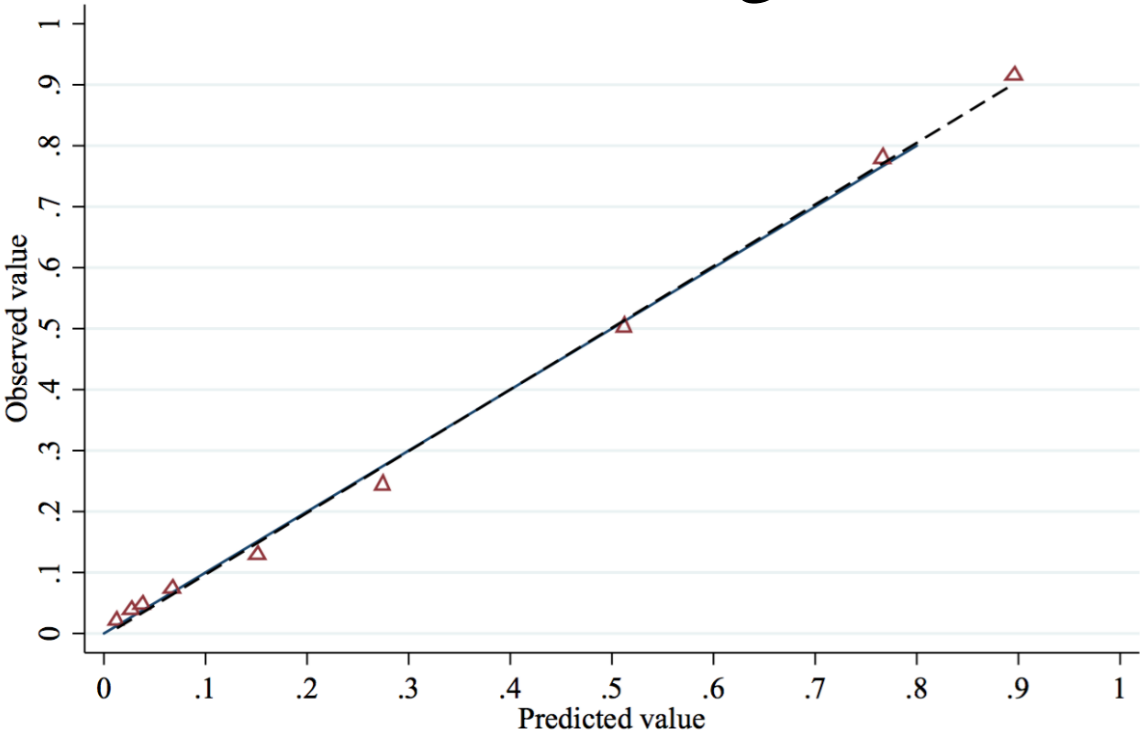
Performances of external validation

Predictor	Phases	Provinces	Mo	Calibration			Discrimination	
				HL Chi²	df	P	O/E (IQR)	C statistic (95% CI)
Death	Derivation			9.82	8	0.28	1.00 (0.50, 1.15)	0.966 (0.960, 0.971)
	External Validation	Ubonratchathani	M ₀	4.23	8	0.84	1.00 (0.76, 1.22)	0.980 (0.970, 0.990)
				7.66	8	0.47	1.05 (0.42, 1.89)	0.948 (0.921, 0.975)
		Trang	M ₀	11.15	8	0.19	1.00 (0.48, 1.86)	0.948 (0.921, 0.975)
SI	Derivation			13.8	8	0.09	0.99 (0.95, 1.05)	0.913 (0.905, 0.922)
	External Validation	Ubonratchathani	M ₀	28.7	8	<0.001	1.00 (0.71, 1.03)	0.909 (0.885, 0.932)
				7.2	8	0.51	1.00 (0.95, 1.05)	0.909 (0.885, 0.932)
		Trang	M ₀	21.0	8	0.007	0.99 (0.78, 1.04)	0.896 (0.871, 0.922)
				7.5	6	0.28	1	0.909 (0.885, 0.932)

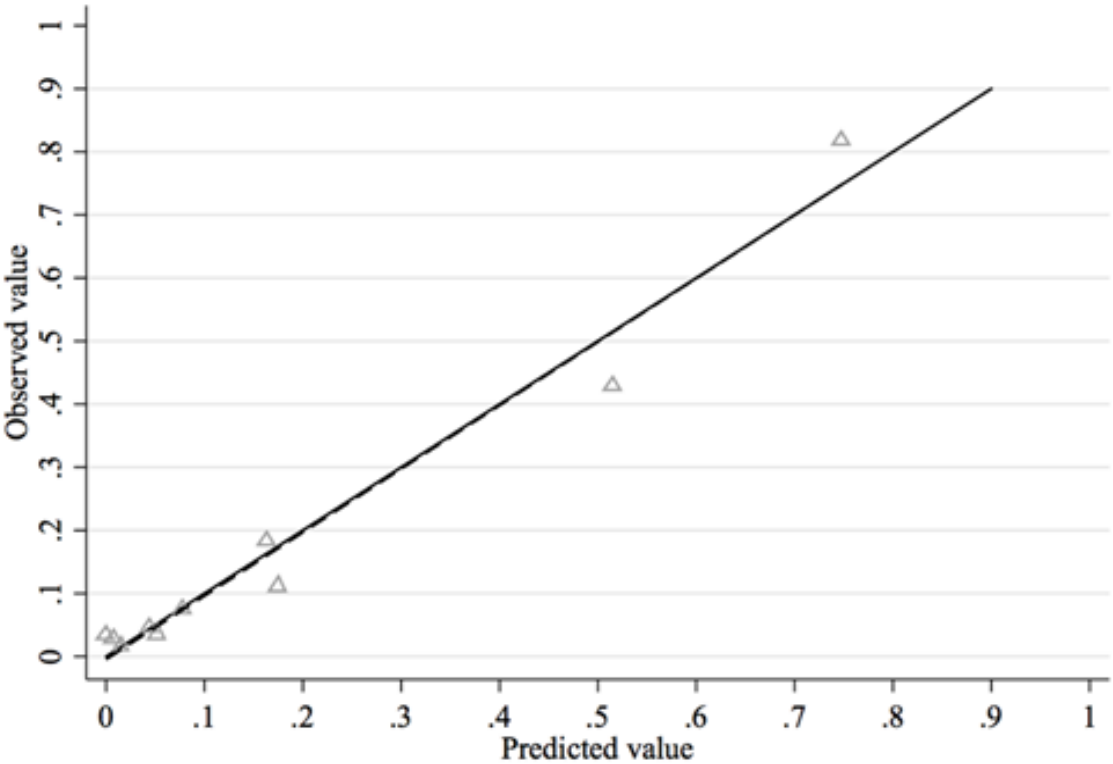
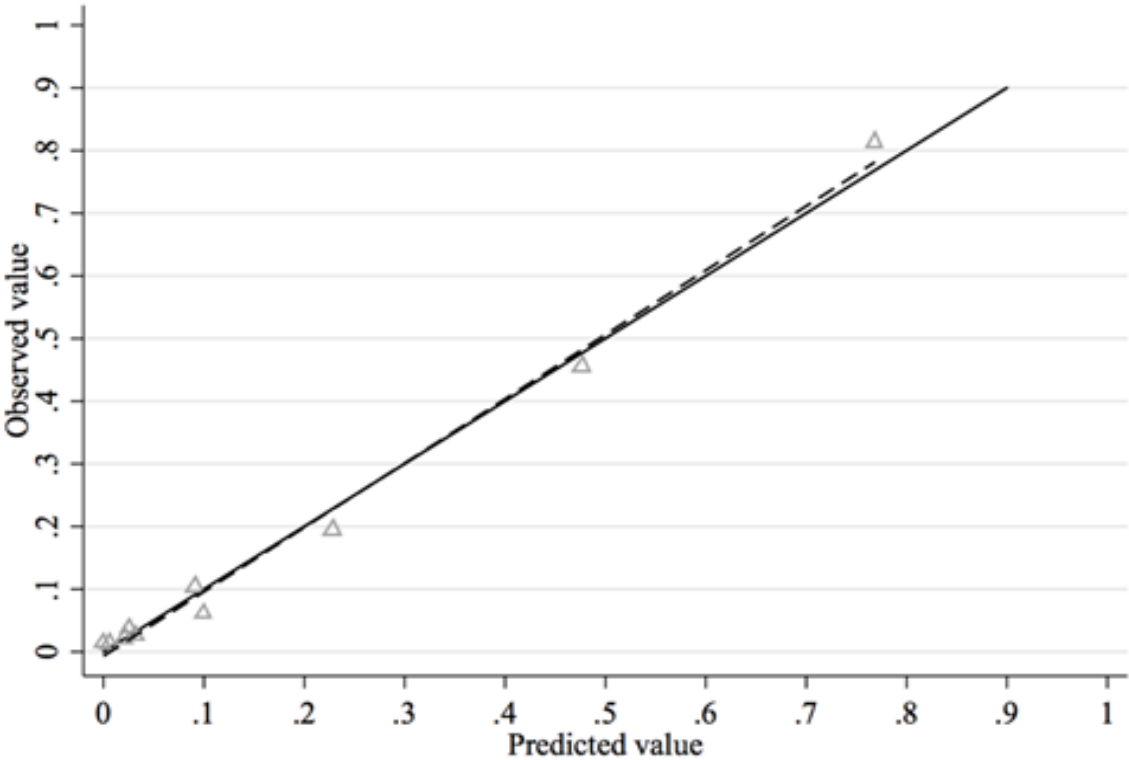
Ubonratchathani

Trang

Death

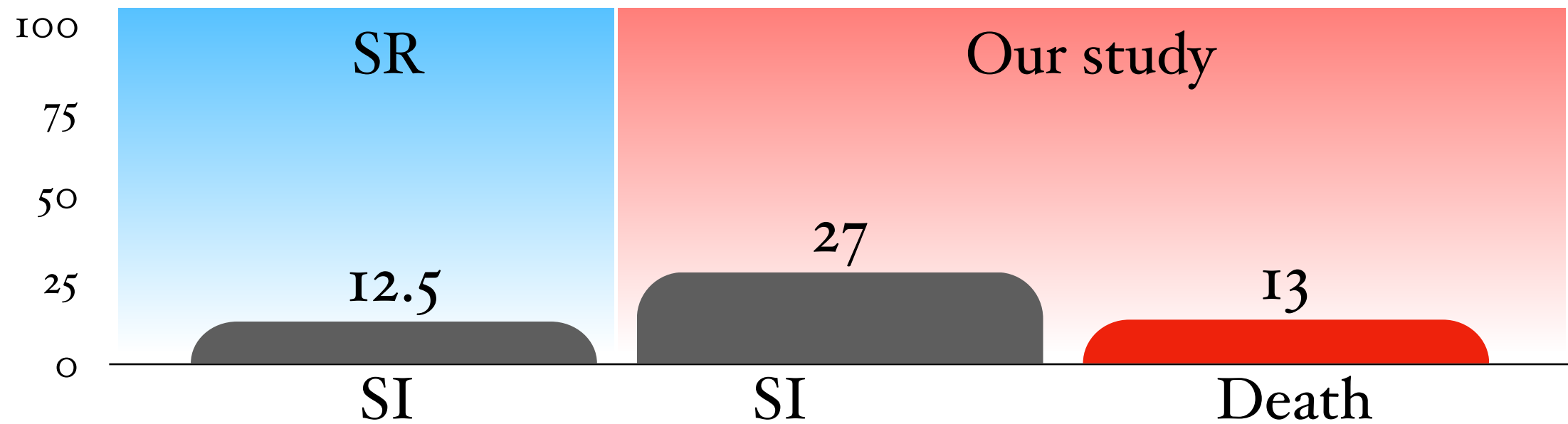


SI



DISCUSSION





- Included only subjects operated by ALS unit
- Better infrastructure (road, traffic rules) in developed countries

Models	Predictors				EMS operation	AUC of ROC
	Physiology	Age	ISS	Crash characteristics		

RTS	• SBP, RR, GCS	-	-	-		0.69 to 0.86
TRISS	• SBP, RR, GCS	Yes	Yes	-		
TRISS liked	• SBP • BMR	Yes	Yes	-		
Triage decision scheme	• SBP, RR, GCS	Yes	-	Yes		
Newgard, 2002	GCS	-	-	• Restrain devices • Intrusion		
Scheetz, 2007	-	-	-	• Extrication • Direction of collision • Numbers of victim		
Scheetz, 2009	-	Yes	-	• Direction of collision • Number of victim		
Kashani, 2005	-	-	-	• Restrain devices • Crash cause • Crash location		
Ayoung-chee, 2013				• Ejection • Intrusion		

Clinical application



in



Prehospital care



- Might be useful in prehospital setting
 - Only 8-9 predictors
 - Ease to assess at scene
 - Non invasive measurement
- Apply to practice
 - Assess at scene
 - Calculate probability of death and SI
 - Stratify into risk groups
 - Estimate post test probability

The car accident occurred on the highway road and this incident was reported to DC at 10.00 am. ALS response unit was subsequently dispatched and arrive at scene at 10.07 am, finding a man motorcyclist aged 35 years. His first examination reveals RR 8 breaths/minute, SBP 80 mmHg and GCS 8, blunt contusion on his right flank. He was urgently intubated, open venous with saline solution.

Outcomes	Pretest prob.	Scores	Risk groups	Posttest prob.
Death	13%	-0.286	Moderate	49.7%
SI	27.5%	1.364	Moderate	74.8%

“Sent to TC”

— ❖ — **STRENGTH** —————

- Conducted multi center study from 7 provinces across the region of Thailand
- Comply to recommendation of development a clinical prediction rule
- Derivation using adequate number of subjects
- Internal, external validation with recalibration
- Prospective data collections by well-trained personals to minimise bias and missing information
- Multiple imputation
- Simple predictors with ease to apply in EMS practice

— ❖ — LIMITATION —————

- Did not apply random sampling across regions of the country
- DC were selected based on;
 - Availability of EP
 - Well developed EMS information system
- being good representative for whole country by;
 - Selection of subjects stratified by regions
 - Numbers of subject for each DC were proportional to size of their RTI population treated by ALS unit/year

Identifying moderate to high risk RTI patients

proper transportation to TC

Receiving definitive care

Decreasing of morbidity and mortality

Evaluate both health and economic outcomes

Cluster RCTs

Impacts of our tools

— **THANK**  **YOU** —



