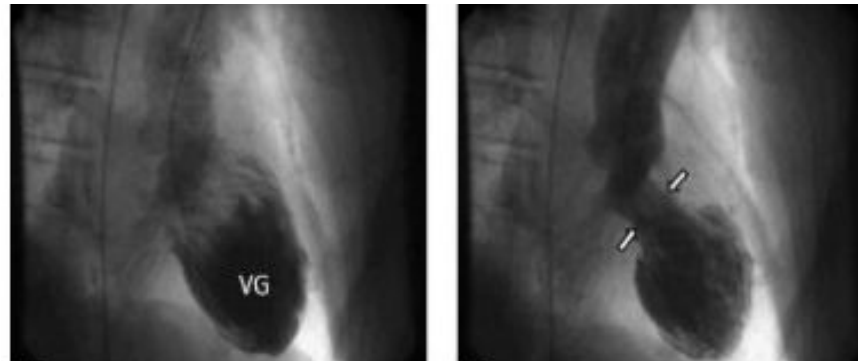


# Takotsubo Syndrome: Prediction of hospitalization outcomes

Python Machine Learning Project  
July 10th 2021



Daisuke KUWABARA  
Nesrine BENANTEUR

# OUTLINE

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**Introduction: Reminders of basic heart physiology to understand the context**

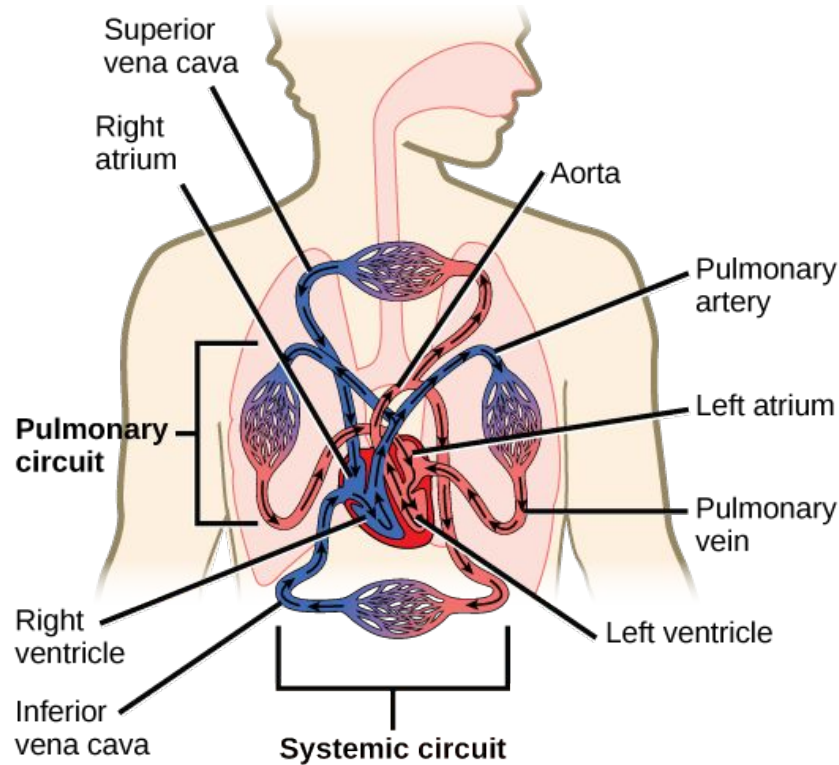
**Takotsubo Syndrome**

**Description of the cohorts and the variables used for prediction**

**Algorithms predictions**

**Conclusion: Perspectives and improvements**

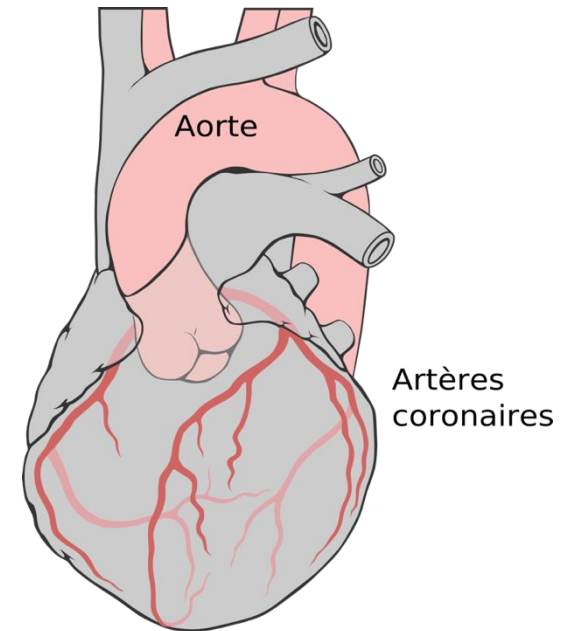
# GENERAL HEART PHYSIOLOGY TO UNDERSTAND THE CONTEXT



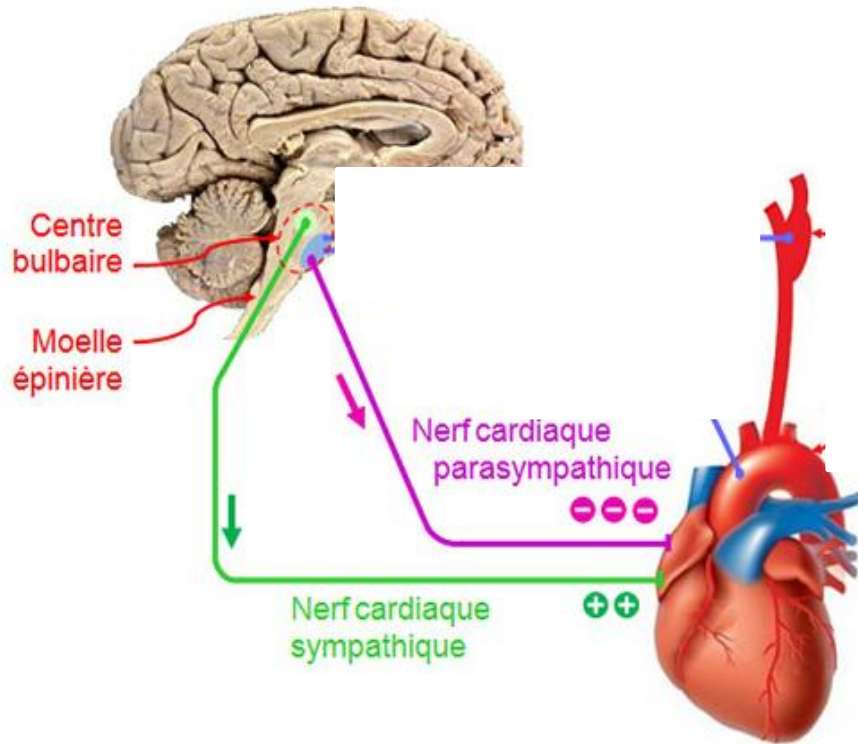
Circulatory system: network consisting of blood, blood vessels, and the heart.

This network supplies tissues in the body with oxygen and other nutrients, transports hormones, and removes unnecessary waste products.

The heart is made of specialized cardiac muscle tissue called **myocardium**. It is made of specific cells called **cardiomyocytes**.

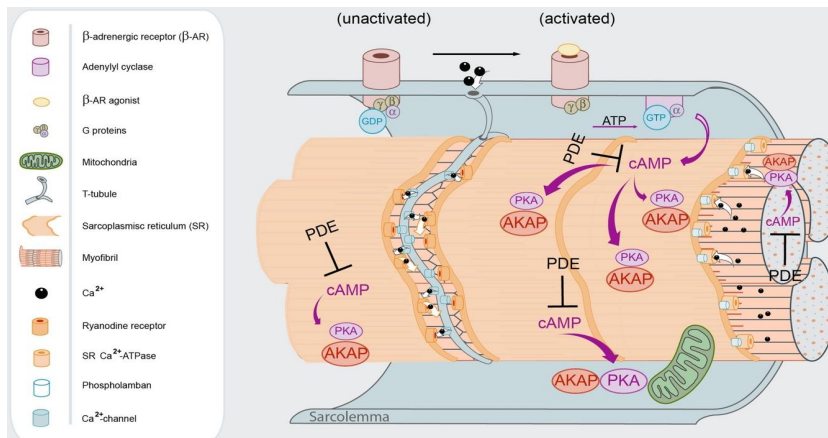


# GENERAL HEART PHYSIOLOGY TO UNDERSTAND THE CONTEXT



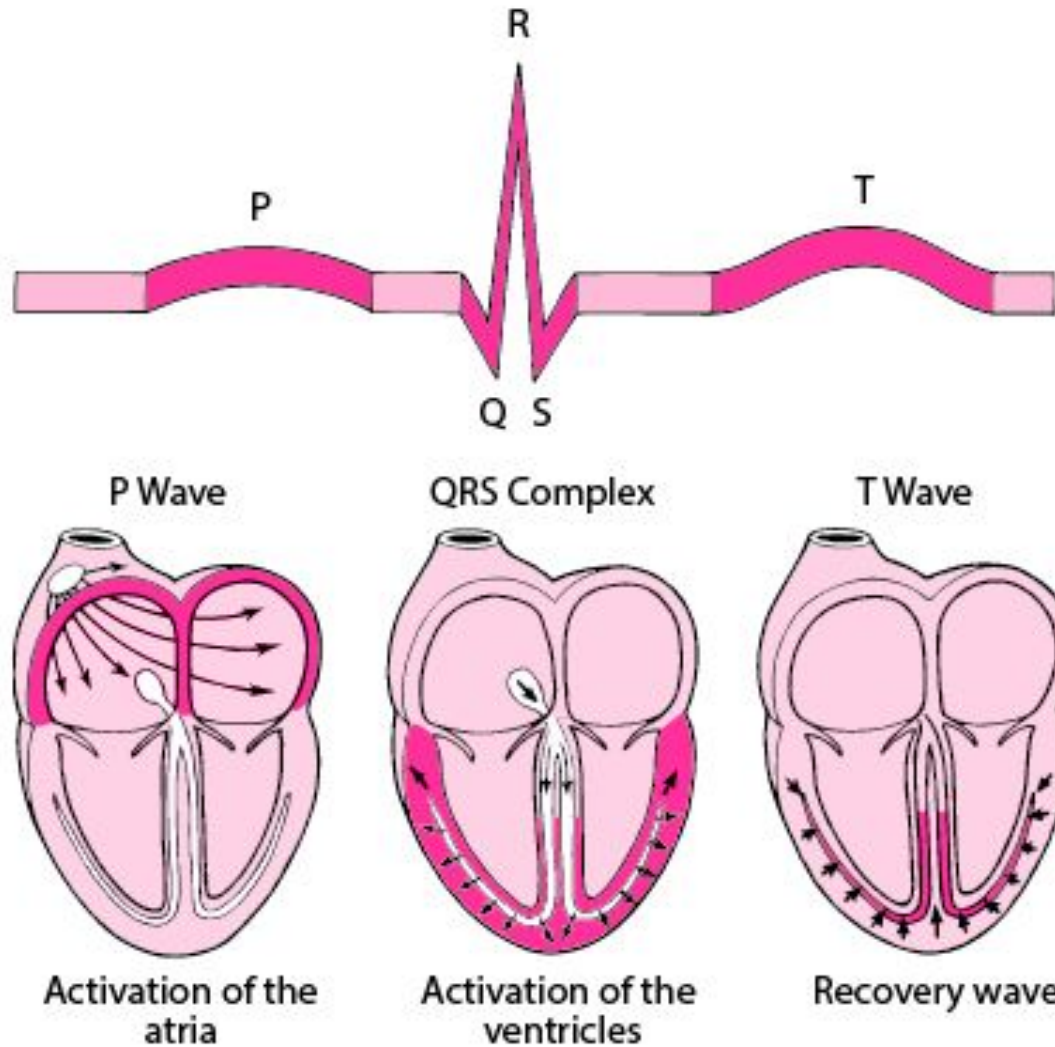
How does the heart beat?

- Nerve conduction: sympathetic cardiac nerve (increases the heartbeat) or parasympathetic cardiac nerve (decreases the heartbeat).
- Biochemicals: catecholamines (adrenaline, noradrenaline) are released to increase the contraction of the cardiomyocytes.

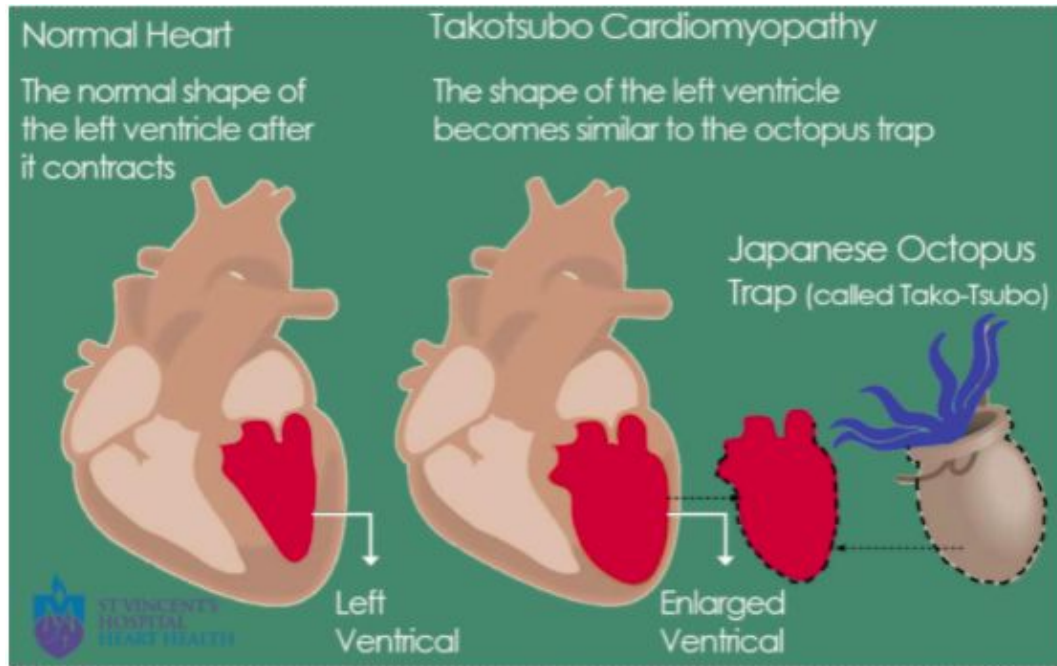


## GENERAL HEART PHYSIOLOGY TO UNDERSTAND THE CONTEXT

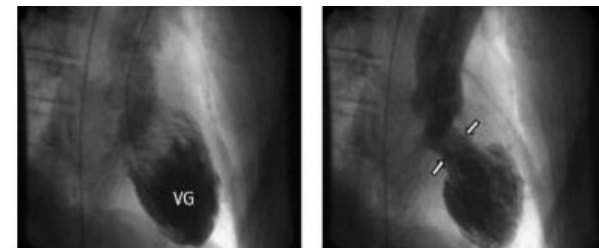
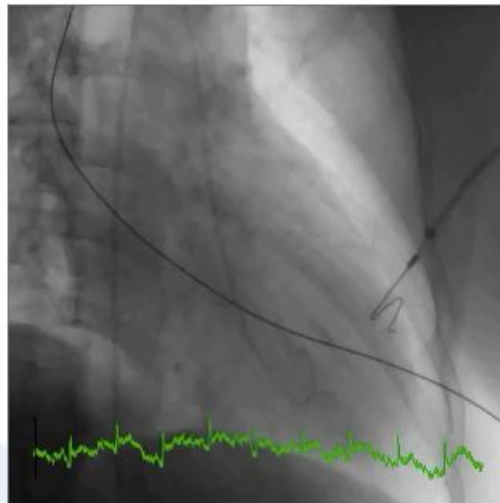
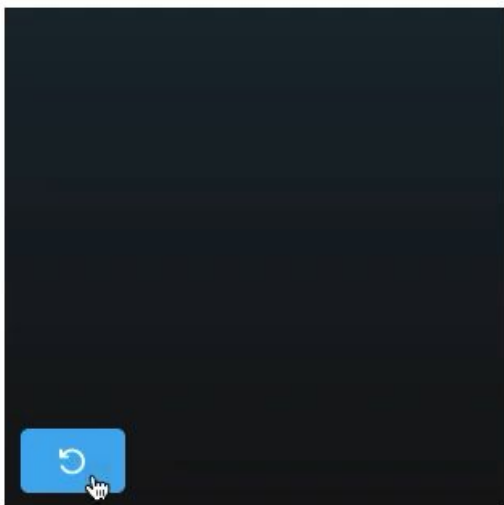
- ▷ The heart rate can be analyzed through an exam called ECG.



# TAKOTSUBO SYNDROME



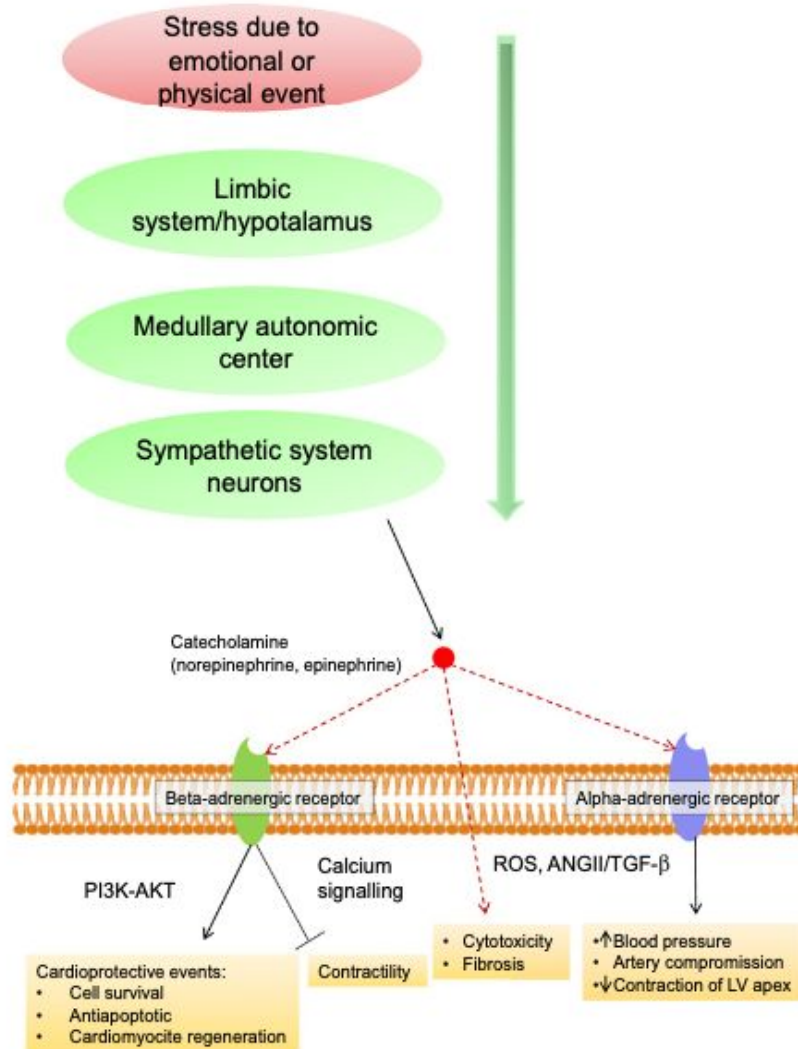
Takotsubo cardiomyopathy is a transient weakening of the left ventricle, the heart's main pumping chamber. Usually: result of severe emotional or physical stress.





# TAKOTSUBO SYNDROME

## Possible causes:



Lots of hypothesis today, but articles seem to all incriminate a catecholamine toxicity.

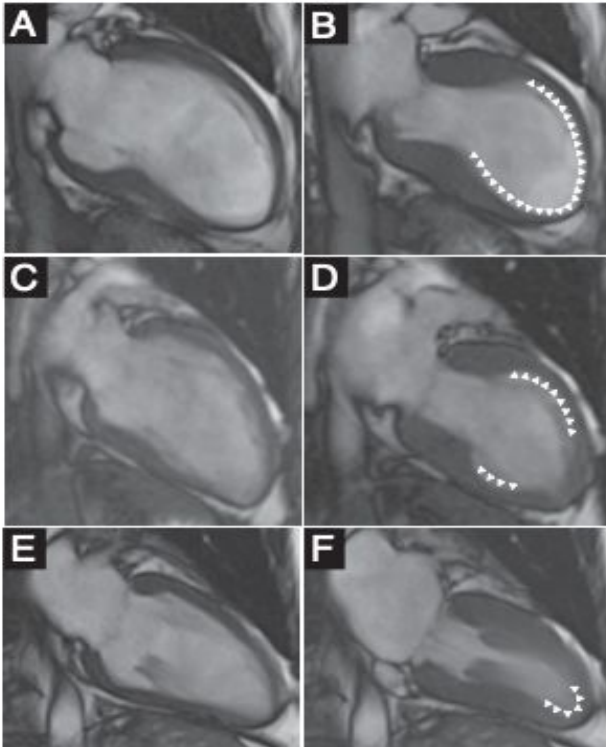
High prevalence in middle-aged women seem to show that estrogen deficiency might predispose them to the disease.

# TAKOTSUBO SYNDROME

## Criterion for Takotsubo diagnosis:

(Mayo Clinic, 2004)

1. Transient hypokinesis, akinesis, or dyskinesis of the left ventricular mid-segments with or without apical involvement; the regional wall motion abnormalities extend beyond a single epicardial vascular distribution; a stressful trigger is often, but not always present.



A, C, E: Diastole – heart relaxing and filling up with blood.

B, D, F: Systole – heart contraction

Diversity of left ventricle contraction patterns



# TAKOTSUBO SYNDROME

## Criterion for Takotsubo diagnosis:

(Mayo Clinic, 2004)

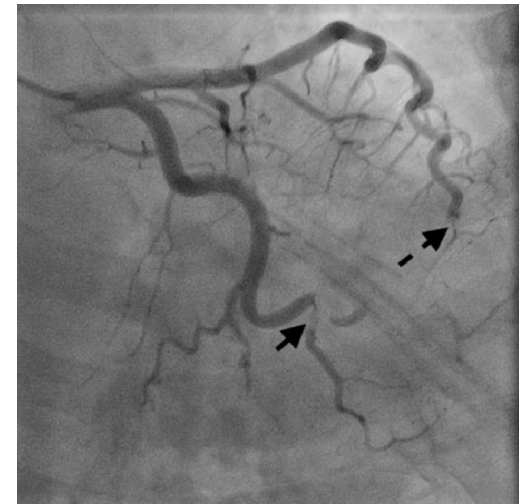
1. Transient hypokinesis, akinesis, or dyskinesis of the left ventricular mid-segments with or without apical involvement; the regional wall motion abnormalities extend beyond a single epicardial vascular distribution; a stressful trigger is often, but not always present.
2. Absence of obstructive coronary disease or angiographic evidence of acute plaque rupture.



Normal coronary arteries on the left side of the heart



Normal coronary arteries on the right side of the heart



Coronary arteries obstructed

# TAKOTSUBO SYNDROME

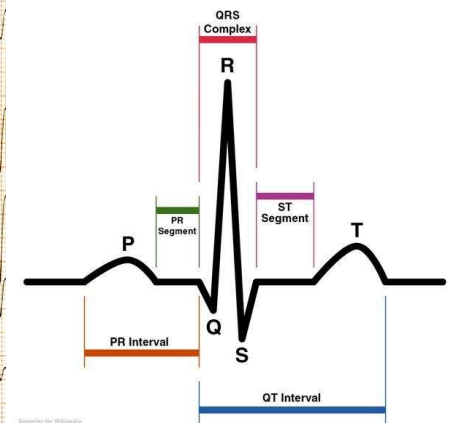
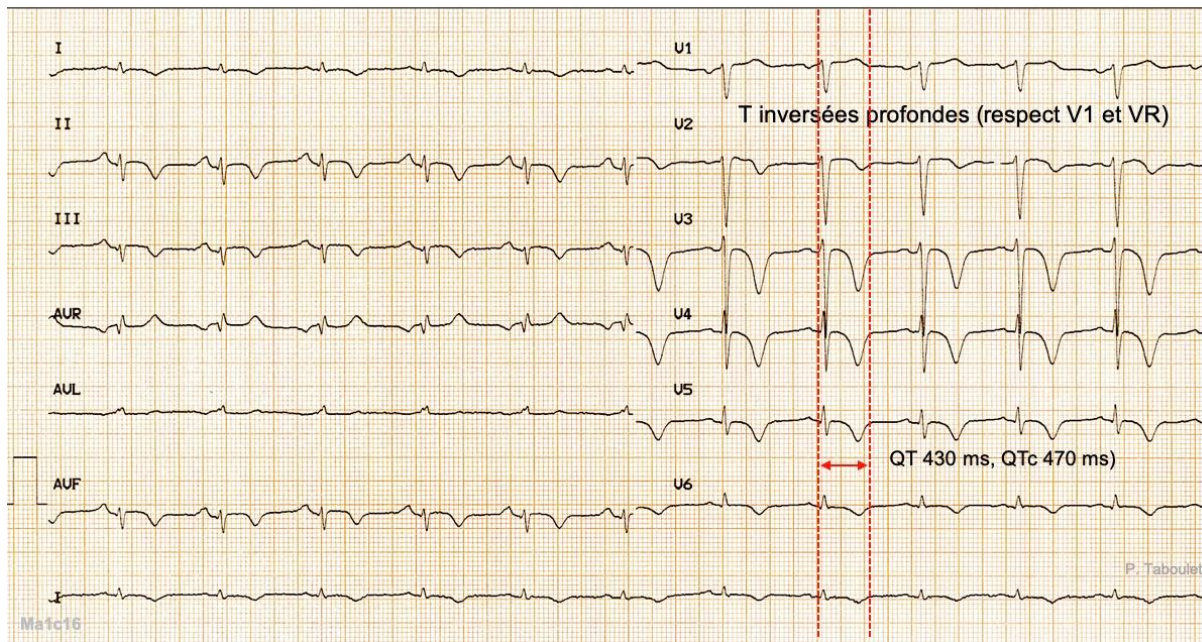
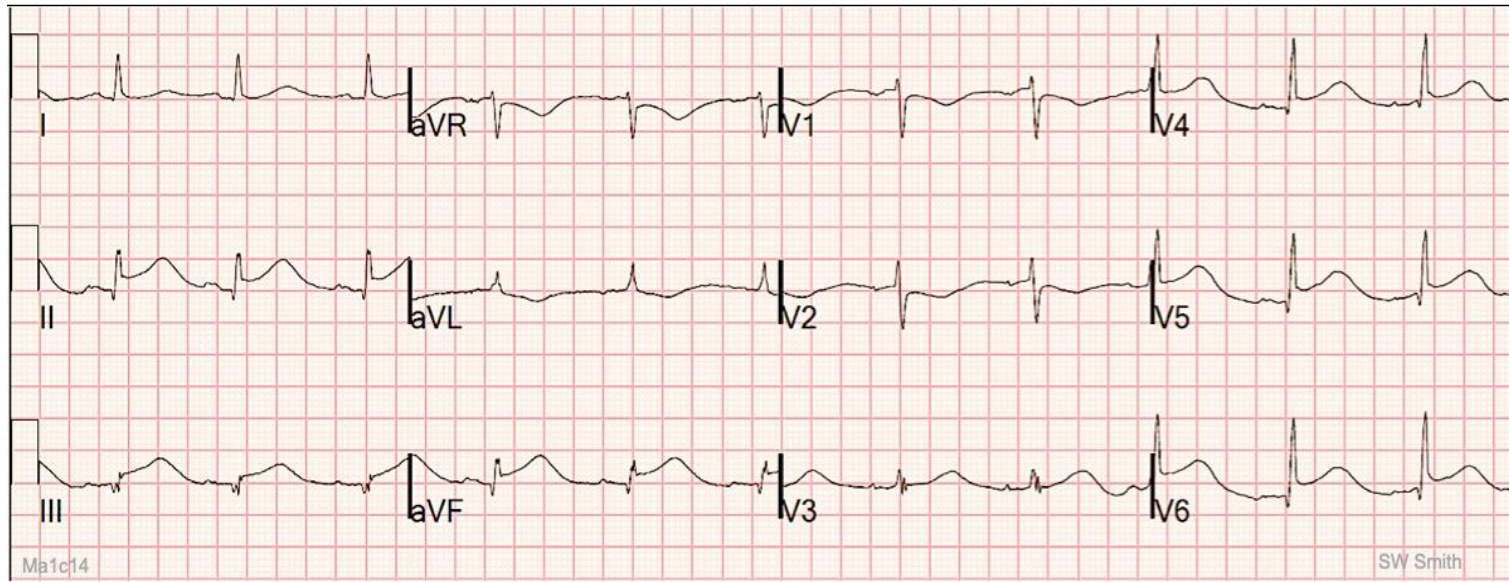
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2. Absence of obstructive coronary disease or angiographic evidence of acute plaque rupture.
3. New electrocardiographic abnormalities (either ST-segment elevation and/or T-wave inversion) or modest elevation in cardiac troponin.
4. Absence of:
  - a. Pheochromocytoma
  - b. Myocarditis

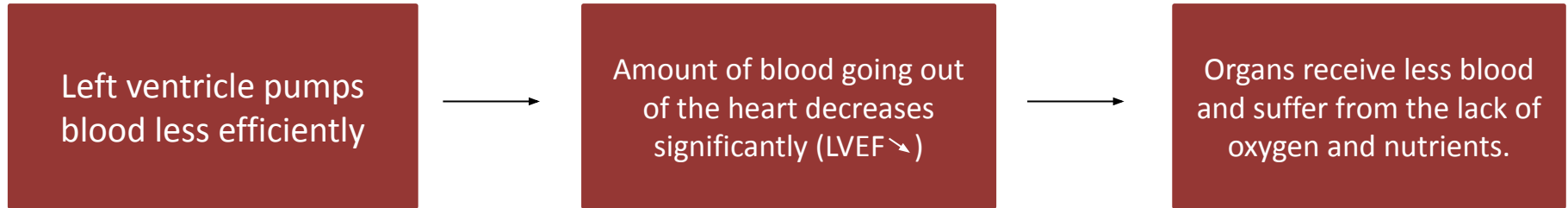




# TAKOTSUBO SYNDROME

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## What happens during a Takotsubo event?



## Why chest pains?

- Coronary arteries receive a lot less blood than usual.
- Cardiomyocytes aren't fed in oxygen and nutrients, and die.

## Consequences?

- Cardiogenic shock: the blood pumped into the whole body cannot meet the other organs' needs, provoking damages to the liver, kidneys from lack of oxygen, which can be permanent.
- Rhythmic abnormalities
- Thrombus due to residual blood in the left ventricle.
- Death

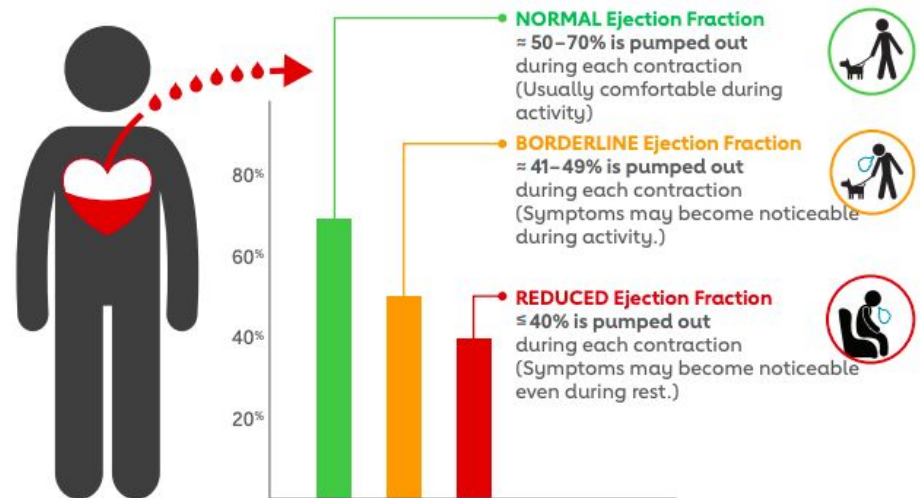
# TAKOTSUBO SYNDROME: PROBLEMATIC

## ► Project goals:

- Predict the in-hospital complications
- Predict the kind of heart failure to anticipate the medical care needed.



## How much blood is pumped out?



It is also possible to have a diagnosis of heart failure with a seemingly normal (or preserved) ejection fraction of greater than or equal to 50%.

# DECRPTION OF THE COHORT AND VARIABLES USED FOR PREDICTION

## Who?

Takotsubo patients between 2015 and 2021 from the CHU de Toulouse.

## What?

Variables selected by reading research articles on the short and long-term prognosis or diagnosis of the disease.

## How?

Reading the patients records and extracting the data patient by patient.

DDN	âge	Date hospit initiale	Homme	poids	taille	IMC ( kg/ cl	ATCD dépression/	ATCD psychiatrique	patho neurologiques	HTA	Dyslipidém	Tabac	Diabète	IRC	AVC/AIT	ATCD Canc	Cari
3/5/1955	66	5/3/2015	1	65	1,78	20,52	0	0	0	1	0	0	1	0	0	0	0
1/6/1964	57	3/2/2016	0	58	1,6	22,66	0	0	0	0	1	0	1	0	0	0	0
30/6/1940	81	10/2/2016	0	50	1,53	21,36	0	0	0	0	1	0	0	1	0	0	0
20/10/1962	58	25/2/2016	1	60	1,78	18,94	0	0	0	1	0	0	1	0	0	0	0
19/8/1939	81	1/3/2016	0	70	1,56	28,76	0	0	0	0	1	0	0	0	0	0	1
6/11/1929	91	28/2/2016	0	57	1,54	24,03	0	0	0	1	1	0	0	0	0	0	0
15/2/1935	86	6/4/2016	0	65			0	0	0	0	1	0	0	1	0	0	0
20/4/1944	77	20/4/2016	0	80	1,56	32,87	0	0	0	1	1	0	0	1	0	1	1
29/5/1991	30	24/4/2016	0	63	1,58	25,24	0	0	0	0	0	0	0	0	0	0	0
3/9/1958	62	2/5/2016	1	55	1,68	19,49	0	0	1	0	0	1	1	0	0	0	0
11/5/1928	93	18/5/2016	0	55	1,55	22,89	0	0	0	0	0	0	1	0	0	0	0
12/3/1949	72	2/6/2016	0	80	1,55	33,30	0	0	0	0	1	1	0	0	0	0	0
11/8/1939	81	3/6/2016	0	98	1,69	34,31	0	0	0	0	1	1	1	1	0	0	0
12/10/1934	86	13/7/2016	0	67	1,7	23,18	0	0	0	1	1	0	0	0	0	1	1
27/6/1949	72	23/7/2016	0	65	1,69	22,76	0	0	0	0	1	0	0	0	0	0	0
12/3/1931	90	23/7/2016	1	73	1,7	25,26	0	0	0	0	0	0	0	0	0	0	0
27/7/1955	65	26/7/2016	0	82	1,67	29,40	1	0	0	0	1	0	1	0	0	0	0
30/7/1955	65	17/8/2016	0	58	1,63	21,83	0	0	0	0	1	0	1	1	0	0	0
26/5/1933	88	20/9/2016	0	57	1,55	23,73	0	0	0	0	1	0	0	1	0	0	0
31/12/1941	79	27/9/2016	0	74	1,5	32,89	0	0	0	0	1	1	0	0	0	0	0
27/6/1952	69	5/10/2016	0	58	1,6	22,66	1	0	0	0	1	0	0	0	0	0	0
1/7/1935	86	12/10/2016	0	60	1,58	24,03	0	0	0	0	1	1	0	0	0	0	0
19/1/1944	77	19/10/2016	0	55	1,55	22,89	0	0	0	0	1	1	0	0	0	0	0
20/2/1943	78	13/11/2016	0	70	1,76	22,60	0	0	0	0	0	0	0	1	0	0	0
31/1/1939	82	29/11/2016	0	68	1,64	25,28	1	0	0	1	1	0	0	0	0	1	0
15/1/1949	72	28/12/2016	1	70	1,73	23,39	0	0	0	0	0	0	1	0	0	0	0
27/12/1944	76	4/1/2017	0	49	1,6	19,14	0	0	0	0	0	0	1	0	0	0	0
3/10/1942	78	20/1/2017	0	60	1,54	25,30	1	0	0	0	0	0	0	0	0	1	0
3/5/1973	48	26/1/2017	1	84	1,86	24,28	0	0	0	0	0	0	0	0	0	0	0
20/9/1998	22	27/1/2017	0	59	1,6	23,05	0	0	0	0	0	0	0	0	0	0	0
5/12/1946	74	8/2/2017	0	75	1,58	30,04	0	0	0	0	1	1	0	0	0	0	1
23/7/1931	89	27/2/2017	0	63	1,53	26,91	0	0	0	0	1	0	0	0	0	0	0
16/2/1949	72	27/2/2017	0	67	1,59	26,50	0	0	0	0	0	1	1	0	0	0	1
31/12/1949	71	14/5/2017	0	64	1,69	22,41	0	0	0	1	0	1	1	0	0	0	0
11/6/1959	62	11/6/2017	0	65	1,68	23,03	1	0	0	0	0	1	0	0	0	0	0
19/4/1924	97	14/6/2017	0	53	1,6	20,70	0	0	0	0	1	0	0	0	0	0	0
8/2/1930	91	20/6/2017	0	60	1,57	24,34	0	0	0	0	0	0	0	0	0	0	1
20/10/1943	78	30/6/2017	0	67	1,6	23,33	0	0	0	1	0	0	0	0	0	1	0



# DESCRIPTION OF THE COHORT AND VARIABLES USED FOR PREDICTION

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## **DEMOGRAPHICS**

Age, BMI, Sex.

## **STRESS FACTOR**

- Emotional
- Physical

## **MEDICAL HISTORY**

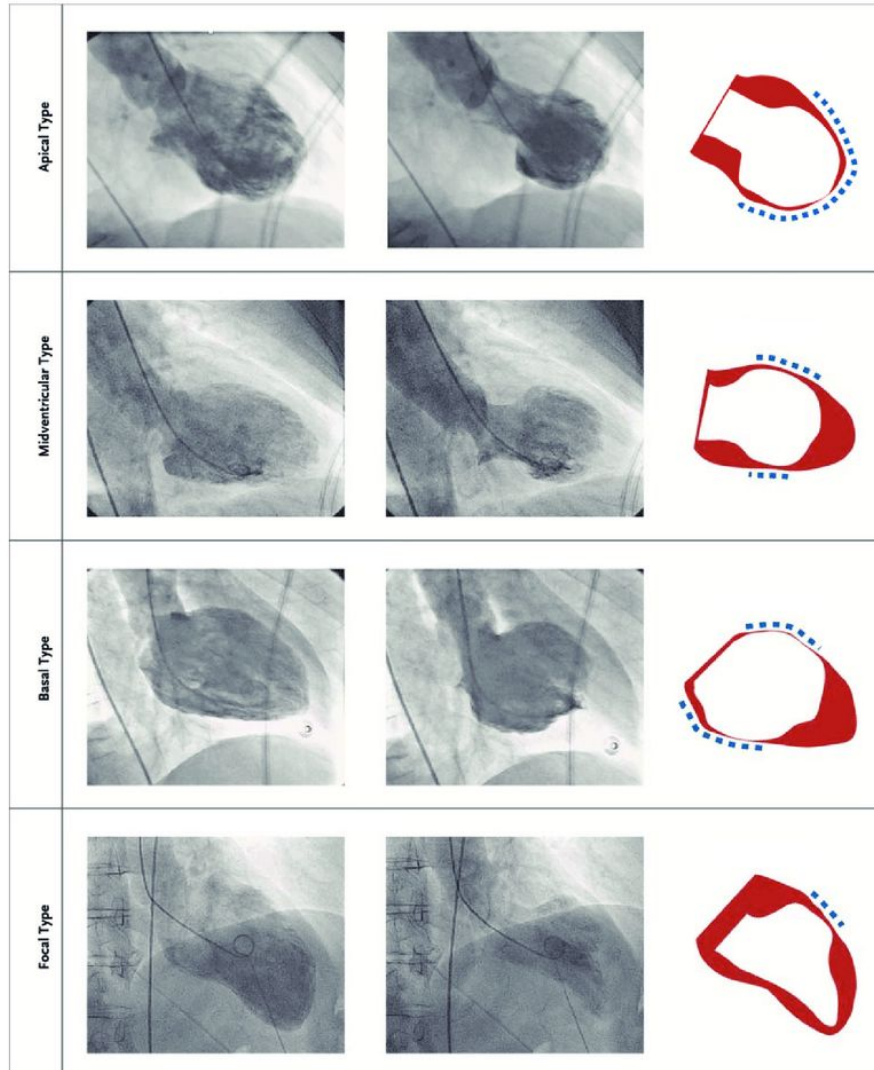
- Depression or Anxiety
- Psychiatric disorders
- Neurological diseases
- Hypertension
- Dyslipidemia
- Smoking
- Diabetes
- Chronic Renal Failure
- Stroke or Transient Ischemic Attack (TIA)
- Cancer history or active Cancer
- Chronic Obstructive Pulmonary Disease (COPD) or asthma
- Alcoholism
- Cardiac diseases history

## **TREATMENTS BEFORE/AFTER EVENT**

- Beta Blockers
- Angiotensin Converting Enzyme Inhibitor
- Angiotensin II receptor blockers
- Aspirin
- Antiplatelets drugs
- Oral anticoagulation drugs
- Statins
- Anti-depressants and anxiolytics

# DESCRIPTION OF THE COHORT AND VARIABLES USED FOR PREDICTION

## ANATOMY



Apical type

Medioventricular type

Basal type

Focal type

# DESCRIPTION OF THE COHORT AND VARIABLES USED FOR PREDICTION

## HAEMODYNAMICS

- Left Ventricle Ejection Fraction (LVEF)
- ECG abnormalities

## BIOMARKERS

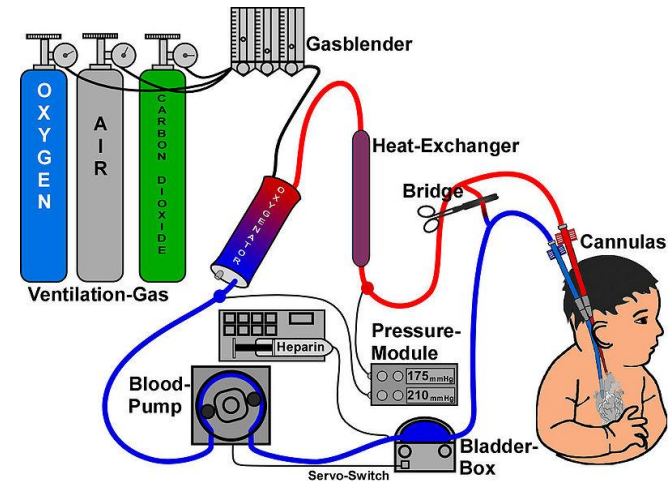
- Troponin T (entry and peak)
- NT pro-BNP
- CRP

## CORONAROGRAPHY

- Harm
- Healthy

## IN-HOSPITAL COMPLICATIONS

- Heart Failure
- Right Ventricle Harm
- Ventricular arrhythmia
- Left ventricle thrombus
- Cardiogenic shock
- ECMO (Extracorporeal membrane oxygenation)
- Death



# ALGORITHM PREDICTION



PYCARRET



O P T U N A



SHAP



## CONCLUSION AND PERSPECTIVES

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- Difficulty of data collection: precision
- Clinical features mostly – how about genetics, epigenetics, proteomics... ?
- Difficulty in data processing: dropping data when we already have just a few?
- ICM codes → make the algorithm more precise by distinguishing the physical/emotional stresses.
- Contradiction of adopting the latest technologies.

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