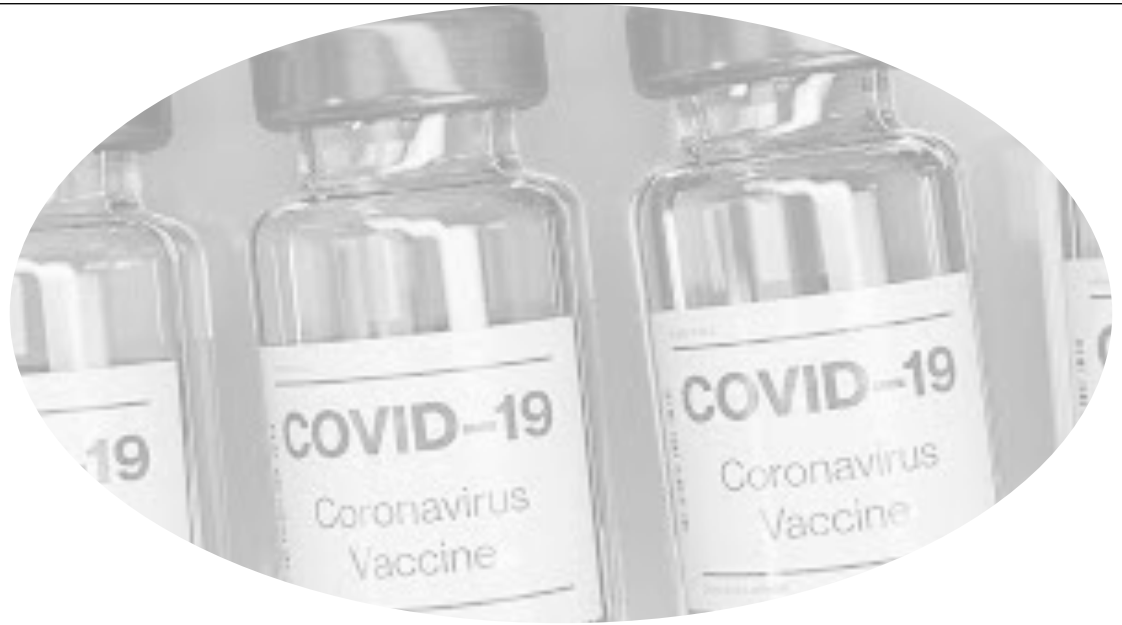
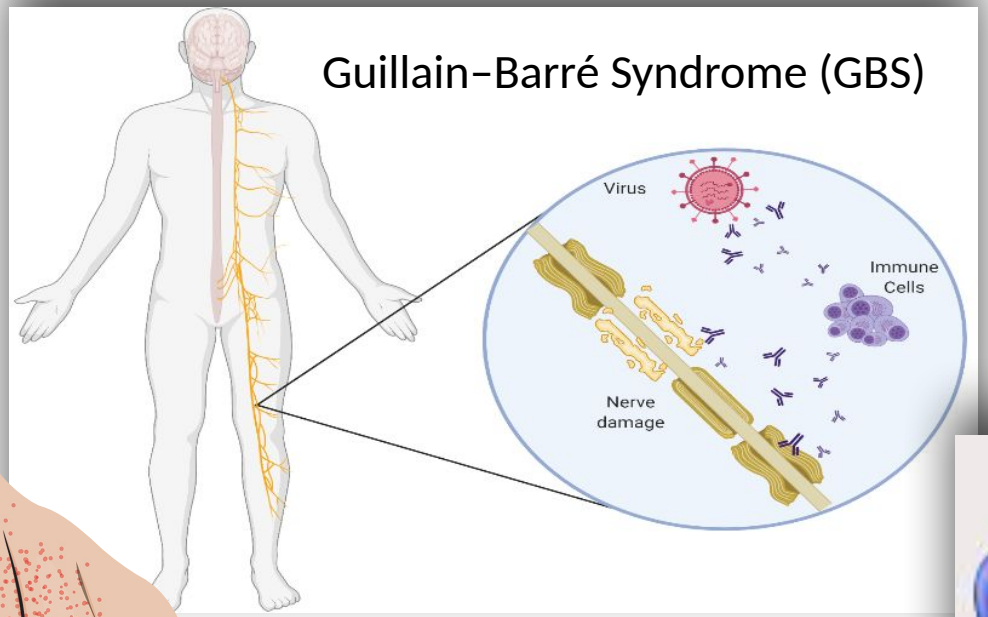
Covid-19 Vaccination Safety in the U.S.
(As For Dec 2020 : Nov 2021)

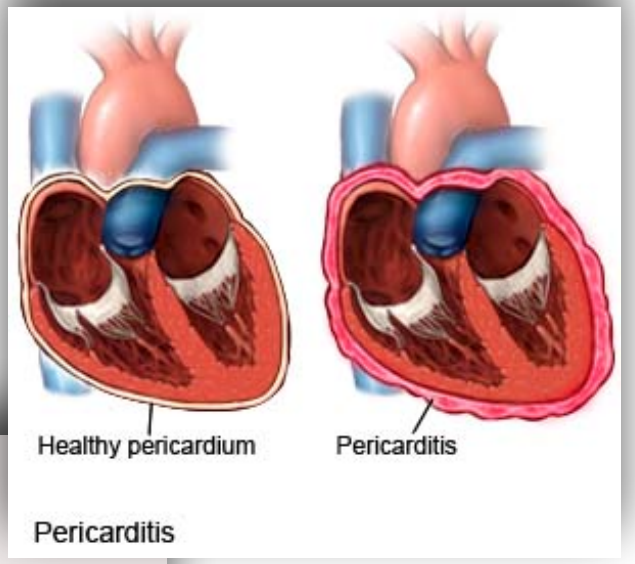


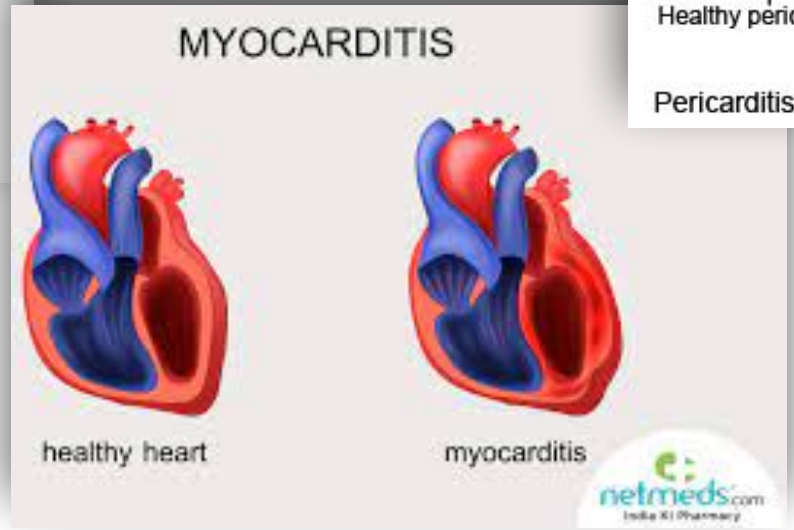
OpenTox 2021 Intern

Nesma Mousa

Am I at “serious risk” if I got vaccinated?







(Thrombotic Thrombocytopenia Syndrome (TTS))

Image source: https://www.drugs.com/cg/chronic-pericarditis.html

Who …?

gender

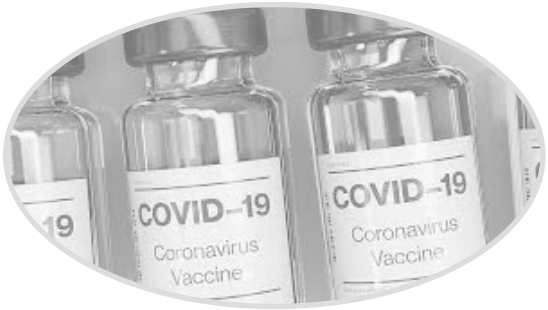
ageGroup

How …?

acute

chronic

Which …?



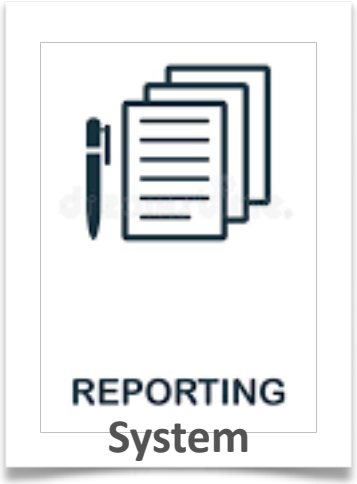
LOT

“Descriptive Analysis” time!

Disorders Distribution

Features Correlation

But hey! Where is the DATA?

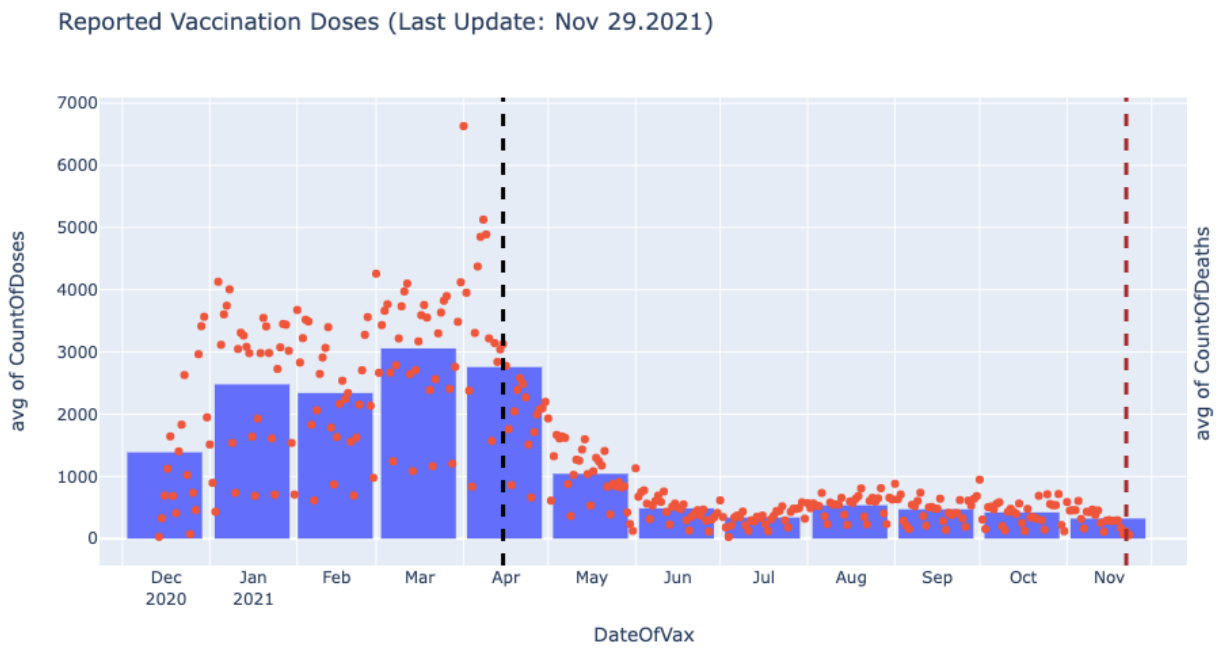


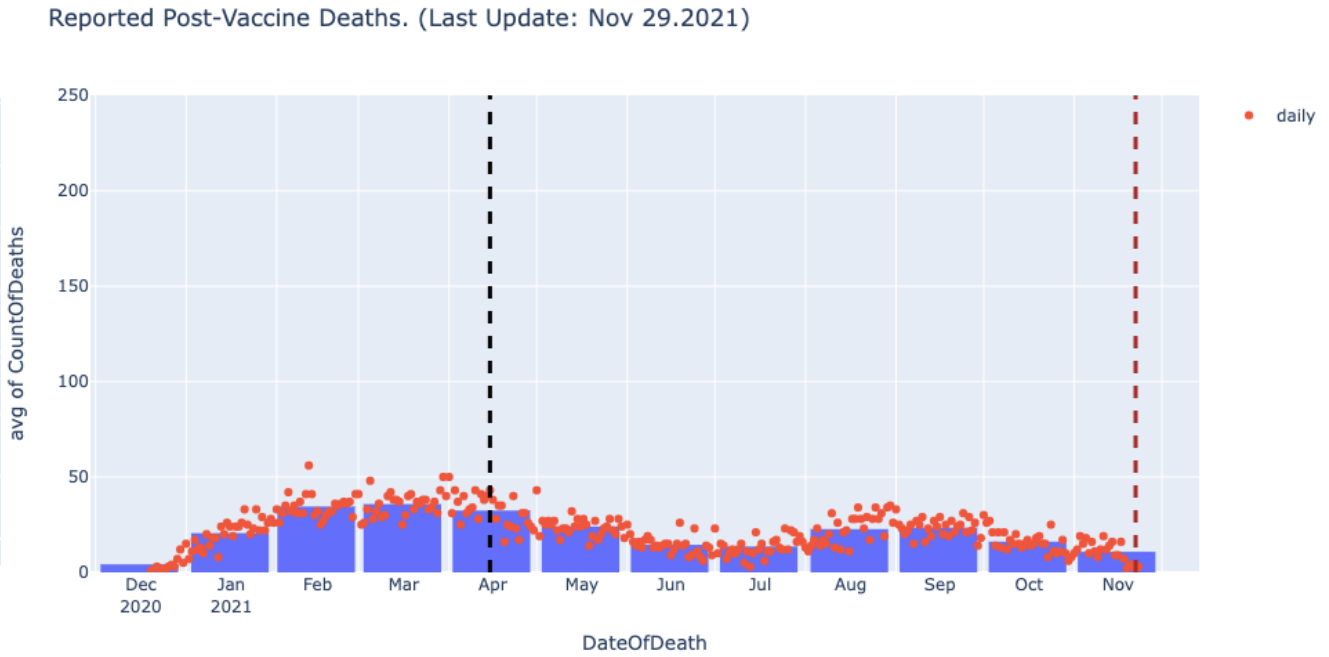
= V.A.E.R.S. database

https://vaers.hhs.gov/data/datasets.html

Am I going to “DIE” from the vaccine?

Considering Death counts alone without the counts of Vaccination Doses could be misleading!



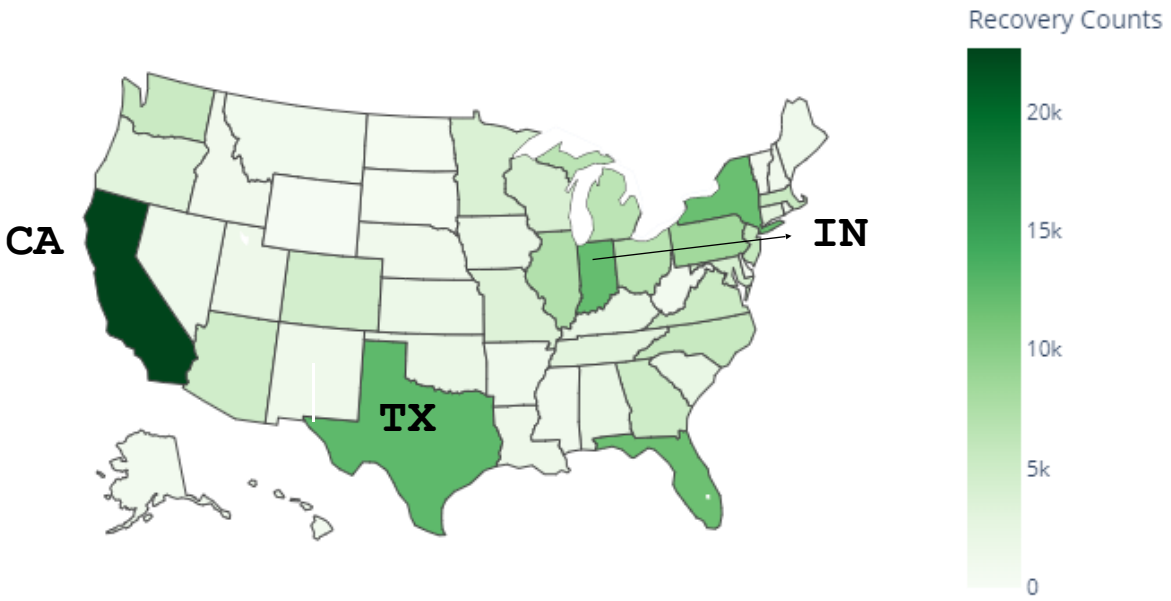


Figures show **Daily Counts** of Vaccination and attributed post deaths in overlapped **red scattered dots.**
Figures Show **Delta-Variant** Outbreak in April 2021 in **black dashed line** (first identified in Oklahoma)
Figure Shows **Omicron-Variant** Outbreak in November 2021 in **brown dashed line** (first identified in California)
Data are preliminary and subject to change as more data become available.

0.0022% post-vaccine deaths

Which State is doing better?

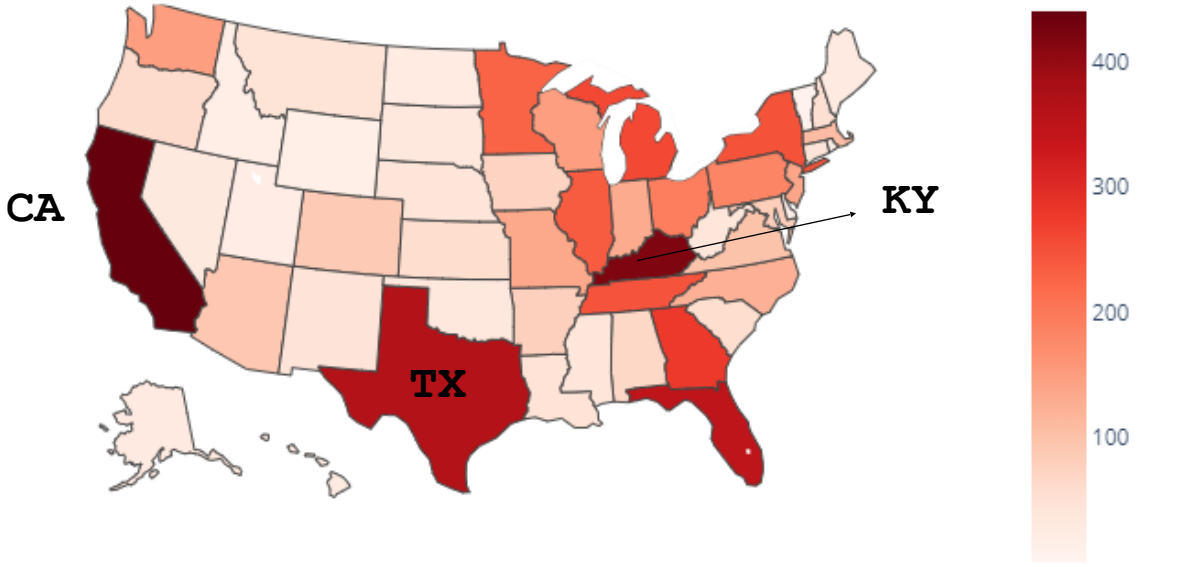
Reported US Post-Vaccines Recovery by State. (Last Update: Nov 29.2021)



US states ranked by **highest reported RECOVERY** counts from covid19 vaccines:

California, Texas, and Indiana

Reported US Post-Vaccines Deaths by State (Last Update: Nov 29.2021)

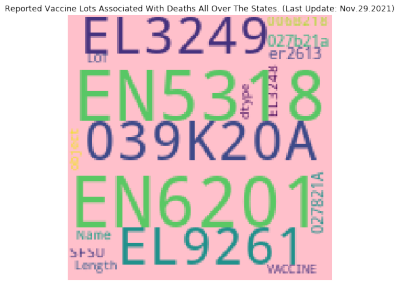


US states ranked by **highest reported DEATHS** after covid19 vaccines:

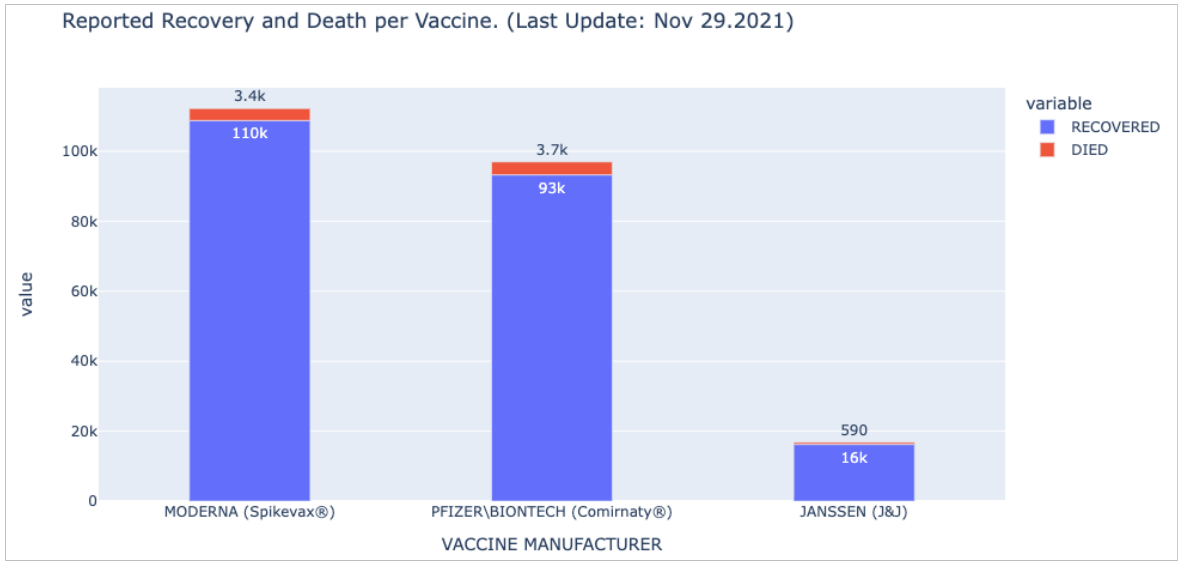
California, Kentucky, and Texas

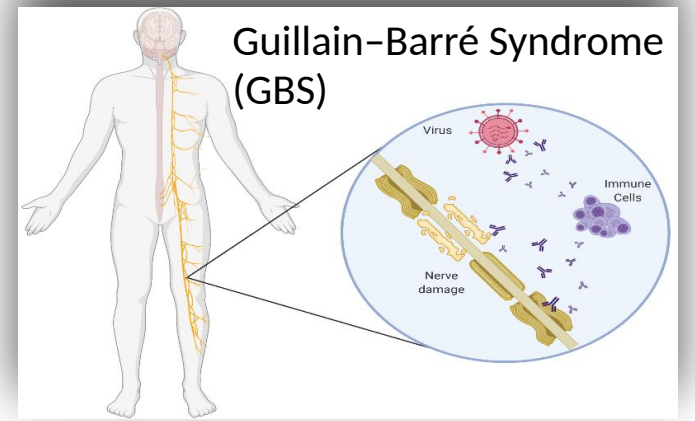
Death

LOT

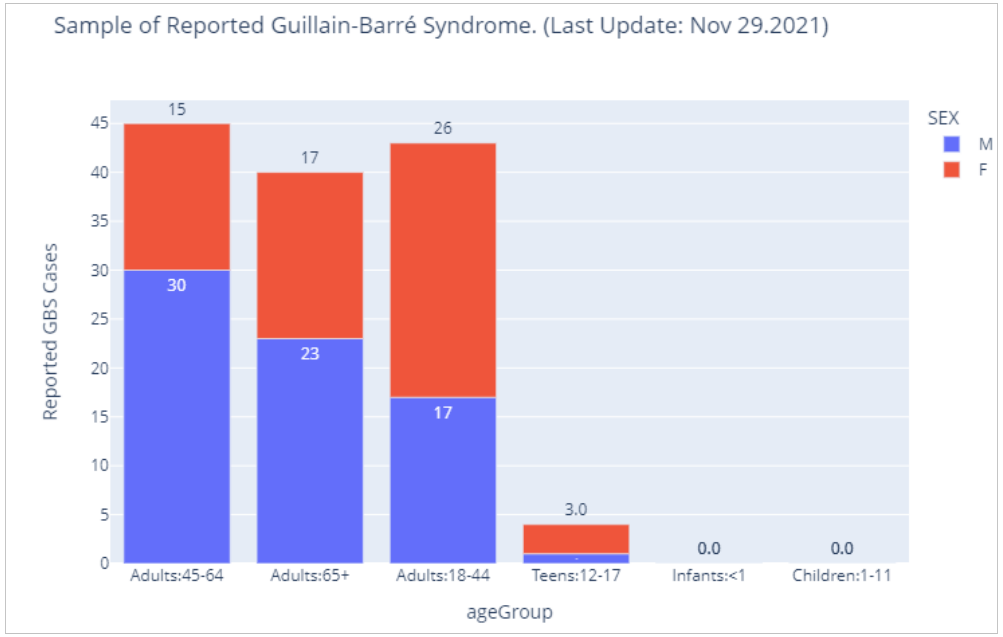


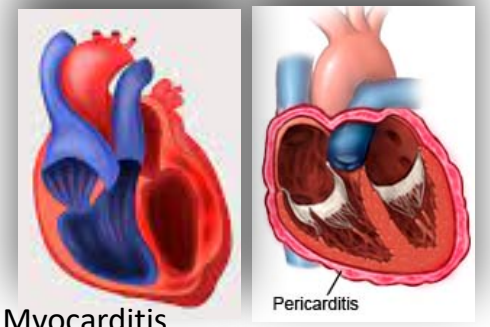
- **Adults** (45+)
- **J&J:** 9 confirmed deaths





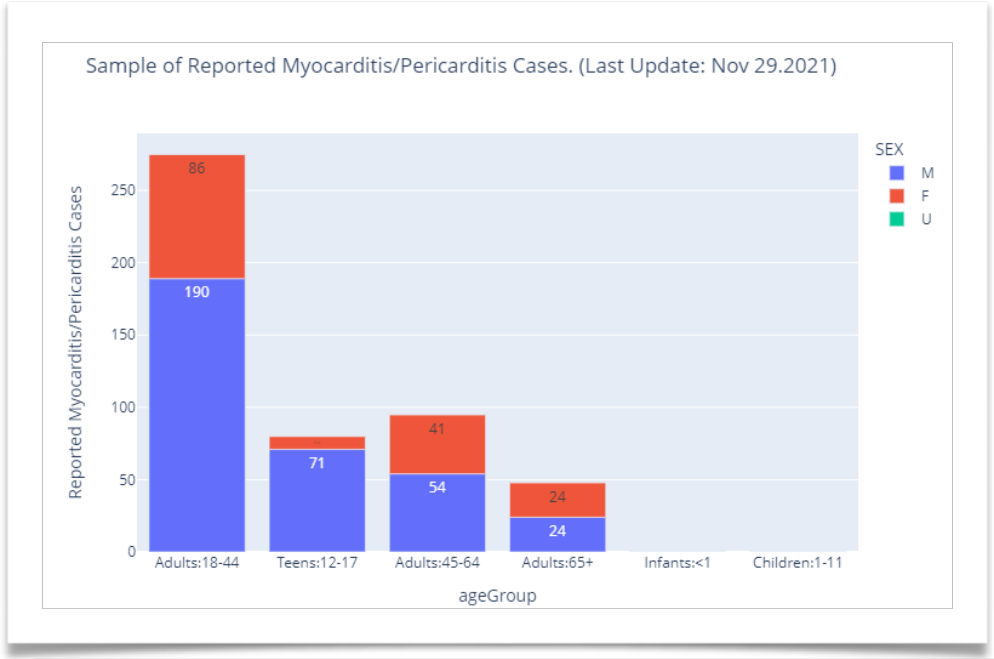
- 3-22 days
- **Rare**
- **Men**
- Many ages
- 278 report/16.9 M doses
- **J&J**

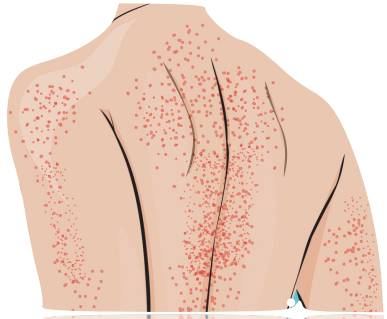




Myocarditis

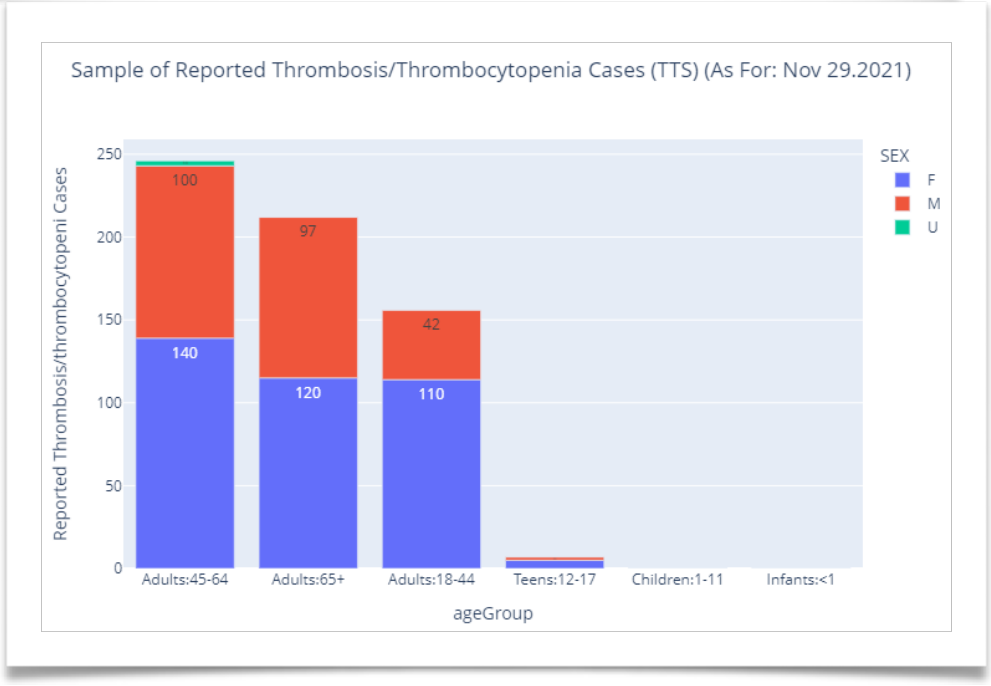
- **Acute** (1-3 days)
- **Rare**
- **Male** adolescents and young adults
- 1,106 confirmed reports
- **Pfizer\BioNTech** (LotNr: EW0187)
- **Moderna** (LotNr: 039K20A)





(Thrombotic Thrombocytopenia Syndrome (TTS))

- 4-42 days
- **Rare**
- **Women**
- **Ages** 30-49 years
- **J&J:** 57 confirmed / 16.9M doses
- **Moderna**: 3 confirmed / 458M doses



What were the other serious outcomes…?

Emergency Visit

- **Young adults (18+)**
- **Pfizer\BioNTech** (EK5730, EH9899)
- **Moderna** (039K20A)

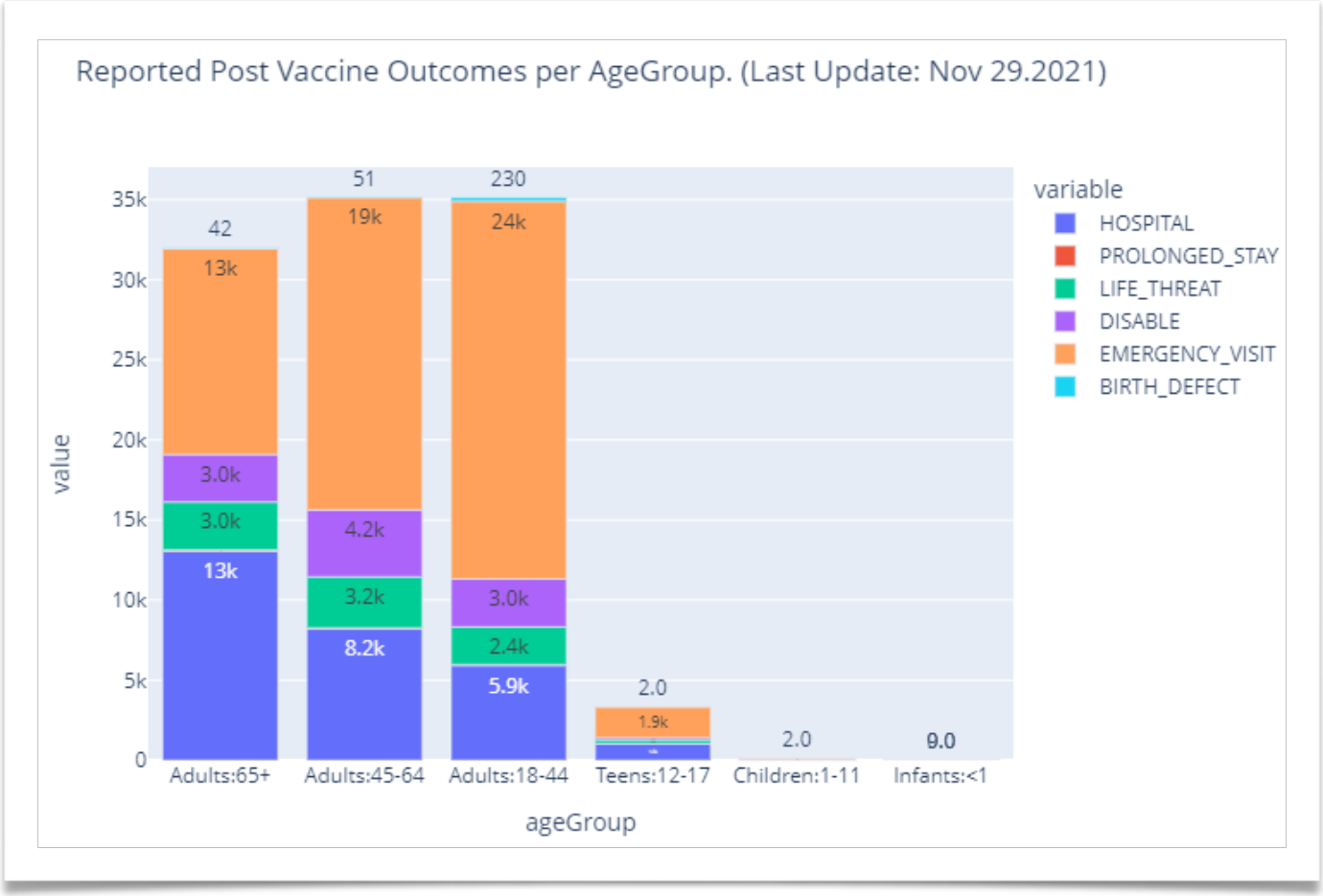
Life Threatening

- **Adults (45+)**
- **Pfizer\BioNTech**

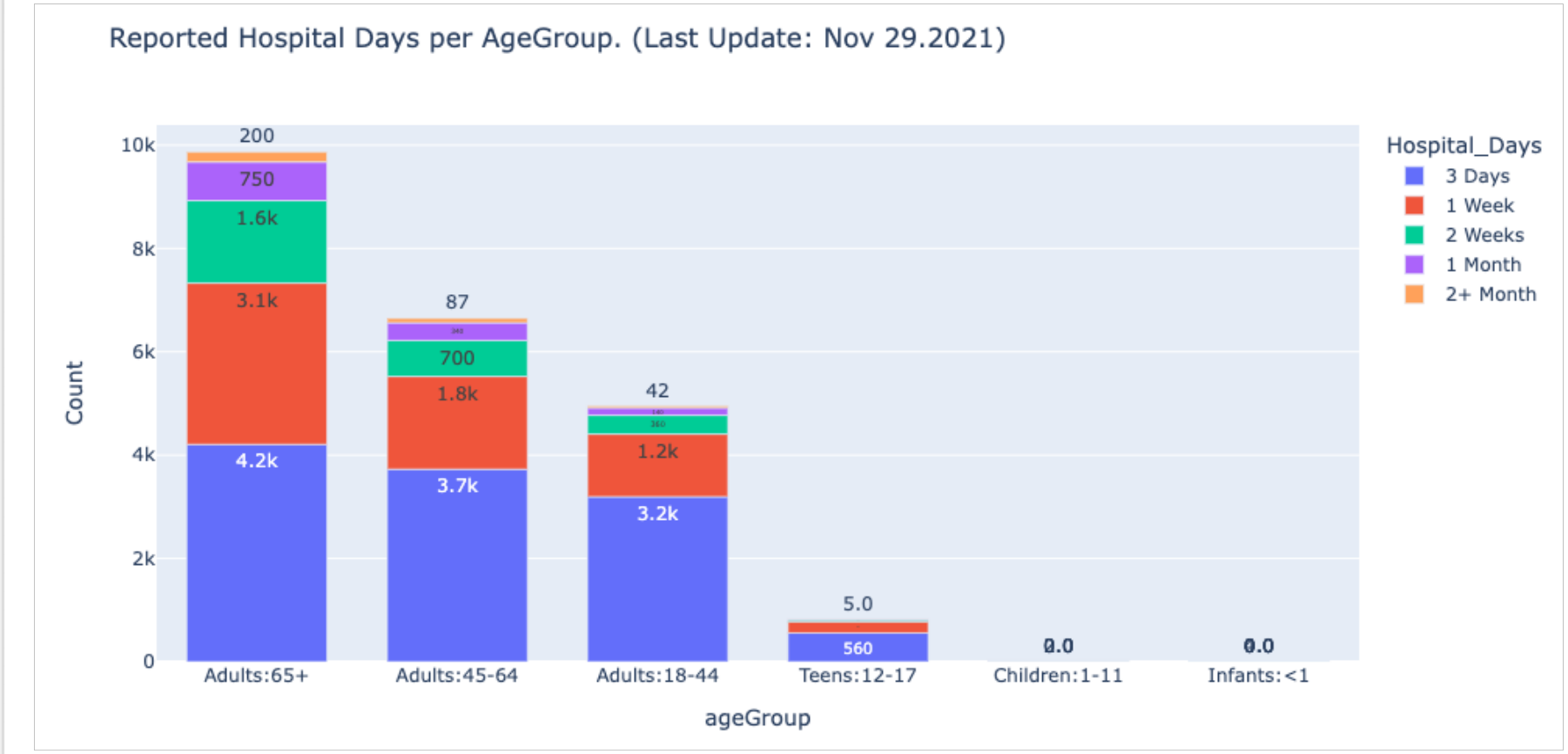
(EN6204, EP6955, EN6208)

Hospital Days

- **Adults (65+)**
- avg. less than a week
- max. 6 months

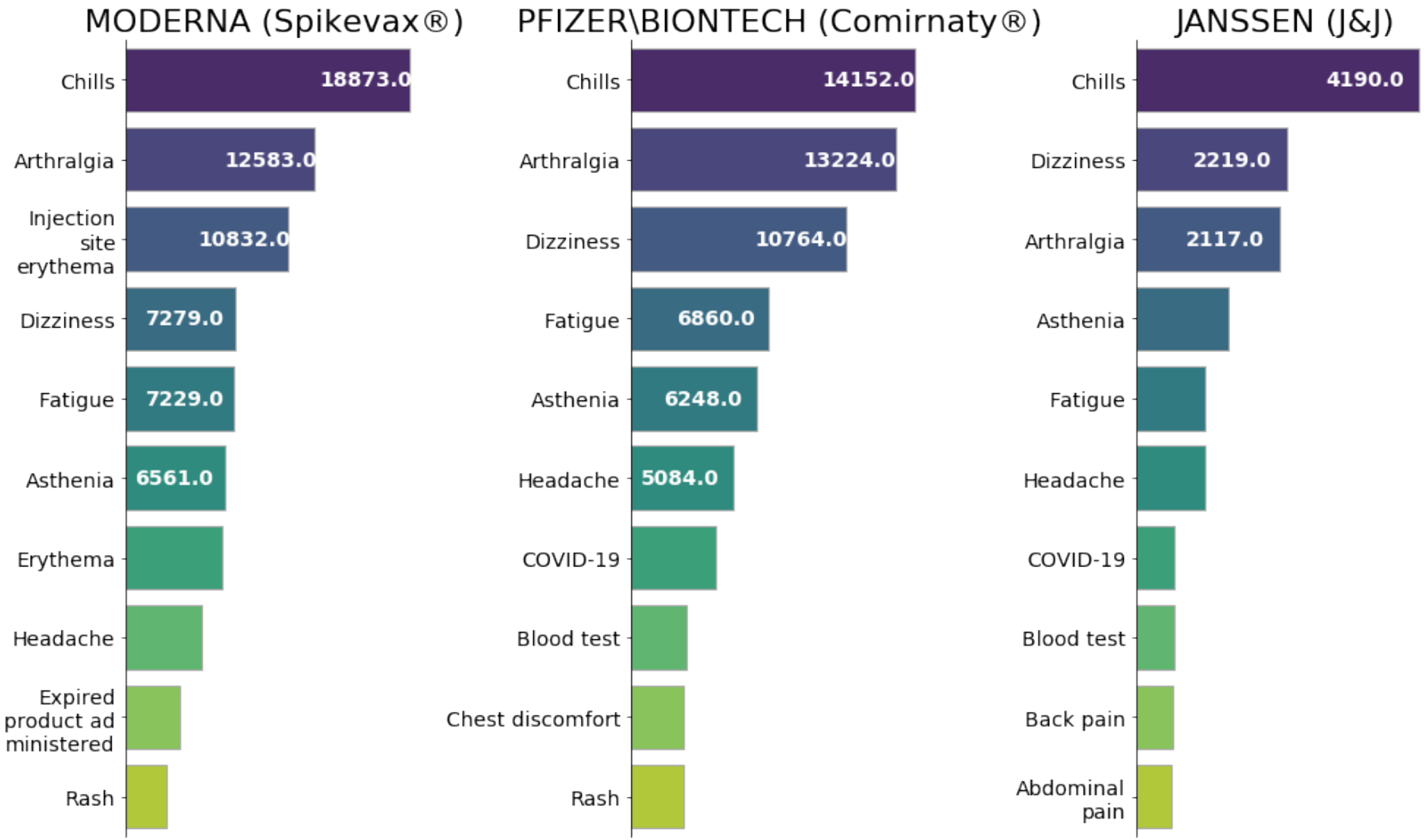


Capacity Management …



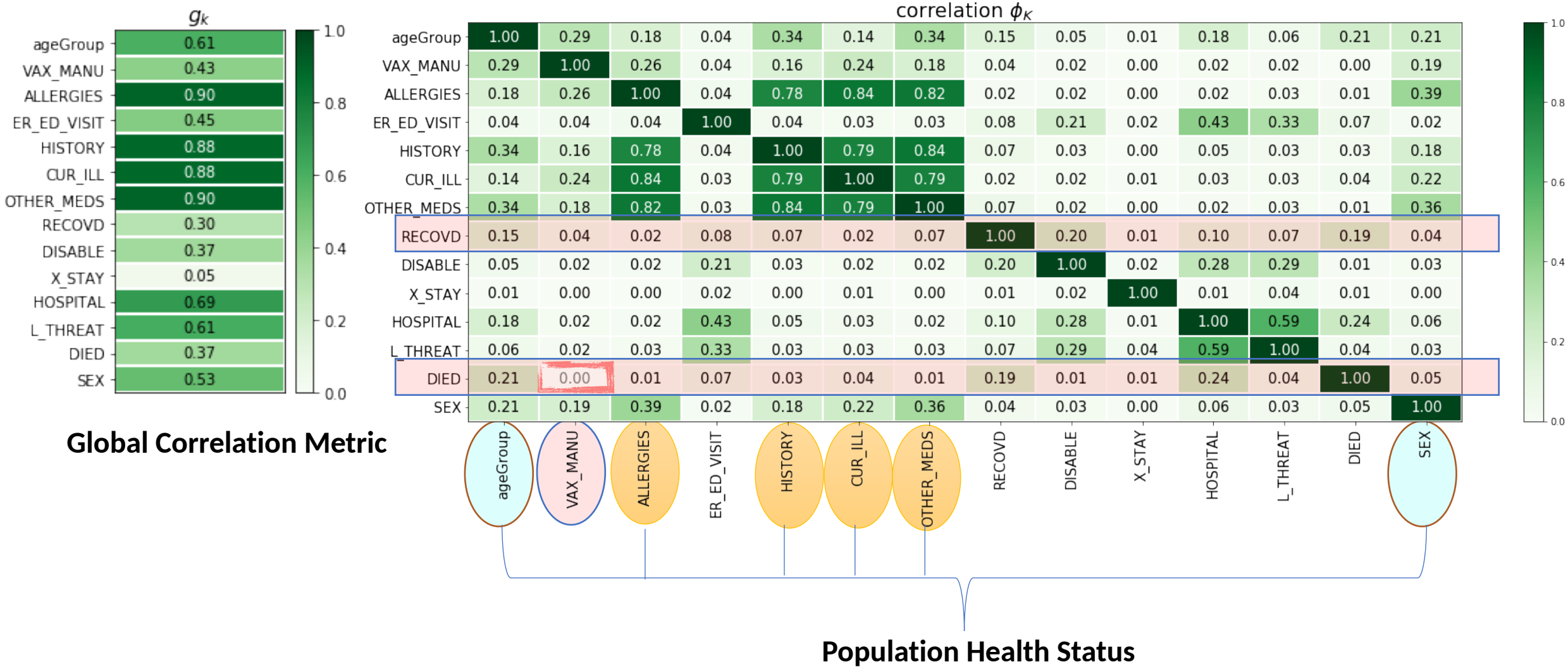
What about the Common symptoms after each vaccine?

Top 10 SYMPTOMS Reported By The Vaccinees. (As For Nov 29.2021)



Alright, enough symptoms distribution…

Show me the correlation of the features!

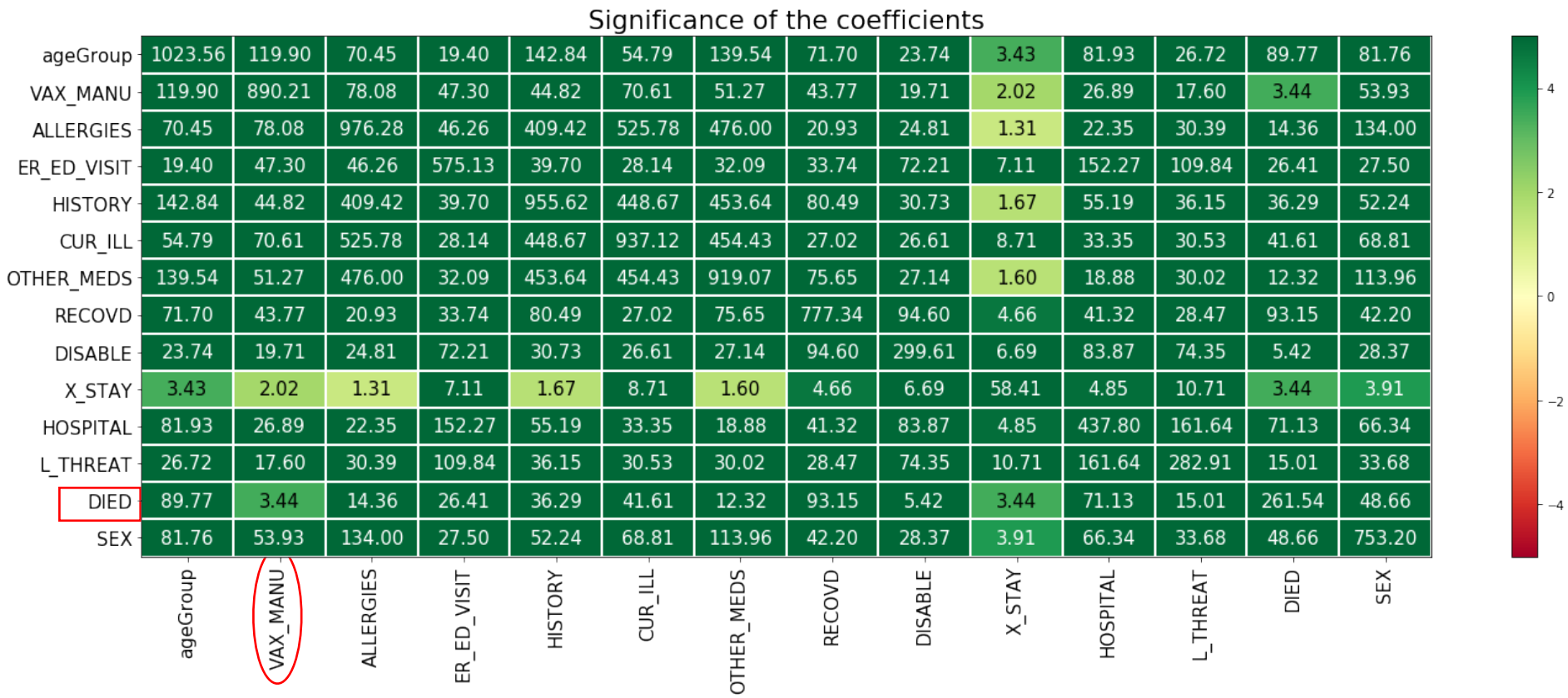


Global Correlation Metric

Population Health Status

Do we need to look at the coefficients' statistical significance?

Yes. Because in the end, a large correlation may be statistically insignificant, and vice versa.



Statistically insignificant means it **could be out of coincidence** or out of the **health status of the vaccinees.**

e.g. Death correlation values showed higher correlation significance with the Age Group, Sex, and Current Illnesses.

Wrap-Up

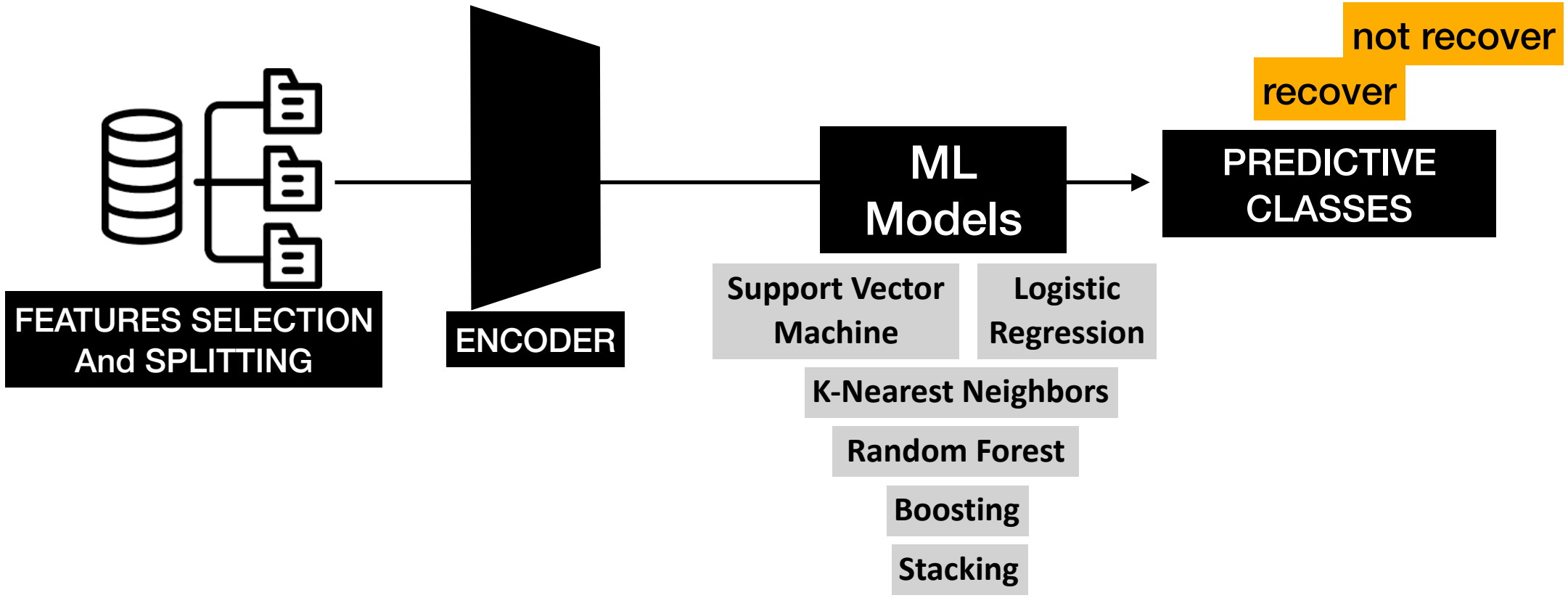
- Vaccines, like drugs, can cause side effects, a small percentage of which may be severe.
- Age group and the individual-health profile are relatively correlated to the recovery or the post-vaccines complications.
- The risk-benefit assessment showed a favorable balance towards vaccines for all people.
- However, vaccine adverse events should be promptly reported and followed up with high priority in order to manage them properly.
- Where to report a side effect? In Europe >>

https://www.adrreports.eu/en/report_side_effect.html

Hey, we are not done yet …

Don’t you want to predict “your” recovery likelihood?

Predictive modeling



- Models Validation: **GridSerachCV**
- Models Evaluation:
  - Error Metrics

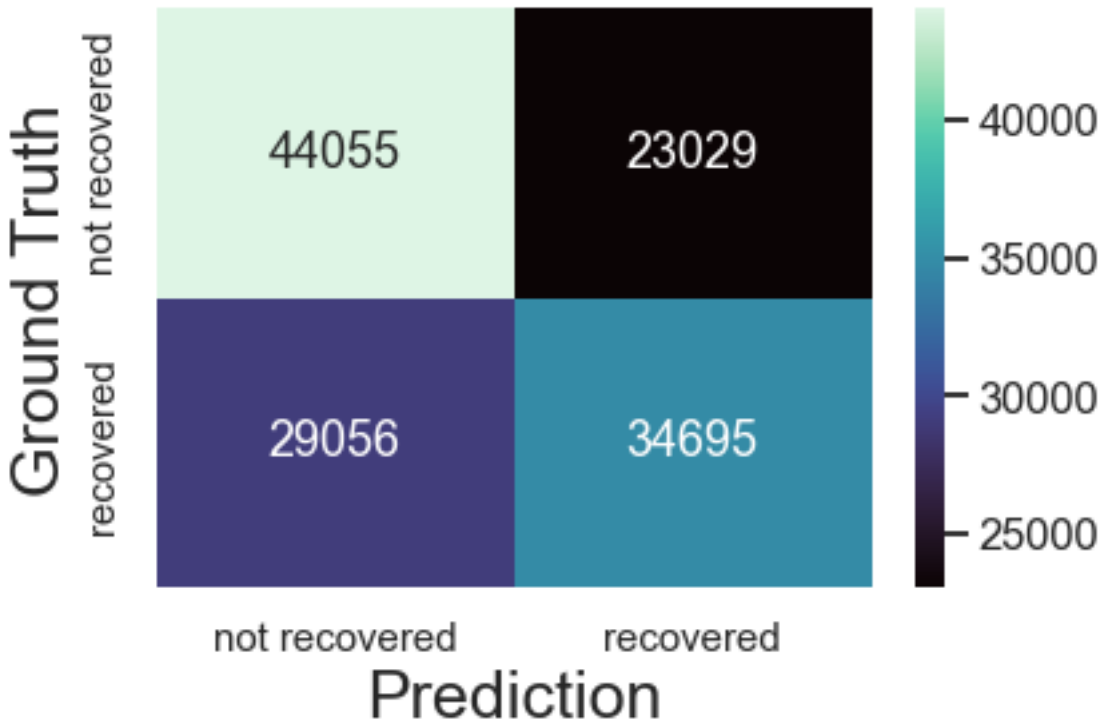
	XGB	AB + DT	RF	Knn	LR
Percision	66 %	67 %	60 %	54 %	58 %
Recall	60 %	58 %	66 %	55 %	58 %
F1 score	63 %	63 %	63 %	41 %	58 %
Accuracy	60 %	59 %	60 %	55 %	58 %

Hyperparameters of their Best Estimator…

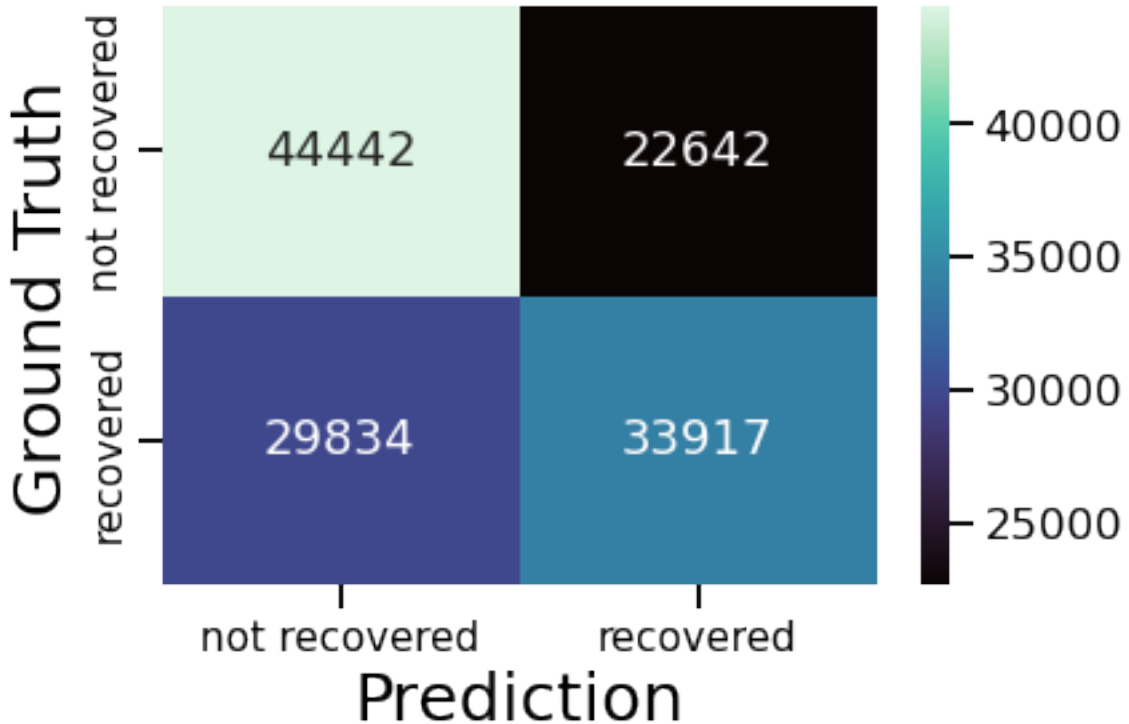
- XGB
  - n_trees= 20,000
  - max_features= 3
  - learning_rate= 0.01
  - subsample= 0.5
  - runtime: 5 hrs
- RF
  - n_estimators=2000
  - runtime: 20 min

Confusion Matrix

- XGB

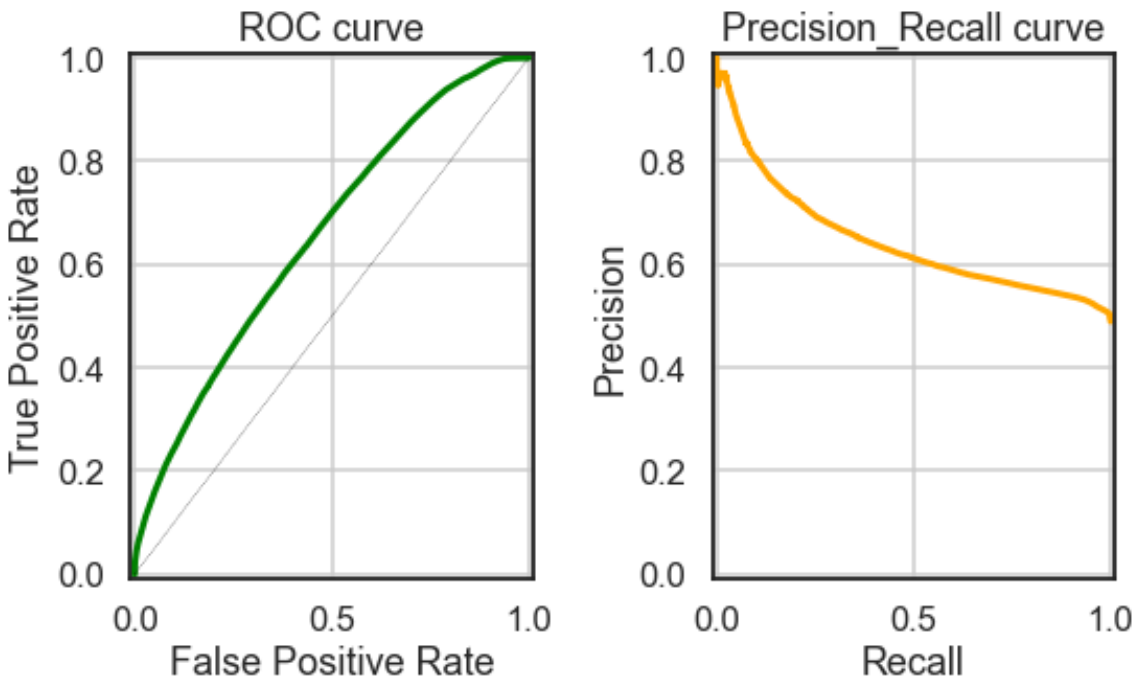


- RF

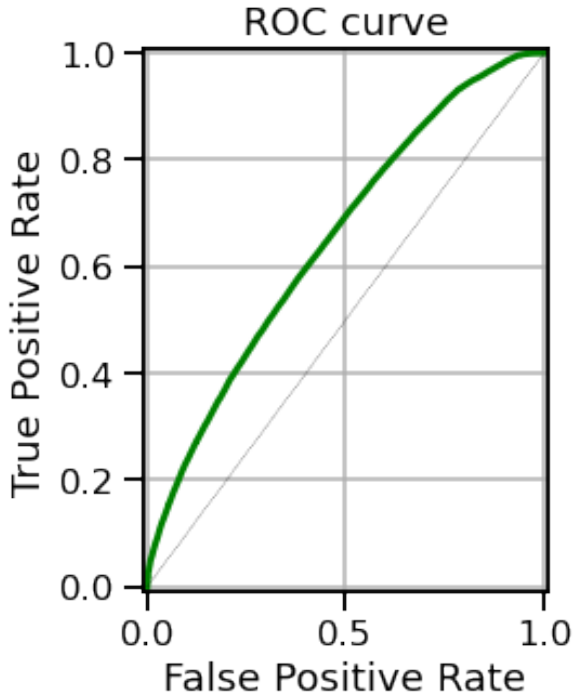


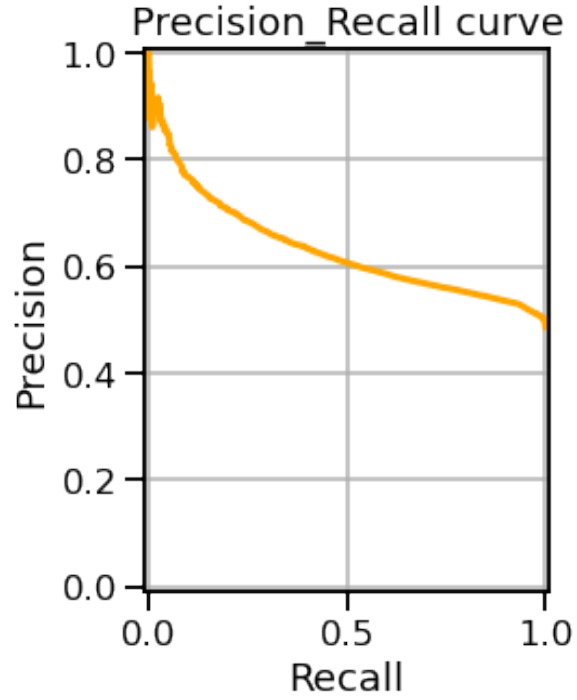
ROC Curve

- XGB

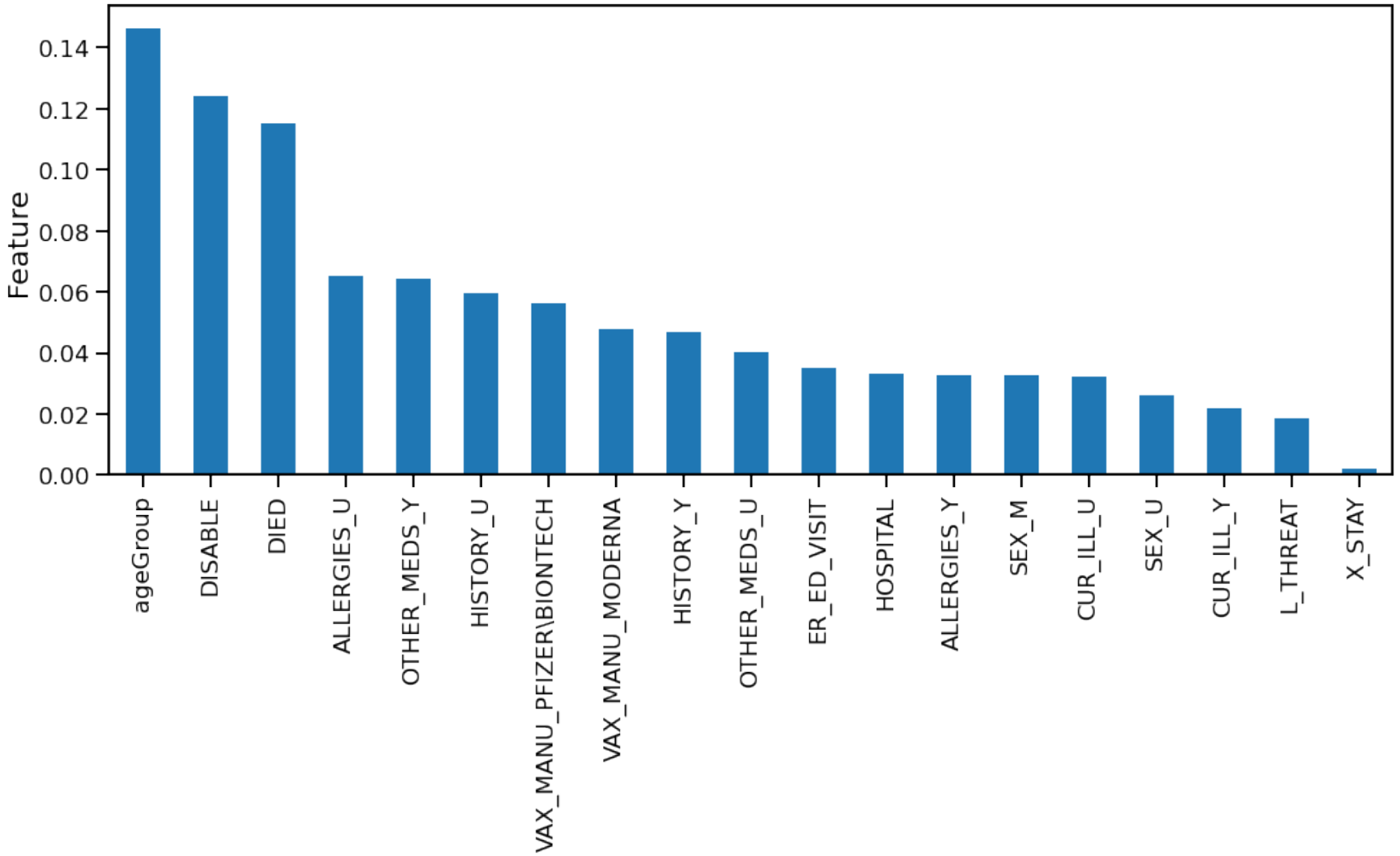


- RF





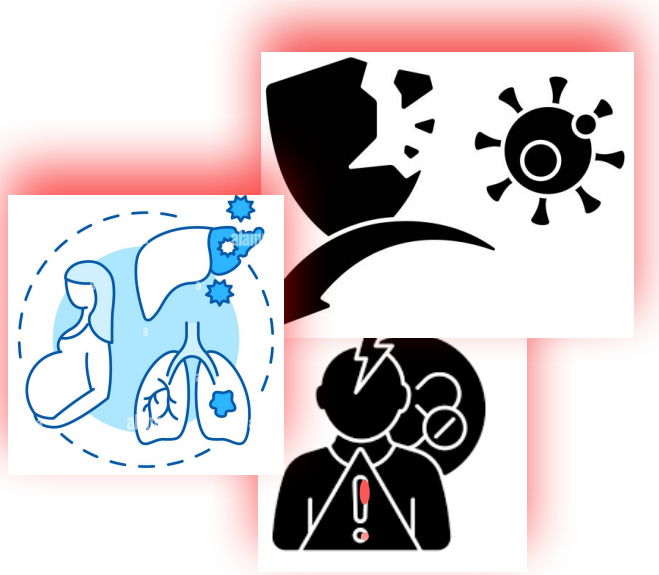
Feature Importance: RF Model



Conclusion

- **Random Forest (RF)** is proposed as the best model to predict the recovery class for a given dataset.
- **ExtremeGradientBoost (XGB)** classifier is proposed as an alternative!

Again, How is this useful?



People at-Risk

Optimize
Decision-Making

- Shared
- Personalized

Model Flaws…

- No model is perfect, right?
- What is the suggested action plan for model improvements?

Packages

- Descriptive analytics was done using these packages:

- All the visualizations were done using these packages:

- Features correlation was done using: phi_k correlation package.

- Machine Learning:

Thank you for your attention!

Looking forward for your feedback!

 -> NesmaMousa

 -> https://github.com/cheminform-bio/VAERS