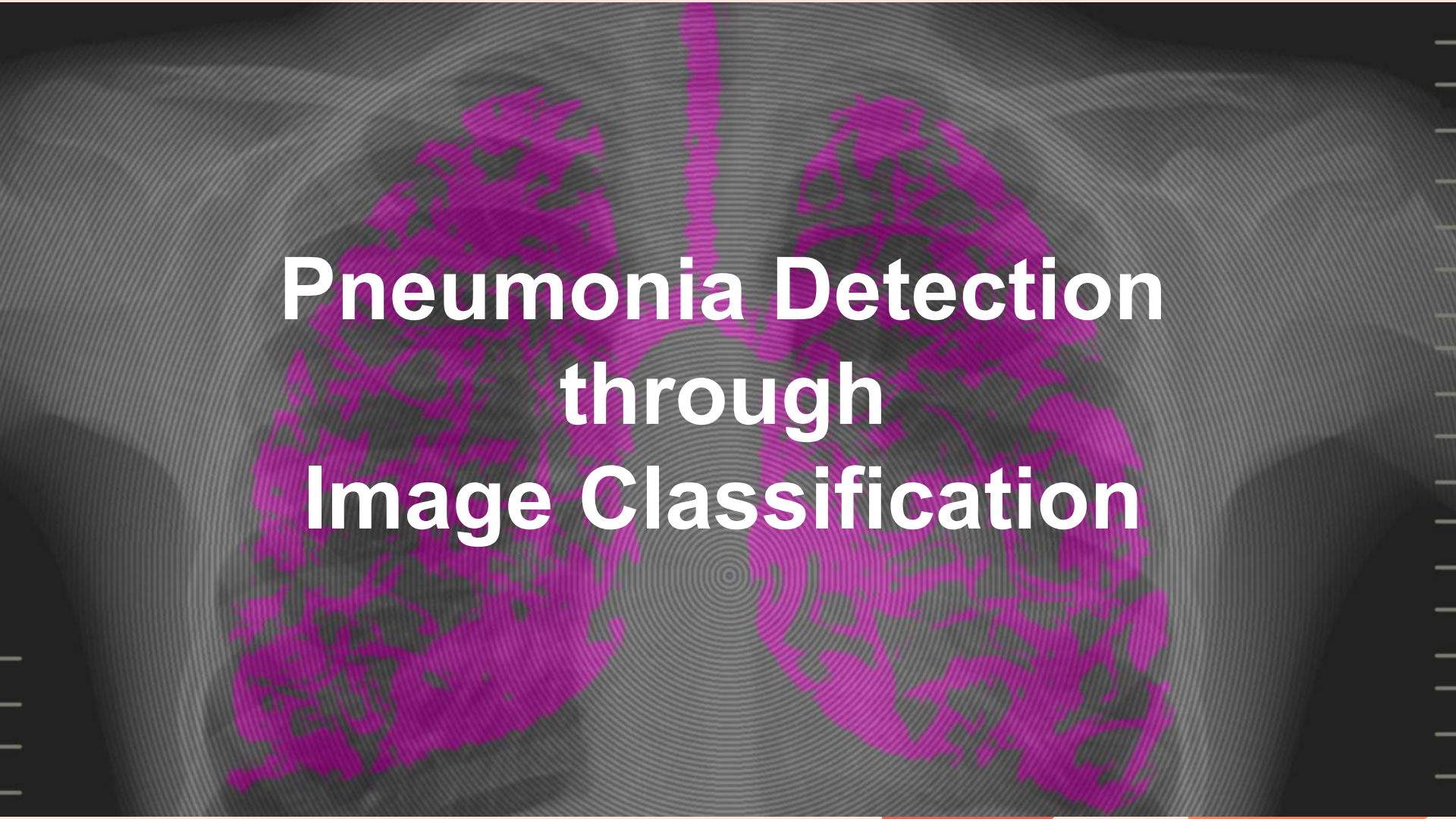

Pneumonia Detection
through
Image Classification

What is Pneumonia?

- An infection that can be caused by bacteria, viruses, or fungi
- Inflammation in air sacs of the lungs, can fill with fluid/pus (infiltrate)
- Especially dangerous for children under 5 years old, people over the age of 65, and those with health problems and/or weakened immune systems
- Some symptoms include: chest pain, difficulty breathing, coughing with phlegm, fever

According to Dadonaite from Our World in Data:

800,000+

Children died from pneumonia worldwide in 2017

15%

Of all child deaths in 2017 were caused by pneumonia, the **leading cause of death in children under age 5**

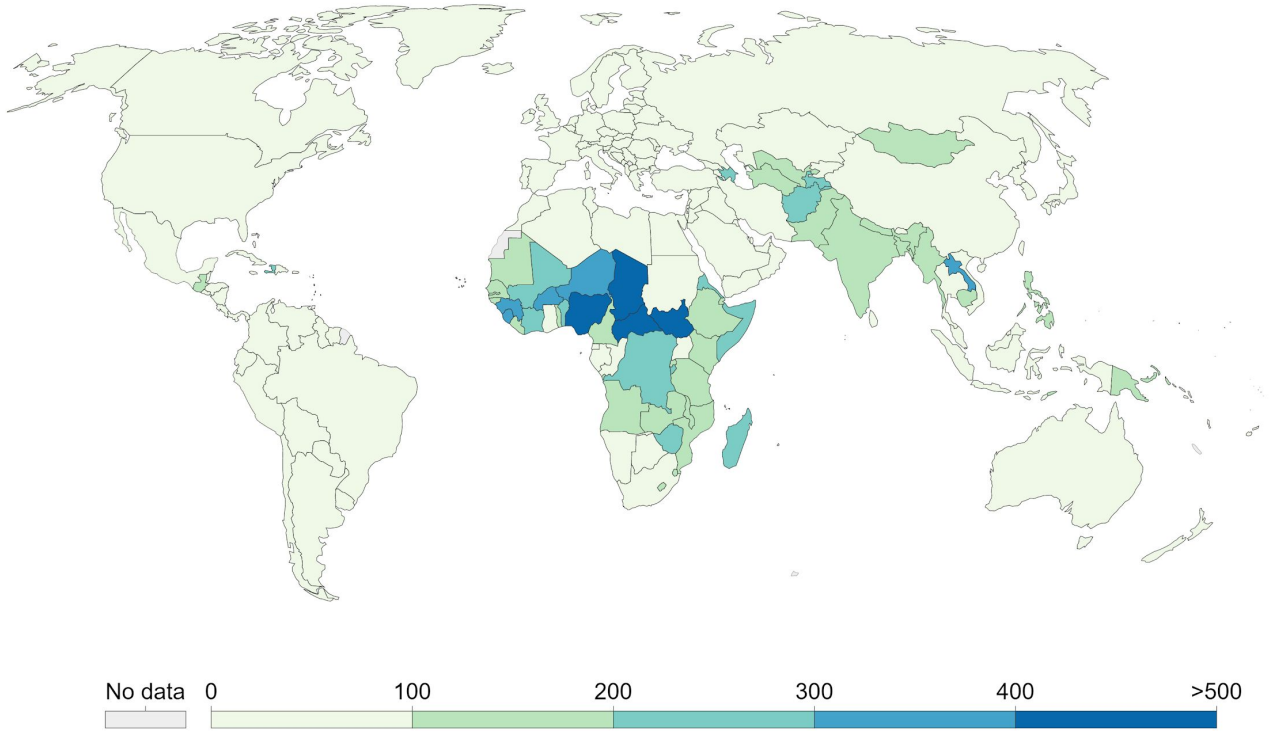
5 countries

Account for **more than half** the deaths:
India, Nigeria, Pakistan, Ethiopia, and the Democratic Republic of Congo

Death rates from pneumonia in children under 5, 2017

The annual number of deaths per 100,000 children under 5.

Our World in Data

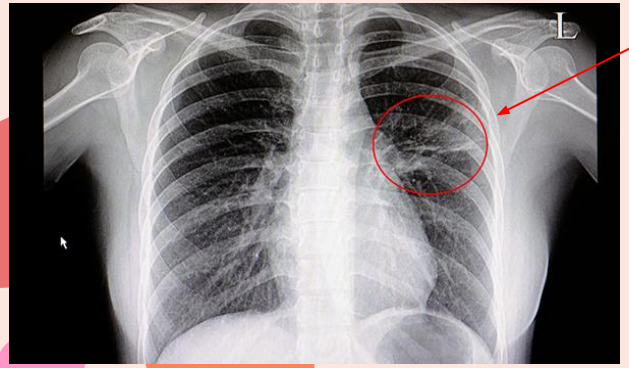


Source: IHME, Global Burden of Disease Study (2018)

OurWorldInData.org/pneumonia • CC BY

Note: Deaths from 'clinical pneumonia', which refers to a diagnosis based on disease symptoms such as coughing and difficulty breathing and may include other lower respiratory diseases.

How Do We Diagnose the Presence of Pneumonia in a Person?



- **Chest X-ray**: most common tool used to identify presence of pneumonia
- A **Radiologist** will diagnose x-ray for pneumonia
  - Look for white spots in lungs called <u>infiltrates</u>
  - There is always human error
  - Assisting Radiologists using an automatic screening tool could be helpful

Our Modeling Process via OSEMN

Obtain:
Our data consisting of chest x-rays of children 5 years and younger was downloaded from Kaggle and then uploaded into our google drive to be accessible for Google Colab

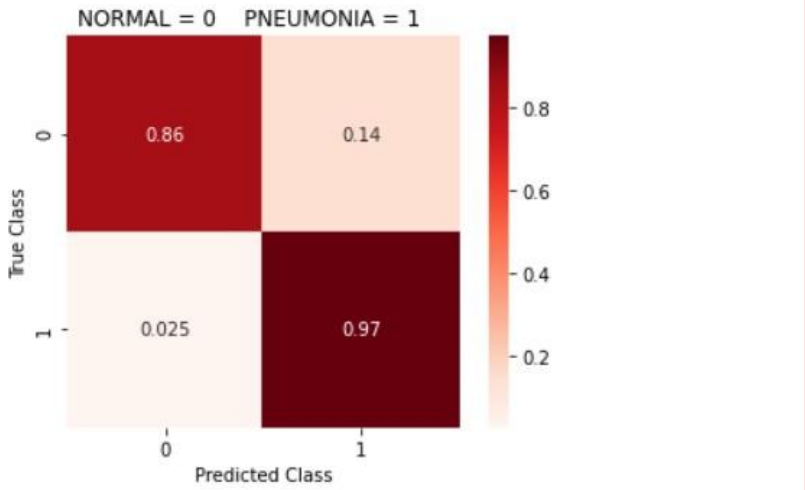
Explore (& Scrub):
Set appropriate sizes for train, test, and validation data, along with viewing class sizes and the images themselves

Model (and more Exploring):
Tried out different model activation functions, optimizers, image sizes, and other parameters while building and evaluating our models. Our Neural Network models were trained on chest x-rays

Interpretation:
Included our findings and results, along with our best model

Classification Report

	precision	recall	f1-score	support
0.0	0.95	0.86	0.90	194
1.0	0.92	0.97	0.95	318
accuracy			0.93	512
macro avg	0.94	0.92	0.92	512
weighted avg	0.93	0.93	0.93	512



Our "Best" Model

Our model's **specificity**: 86%
Our model's **accuracy**: 93%
Our model's **sensitivity**: 97.5%

- With a high sensitivity, this model has a strong ability to correctly identify those who have pneumonia.
- It will create more false positives and very little false negatives.

Our Best Balanced Model

Our model's **specificity**: 89%
Our model's **accuracy**: 93%
Our model's **sensitivity**: 95%

Recommendations: Sensitivity is best when we are screening for a contagious/deadly pathogen, or our targeted population is at a greater risk of harm. Specificity may be desired over sensitivity when the costs or risks of further testing are significant, as they are, for example, with surgical biopsy. Determining the severity, the population at greatest risk, the cost of further testing, and mental stress of diagnosing (e.g. telling someone they have cancer) all play a role in determining which model we want to use.

Classification Report

	precision	recall	f1-score	support
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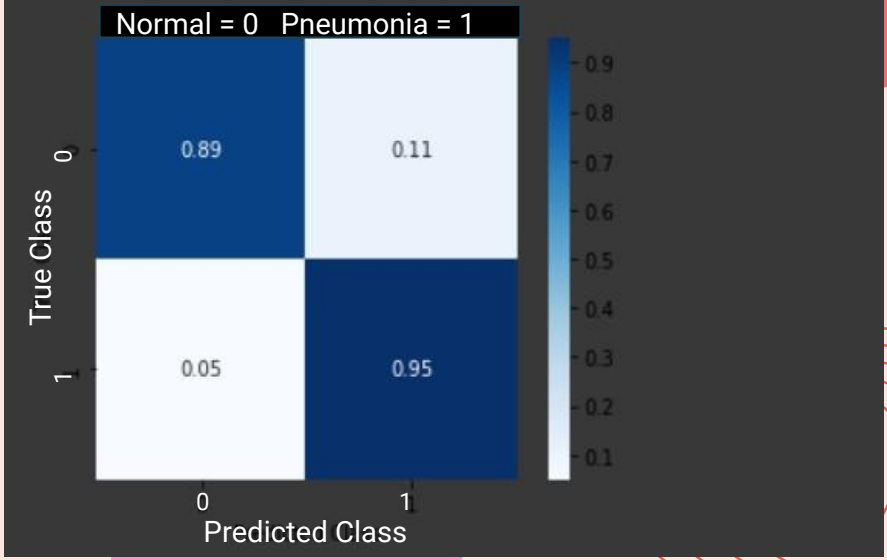


Assisting Radiologists with Our Model

Our model is able to provide high **accuracy and sensitivity** when diagnosing a patient's chest x-ray for pneumonia.

Recommendation:

Our model could help radiologists with:

- Decreasing the time it takes to diagnose a patient for pneumonia
- Assist with diagnosing when dealing with high volume of patients or low number of radiological staff.
- Help with identifying more difficult x-rays that may indicate presence of pneumonia

Further Research:

1. Increase our model's sensitivity and specificity scores by getting a larger dataset to train on - have hospitals pool their image data together to help models become more accurate

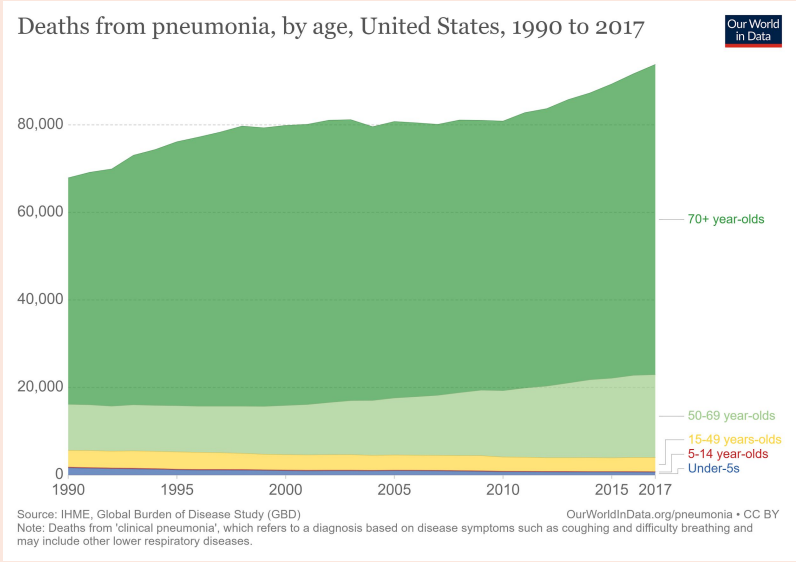
2. Go further and create a model that not only has the ability to diagnose pneumonia, but also the type of pneumonia (e.g. bacterial, viral, fungal) - would maybe need more data than strictly images

3. Create other models that can do more than just identify pneumonia through chest x-rays, but could also detect other diseases and infections that are primarily identified through chest x-rays

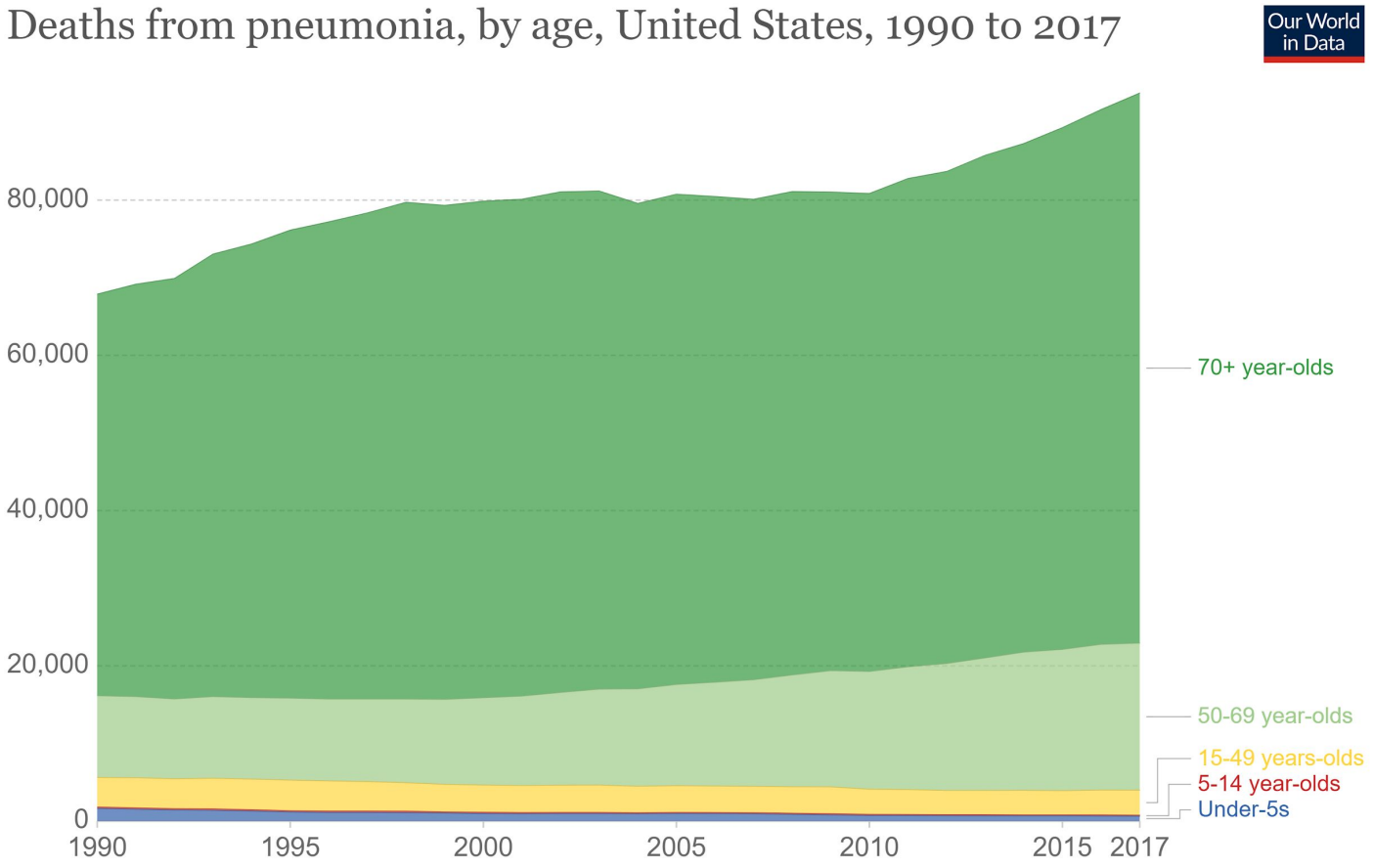
In The U.S.

- In 2017, over 60,000 people over the age of 70 died from pneumonia.
- Highest age group at risk of mortality (20% mortality rate)
- More likely to develop complications from severe cases of pneumonia
- The earlier we can diagnose cases, the better the edlerly patient's survival chance[4]

Future Work: Creating a model trained off of elderly chest x-rays could help with earlier detection in elderly patients, which could lead to earlier treatment, better outcomes, and possibly even lower mortality rate



Deaths from pneumonia, by age, United States, 1990 to 2017



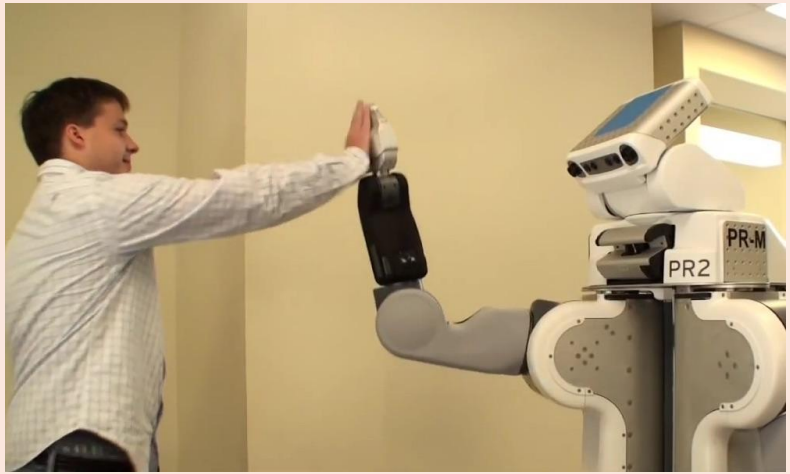
Source: IHME, Global Burden of Disease Study (GBD)

OurWorldInData.org/pneumonia • CC BY

Note: Deaths from 'clinical pneumonia', which refers to a diagnosis based on disease symptoms such as coughing and difficulty breathing and may include other lower respiratory diseases.

Thank you for your time!

Are there any questions?



Citations:

1. Dadonaite, Bernadeta. “Pneumonia.” *Our World in Data*, 4 Nov. 2018, ourworldindata.org/pneumonia#:%7E:text=2.56%20million%20people%20died%20from,of%20the%20lungs%2C%20called%20alveoli.

2. Mayo Clinic Staff. “Pneumonia - Symptoms and Causes.” *Mayo Clinic*, 13 June 2020, www.mayoclinic.org/diseases-conditions/pneumonia/symptoms-causes/syc-20354204.

3. Mitchell, Cristina. “World Radiography Day: Two-Thirds of the World’s Population Has No Access to Diagnostic Imaging.” *Pan American Health Organization / World Health Organization*, www.paho.org/hq/index.php?option=com_content&view=article&id=7410:2012-dia-radiografia-dos-tercios-poblacion-mundial-no-tiene-acceso-diagnostico-imagen&Itemid=1926&lang=en.

4. Mody, Lona et al. “Assessment of pneumonia in older adults: effect of functional status.” *Journal of the American Geriatrics Society* vol. 54,7 (2006): 1062-7. doi:10.1111/j.1532-5415.2006.00797.x

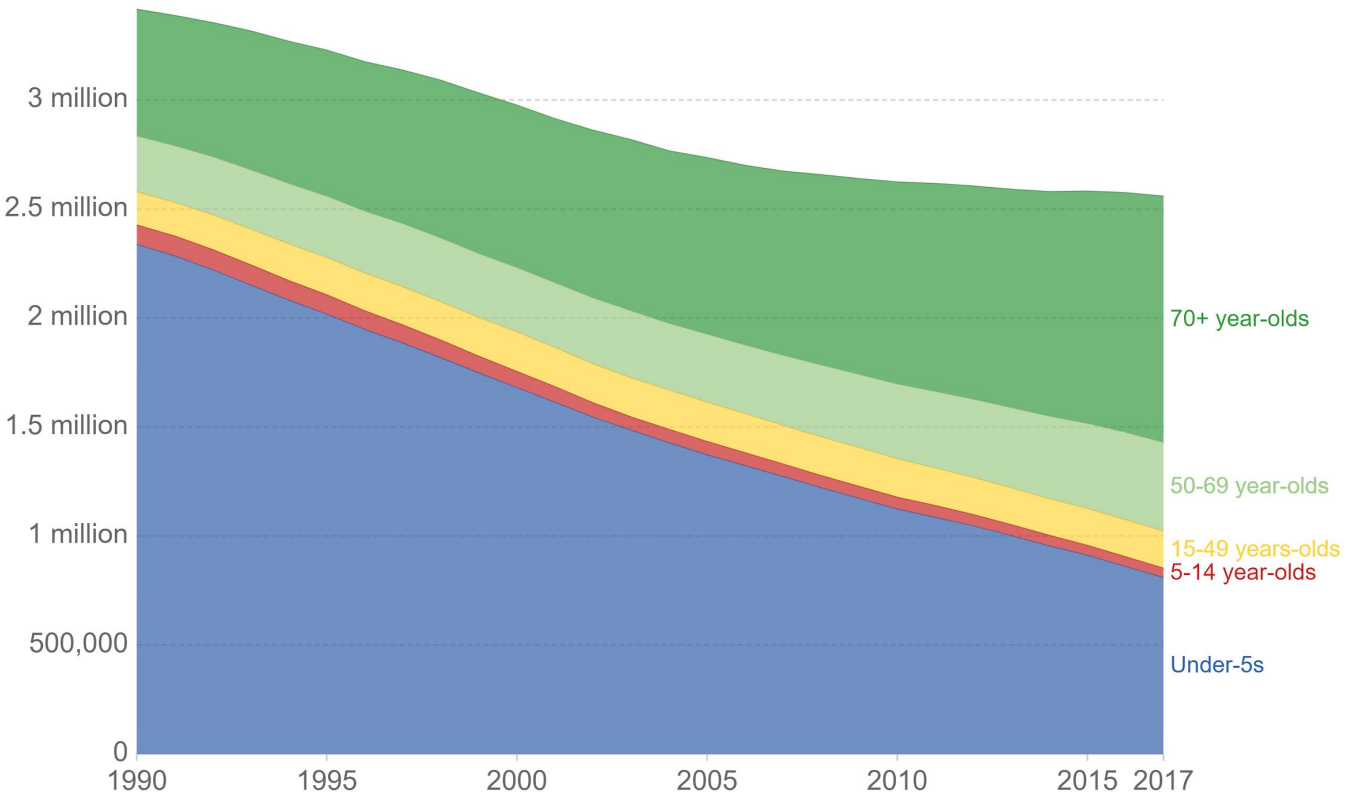
APPENDIX

The Bigger Picture

Symptoms Can Include:

1. Chest pain when breathing or coughing
2. Cough with phlegm
3. Fatigue
4. Fever, sweating, shaking, chills
5. Nausea, vomiting, or diarrhea
6. Shortness of breath
7. Confusion (in adults > 65 y.o.)
8. Lower than normal body temperatures (in adults > 65 with weakened immune systems)

Deaths from pneumonia, by age, World, 1990 to 2017



Source: IHME, Global Burden of Disease Study (GBD)

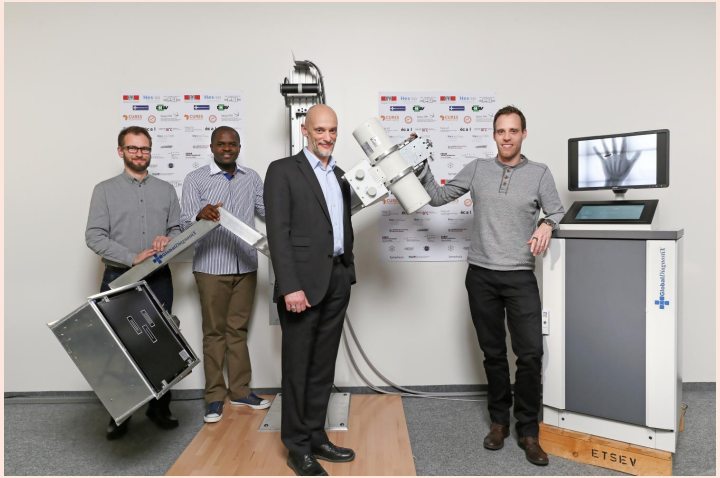
OurWorldInData.org/pneumonia • CC BY

Note: Deaths from 'clinical pneumonia', which refers to a diagnosis based on disease symptoms such as coughing and difficulty breathing and may include other lower respiratory diseases.

Who's Got Access to Radiology?

According to The **Pan-American Health Organization (PAHO)**, approximately **two-thirds** of the world's population has no access to diagnostic imaging via x-rays.

"The use of **X-rays** and other physical waves such as ultrasound can **resolve between 70% and 80% of diagnostic problems**, but nearly two-thirds of the world's population has no access to diagnostic imaging."[3]



Recommendation: Implementing our model could **reduce the costs** of diagnosing pneumonia in those countries with little access to radiologists but have the necessary equipment to create quality x-ray images

Sensitivity & Specificity

$$\text{Sensitivity} = \frac{\text{True Positives}}{\text{True Positives} + \text{False Negatives}}$$

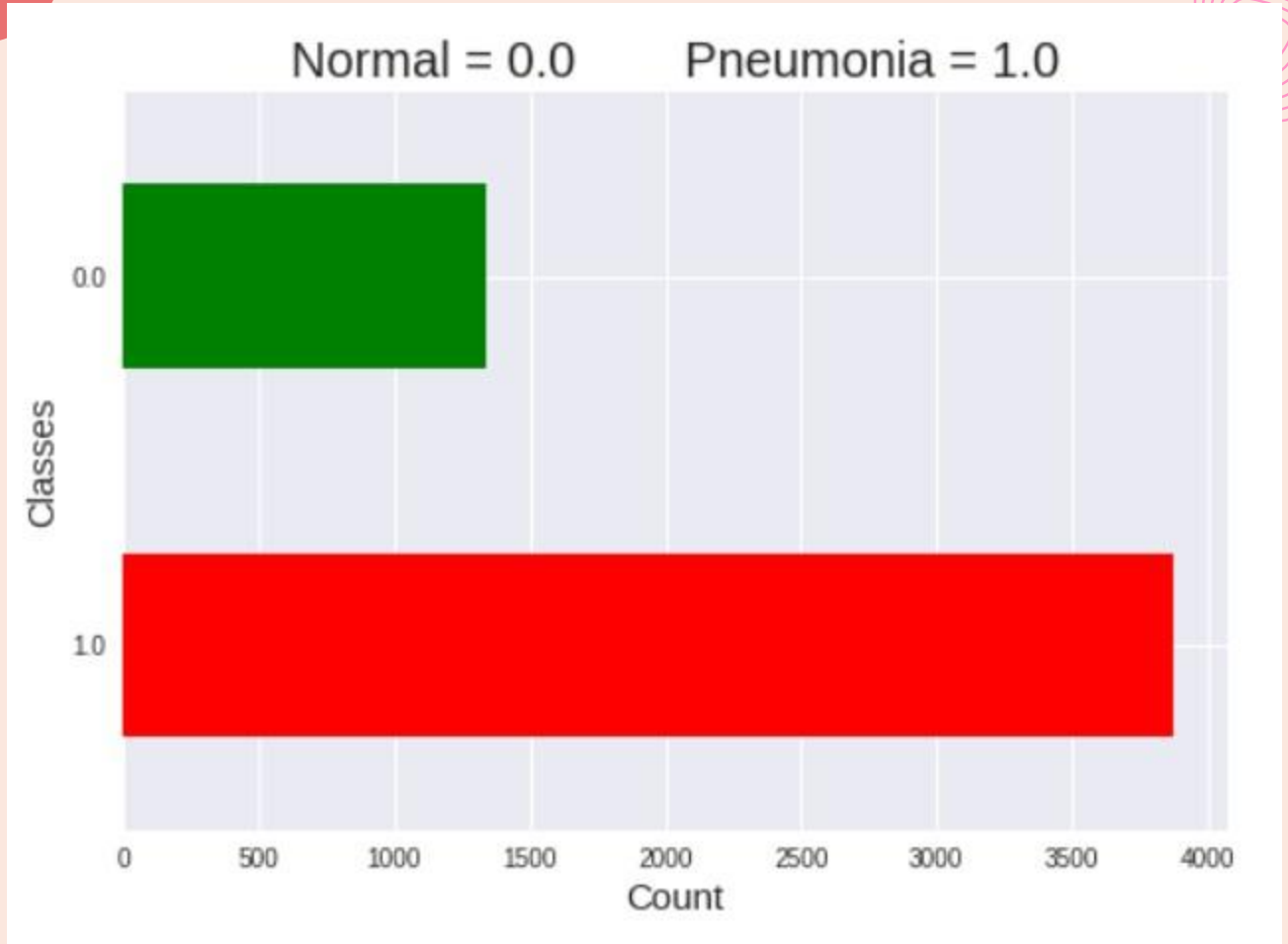
$$\text{Specificity} = \frac{\text{True Negatives}}{\text{True Negatives} + \text{False Positives}}$$

Sensitivity

The ability of a test to correctly identify those with the disease (true positive rate)

Specificity

The ability of the test to correctly identify those without the disease (true negative rate)


Normal = 0.0
Pneumonia = 1.0
Classes
0.0
1.0
0
500
1000
1500
2000
2500
3000
3500
4000
Count

According to Mody, Lona et al.

“**Early diagnosis** and treatment of pneumonia are critical for successful management of pneumonia. FI **older adults** present with more-typical pulmonary symptoms and therefore may have earlier diagnostic evaluation and initiation of treatment. A focus on earlier diagnosis of pneumonia in older adults with preadmission functional dependency, even in the absence of typical symptoms, **might lead to earlier treatment and better outcomes**.”[4]

Definitions:

infiltrate - the filling of airspaces with fluid (**pulmonary** oedema), inflammatory exudates (white cells or pus, protein and immunological substances), or cells (malignant cells, red cells or haemorrhage) that fill a region of **lung** and increase the visual impression of increased soft tissue density.