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Use Of Artificial Intelligence To Screen COVID-19 Patients

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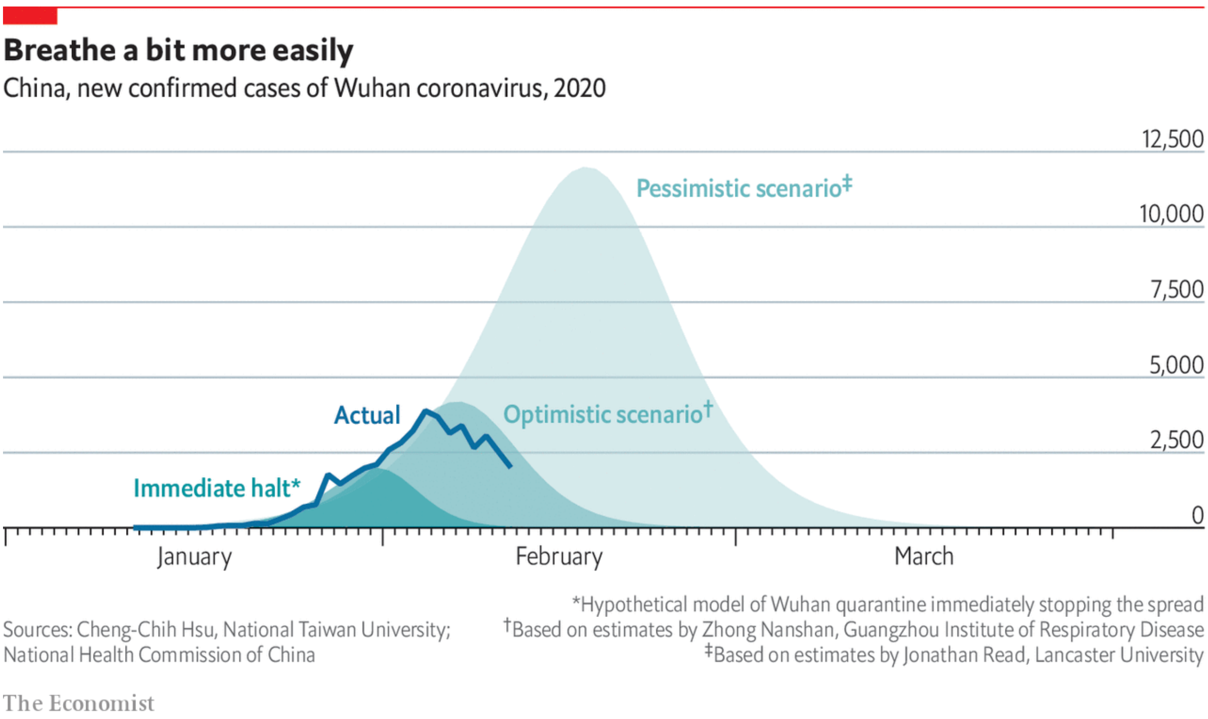
1. Abstract and Introduction

The day when the first new novel coronavirus case was diagnosed was on 8th December 2019 in the Wuhan city of China. The breakout was tremendously visible in January 2020 when China started getting exponential number of cases. The graph shows the number of incremental cases in Wuhan during the three months of Jan-March 2020.



Epidemiologists suspected that the coronavirus cases would reach a peak of its count in ninety days and would further disappear almost in four to five months of time. The unstoppable increase in the cases couldn't stop the panic in the community, the irreparable losses families were facing could not be ever set right again. The World Health Organisation(WHO) on January 31,2020 declared China's novel coronavirus as a public health emergency of international concern" (PHEIC) worldwide. By this time the virus had started spreading in large numbers in other countries as well. China also expressed their concern on the asymptomatic and non-predictive nature of the contagion virus. Nobel coronavirus is an infectious and contagious disease which can be transferred through respiratory tract even with a tender particle from the infected person. On 11th March 2020 the World Health Organisation (W.H.O) declared the situation as a pandemic condition over the world. It is therefore a global health crisis and therefore many countries have imposed different kinds of restrictions like: flight travel restrictions (international as well as domestic), border movement restrictions, total lockdown in cities and towns, following norms of social distancing and special training on hygiene and sanitization. Howsoever, even after implementing all these the spread of virus is not easily contained. A large amount of people diagnosed with COVID-19 seem to be facing one or the other kind of respiratory illness while some developed deadly pneumonia. There are found possibilities that the people with more age above 60 years and with predefined issues of diabetes, cardiovascular disease, respiratory issue, hepatic diseases, cancer diseases are more likely to develop the illness as their immunity system already is not functioning well. Until now there is no define treatment or vaccine which is hundred percent effective for COVID-19 treatment.

The novel coronavirus of 2019, has spread like fire in the world affecting 4307287 people globally and taking away lives of 295101 people. There are total of 216 countries fighting with this severe pandemic.

There is a scarcity of the test kits and human labour to cope up with the deadly virus, therefore there is a high priority need to develop and automate the screening process of the COVID-19 situation. This would act as a swift alternative to diagnose and detect the COVID-19 virus amongst the suspected patients.

There are a limited number of COVID-19 test kits available in hospitals due to the increasing cases daily. Therefore, it is necessary to implement an automatic detection system as a quick alternative diagnosis option to prevent COVID-19 spreading among people.

2. Problem

As the number of test to be conducted per day are humongous therefore there is a severe need to automate the screening of COVID-19 patients using artificial intelligence. There is an urgent requirement to develop an accurate and automatic detection of COVID-19 using CT for Chest. So, a fully automated framework to detect the COVID-19 using CT for chest and to measure its accuracy of performance.

3. Literature Review

The ways to execute a laboratory examination is most common by RT-PCR. In this, throat swab sample is collected and with a chemical methodology an enzyme is added to DNA strand wise. Then addition of nucleotides which helps in DNA multiplication. They are all used to signal if the patient is COVID19 positive. (Aidence,2020)

The sensitiveness of the results can vary in a great way. Each country is developing their own test method with sensitivity ranges (60-70 percent and 95-97 percent). Some are trying to cope with huge false negatives.(Bayarri,2020):

Another test is molecular based that can be performed in 30 mints times or by testing of antibodies present via testing of blood though it is not a very relevant option. It is therefore not considered to have a good accuracy. (Bayarri,2020)

Then comes the Image based testing of X-Ray CT which is used for fast and accurate results to diagnose COVID19 patients. The sensitivity is as high (90-95%). To recognise, uses ground-glass opacity, bronco vascular and traction of throat scans. The symptoms are similar to pneumonia but radiological differences are available in the scans. (Hatmaker,2020)

There is a close relationship between the CT scan outputs and US (ultrasound outputs).It deduces ultrasound to be a better way than CT x-ray in case of pneumonia whereas it is otherwise in case of COVID19 analysis.

During the initial phase of March 2020, ACR came up with the norms of image processing for COVID19 analysis. In its image processing is mentioned as the primary method whereas X-ray as optional process.(Moore and Bell.,2019)

AI has been analysed to play a primary role in screening of COVID19 patients in diagnosing and fastening the process. Several methods of testing have been found to enable AI community so as to be able to contribute towards COVID19 diagnosis. (Infervision Products, Kharpal,A,2020)

In a very fast pace, the group of researchers are taking forward deep learning as a based proof principle for COVID19 analysis.(Rogers,2019) The same is the situation of a huge range of companies. Likewise, the tool which has deployed is almost based on the CT-Scan tool of Pneumonia.(Palmer,2019) The pneumonia results have been deeply in relation with the COVID19, therefore the tool would be of great help. The crux here is to find the differentiating factor between Pneumonia and COVID19.(Rosebrock,2020)Everyone has this question as a primary issue where Alibaba claims to differentiate between COVID19 and Pneumonia symptoms with 96% accuracy where they claim that CT X-ray scans provide a specificity of 90-96 percent for analysing COVID19. (Stempniak, 2020)The existing researchers use RT-PCR as the definitive truth whose substantiality has not yet been accurately found as of CT X-Ray. The numbers are not mentioned in the article.(Stempniak ,2020)There so companies who have initiated to bring forth accurate and justified algorithms for COVID19 diagnosis with the help of CT X-Ray with the scans received of the patients who have been tested COVID19 positive. The goal is to provide with evident solution on the AI process.(Trafton, and Wang ,2020)

4. Research Methodology and Approach

In this multi-centre study and retrospective, a model known as Deep Learning for COVID-19 detection Neural Network known as COVNet, was experimented to get the visual and visible features from the chest CT X-Rays in volumetric amounts. Such datasets were collected and divided into training and test data sets for development of algorithm and usual visual analysis can be carried out with accuracy and effectiveness. The collected and used data sets had 4356 chest X-Ray scans result of about more than 3300 patients. The varied age group has been covered in the sample which has been used for training and analysis purpose. The per examination specificity and sensitivity for the analysation and detection of COVID-19 in the individual test set was 114 successful out of 127(accounting to 90%) and 294 out of 307(which accounts to 90%).The results achieved show that the usage of artificial intelligence to analyse and interpret the radiological reports for time saving and accurate diagnosis of COVID-19.

The below figure depicts the image samples for three kinds of people namely: Normal Chest X-Ray, COVID-19 Chest X-Ray and Pneumonia Chest X-Ray. The X-Ray images of patients can be auto- analysed using artificial intelligence for detecting and speedy analysis of COVID-19 cases.

Sample X-ray image from the dataset: (A) shows normal cases, (B) shows COVID-19 cases, and (B) shows Viral Pneumonia case.

5. Model

Model in support of the solution of **“Use of AI to screen COVID19 patients”**

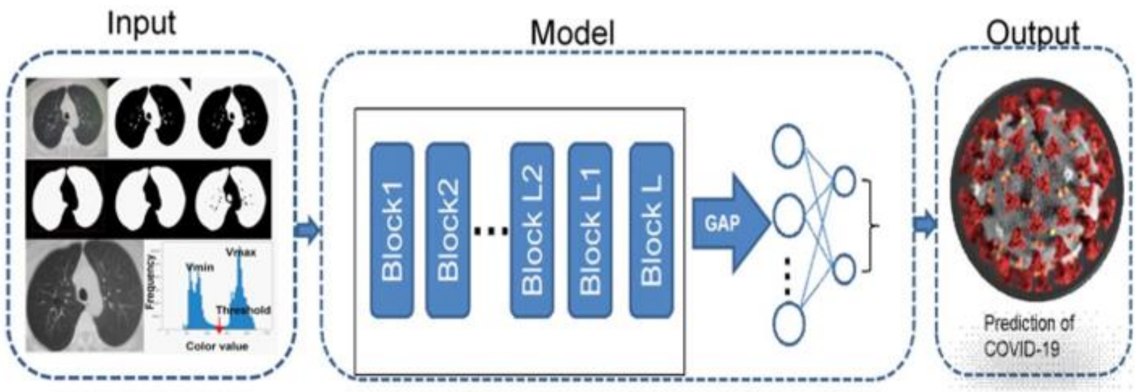


Fig 1: Deep Learning Algoritm Framework

6. Deep Learning Approach to diagnose COVID19 patients

1. Find out an open source dataset of Chest X-ray images for patients with COVID19 positive

2. Find the normal (COVID19 negative) Chest X-ray images.

3. Train the CNN to detect COVID19.

4. Verify the results.

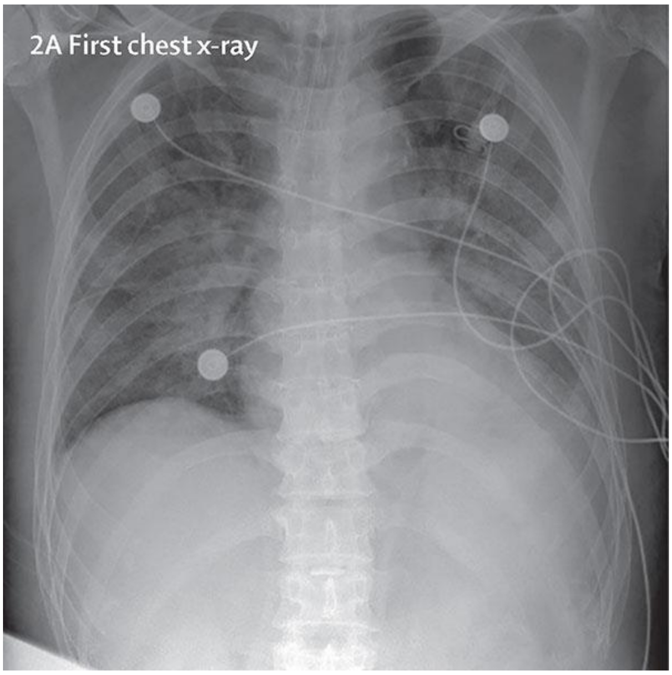


Figure 2: COVID19 Positive Patient Chest X-Ray

As COVID19 damages epithelial cells of respiratory tract, chestX-Rays can be used to analyse patient's lungs. As hospitals have Chest X-Ray and image processing machines therefore it could be used to test COVID19 patients without using the test kits. X-Ray processing and analysis takes radiologist support and time there developing an AI algorithm would accelerate the process.

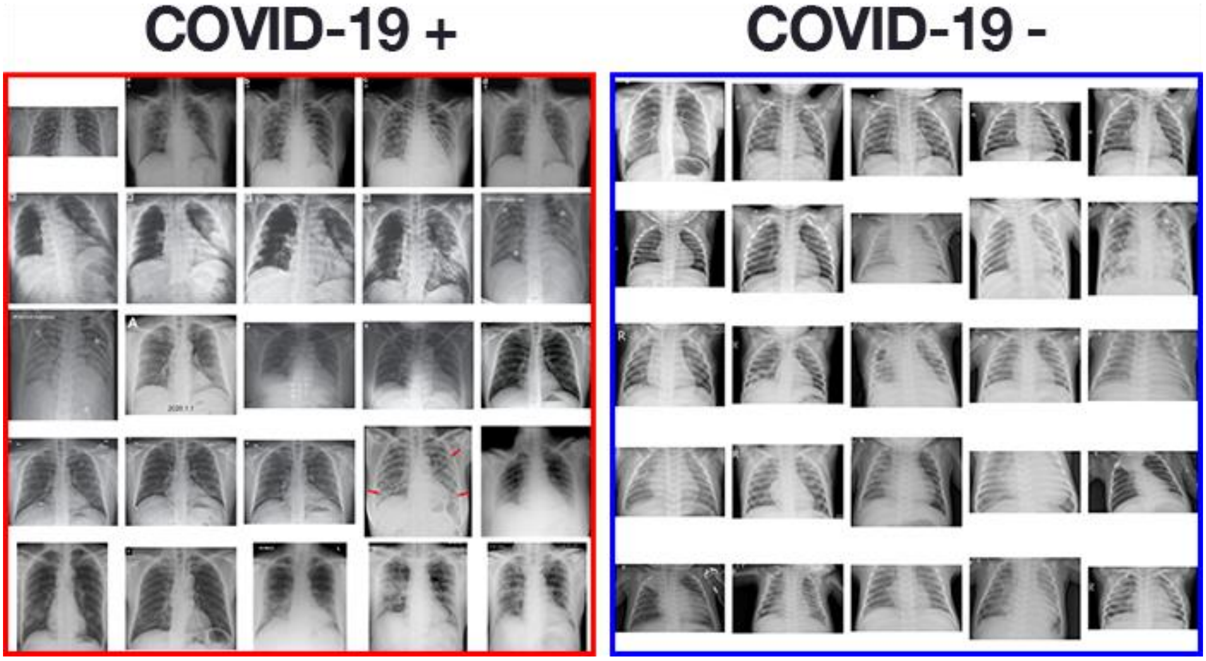


Figure 3:COVID19 Chest X-Ray Dataset, Left is COVID19 positive and Right is COVID19 negative

```
├── dataset
│   ├── covid [25 entries]
│   └── normal [25 entries]
├── build_covid_dataset.py
├── sample_kaggle_dataset.py
├── train_covid19.py
├── plot.png
└── covid19.model
```

The command line arguments :

- --dataset: Path to input data set of Chest X-ray
- --plot: Path to output history plot of training
- --model: Output path of model

```
# grab the list of images in our dataset directory, then initialize
# the list of data (i.e., images) and class images
print("[INFO] loading images...")
imagePaths = list(paths.list_images(args["dataset"]))
data = []
labels = []

# loop over the image paths
for imagePath in imagePaths:
    # extract the class label from the filename
    label = imagePath.split(os.path.sep)[-2]

    # load the image, swap color channels, and resize it to be a fixed
    # 224x224 pixels while ignoring aspect ratio
    image = cv2.imread(imagePath)
    image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
    image = cv2.resize(image, (224, 224))

    # update the data and labels lists, respectively
    data.append(image)
    labels.append(label)

# convert the data and labels to NumPy arrays while scaling the pixel
# intensities to the range [0, 1]
data = np.array(data) / 255.0
labels = np.array(labels)
```

- Paths of images are stored in --dataset directory.
- Extract label (covid or normal) from the path.
- Image is loaded, pre-processed (covert to RGB by channel order).
- Resize to 224*224 px.

```
# perform one-hot encoding on the labels
lb = LabelBinarizer()
labels = lb.fit_transform(labels)
labels = to_categorical(labels)

# partition the data into training and testing splits using 80% of
# the data for training and the remaining 20% for testing
(trainX, testX, trainY, testY) = train_test_split(data, labels,
    test_size=0.20, stratify=labels, random_state=42)

# initialize the training data augmentation object
trainAug = ImageDataGenerator(
    rotation_range=15,
    fill_mode="nearest")
```

- Split the data.
- 80% data as training data set
- 20%data as test data set

- To generalize model, data augmentation is performed by setting rotation to 15 degrees (clockwise or anti clockwise).

```
# compile our model
print("[INFO] compiling model...")
opt = Adam(lr=INIT_LR, decay=INIT_LR / EPOCHS)
model.compile(loss="binary_crossentropy", optimizer=opt,
   metrics=["accuracy"])

# train the head of the network
print("[INFO] training head...")
H = model.fit_generator(
   trainAug.flow(trainX, trainY, batch_size=BS),
   steps_per_epoch=len(trainX) // BS,
   validation_data=(testX, testY),
   validation_steps=len(testX) // BS,
   epochs=EPOCHS)
```

Now, the chest X-Ray data is passed via object of data augmentation.

```
# make predictions on the testing set
print("[INFO] evaluating network...")
predIdxs = model.predict(testX, batch_size=BS)

# for each image in the testing set we need to find the index of the
# label with corresponding largest predicted probability
predIdxs = np.argmax(predIdxs, axis=1)

# show a nicely formatted classification report
print(classification_report(testY.argmax(axis=1), predIdxs,
   target_names=lb.classes_))
```

- To evaluate, the predictions are made on test data set and prediction indices are identified.

- With train_covid19.py script the automatic COVID19 detector is trained.

```
$ python train_covid19.py --dataset dataset
[INFO] loading images...
[INFO] compiling model...
[INFO] training head...
Epoch 1/25
5/5 [==============================] - 20s 4s/step - loss: 0.7169 - accuracy: 0.6000 -
val_loss: 0.6590 - val_accuracy: 0.5000
Epoch 2/25
5/5 [==============================] - 0s 86ms/step - loss: 0.8088 - accuracy: 0.4250 -
val_loss: 0.6112 - val_accuracy: 0.9000
Epoch 3/25
5/5 [==============================] - 0s 99ms/step - loss: 0.6809 - accuracy: 0.5500 -
val_loss: 0.6054 - val_accuracy: 0.5000
Epoch 4/25
5/5 [==============================] - 1s 100ms/step - loss: 0.6723 - accuracy: 0.6000 -
val_loss: 0.5771 - val_accuracy: 0.6000
...
Epoch 22/25
5/5 [==============================] - 0s 99ms/step - loss: 0.3271 - accuracy: 0.9250 -
val_loss: 0.2902 - val_accuracy: 0.9000
Epoch 23/25
5/5 [==============================] - 0s 99ms/step - loss: 0.3634 - accuracy: 0.9250 -
val_loss: 0.2690 - val_accuracy: 0.9000
Epoch 24/25
5/5 [==============================] - 27s 5s/step - loss: 0.3175 - accuracy: 0.9250 -
val_loss: 0.2395 - val_accuracy: 0.9000
Epoch 25/25
5/5 [==============================] - 1s 101ms/step - loss: 0.3655 - accuracy: 0.8250 -
val_loss: 0.2522 - val_accuracy: 0.9000
[INFO] evaluating network...
              precision    recall  f1-score   support

       covid       0.83      1.00      0.91         5
      normal       1.00      0.80      0.89         5

    accuracy                           0.90        10
   macro avg       0.92      0.90      0.90        10
weighted avg       0.92      0.90      0.90        10

[[5 0]
 [1 4]]
acc: 0.9000
sensitivity: 1.0000
specificity: 0.8000
[INFO] saving COVID-19 detector model...
```

Results of the automatic detector of COVID19 is 90-92% accurate on the basis of Chest X-ray. The model obtains sensitivity of 100% and specificity of 80%. It implies that the patients with COVID19 positive can be identified with 100% accuracy whereas the patient with COVID19 negative can be identified with 80% accuracy.

To balance the specificity and the sensitivity is challenging and incredibly critical task in case of severe medical issues especially contagious diseases like COVID19.This is because the consequences can be very severe as – "**a missed diagnosis can cost lives**".

7. Limitations and Implications

To deploy a COVID19 detector as it's a crucial investigator a rigorous and strict testing has to be done by trained professionals of medical background in collaboration with the AI Deep

Learning implementers. The algorithmic method shown here is not such a method, it is to explain the model defined.

It is further possible that the model defined here has the learnings that are not exactly relevant to COVID19 as the radiologists and newer observations are not considered here as not being from a typical medical background.

Therefore, for exact and accurate results more and more samples should be included in the training set so that all the possible scenarios get tested and identified. This has to be incorporation with medical professionals to continuously evaluate the outcomes of the COVID19 detector.

8. Conclusion

The model of Deep Learning can therefore accurately detect COVID-19 and differentiate it in an automated fashion from Viral Pneumonia case and normal case. Cost, long turnaround time, scarce resources of clinical testing are major factors behind the exponential increase in spread of the pandemic COVID-19. We thereby note that COVID-19 immensely affects the respiratory system of an individual in a unique way which can be analysed from Chest X-Rays which are therefore used as a method of analysis for the COVID-19.

9. References

1. Aidence(2020). Retrieved from https://www.linkedin.com/posts/aidence_johns-hopkins-coronavirus-resource-center-activity-6645980918089596928-8Rt3/
2. Bayarri,A.(2020). Retrieved from https://www.linkedin.com/posts/angelalberich_quibimprecision-quantitative-imaging-biomarkers-activity-6645740427137941504-q1j2se
3. Bayarri,A.(2020): Retrieved from https://quibim.com/2020/02/14/imaging-ai-and-radiomics-to-understand-and-fight-coronavirus-covid-19/
4. Hatmaker (2020).Retrieved from https://techcrunch.com/2020/03/16/coronavirus-machine-learning-cord-19-chan-zuckerberg-ostp/?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAAFXM3qnCspbtPxBBuSEn8Wye4PMTe9MTwMJDQcJ9XKXpS9HopZIpEEP01YMTWbuY_a3iOFH16wy6Ah_jG3SJQnWDpRVpVHJ69sErLgEROwTtIxZIUEP2QC6JM7XMhuXGdAw8bV_oDpbgpw2C1XJQwhMmJWZpzlx5RCZ-TupfG0Hs.
5. Infervision Products (2020). Retrieved from https://global.infervision.com/product/5/
6. Kharpal, A. (2020). Retrieved from https://www.cnbc.com/2020/03/04/coronavirus-china-alibaba-tencent-baidu-boost-health-tech-efforts.html
7. Rogers,M.M. (2019). Retrieved from https://www.wired.com/story/everything-you-need-to-know-about-coronavirus-testing/
8. Moore, C. M. and Bell. (2019). Retrieved from https://radiopaedia.org/articles/covid-19-2
9. Palmer, W. J. ACR. (2019):https://www.diagnosticimaging.com/coronavirus/acr-releases-ct-and-chest-x-ray-guidance-amid-covid-19-pandemic

10. Rosebrock.(2020). Retrieved from https://www.pyimagesearch.com/2020/03/16/detecting-covid-19-in-x-ray-images-with-keras-tensorflow-and-deep-learning/
11. Joaquin,San. (2019). Retrieved from https://towardsdatascience.com/using-deep-learning-to-detect-ncov-19-from-x-ray-images-1a89701d1acd
12. Stempniak (2020). Retrieved from https://www.radiologybusiness.com/topics/care-delivery/radiologists-ultrasound-covid-19-chest-x-ray-coronavirus
13. Trafton, A., Chu. (2020). Retrieved from http://news.mit.edu/2020/covid-19-diagnostic-test-prevention-0312
14. Wang, S. et al. (2020). A novel coronavirus outbreak of global health concern,The Lancet,Volume 395, Issue 10223,2020,Pages 470-473,ISSN 0140-6736,https://doi.org/10.1016/S0140-6736(20)30185-9.