Final Pipeline for Econder Decoder Model

In [1]:
```
import tensorflow as tf
from tensorflow.keras.applications import densenet
from tensorflow.keras.applications.densenet import preprocess_input
from tensorflow.keras.layers import Dense, Dropout, Input, Conv2D
from tensorflow.keras.models import Model
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from tqdm import tqdm
import os
import cv2
import tensorflow as tf
import re
import pickle
from PIL import Image
from skimage.transform import resize
import warnings
warnings.filterwarnings('ignore')
import seaborn as sns
from tqdm import tqdm
import tensorflow as tf
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
from sklearn.model_selection import train_test_split
import time
from tensorflow.keras.models import Model
from tensorflow.keras.layers import Dense, LSTM, Input, Embedding, Conv2D, C
import random
import datetime
from nltk.translate.bleu_score import sentence_bleu
```

In [37]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

In [2]:
```
train_data = pd.read_csv('/content/Final_Train_Data.csv')
test_data = pd.read_csv('/content/Final_Test_Data.csv')
cv_data = pd.read_csv('/content/Final_CV_Data.csv')
```

In [7]:
```
! gdown "https://openi.nlm.nih.gov/imgs/collections/NLMCXR_png.tgz"
```

```
Downloading...
From: https://openi.nlm.nih.gov/imgs/collections/NLMCXR_png.tgz (https://openi.nlm.nih.gov/imgs/collections/NLMCXR_png.tgz)
To: /content/NLMCXR_png.tgz
100% 1.36G/1.36G [00:32<00:00, 42.4MB/s]
```

In [8]:
```
import shutil
shutil.unpack_archive("/content/NLMCXR_png.tgz","/content/NLMCXR_png")
```

In [9]:
```
! gdown "https://drive.google.com/u/0/uc?id=19BllaOvs2x5PLV_vlWMy4i8LapLb2j6
```

```
Downloading...
From: https://drive.google.com/u/0/uc?id=19BllaOvs2x5PLV_vlWMy4i8LapLb2j6b&expo
rt=download (https://drive.google.com/u/0/uc?id=19BllaOvs2x5PLV_vlWMy4i8LapLb2j
6b&export=download)
To: /content/brucechou1983_CheXNet_Keras_0.3.0_weights.h5
29.1MB [00:00, 178MB/s]
```

In [ ]:
```
chexNet = densenet.DenseNet121(include_top=False, weights = None,   input_sh
X = chexNet.output
X = Dense(14, activation="sigmoid", name="predictions")(X)
chexNet = Model(inputs=chexNet.input, outputs=X)

#loadind pretrained weights for ChexNet model
chexNet.load_weights('brucechou1983_CheXNet_Keras_0.3.0_weights.h5')

chexNet = Model(inputs = chexNet.input, outputs = chexNet.layers[-2].output)
```

In [97]:
```
#loading all files

f = open('/content/Image_features_ecoder_decoder.pickle','rb') # 300d glove
cheXnet_Features = pickle.load(f)
f.close()

f = open('/content/drive/MyDrive/glove_vectors','rb') # 300d glove vectors
glove_vectors = pickle.load(f)
f.close()

f = open('/content/tokenizer.pickle','rb') # 300d glove vectors
tokenizer = pickle.load(f)
f.close()

f = open('/content/embedding_matrix.pickle','rb') # 300d glove vectors
embedding_matrix = pickle.load(f)
f.close()
```

Function 1

In [105]:

```
def enc_dec_model(input_image_idx,Algo = 'greedy'):

  '''This fun takes index of an image as input and prints the actual and pre

  input1 = Input(shape=(2048), name='Image_input')
  dense1 = Dense(256, kernel_initializer=tf.keras.initializers.glorot_unifor

  input2 = Input(shape=(153), name='Text_Input')
  embedding_layer = Embedding(input_dim = vocab_size, output_dim = 300, inpu
                weights=[embedding_matrix], name="Embedding_layer")
  emb = embedding_layer(input2)

  LSTM1 = LSTM(units=256, activation='tanh', recurrent_activation='sigmoid',
            kernel_initializer=tf.keras.initializers.glorot_uniform(seed=23)
            recurrent_initializer=tf.keras.initializers.orthogonal(seed=7),
            bias_initializer=tf.keras.initializers.zeros(), return_sequences
  #LSTM1_output = LSTM1(emb)

  LSTM2 = LSTM(units=256, activation='tanh', recurrent_activation='sigmoid',
            kernel_initializer=tf.keras.initializers.glorot_uniform(seed=23)
            recurrent_initializer=tf.keras.initializers.orthogonal(seed=7),
            bias_initializer=tf.keras.initializers.zeros(), name="LSTM2")
  LSTM2_output = LSTM2(LSTM1)

  dropout1 = Dropout(0.5, name='dropout1')(LSTM2_output)

  dec =  tf.keras.layers.Add()([dense1, dropout1])

  fc1 = Dense(256, activation='relu', kernel_initializer=tf.keras.initialize
  fc1_output = fc1(dec)
  dropout2 = Dropout(0.4, name='dropout2')(fc1_output)
  output_layer = Dense(vocab_size, activation='softmax', name='Output_layer'
  output = output_layer(dropout2)

  encoder_decoder = Model(inputs = [input1, input2], outputs = output)
  encoder_decoder.load_weights("/content/encoder_decoder_epoch_5.h5")

  # encoder
  encoder_input = encoder_decoder.input[0]
  encoder_output = encoder_decoder.get_layer('dense_encoder').output
  encoder_model = Model(encoder_input, encoder_output)

  # decoder#
  text_input = encoder_decoder.input[1]
  enc_output = Input(shape=(256,), name='Enc_Output')
  text_output = encoder_decoder.get_layer('LSTM2').output
  add1 = tf.keras.layers.Add()([text_output, enc_output])
  fc_1 = fc1(add1)
  decoder_output = output_layer(fc_1)

  decoder_model = Model(inputs = [text_input, enc_output], outputs = decoder

  def greedysearch(img):
    image = cheXnet_Features[img]
    input_ = 'startseq'
    image_features = encoder_model.predict(image)
```

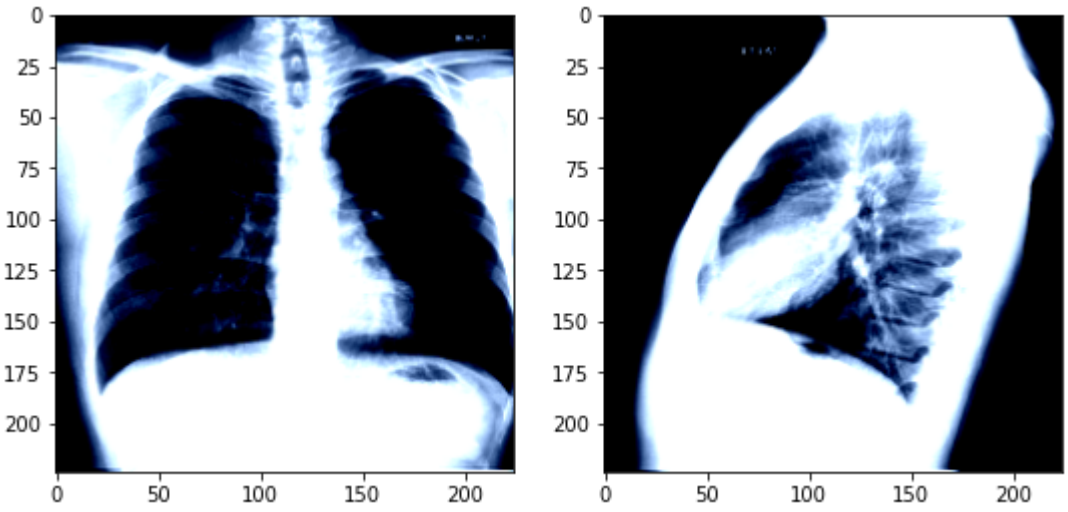
```
57
58      result = []
59      for i in range(153):
60          input_tok = [tokenizer.word_index[w] for w in input_.split()]
61          input_padded = pad_sequences([input_tok], 153, padding='post')
62          predictions = decoder_model.predict([input_padded, image_features])
63          arg = np.argmax(predictions)
64          if arg != 7:   # endseq
65              result.append(tokenizer.index_word[arg])
66              input_ = input_ + ' ' + tokenizer.index_word[arg]
67          else:
68              break
69      rep = ' '.join(e for e in result)
70      return rep
71
72  def load_image(img_name):
73      image = Image.open(img_name)
74      X = np.asarray(image.convert("RGB"))
75      X = np.asarray(X)
76      X = preprocess_input(X)
77      X = resize(X, (224,224,3))
78      X = np.expand_dims(X, axis=0)
79      X = np.asarray(X)
80      return X
81
82  def get_result(idx=0):
83
84      plt.figure(figsize=(9,5))
85
86      pre_Report = greedysearch(cv_data['Person_id'][idx]) # result after 20 e
87      print('--------------------------------------------------------------------
88      print("Predicted Report : ",pre_Report)
89      print('--------------------------------------------------------------------
90      print("Actual Report : ",cv_data['Report'][idx])
91
92      plt.subplot(121)
93      img = load_image(cv_data['Image1'][idx])
94      plt.imshow(img[0])
95
96      plt.subplot(122)
97      img = load_image(cv_data['Image2'][idx])
98      plt.imshow(img[0])
99
100 # beam_width = 2
101 def beamsearch(image, beam_width = 2):
102
103     start = [tokenizer.word_index['startseq']]
104
105     sequences = [[start, 0]]
106
107     img_features = cheXnet_Features[image]
108     img_features = encoder_model.predict(img_features)
109     finished_seq = []
110
111     for i in range(153):
112         all_candidates = []
113         new_seq = []
```

```
        for s in sequences:

            text_input = pad_sequences([s[0]], 153, padding='post')
            predictions = decoder_model.predict([text_input,img_features])
            top_words = np.argsort(predictions[0])[-beam_width:]
            seq, score = s

            for t in top_words:
                candidates = [seq + [t], score - np.log(predictions[0][t])
                all_candidates.append(candidates)

        sequences = sorted(all_candidates, key = lambda l: l[1])[:beam_wid
        # checks for 'endseq' in each seq in the beam
        count = 0
        for seq,score in sequences:
            if seq[len(seq)-1] == tokenizer.word_index['endseq']:
                score = score/len(seq)   # normalized
                finished_seq.append([seq, score])
                count+=1
            else:
                new_seq.append([seq, score])
        beam_width -= count
        sequences = new_seq

        # if all the sequences reaches its end before 155 timesteps
        if not sequences:
            break
        else:
            continue

    sequences = finished_seq[-1]
    rep = sequences[0]
    score = sequences[1]
    temp = []
    rep.pop(0)
    for word in rep:
        if word != tokenizer.word_index['endseq']:
            temp.append(tokenizer.index_word[word])
        else:
            break
    rep = ' '.join(e for e in temp)

    return rep, score

def get_result_beam(idx,beam_width):

  plt.figure(figsize=(9,5))

  pre_Report,Score = beamsearch(cv_data['Person_id'][idx],beam_width) # re
  print('--------------------------------------------------------------------
  print("Predicted Report : ",pre_Report)
  print('Score is :',Score)
  print('--------------------------------------------------------------------
  print("Actual Report : ",cv_data['Report'][idx])

  plt.subplot(121)
  img = load_image(cv_data['Image1'][idx])
```

```
    plt.imshow(img[0])

    plt.subplot(122)
    img = load_image(cv_data['Image2'][idx])
    plt.imshow(img[0])

  if Algo == 'greedy':
    get_result(input_image_idx)
  if  Algo == 'beam':
    get_result_beam(input_image_idx,beam_width=5)

```

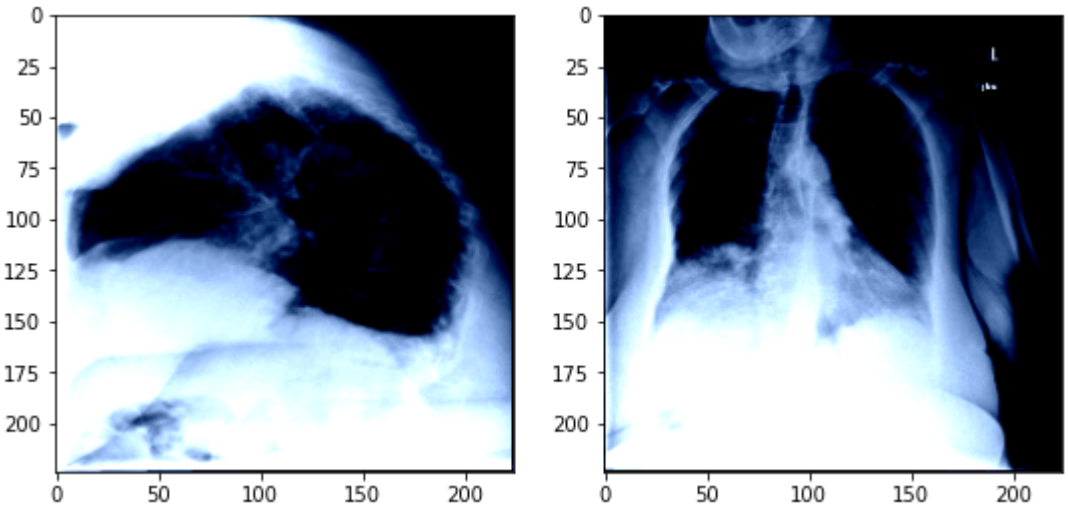
In [106]:
```
enc_dec_model(2,Algo = 'greedy')
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).

--------------------------------------------------------------------------------
-----------------------
Predicted Report :  the heart size normal . the mediastinum unremarkable . the
lungs are clear .
--------------------------------------------------------------------------------
-----------------------
Actual Report :  startseq no pneumothora .  no large pleural effusions .  heart
size normal .  no acute focal space opacities .  endseq
```



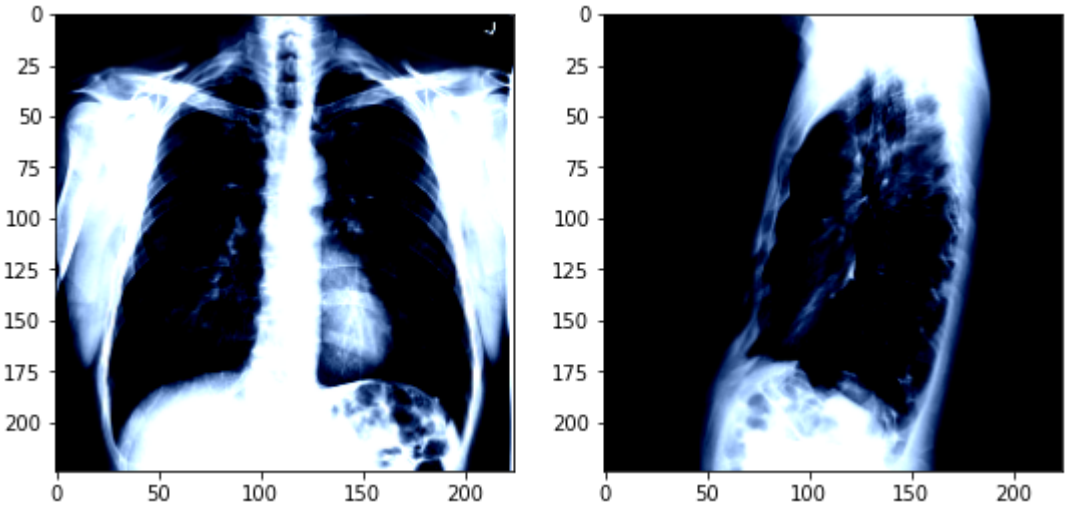
In [107]:
```
1 enc_dec_model(98,Algo = 'greedy')
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).

--------------------------------------------------------------------------------
-----------------------
Predicted Report :  the heart size normal . the mediastinal contour within norm
al limits . the lungs are free focal airspace disease . no pleural effusion pne
umothora .
--------------------------------------------------------------------------------
-----------------------
Actual Report :  startseq the heart mildly enlarged .  pulmonary vascularity in
creased .  there again mild elevation the right hemidiaphragm .  air space dise
ase andor atelectasis noted right lung base .  there also streaky opacity the l
eft base .  the costophrenic are blunted .  endseq
```



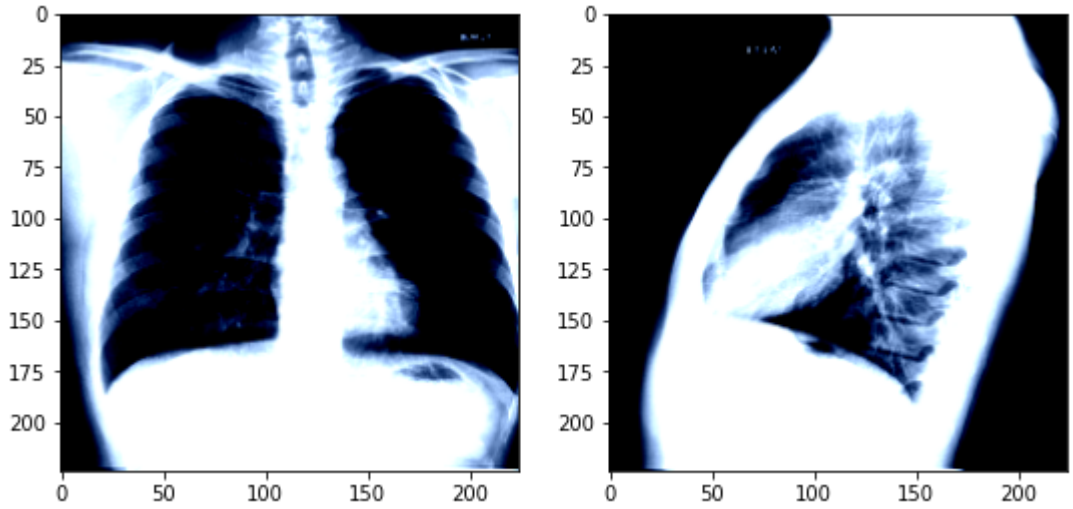
In [108]:
```
1 enc_dec_model(48,Algo = 'greedy')
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).

--------------------------------------------------------------------------------
-----------------------
Predicted Report :  the heart size and mediastinal contours are within normal l
imits . no focal consolidation pleural pleural effusion .
--------------------------------------------------------------------------------
-----------------------
Actual Report :  startseq the heart normal size .  the mediastinum unremarkable
.  there again biapical scarring .  small stable calcified left lower lobe gran
uloma .  the lungs are otherwise clear .  endseq
```



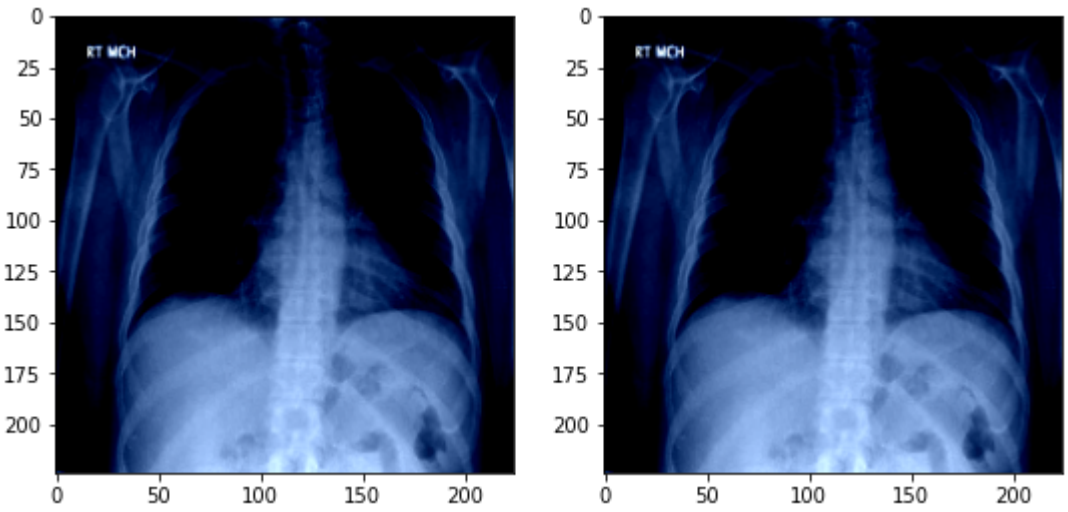
In [109]:
```
1 enc_dec_model(2,Algo = 'beam')
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).

--------------------------------------------------------------------------------
-----------------------
Predicted Report :  the heart size and mediastinal contours are within normal l
imits . no focal airspace consolidation pleural effusion pneumothora .
Score is : 0.5701761486055884
--------------------------------------------------------------------------------
-----------------------
Actual Report :  startseq no pneumothora .  no large pleural effusions .  heart
size normal .  no acute focal space opacities .  endseq
```



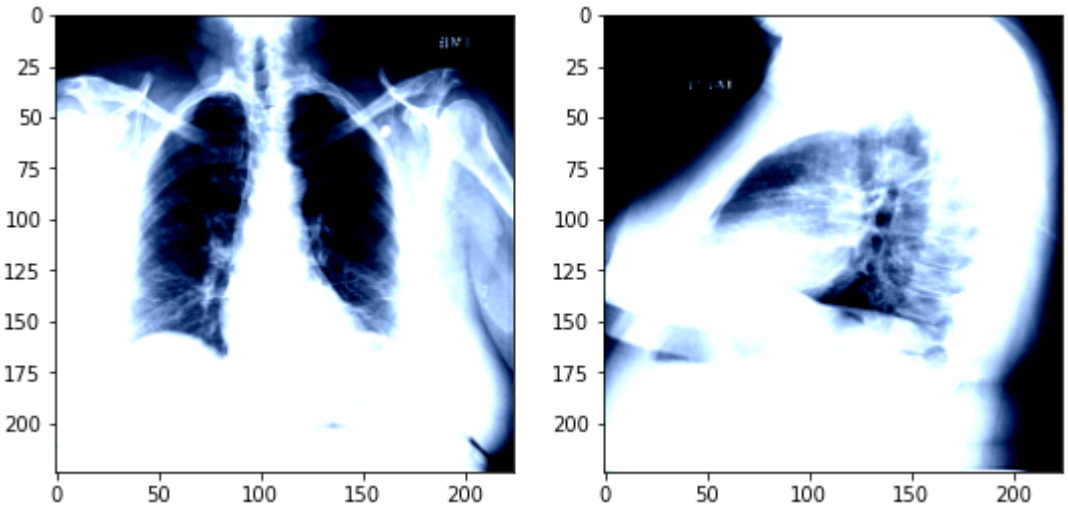
In [110]:
```
1 enc_dec_model(5,Algo = 'beam')
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).

------------------------------------------------------------------------------
-----------------------
Predicted Report :  the heart normal size . the mediastinum unremarkable . the
lungs are free focal airspace disease . no pleural effusion pneumothora .
Score is : 0.61768415896222
------------------------------------------------------------------------------
-----------------------
Actual Report :  startseq normal heart size and mediastinal contours .  low lun
g volumes with no significant airspace consolidation .  no pleural effusion pne
umothora .  visualized osseous structures are unremarkable appearance .  endseq
```



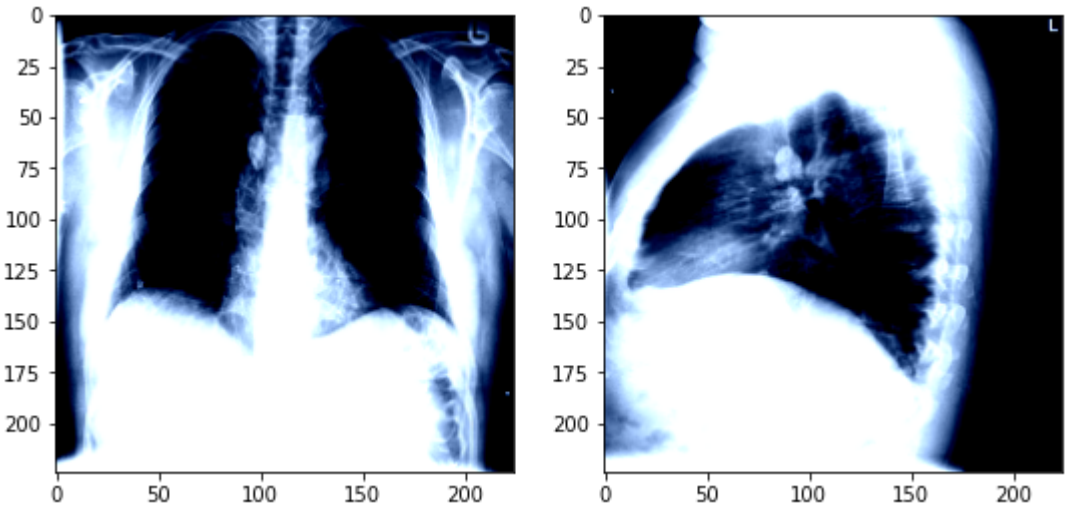
In [113]:
```
1 enc_dec_model(37,Algo = 'beam')
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).

--------------------------------------------------------------------------------
----------------------
Predicted Report :  the lungs are clear bilaterally . specifically no evidence
focal consolidation pneumothora pleural effusion pneumothora cardio mediastinal
silhouette unremarkable . visualized osseous structures the thora are without a
cute abnormality .
Score is : 0.3825261330930516
--------------------------------------------------------------------------------
----------------------
Actual Report :  startseq the heart size and mediastinal contours appear within
normal limits .  there are low lung volumes with left basilar subsegmental atel
ectasis .  no focal airspace consolidation effusions pneumothora .  no acute bo
ny abnormalities .  endseq
```



In [114]:
```
1 enc_dec_model(89,Algo = 'beam')
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).

------------------------------------------------------------------------------
----------------------
Predicted Report :  the heart normal size . the mediastinum unremarkable . the
lungs are free focal airspace disease . no pleural effusion pneumothora .
Score is : 0.5942948383744806
------------------------------------------------------------------------------
----------------------
Actual Report :  startseq the cardiac and mediastinal contours are within norma
l limits .  there are calcified mediastinal lymph with calcified right lower lo
be pulmonary nodule .  the lungs are wellinflated and clear .  there no focal c
onsolidation pneumothora effusion .  there are degenerative changes the first c
ostochondral joints bilaterally .  no acute bony abnormalities are seen .  ends
eq
```



Function 2

In [116]:

```
def enc_dec_model_pred(input_image_idx,Algo = 'greedy'):

    '''This fun takes index of an image as input and prints predicted result

  input1 = Input(shape=(2048), name='Image_input')
  dense1 = Dense(256, kernel_initializer=tf.keras.initializers.glorot_unifor

  input2 = Input(shape=(153), name='Text_Input')
  embedding_layer = Embedding(input_dim = vocab_size, output_dim = 300, inpu
                weights=[embedding_matrix], name="Embedding_layer")
  emb = embedding_layer(input2)

  LSTM1 = LSTM(units=256, activation='tanh', recurrent_activation='sigmoid',
            kernel_initializer=tf.keras.initializers.glorot_uniform(seed=23)
            recurrent_initializer=tf.keras.initializers.orthogonal(seed=7),
            bias_initializer=tf.keras.initializers.zeros(), return_sequences
  #LSTM1_output = LSTM1(emb)

  LSTM2 = LSTM(units=256, activation='tanh', recurrent_activation='sigmoid',
            kernel_initializer=tf.keras.initializers.glorot_uniform(seed=23)
            recurrent_initializer=tf.keras.initializers.orthogonal(seed=7),
            bias_initializer=tf.keras.initializers.zeros(), name="LSTM2")
  LSTM2_output = LSTM2(LSTM1)

  dropout1 = Dropout(0.5, name='dropout1')(LSTM2_output)

  dec =  tf.keras.layers.Add()([dense1, dropout1])

  fc1 = Dense(256, activation='relu', kernel_initializer=tf.keras.initialize
  fc1_output = fc1(dec)
  dropout2 = Dropout(0.4, name='dropout2')(fc1_output)
  output_layer = Dense(vocab_size, activation='softmax', name='Output_layer'
  output = output_layer(dropout2)

  encoder_decoder = Model(inputs = [input1, input2], outputs = output)
  encoder_decoder.load_weights("/content/encoder_decoder_epoch_5.h5")

  # encoder
  encoder_input = encoder_decoder.input[0]
  encoder_output = encoder_decoder.get_layer('dense_encoder').output
  encoder_model = Model(encoder_input, encoder_output)

  # decoder#
  text_input = encoder_decoder.input[1]
  enc_output = Input(shape=(256,), name='Enc_Output')
  text_output = encoder_decoder.get_layer('LSTM2').output
  add1 = tf.keras.layers.Add()([text_output, enc_output])
  fc_1 = fc1(add1)
  decoder_output = output_layer(fc_1)

  decoder_model = Model(inputs = [text_input, enc_output], outputs = decoder

  def greedysearch(img):
    image = cheXnet_Features[img]
    input_ = 'startseq'
    image_features = encoder_model.predict(image)
```

```
57
58      result = []
59      for i in range(153):
60          input_tok = [tokenizer.word_index[w] for w in input_.split()]
61          input_padded = pad_sequences([input_tok], 153, padding='post')
62          predictions = decoder_model.predict([input_padded, image_features])
63          arg = np.argmax(predictions)
64          if arg != 7:   # endseq
65              result.append(tokenizer.index_word[arg])
66              input_ = input_ + ' ' + tokenizer.index_word[arg]
67          else:
68              break
69      rep = ' '.join(e for e in result)
70      return rep
71
72  def load_image(img_name):
73      image = Image.open(img_name)
74      X = np.asarray(image.convert("RGB"))
75      X = np.asarray(X)
76      X = preprocess_input(X)
77      X = resize(X, (224,224,3))
78      X = np.expand_dims(X, axis=0)
79      X = np.asarray(X)
80      return X
81
82  def get_result(idx=0):
83
84      plt.figure(figsize=(9,5))
85
86      pre_Report = greedysearch(test_data['Person_id'][idx]) # result after 20
87      print('---------------------------------------------------------------------
88      print("Predicted Report : ",pre_Report)
89
90      plt.subplot(121)
91      img = load_image(test_data['Image1'][idx])
92      plt.imshow(img[0])
93
94      plt.subplot(122)
95      img = load_image(test_data['Image2'][idx])
96      plt.imshow(img[0])
97
98  # beam_width = 2
99  def beamsearch(image, beam_width = 2):
100
101         start = [tokenizer.word_index['startseq']]
102
103         sequences = [[start, 0]]
104
105         img_features = cheXnet_Features[image]
106         img_features = encoder_model.predict(img_features)
107         finished_seq = []
108
109         for i in range(153):
110             all_candidates = []
111             new_seq = []
112             for s in sequences:
113
```

```
                text_input = pad_sequences([s[0]], 153, padding='post')
                predictions = decoder_model.predict([text_input,img_features])
                top_words = np.argsort(predictions[0])[-beam_width:]
                seq, score = s

                for t in top_words:
                    candidates = [seq + [t], score - np.log(predictions[0][t])
                    all_candidates.append(candidates)

            sequences = sorted(all_candidates, key = lambda l: l[1])[:beam_wid
            # checks for 'endseq' in each seq in the beam
            count = 0
            for seq,score in sequences:
                if seq[len(seq)-1] == tokenizer.word_index['endseq']:
                    score = score/len(seq)   # normalized
                    finished_seq.append([seq, score])
                    count+=1
                else:
                    new_seq.append([seq, score])
            beam_width -= count
            sequences = new_seq

            # if all the sequences reaches its end before 155 timesteps
            if not sequences:
                break
            else:
                continue

        sequences = finished_seq[-1]
        rep = sequences[0]
        score = sequences[1]
        temp = []
        rep.pop(0)
        for word in rep:
            if word != tokenizer.word_index['endseq']:
                temp.append(tokenizer.index_word[word])
            else:
                break
        rep = ' '.join(e for e in temp)

        return rep, score

    def get_result_beam(idx,beam_width):

      plt.figure(figsize=(9,5))

      pre_Report,Score = beamsearch(test_data['Person_id'][idx],beam_width) #
      print('--------------------------------------------------------------------
      print("Predicted Report : ",pre_Report)
      print('Score is :',Score)

      plt.subplot(121)
      img = load_image(test_data['Image1'][idx])
      plt.imshow(img[0])

      plt.subplot(122)
      img = load_image(test_data['Image2'][idx])
```

```
    plt.imshow(img[0])

  if Algo == 'greedy':
    get_result(input_image_idx)
  if  Algo == 'beam':
    get_result_beam(input_image_idx,beam_width=5)

```

In [118]:
```
enc_dec_model_pred(89,Algo = 'beam')
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).

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-----------------------
Predicted Report :  the lungs are clear bilaterally . specifically no evidence
focal consolidation pneumothora pleural effusion pneumothora cardio mediastinal
silhouette unremarkable . visualized osseous structures the thora are without a
cute abnormality .
Score is : 0.38339576142607257
```

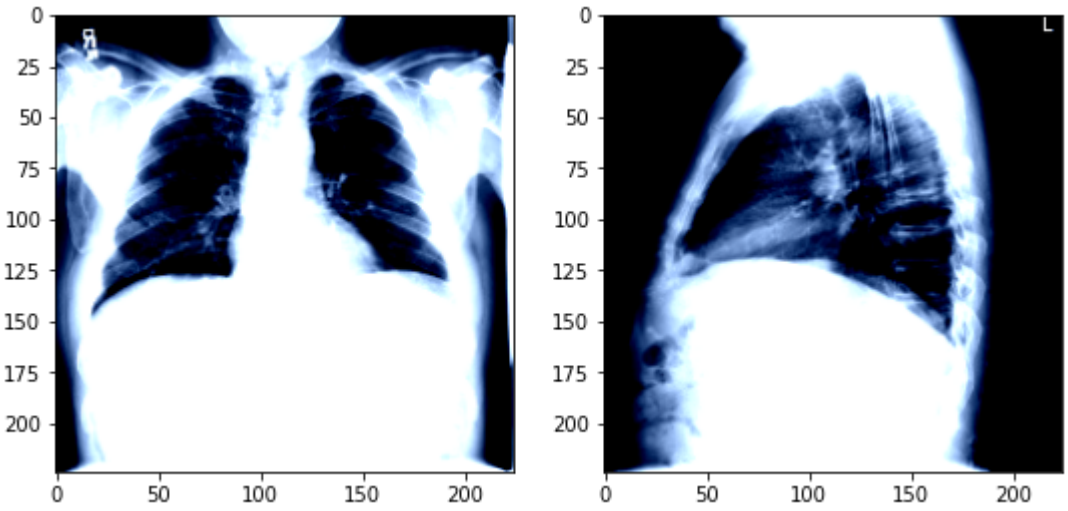

In [119]:
```
1 enc_dec_model_pred(12,Algo = 'beam')
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).

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----------------------
Predicted Report :  the heart size and mediastinal contours are within normal l
imits . the lungs are free focal airspace disease . no pleural effusion pneumot
hora .
Score is : 0.5883563925744966
```
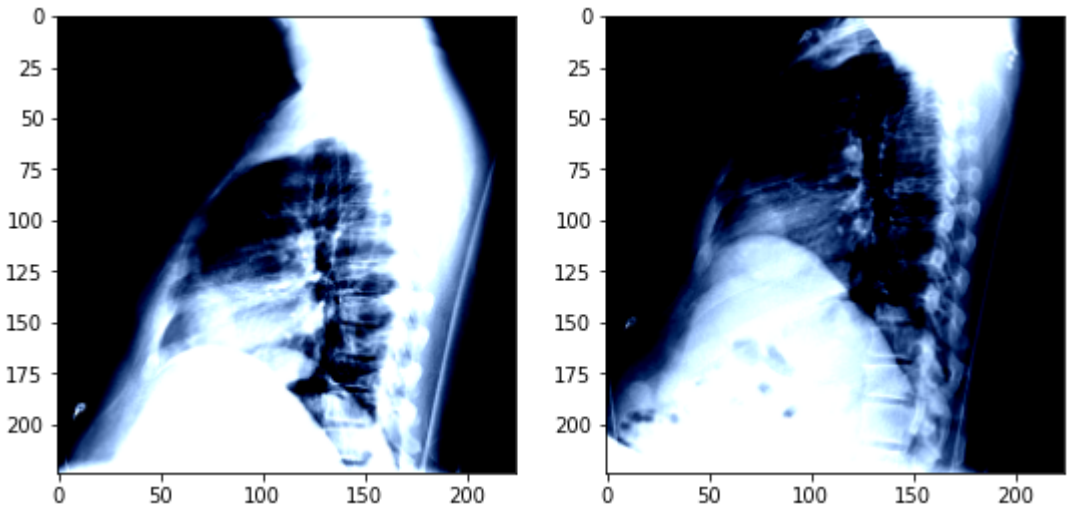
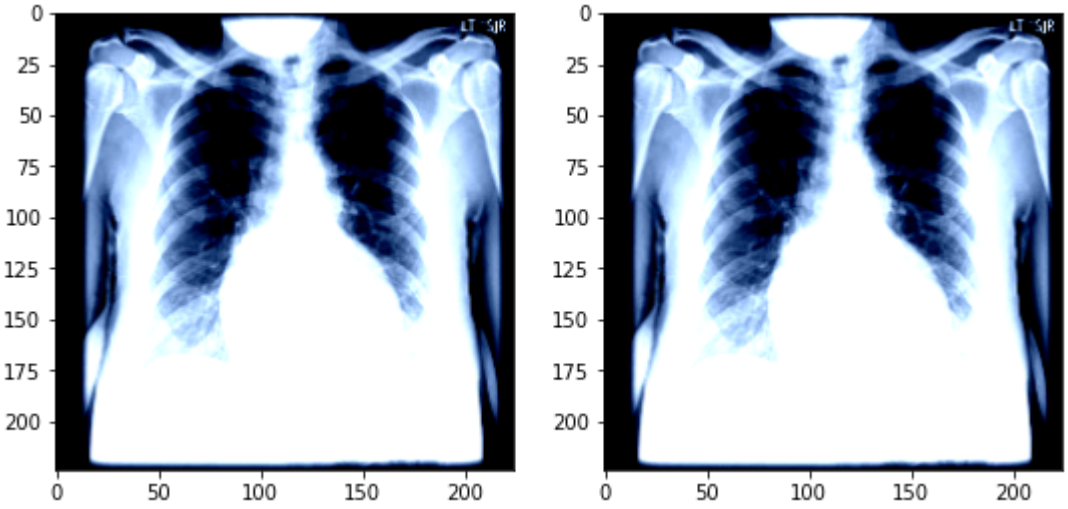



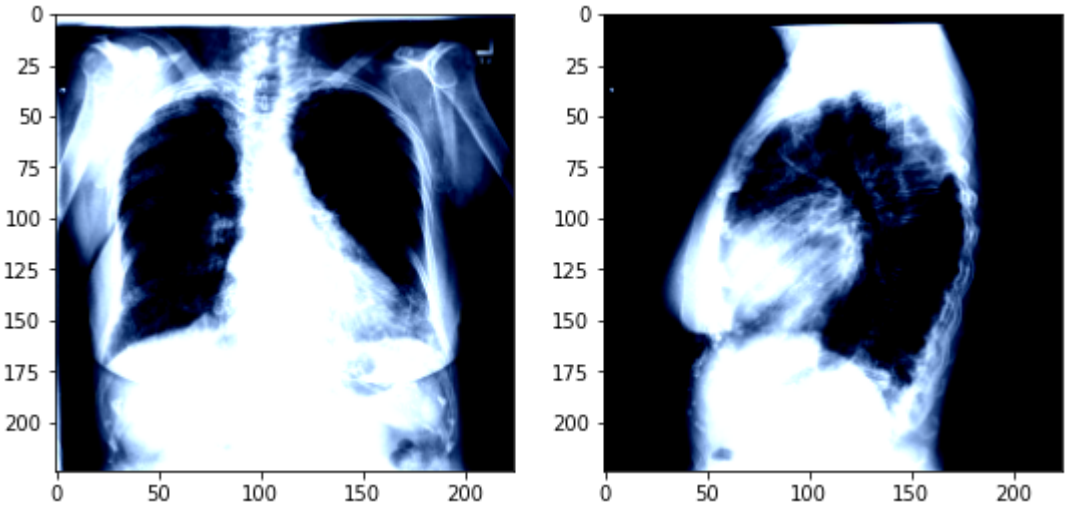
In [120]:
```
1 enc_dec_model_pred(21,Algo = 'beam')
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).

--------------------------------------------------------------------------------
----------------------
Predicted Report :  the heart size and mediastinal contours are within normal l
imits . no focal airspace consolidation pneumothora effusion pneumothora .
Score is : 0.6146528686721078
```



In [122]:
```
1 enc_dec_model_pred(118,Algo = 'beam')
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for flo
ats or [0..255] for integers).

--------------------------------------------------------------------------------
----------------------
Predicted Report :  the lungs are clear bilaterally . specifically no evidence
focal consolidation pneumothora pleural effusion pneumothora cardio mediastinal
silhouette unremarkable . visualized osseous structures the thora are without a
cute abnormality .
Score is : 0.42667727160733193
```



In [ ]:
```
1
```