Cough-O-Meter: A Mobile Respiratory Illness Diagnostic Tool

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1 Abstract

Cough-O-Meter is a mobile respiratory illness diagnostic tool that uses a uses the results from a user inputting their individual risk factors and symptoms. Cough-O-Meter was developed during the 2019-2020 COVID-19 Pandemic to raise awareness and hopes to decrease the load on the healthcare system, by guiding users to seek further medical attention or not. By associating illnesses with their respective symptoms, we weighted each symptom with a specific value ranging from 0.0-1.0. The larger the value, the more associated that symptom was with a specific illness. We also asked the user any risk factors that they may have (e.g. medical history, weight, age). After a series of 29 questions the user was greeted with a result screen with what our algorithm determined was the most likely respiratory illness they may had. Though this application is not meant to replace a professional medical diagnosis, it can be used as a quick and easy to use tool for a user to figure out whether they should pursue further medical attention during COVID-19 pandemic.

Keywords: COVID, Respiratory, Application, Diagnosis, Kivy, Cough

2 Introduction

In biology/medicine, there is an important need for easily accessible testing and assessments for different diseases and viruses. With the current COVID-19 virus pandemic, health officials expect the number of cases to continue to rise, and with the neighboring United States now leading in the number of confirmed cases of COVID-19, the fear of Canadians contracting the virus has never been higher.

This fear of contracting COVID-19 has started to overburden the healthcare industry with people displaying a variety of respiratory symptoms, many of which can be considered minor and can be treated from home. However, this brings up the question of 'which symptoms can be considered dangerous and unhealthy?' How does one know whether they are at risk of having COVID-19 or some other respiratory illness? Therefore, our project motivation is a simple tool to help guide Canadians to diagnose what respiratory illness they may have. This can range from minor illnesses like the common cold to more major illnesses that need professional medical attention like COVID-19 or Lung Cancer.

Depending on the illness, different symptoms will occur and be displayed by an infected patient. To illustrate, the Centre of Disease Control (CDC) have noted that the more common symptoms are coughing, fever, a difficulty in breathing, and fever [1]. Notice how sneezing (a common cold symptom) is not a common COVID-19 symptom. Using this idea, we set out to develop a tool that will provide a series of questions for the user to answer.

These questions can be related but not limited to symptoms, the area and density where the user is living and has been to, their age, underlying conditions, lifestyle, etc. Based on the answers received, the tool will calculate and output the most probable

illness/ diagnostic. In addition, the tool will provide tips on the best practices to avoid getting sick.

The rest of the report will be divided as follows:

- Section 3: We discuss the material we used and incorporated into our project
- Section 4: The method used and applied to the application
- Section 5: The results that we calculated
- Section 6: Accomplishments made
- Section 7: Contributions from each team member during this project
- Section 8: Conclusion and Discussion
- Section 9: Future Work and Improvements

3 Material

The data that was used was gathered through several sources, they can be found in the reference and acknowledgement sections. These sources indicate the symptoms, and any other factors, associated with the conditions that our app addresses. Once the data was received we constructed the app using Python with the library Kivy. The algorithm which determined the results at the end was established after examining the research. Images and UI displays were created using Adobe Stock Images & Photoshop.

4 Methods

Illness predictions by the tool are made by an underlying scoring system which consists of a symptom component and a risk factor component.

Starting with the symptoms. Based on a combination of clinical and epidemiological results, and the data provided by different health organizations, we came up with a scoring system based on how common a symptom was to occur in the presence of an illness. Those which were found to be common symptoms of an illness were assigned a score of 1.0, those which were symptoms that only sometimes occurred were assigned a score of 0.5, those which were symptoms that rarely occurred with the illness were assigned a score of 0.2, and symptoms that never occur with the illness were assigned a score of 0.0. To illustrate, we found that fever was a symptom commonly associated with Covid-19, flu, and pneumonia, was rarely a symptom of the common cold and bronchitis, and not a symptom of asthma, chronic obstructive pulmonary disease, lung cancer, and pulmonary hypertension; as a result, if the user answers yes to the question "Do you have a fever > 37.6 degrees Celsius?", we would add 1.0 to the total scores for Covid-19, flu, and pneumonia, 0.2 to common cold and bronchitis, and 0.0 to asthma, chronic obstructive pulmonary disease, lung cancer, and pulmonary hypertension. In the case where the user answers no, a score of 0.0 or in other words, no score would be added to the total scores of all illnesses.

We then went further and identified the factors which increased the risk of contracting different illnesses. For each risk factor that we found to be associated with an illness, we assigned a score of 1.0 to that risk factor. For example, we found that if a user was

overweight, they would have a higher chance of getting Covid-19, asthma, and pulmonary hypertension; as a result, if the user answers yes to the question “are you overweight”, we would add 1.0 to the total scores for Covid-19, asthma, and pulmonary hypertension, and 0.0 to common cold, bronchitis, asthma, chronic obstructive pulmonary disease, lung cancer, and pulmonary hypertension. Again, in the case where the user answers no, a score of 0.0 or in other words, no score would be added to the total scores of all illnesses.

5 Results

Using 9 different respiratory conditions (COVID-19, Cold, Flu, COPD, Asthma, Lung Cancer, Pulmonary Hypertension, Pneumonia, Bronchitis) and their unique symptoms (Fever, Cough, Sneezing, Sense of Taste/Smell, Fatigue, Myalgia, Runny/Stuffy Nasal, Throat Soreness, Breathing, Edema, Heart Rate, Chest Pressure, Skin Color), combined with unique information of the user (e.g. age, weight, location, time of year, heatlth history) we were able to provide a probable diagnosis to the user of what respiratory illness they may have.

6 Accomplishments

We learned a great deal about the different risk factors for various respiratory illnesses. We also learned how to make a basic application using Kivy (a Python library for developing mobile apps). Putting the research and code together to create a useful application that gave meaningful results required great co-operation and communication, the organized utilization of multiple skill sets, and an in-depth understanding of the subject matter by all group members. The biggest obstacle that we had to overcome as a group was creating this application together without being able to meet in person. We had to overcome this obstacle by having regular group meetings by phone and maintaining contact frequently using Discord.

7 Contributions

Lukezander Asayo – Wrote majority of the proposal and final project report, organized meeting dates and topics to be discussed, expanded project scope to more than just COVID, created UI buttons and background design for application, created and edited demo video, minority in research, ensured data reaserch used was viable and reliable

Stefan Lynka - Setup initial Kivy environment and created installation guide. Divided and organized project into research, back-end, and front-end components. Developed front-end tools including buttons, screens, and aligners, and implemented basic UI

Skye Mason - Provided the basic idea behind the app. Used the installation guide for Kivy provided by Stefan. Worked on back-end and front-end components of the app to add backgrounds, text effects/alignment, and button images to the existing code. Added title page and results page and integrated images. Fixed alignment issues and worked with Richesh to merge the completed product together.

Alan Ou - Did majority of the research and created all the questions used in the tool. Also made a readme file with installation instructions from Stefan and example results from the program implemented by Stefan, Skye, and Richesh.

Richesh Patel - Worked on the back-end code to implement the algorithm, buttons, result screen, and inputs and outputs. Also worked on the front-end of the result screen. Received code from Stefan and Skye to implement it into the back-end code and result screen.

8 Conclusion and Discussion

Cough-O-Meter was developed to be a basic application that can give the user an idea of which respiratory illness they may be suffering from. This application can better inform the user whether they should seek further medical attention or they can self-treat and isolate from the comfort of their own home. However, our application is incomplete and there are ways that it can be improved upon.

Firstly, our application is in no way meant to replace or be taken as a professional medical diagnosis. Our results were calculated as assigning weights to specific symptoms and associating the combined wieghts into a diagnosis. However, many of the illnesses that we attempted to calculate can be considered as non-binary, where we must calculate the probabilities of one having that specific disease. Therefore, when compared to professional mediacal diagnosis techniques, our technique is rudementary and basic. To illustrate, we have no way of differentiating False Negatives and Postives in our weighting system whereas a system that uses probability distributions, thresholds and, a receiver operating characteristics (ROC) curve will.

Secondly, our testing methadology is incomplete when compared to proper medical diagnosing. Melo et al. note that even with medical history and symptoms, procedures like medical tests and data analyses are needed before coming to a proper medical diagnosis [2]. These tests and and analyses can only be done by professionals that have speant years on learning the intracacies on how different results may affect different diagnoses.

Lastly, our current method of detection relies only on the answers provided by the user. Users are likely to be untrained in taking medical tests and inputting accurate results into the application. Simple tasks for a medical professional (e.g. taking heart rate and internal body temperature) can be easily botched by the everyday person. In addition, when users are asked to input self-data users can purposefully input data that is inaccurate. For example, a study conducted by Palmieri & Stern note that patients tend to exagerate or minimize symptoms, habits, and personal information (e.g. underestimation of weight, exageration of height, etc.) [3].

In conclusion, as social distancing has come into effect to ease demand on the medical industry adaptations must occur. The current COVID-19 pandemic has resulted in a decrease of in-person access to medical professionals. Though there are communcation means to a medical professional other than in-person (via internet or phone) these are still limited. Cough-O-Meter is designed to help lessen the burden on the medical indutry and help ‘Flatten the Curve‘.

9 Future Work

Although we tried our best to include as many respiratory illnesses, and related clinical and epidemiological studies as we could, many were left out due to insufficient time. Furthermore, the emerging nature of COVID-19 means more results from clinical and epidemiological studies will emerge as time goes by. Lastly, our current method of detection relies only on the answers provided by the user; in cases where the user does not know what the symptoms they have are called, the integration of new illness detection methods like an AI sound recognition system would be helpful. In summary, future work concerns the inclusion of new respiratory illnesses, new methods of illness detection, and new studies that bring more up to date and reliable data into the tool.

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Appendix

Symptoms

Symptom	Question	Covid-19	Cold	Flu	Asthma	Chronic Obstructive Pulmonary Disease (COPD)	Lung Cancer	Pulmonary Hypertension	Pneumonia	Bronchitis
Fever	Do you currently have a body temperature greater than 37.6°C (99.7°F)? [Reference 5]	Common = 1.0	Rare = 0.2	Common = 1.0	No = 0.0	No = 0.0 [reference 13]	No = 0.0 [reference 14]	No = 0.0 [reference 15]	Common = 1.0	Rare = 0.2
Cough	Do you currently have a cough?	Common = 1.0	Mild = 1.0	Common = 1.0	Common = 1.0	Common = 1.0 Ongoing cough or cough with mucus (Wet cough)	Common = 1.0	Common = 1.0 Dry cough, sometimes with blood	Common = 1.0	Common = 1.0
Sense of smell/taste	Have you recently started experiencing a loss or alteration of smell or taste? Loss of smell related to Covid, cold, and flu	Sometimes = 0.6 [Reference 1]	Sometimes = 0.5	Sometimes = 0.5	No = 0.0	No = 0.0	Rare = 0.3 [Reference 16]	No = 0.0	No = 0.0	No = 0.0
	Alteration of smell related to lung cancer									
Fatigue [4]	Have you recently started experiencing lingering tiredness?	Sometimes = 0.5	Sometimes = 0.5	Common = 1.0	Sometimes = 0.5	Common = 1.0 [Reference 18]	Common = 1.0	Common = 1.0	Sometimes = 0.5	Common = 1.0
Aches and pains (Myalgia)	Have you suddenly been experiencing muscle or chest pain lately?	Rare = 0.2	Common = 1.0	Common = 1.0	Common = 1.0	Common = 0.7	Common = 1.0	Sometimes = 0.5	Common = 1.0	Common = 0.8
Runny or stuffy nose	Do you currently have a runny or stuffy nose?	Rare = 0.2	Common = 1.0	Sometimes = 0.5	No = 0.0	No = 0.0	No = 0.0	No = 0.0	No = 0.0	No = 0.0
Sore Throat	Do you currently have a sore throat?	Sometimes = 0.5	Common = 1.0	Sometimes = 0.5	No = 0.0	No = 0.0	No = 0.0	No = 0.0	No = 0.0	Common = 0.8
Diarrhea	Have you been having diarrhea recently?	Rare = 0.2	No = 0.0	Sometimes for children = 0.5 0.2 for ages >= 18	No = 0.0	No = 0.0	No = 0.0 Treatment can cause diarrhea	No = 0.0	Sometimes = 0.5	No = 0.0
Headache	Do you currently have a	Sometimes = 0.5	Rare = 0.2	Common = 1.0	No = 0.0	No = 0.0	Common = 1.0	No = 0.0	No = 0.0	Common = 0.8
	headache?									
Shortness of breath	Are you currently experiencing a shortness of breath?	Sometimes = 0.5	No = 0.0	No = 0.0	Common = 1.0	Common = 1.0	Common = 1.0	Common = 1.0	Common = 1.0	Common = 0.8
Sneezing	Have you been sneezing a lot lately?	No = 0.0	Common = 1.0	No = 0.0	No = 0.0	No = 0.0	No = 0.0	No = 0.0	No = 0.0	No = 0.0
Haemoptysis(coughing up of blood) or rust-coloured spit/phlegm	Have you been coughing up blood or a lot of spit or phlegm recently?	No = 0.0	No = 0.0	No = 0.0	No = 0.0	Common = 1.0	Common = 1.0	No = 0.0	Sometimes = 0.5	Rare = 0.2
Edema (swelling) [Reference 11]	Have you recently been experiencing swelling in your ankles and knees?	No = 0.0	No = 0.0	No = 0.0	No = 0.0	No = 0.0	No = 0.0 [reference 10]	Common = 1.0	No = 0.0	No = 0.0
Racing Pulse	Has your heart been beating a lot faster than normal?	No = 0.0	No = 0.0	No = 0.0	Common = 1.0	Sometimes = 0.5	No = 0.0	Common = 1.0	Common = 1.0	No = 0.0
Wheezing [Reference	When you breathe, do you hear wheezing sounds?	No = 0.0	No = 0.0	No = 0.0	Common = 1.0	Common = 1.0	Common = 1.0	No = 0.0	Sometimes = 0.5	Common = 0.8
20]										
Chest tightness/pressure	Do you feel a sense of tightness or pressure in your chest?	Common = 1.0	No = 0.0	No = 0.0	Common = 1.0	Common = 1.0	Common = 1.0	Common = 1.0	No = 0.0	Common = 0.8
Bluish lips and skin	Do you notice a bluish tint to your lips and/or skin?	No = 0.0	No = 0.0	No = 0.0	No = 0.0 Bluish lips only during asthma attack	Sometimes = 0.5 Only when COPD becomes serious	No = 0.0	Common = 1.0	Common = 1.0	No = 0.0

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