Benefits of Electronic Nose for Earlier Detection of Covid-19
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Abstract:
COVID 19 has caused capitulation from health care entities all over the world. First described in Hubei, China, the virus has spread to 185 countries, showing little signs of eradication. There does not exist a medical treatment regimen or a vaccine to address COVID 19 definitively. The best response, to date, has been early diagnosis and immediate isolation or quarantine of the patient, with supportive care. As medical institutions all around the world struggle to keep up with this pandemic, there is not a consensus amongst medical professionals in the rapid diagnosis of this disease entity.

Purpose:
The purpose of our study is to review the literature and establish an earlier test, or tests that would aid the clinician in attaining an immediate isolation, yet accurate diagnosis.

Methods:
We searched PubMed and Google scholar and reviewed few articles. Keyword searches consisted of COVID 19, pandemic, diagnoses, diagnostic testing, pandemic amongst others. We compared the data obtained from these studies in an effort to find the best earlier diagnostic detection test using the Electronic nose.

Results:
There were a total of 12,270 patients that were in our study. This is the largest study to date in the literature addressing diagnosis of COVID 19. Fever, cough and fatigue, in that respective order were the most common clinical symptoms. Laboratory findings consisted of leukopenia, elevated erythrocyte sedimentation (ESR) and elevated C-reactive protein, CRP. The gold standard test described in multiple studies was the RT-PCR. Serum assays of IgM and IgG were also drawn and found to be accurate in 93% of the time. CT Chest was both sensitive and specific, 90% and 86%. This diagnostic imaging was even more successful when coupled with clinical symptoms and approaching days 7 - 12 since the onset of clinical symptoms.

Discussion:
This is the largest study compiled to address diagnostic testing in COVID 19 patients. The patient population is spread vastly around the world, with access to many reported tests limited in certain countries. Given the significant sensitivity and specificity of diagnostic imaging, in the setting of clinical symptoms, we recommend patient undergo CT Chest in the face of COVID 19 exposure and clinical symptoms. While RT-PCR, IgM-IgG assays are beneficial, isolation, treatment, and possible quarantine of presumptive positive COVID 19 patients (based upon clinical symptoms and imaging) should not be delayed, for fear of increased infectivity and further risk to society at large.

Keywords: COVID 19, Diagnostic Test, RT-PCR, IgM-Ig G, Chest CT, Pandemic.

1. INTRODUCTION
COVID 19 is a pandemic that has seriously impacted our daily living. First described in Wuhan, China, in late December, 2019, the disease has since spread worldwide. Mortality rates have been shocking, with new hot spots emerging daily. There has not been any successful treatment reported. There does not exist a vaccine to prevent the spread of SARS-CoV-2 virus, responsible for COVID 19. The hallmark of treatment has been early detection of the patient population with immediate isolation and/or quarantine. Multiple reports have been published attempting to identify and share the best diagnostic technique. However, there has yet to be a consensus paper outlining and comparing the best earlier detection test, one that offers both a high sensitivity and specificity.

2. PURPOSE
The purpose of our study was to review the literature and establish an earlier detection test, or tests, that would aid the clinician in attaining an earlier isolation of a person using Electronic nose detector, yet accurate diagnosis.

3. ABOUT ELECTRONIC NOSE
We searched PubMed and Google scholar and reviewed few articles. The focus of most of these articles was that it was well
known that the electronic nose can be used to identify differences between human health and disease for a range of disorders test. Rapid advances in sensor technologies have facilitated the development of high-performance electronic noses that can detect. The electronic nose is a device that detects the smell more effectively than the human sense of smell. An electronic nose consists of a mechanism for chemical detection. The electronic nose is an intelligent sensing device that uses an array of gas sensors which are overlapping selectively along with a pattern reorganization component. Now a day the electronic noses have provided external benefits to a variety of commercial industries, agriculture, biomedical, cosmetics, environmental, food, water and various scientific research fields. Electronic noses have a clear potential to be a non-invasive, simple and rapid but above all accurate early diagnostic screening tool.

**PRINCIPLE OF ELECTRONIC NOSE:**

The electronic noses work in a similar manner of human. The electronic nose uses sensors as the receptor. When a specific sensor receives the molecules, it transmits the signal to a program for processing, rather than to the brain. The electronic nose was developed in order to mimic human olfaction whose functions are non-separate mechanisms, i.e., the smell or flavor is perceived as a global fingerprint. Essentially the instrument consists of sensor array, pattern reorganization modules, and headspace sampling, to generate signal patterns that are used for characterizing smells. The electronic nose consists of three major parts which are detecting system, computing system, and sample delivery system.

**The sample delivery system:**
The sample delivery system enables the generation of headspace of sample or volatile compounds which is a fraction analyzed. The system then sends this head space into the detection system of the electronic nose.

**The detection system:**
The detection system which consists of a group of sensors is the reactive part of the instrument. When in contact with volatile compounds at that time the sensors react causing changes in electrical characteristics.

**The Computing system:**
In most electronic noses each sensor is sensitive to all molecules in their specific way. However in bioelectric noses the receptor proteins which respond to specific smell molecules are used. Most of electronic noses use sensor arrays that react to volatile compounds. Whenever the sensors sense any smell, a specific response is recorded that signal is transmitted into the digital value. The more commonly used sensors in electronic nose Metal oxide semiconductor (MOSFET) Metal Oxide semiconductor sensor: This is used for switching or amplifying electronic signals. The working principle of MOSFET is that molecules entering into the sensor area will be charged positively or negatively which have directly effect on the electric field inside MOSFET.

**Metal Oxide sensors: (MOS)**
This sensor is based on adsorption of gas molecules to provoke change in conductivity. This conductivity change is the measure of the amount of volatile organic compounds adsorbed.
ELECTRONIC NOSE BLOCK DIAGRAM

Data Analysis for Electronic Nose:
The digital output generated by electronic nose sensors has to be analyzed and interpreted in order to provide. There are three main types of commercially available techniques.

- Graphical analysis
- Multivariate data analysis
- Network analysis

DATA ANALYSIS FOR ELECTRONIC NOSE

The choice of method utilized depends on available input data from sensors. The simplest form of a data reduction is a graphical analysis useful for comparing samples or comparing smells identification elements of unknown analysts relative to those of known sources in reference libraries. The multivariate data analysis generates a set of techniques for the analysis of data that is trained or untrained technique. The untrained techniques are used when a data base of known samples has not been built previously. The simplest and most widely used untrained MDA technique is a principle component analysis. The electronic nose data analysis MDA is a very useful when sensors have partially coverage sensitivities to individual compounds present in a sample mixer. The PCA is a most useful when no known sample is available. The neural network is the best known and most derived analysis techniques utilized in a statistical software packages for commercially available electronic nose. For examples electronic nose system for the fruit smell detection:
ELECTRONIC NOSE SYSTEM

4. RESULTS OF ELECTRONIC NOSE IN MEDICAL FIELD:

Modern medicine faces the problem and challenge of achieving effective disease diagnoses through early detections of pathogenesis or disease conditions in order to facilitate the application of rapid treatments, but at the same time dramatically reducing the invasiveness of diagnostic treatments. Chemical analysis of human biological samples, such as breath, blood, urine, sweat and skin, are the most common means of diagnosing most pathological conditions. Conceptually, the electronic nose has interesting applications in the sensor analysis of human breath to potentially provide quick diagnosis of many diseases. In the case of pneumonia diagnosis, Hockstein et al. discriminated between diseased and non-diseased patients with an accuracy as high as 91.6%. One of the most disputed yet promising application of electronic nose technologies is for the early detection and diagnosis of oncologic diseases, in particular lung cancer. They collected breath samples from 60 individuals: 35 of which were affected by lung cancer; 9 had just had surgical therapy and 18 were used as controls. Two more individuals were measured before and after surgical therapy. The electronic nose could successfully detect 100% of lung cancer affected patients, 94% of controls and 44% of post-surgery patients (the others were classified as healthy controls). They found this e-nose performed at 71.4% sensitivity and 91.4% specificity for detecting lung cancer, with positive and negative predictive values of 66.6% and 94.5%, respectively. Many other developing medical applications for the electronic nose recently have shown promise including the diagnosis of ventilator-associated pneumonia, early screening for the presence of many different types of cancers, and breath analyses for detection of various diseases. Electronic nose sensors do not require chemical reagents, have good sensitivity and specificity, provide rapid results, and allow non-destructive sampling of odorants or analytes. Furthermore, e-noses generally are far less expensive than analytical systems, easier and cheaper to operate, and have greater potential for portability and field use compared with complex analytical laboratory instruments. Thus, electronic noses have far greater potential to be used eventually by unskilled consumers for innumerable practical applications in residential and public settings and offer quick real-time detection and discrimination solutions for applications requiring accurate, rapid and repeated determinations.

5. DISCUSSION:

COVID 19 does not affect a specific patient population. Although the virus does impact the immune compromised and elderly population with increased morbidity and mortality, the disease has affected all age ranges, including the pediatric population. The constellation of clinical symptoms encompass fever, cough and fatigue in decreasing order of presentation. Given the widespread presence of COVID 19, it is important that the clinician entertain this diagnosis when these clinical symptoms are encountered. Since COVID 19 has been rapidly spreading the electronic nose can be used as the earlier detecting tool for detecting the odor produced by the person through their body, breath. Thus by following this procedure a number of persons can be screened and be isolated and treated further so the rapid spread of the disease can be controlled. Until the cure can be found, immediate earlier screening of the person is essential. Hence in our study, the electronic nose can be an efficient tool for the early detection of COVID 19.

6. REFERENCES:


