IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 11, November 2024

DOI: 10.17148/IJARCCE.2024.131116

DETECTION OF HEART ATTACK USING ACETONE SIGNATURE

Ramya R[1], Prakruthi K P[2], Sahana[3],Sindhu S Patil [4], Sushanth Lobo[5]

Department Of Electronics & Communication Engineering, AIET, Moobidri,Mijar[1,2,3,4,5]

Abstract: Exhaled volatile organic compounds (VOCs) can be used to diagnose certain chronic conditions, however there is no data about how well they work to distinguish between individuals with congestive heart failure (CHF), particularly with older patients when Natriuretic peptides are less accurate [2]. The prognosis for heart failure (HF) is not good, and finding indicators of the disease's severity may aid in its management. In a pilot investigation, we found that HF patients' exhaled breath contained substantial amounts of acetone. The purpose of this study was to assess exhaled acetone as an indicator of heart failure diagnosis and heart failure severity [4]. We assessed the ability of VOCs evaluation to detect patients with or without CHF, classify the severity of CHF, and forecast how well decompensated CHF patients will respond to treatment. Procedures and Outcomes: In addition to 117 healthy controls and 103 controls with chronic obstructive pulmonary disease (COPD), we enrolled 89 participants who had been hospitalized to an intensive care ward with acutely decompensated CHF [2]. 89 patients (the HF group) who met the inclusion criteria were compared to age- and sex-matched healthy subjects out of the 235 patients with systolic dysfunction who were assessed between May 2009 and September 2010. Exhaled breath was collected from patients with heart failure (HF) who were categorized based on their clinical stability (acute decompensated HF [ADHF], n = 59; chronic HF, n = 30). Gas chromatography-mass spectrometry was used to identify the chemical species, and Spectrophotometry was used to quantify the results. Diabetic patients were not accepted [4]. Echocardiography was conducted by CHF patients. The Pneumo Pipe was used to gather the VOCs, and the BIONOTE electronic nose was used to evaluate them. A partial least squares analysis was assessed to assess the VOCs' ability to discriminate [2]. The accuracy of the CHF classification against the healthy and COPD controls was 81% and 69%, respectively; the accuracy remained unchanged in a sensitivity analysis that excluded participants who were 65 years of age or older, although therapy-induced weight changes were not predicted. Conclusions: VOC pattern corresponds with heart function markers and can distinguish elderly CHF patients from healthy individuals and COPD sufferers [2].

Keywords: Exhaled volatile organic compounds (VOCs), Congestive heart failure (CHF), Heart failure diagnosis, Exhaled breath acetone (EBA), Acutely decompensated heart failure (ADHF), Chronic heart failure (CHF), Gas chromatography-mass spectrometry (GC-MS), BIONOTE electronic nose, Pneumo Pipe VOC collection, Heart failure severity assessment, Natriuretic peptides (BNP), Heart function markers, COPD and heart failure differentiation, VOC biomarkers, Echocardiography in heart failure

INTRODUCTION

One of the leading causes of death worldwide is myocardial infarctions, also known as heart attacks. Timely identification and intervention are essential for reducing related morbidity and mortality. Even in cases where they prove to be effective, conventional diagnostic methods such as electrocardiograms (ECG), blood tests for cardiac biomarkers, and imaging modalities come with limitations concerning cost, timeliness, and accessibility. It is imperative in this case to look into rapid, noninvasive diagnostic methods that are state-of-the-art. Identifying cardiac attacks by breath acetone level analysis is an intriguing area of investigation. The body produces acetone, a volatile chemical molecule, as a consequence of the metabolism of fat. Low amounts of acetone are typically found in breath under normal circumstances. Breath analysis as a medical diagnostic tool is not a novel idea. VOCs, or volatile organic compounds, are a complex mixture found in breath that can represent a range of physiological and pathological conditions. Thanks to developments in analytical methods and sensor technology, these chemicals may now be detected and quantified with great specificity and sensitivity. Of them, acetone has attracted a lot of attention because of its association with metabolic processes and its potential to serve as a non-invasive marker for a number of diseases, such as diabetes and, as of late, heart attacks.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁕ Peer-reviewed & Refereed journal ⁕ Vol. 13, Issue 11, November 2024

DOI: 10.17148/IJARCCE.2024.131116

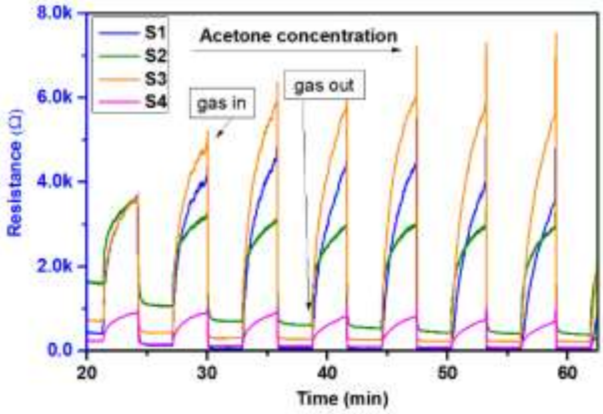

Figure 1. The gas-sensing characteristics of each particular gas sensor in the gas-sensing chamber under exposure to acetone in the 20–200 ppm range. Optimal operating temperature (given by the manufacturer) was ensured and 50% relative humidity was stabilized.

The recognition of acetone in breath as a heart attack warning sign entails several crucial steps. Breath samples are initially taken using non-invasive techniques and equipment designed to collect exhaled air without contamination in order to get accurate and reliable results.

Acetone is then detected and measured using advanced sensors or analytical instruments like gas chromatography-mass spectrometry (GCMS) or laser-based sensors. These methods provide a high degree of specificity and sensitivity when measuring acetone levels. Finally, the collected data is analyzed and interpreted using computational and statistical methods.

This process comprises distinguishing between normal and elevated acetone levels and establishing a correlation between these readings and the probability of a heart attack in order to improve diagnostic accuracy and reliability. Likewise it could employ complex algorithms and machine learning models.

Globally, the prevalence of HF has been increasing. In the United States and Brazil, HF remains a primary cause of hospitalization and is linked to a high death rate, even with significant advancements in therapy over the past few decades. It is crucial in clinical practice to identify patients who are more likely to be at risk or patient groups who can benefit from particular interventions. Finding novel indicators of prognosis and severity is therefore quite interesting. Although Natriuretic peptides are the most often used, novel non-invasive biomarkers have been reported recently. It is still difficult to forecast how this extremely diverse condition will develop. The biomarker of heart failure diagnostic and severity has been demonstrated to be exhaled breath acetone (EBA). It was examined as a prognostic biomarker as well. Our group's earlier research revealed a possible link between high acetone levels and a higher risk of heart transplantation and 12-month death. The majority of the patients in the cohort, still experienced acute decompensated heart failure (ADHF) [78% New York Heart Association (NYHA) III/IV and 66% hot/wet or cold/wet hemodynamic profile]. This was in addition to the cohort's small sample size [1]. As far as we are aware, there is no information available about the potential of exhaled acetone as a biomarker of long-term prognosis in individuals with stable symptoms but chronic heart failure. As a result, we set out to investigate how exhaled acetone may be used to distinguish particular clinical presentation patterns and—above all predict prognosis in a foreseeable, single-center cohort of patients with chronic heart failure [1].

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 11, November 2024

DOI: 10.17148/IJARCCE.2024.131116

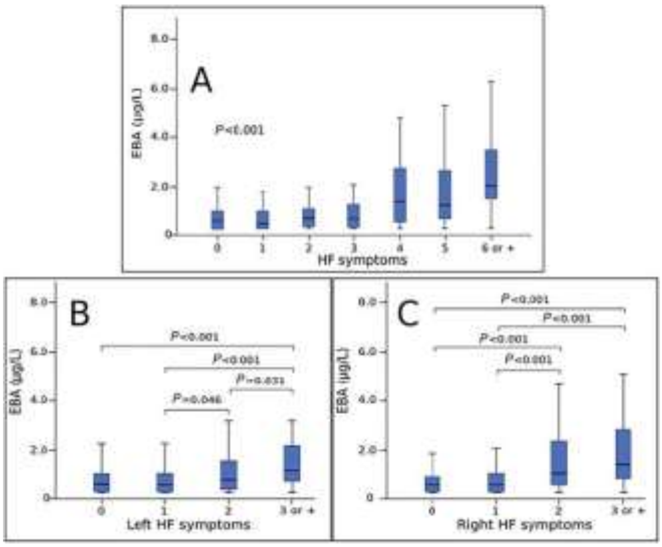

FIGURE 2.Acetone concentration in exhaled breath varies depending on the amount of heart failure symptoms. Panel A shows exhaled breath acetone (EBA) levels in relation to the amount of heart failure symptoms. Panel B shows EBA levels based on the amount of left heart failure symptoms. Panel C shows EBA levels based on the amount of right heart failure symptoms.

LITERATURE SURVEY

Researchers are pursuing fast, non-invasive heart attack diagnosis by looking into cutting-edge techniques like breath analysis. Among the many biomarkers that have been discovered, acetone has emerged as a promising contender due to its association with metabolic activities. This review of the scientific literature provides an overview of the corpus of research on the use of acetone signatures in analysis of breath for heart attack detection. One fascinating area of research is the identification of heart attacks by breath analysis. There was extensive research on the possibility that breath analysis, by virtue of the existence of volatile organic compounds (VOCs), can reflect various physiological and pathological states. Among these compounds, acetone has emerged as a significant biomarker.

Table 1 Concentration of MIX22 components calculated at 37 °C and ambient pressure.

	Concentration in the glass flask (ppmv)
Ethanol	312
Acetone	168
2-propanol	238
Pentane	290
Isoprene	297
Dimethyl sulfide	228
Carbon disulfide	235
1-propanol	242
Butanal	128
2-butanone	193

DOI: 10.17148/IJARCCE.2024.131116

	Concentration in the glass flask (ppmv)
Hexane	150
1-butanol	199
2-pentanone	202
Pentanal	206
Dimethyl disulfide	107
Toluene	193
2-hexanone	149
Hexanal	116
4-heptanone	171
2-heptanone	130
Heptanal	444
Benzaldehyde	353

As shown in the above table ,Acetone is a byproduct of fat metabolism and can be detected in the breath in different amounts based on an individual's health and metabolic status. Recent studies suggest that breath acetone levels could be an indicator of myocardial infarction. This can be explained by the hypothesis that metabolic changes associated with heart attacks are the cause of elevated acetone levels. When contrasting this non-invasive approach with conventional diagnostic methods, there can be advantages like simplicity of use, speedy results, and less anxiety for patients. One fascinating area of research is the identification of heart attacks by breath analysis. There has been much research done on the possibility that breath analysis, by virtue of the existence of volatile organic compounds (VOCs), can reflect various physiological and pathological states. Among these, acetone has emerged as a significant biomarker. Acetone is a byproduct of fat metabolism and can be found in breath at varying percentages depending on one's health and their metabolic rate.

Recent studies demonstrate that breath acetone levels could be an indicator of myocardial infarction. This can be explained by the hypothesis that metabolic changes associated with heart attacks are the cause of elevated acetone levels. When contrasting this non-invasive approach with conventional diagnostic methods, there can be advantages like accessibility of use, speedy results, and less patient discomfort.

This literature review was carried out to provide a comprehensive summary of the most current discoveries and developments in the field of breath acetone analysis for heart attack detection. We'll go over the fundamental studies that looked at the connection between acetone levels and metabolic changes related to cardiovascular health, as well as advancements in detecting technology and challenges in implementing this approach. Their study shown how breath acetone levels could serve as a blood glucose indicator, highlighting its potential to oversee diabetes.

 ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 11, November 2024

DOI: 10.17148/IJARCCE.2024.131116

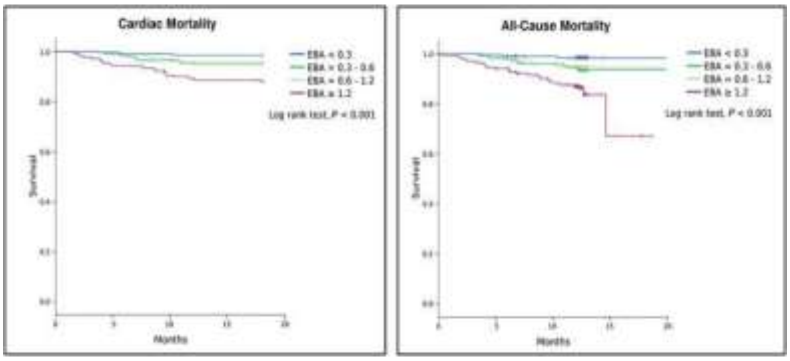

Figure 3.Kaplan–Meier curves for cardiac and all-cause death according to exhaled breath acetone quartile. EBA, exhaled breath acetone.

This ground-breaking work not only validated the use of acetone in metabolic monitoring but also paved the way for more investigation into the substance's possible use in Because of this, acetone's role in breath analysis has expanded beyond the treatment of diabetes, providing a basis for further research into its possible application in the detection of diseases like myocardial infarction. Because of this, acetone's function in studying breath has expanded beyond the treatment of diabetes, providing opportunities for further research into its possible application in the detection of conditions like heart attacks.

ADVANTAGES

1. **Non-Invasive and Patient-Friendly**: Because exhaled volatile organic compounds (VOCs) like acetone may be collected non-invasively, patients—especially those with critical diseases like heart failure—will find this method far more comfortable. This method eliminates discomfort or consequences, especially for elderly or vulnerable patients, in contrast to blood testing or imaging.

2. **Early and Accurate Detection**: The project's emphasis on exhaled breath acetone (EBA) is consistent with earlier studies that show a substantial correlation between EBA levels and the severity of heart failure. By identifying heart failure (and, in your case, heart attack risk) early on, increased acetone level detection may assist improve patient outcomes.

3. **Sensitive and Reliable Diagnostic Tool**: EBA has demonstrated diagnostic sensitivity and accuracy with an approximate accuracy of 85% that is equivalent to standard biomarkers such as B-type natriuretic peptide (BNP). This makes your gadget a viable substitute for traditional techniques, particularly when it comes to identifying sudden illnesses like heart attacks.

4. **Real-Time Prognosis and Monitoring**: Healthcare professionals can monitor the course of a disease or the effectiveness of a treatment by keeping an eye on exhaled acetone levels in real-time. Continuous monitoring could aid in your project's prediction of heart attack onset and enhance prompt medical measures.

5. **Portable and Easily Deployable**: Your gadget can be used in a variety of circumstances, including clinics, hospitals, and even homes, because it was built with equipment like an Arduino Nano and gas sensors. This allows for greater patient monitoring flexibility without the need for costly or large medical equipment.

6**. Specificity to Heart Conditions**: According to the abstract, breath acetone may be a particular biomarker for heart-related disorders because it may distinguish between COPD patients, CHF patients, and healthy individuals using VOC patterns, which include acetone. This specificity for heart attack detection can be enhanced further by your project.

7. **Accessible and Cost-Effective:** A breath-based acetone analysis device can be more affordable and accessible than traditional diagnostic tools like echocardiography or natriuretic peptide testing. It also requires less specialized equipment and can be used widely, especially in settings with limited resources.

COMPONENTS

- **ATmega328P-based Arduino Nano**: is a small-sized microcontroller board that is ideal for DIY applications.
- **I²C Module**: Uses the I²C protocol to enable communication between the Arduino and other devices, such as the LCD display.
- **MQ2 Gas Sensor**: is a vital tool for determining the quantities of acetone in breath that is exhaled since it can identify volatile gases like acetone, methane, butane, LPG, smoke, and alcohol.
- **16x2 LCD Display**: This type of liquid crystal display shows information which involves system status, GPS coordinates, pulse rate, and acetone levels.

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⁒ Peer-reviewed & Refereed journal ⁒ Vol. 13, Issue 11, November 2024
DOI: 10.17148/IJARCCE.2024.131116

- **Acetone Volatile Gas**: An indicator of a possible heart attack, increased amounts of this target analyte in exhaled breath.
- **Jumper wires**: these are utilized to connect electrical components on a PCB or breadboard together.
- **A GPS tracker module**: such as the Neo-6M GPS Module, may give precise position data in real time, which is essential in emergency situations to immediately locate the patient.
- **A pulse rate detector:** also known as a heart rate sensor (e.g., MAX30100 or MAX30102), provides extra vital indicators for evaluating the health of the patient's heart.
- **Buzzer**: Sound a warning when crucial thresholds, like elevated acetone levels or irregular pulse rates, are recognized.
- **Breadboard**: An electronic circuit construction and testing platform that eliminates the need for soldering.
- **Power Source (such as a lithium-ion battery):**
ensures portability and continuous operation by providing power to the entire system.
- **Programmer and USB cable**:
for initializing power during programming and uploading code to the Arduino Nano.
- **Resistors and capacitors**: are two examples of the numerous passive parts needed for sensor operation and circuit stability.
- **Housing Enclosure/Wristband**:
a wristband-like housing that is intended to safely contain every component, enabling the gadget to be worn.

SOFTWARE RESOURCES

Introduction: The Arduino Nano serves as the main microcontroller unit and is essential to the implementation of the suggested model. The Arduino IDE is used in the software environment design to enable real-time debugging, uploading, and code development. The device processes communication, display outputs, and sensor data in an integrated manner.

Installing the Arduino IDE: In order to program and operate the Arduino Nano, you must have the Arduino Integrated Development Environment (IDE). The official Arduino website offers a download for it. An installation step-by-step guide is provided below:

•Download: There are installation and ZIP versions of the software available. It is advised to use the Windows ZIP file for convenience of removal and mobility.

•Installation: After extracting the ZIP file, drag it to your desktop or another location of your choosing. Arduino.exe, which opens the IDE, is contained within a folder.

•Launching the Arduino IDE: Find the arduino.exe file and make a shortcut for convenient access to launch the Arduino IDE.

•How to Install Drivers for Arduino: An Arduino board should install a virtual COM port driver automatically when connected to a Windows computer. If not, updating the drivers from the Arduino folder in Device Manager can be used to manually install the drivers. As a result, the Arduino board and computer can communicate.

Libraries: Both internal and external library can be used to increase the capabilities of Arduino. The subsequent libraries are necessary for this project:

•**SoftwareSerial.h**: Enables data sharing via serial communication between the Arduino Nano and linked modules.

•**MQSensor Library**: Offers features to communicate with the MQ2 gas sensor, making it possible to identify volatile organic substances like acetone.

•**LCD Display Library**: Manages the interface between the system and the 16x2 LCD, enabling the display of status updates and sensor readings.

By going to Sketch > Include Library > Manage Libraries in the Arduino IDE, these libraries can be easily imported. For this particular application, this increases the Arduino's basic capabilities.

Debugging and Communication Protocols: The project manages communication between the LCD, sensors, and microcontroller via the I C protocol, facilitating effective data transfer. To assess the data from the gas sensor and other peripherals in real-time debugging and testing, serial communication via the serial monitor of the IDE is utilized.

In conclusion: Configuring the Arduino Nano with the right libraries and making sure the right communication protocols are in place are part of the software setup for the heart attack detecting system. The Arduino IDE makes real-time data collecting and presentation possible by streamlining the development and deployment process.

DOI: 10.17148/IJARCCE.2024.131116

CONCLUSION

This research represents a significant step in revolutionizing cardiac care through the non-invasive identification of heart attacks. The integration of artificial intelligence (AI) into medical diagnostics has the potential to change several aspects of healthcare. We are moving closer to a time when breath analysis will be as easy and quick for early heart attack diagnosis as we focus on acetone as a biomarker in exhaled breath. This approach offers the potential to lower heart attack-related death rates by facilitating early and accurate identification, even in underprivileged and rural populations, in addition to streamlining the diagnostic procedure.

This study highlights the possible use of acetone, a volatile organic molecule (VOC) that is readily observable, as a trustworthy heart attack risk indicator. Breath acetone levels have long been associated with metabolic processes and are known to play a part in diseases like diabetes. But this study is revolutionary in that it shows that acetone can also be used as a biomarker for the likelihood of having a heart attack, which is a new development in the field of cardiac diagnostics. Through the creation of a model that links acetone levels to the intensity and symptoms of heart attacks, this initiative creates the foundation for the widespread use of non-invasive diagnostics in clinical settings in the future.

The main goal of this research is to create a diagnostic system that can forecast the danger of a heart attack by measuring breath acetone levels. The following are the study's main contributions:

Data Collection and Processing: Using a MQ-2 gas sensor coupled to an Arduino Nano, the methodology focuses on advanced methods for collecting and evaluating breath samples. With this method, acetone levels may be monitored in real time, guaranteeing the precision and dependability of the information gathered. Preprocessing and feature extraction improve data quality even more, providing a strong basis for training AI models successfully.

AI Model Development: The AI model used in this study to find patterns in acetone levels that correspond with symptoms of a heart attack is crucial. The model is trained on a large dataset of breath samples using machine learning techniques, allowing it to discriminate between normal and increased acetone levels that may be signs of impending cardiac events. In order to ensure that the model is efficient and precise enough for clinical use, it must be optimized.

Ethical Issues and Data Privacy: With AI technology becoming more and more common in healthcare, it is critical to pay close attention to ethical issues and data privacy. The study upholds high ethical standards by putting policies like anonymization and secure data management into practice.

Testing and Continuous Improvement: As part of the project, the system's performance is continuously assessed, which makes it easier to develop and enhance the diagnostic tool over time. Frequent evaluation of performance measures enables incremental improvements, guaranteeing that the finished product is accurate and flexible enough to be used in different clinical settings.

An acetone-based diagnostic method has a major potential impact on heart health. Heart attack early identification is essential since prompt treatment can significantly lower morbidity and death. This breath analysis system's non-invasiveness offers a quick and easy substitute for more involved, expensive, and time-consuming traditional diagnostic procedures. Additionally, this technology has the potential to democratize access to cardiac care, especially in poor areas with inadequate medical resources.

In conclusion, the creation of an AI-driven acetone-based breath analysis system by this research represents a substantial improvement in the field of cardiac diagnostics. This research paves the way for a time when heart attacks can be identified early, improving patient outcomes and possibly saving countless lives. It does this by concentrating on non-invasive and prompt detection techniques. In the years to come, this technology has the potential to completely change the way we detect and treat cardiovascular problems, revolutionizing cardiac care. We can picture a future in which early detection and individualized treatment become standard practices for controlling heart health with more research and implementation.

REFERENCES

[1]. Fabiana G. Marcondes-Braga, Luciana Gioli-Pereira, Sabrina Bernardez-Pereira, Guilherme L. Batista, Sandrigo Mangini, Victor S. Issa, Fabio Fernandes, Edimar A. Bocchi, Silvia M. Ayub-Ferreira, Alfredo J. Mansur, Ivano G.R. Gutz, Jose E. Krieger, Alexandre C. Pereira, and Fernando Bacal https://doi.org/10.1002/ehf2.12736

[2]. P Finamore1, C Pedone1, D Lelli1, L Costanzo1, I Rossi Bartoli1, A De Vincentis2, S Grasso3, F Romana Parente3, G Pennazza3, M Santonico3 Published 6 February 2018 • © 2018 IOP Publishing Ltd
Journal of Breath Research, Volume 12, Number 2 Citation P Finamore et al 2018 J. Breath Res. 12 026007DOI 10.1088/1752-7163/aa8cd4

DOI: 10.17148/IJARCCE.2024.131116

[3]. D Biagini1 , T Lomonaco1 , S Ghimenti1 , F G Bellagambi1 , M Onor2 , M C Scali3 , V Barletta3 , M Marzilli3 , P Salvo4 , M G Trivella4 , R Fuoco1 and F Di Francesco1Citation D Biagini et al 2017 J. Breath Res. 11 047110 DOI 10.1088/1752-7163/aa94e7

[4]. Marcondes-Braga FG, Gutz IGR, Batista GL, Saldiva PHN, Ayub-Ferreira SM, Issa VS, Mangini S, Bocchi EA, Bacal F. Exhaled acetone as a new biomarker of heart failure severity. Chest. 2012 Aug;142(2):457-466. doi: 10.1378/chest.11-2892. PMID: 22345382.

[5]. Marcondes-Braga FG, Gioli-Pereira L, Bernardez-Pereira S, Batista GL, Mangini S, Issa VS, Fernandes F, Bocchi EA, Ayub-Ferreira SM, Mansur AJ, Gutz IGR, Krieger JE, Pereira AC, Bacal F. Exhaled breath acetone for predicting cardiac and overall mortality in chronic heart failure patients. ESC Heart Fail. 2020 Aug;7(4):1744-1752. doi: 10.1002/ehf2.12736. Epub 2020 May 7. PMID: 32383349; PMCID: PMC7373929.