Use of AI and Machine Learning for Asthma Patients: A Systematic Literature Review

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ABSTRACT

In the modern times, the collection of data is not a big deal but using it in a meaningful is a challenging task. Different organizations are using the artificial intelligence and machine learning for collecting and utilizing the data. These should also be used in the medical because different disease requires the prediction. One of these diseases is the asthma that is continuously increasing and affecting more and more people. The major issue is that it is difficult to diagnose in the children. Machine learning algorithms can help in diagnosing it early so that the doctors can start the treatment early. Machine learning algorithms can perform this prediction so this study will be helpful for both the doctors and patients. There are different machine learning predictive algorithms are available that have been used for this purpose.

Keywords: machine learning, prediction, asthma exacerbation, artificial intelligence, clinical decision support

INTRODUCTION

Different types of disease are affecting human beings. One of them is the asthma disease. Asthma is actually the disease of lungs that makes the breathing difficult. It affects the airways that are the path that is followed by the air to get inside the lungs and outside of the lungs. Because of the asthma disease, these airways get inflamed. The life of asthma patients becomes difficult because if it is not controlled then it can be a threat to life. Different factors are associated with asthma. Using antibiotics in first year of the life is also associated with the asthma (Foliaki et al., 2009). Artificial intelligence based system can be used for the monitoring of asthma patients. Use of artificial intelligence makes the system intelligent to perform the tasks that can be performed by intelligent humans. These systems learn with the help of machine learning algorithms. Different machine learning algorithms are available to train the systems. Artificial intelligence and machine learning are using in different sectors or organizations to perform the tasks efficiently. These can also be used in the medical sector for asthma patients.

The patients of asthma are increasing because of different factors. This can be a lack of awareness in the peoples. Some people have the asthma disease when they born. But some people are attacked by this disease because of the environment. The environment in which they are living can be dangerous that can be the cause of asthma disease. Small particles in the air can pass through the nose or mouth and get into the lungs. Researchers in (Hoggaard & Allergy, 2014) have said that the dust in the environment can be a cause for asthma in the children. People with asthma are at greater risk because of breathing in this environment. The particles can make asthma worse. Both long-term and short-term exposure can cause health problems such as reduced lung function and more asthma attacks. Such peoples can be secured from the asthma disease through an artificial intelligence based system that can detect such environment.
Researchers from different countries are continuously working on this disease. They have found that the artificial intelligence and machine learning is helpful for the asthma patients. These systems can detect the particles in the air and can alert the asthma patients about the air that is harmful to them. Moreover, the use of artificial intelligence is very helpful in the field of medical. This can help in providing better insights, increasing speed, and giving better accuracy (Shin et al., 2018). Expert systems that are based on artificial intelligence can be very helpful for the asthma patients (Gautier et al., 1996). Machine learning predictive algorithms can help to know whether the asthma patient will visit the hospital again. Moreover, in children the asthma can be predicted at its early stage through the machine learning predictive algorithms. This is helpful for both the parents and doctors. The doctors can start the treatment early because if the treatment is started late then the asthma can be at its worst stage.

The purpose of this literature review is to provide answers to different research questions. This paper will tell the use of artificial intelligence and machine learning for asthma patients. Machine learning algorithms will be discussed along with their use for asthma patients. The work that is done by different researchers will be discussed in this literature review.

Further parts of this literature review are the Methodology that is given in section 2, Research Questions are given in section 3, Search process explained in section 4, Result and discussion in section 5, and Conclusion in section 6.

**Methodology**

SLR (Systematic literature review) is used to write this literature review. Using this methodology the research questions will be answered on the basis of arguments. The arguments will be based on the research work of different researchers. References will be given to support each of the argument given in this literature review.

**Inclusion and Exclusion**

There was an inclusion and exclusion criteria that is followed to include the paper in this literature review. This inclusion and exclusion criteria is defined in below given table.

| Inclusion Criteria                          | Exclusion Criteria                          |
|--------------------------------------------|---------------------------------------------|
| The research keyword conditions are met.    | Does not meet the research keyword conditions.|
| Artificial intelligence or Machine learning research. | Not an artificial intelligence or machine learning research. |
| The full paper is accessible.               | The full paper is not accessible.            |
| Written in the English Language.            | Not written in the English Language.         |

Table 1: Inclusion and Exclusion criteria

**Quality Assessment**

The paper’s quality was assessed on the basis of researchers work presented in that paper. Papers were studied to check what the researchers have said in the papers. The papers that were relevant to the artificial intelligence, machine learning, and asthma patients, were included and discussed in this literature review.

**Research Question**

One of the most important parts of a systematic literature review is the research questions. This systematic literature review has to answer one or more research questions. This systematic literature review will answer the below given research questions.

RQ 1: Why there is a need for the early detection of asthma?
RQ 2: Why prediction is required for asthma patients and how machine learning is helpful in this regard?
RQ 3: What are the factors that can be used to train the machine learning algorithm for early diagnosing asthma?

**Search Process**

There were various papers found against the search keywords. Some of the popular databases were checked for the papers. In these databases, against the search keywords a number of papers were available. As it is displayed in the search process model that these papers were then analyzed. First of all, the papers were analyzed on the basis of their title and abstract. An Abstract is a part that gives the complete summary of a paper. In the next step, the rest of the paper is also studied for including or excluding the paper in this literature review. So according to the search keyword, sixty five papers were found but thirty four papers were according to the criteria.
Below is the model that shows the search process that is followed for this literature review.

Figure 1: Search Process Model

RESULT AND DISCUSSION

The patients of asthma are increasing day by day. It affects the one or two out of ten kids. This disease affects the children in the age of less than five years but it is difficult to diagnose this disease at a young age. Symptoms of asthma can vary between different children. There is a higher prevalence of asthma in the children that are aged between 0 to 17 years. Researchers in (Fitzpatrick et al., 2011) used the cluster analysis that is the machine learning unsupervised technique. They used the cluster analysis to identify the phenotypes of asthma in children. Artificial intelligence systems can be created using the different technologies. These systems can help in performing the tasks that can be performed by the humans that are intelligent. The main goal of the artificial intelligence is to provide the machines that are helpful to the human in taking important decisions. Researchers in (Bracken et al., 2002) said that the disease of asthma is increasing with the passage of time. There is a need for using the artificial intelligence and machine learning to overcome this disease. Researchers in (Chatzimichail et al., 2010) proposed a technique that will help in the diagnostic medical field. They have used the artificial neural network to diagnose the asthma. Supervised machine learning is applied to predict the severity of asthma. Researchers said that this can be helpful in diagnosing the asthma because artificial neural network has given them 98% success. A method is proposed by the researchers in (Chatzimichail et al., 2010) to predict the asthma severity on the base of breathing tests.

RQ 1: Why there is a need for the early detection of asthma?

Asthma can attack the human at a younger age. But there is a difficulty in detecting asthma at its early stage. Study shows it is difficult to detect the asthma through different tests before the age of five years. So the health condition becomes more difficult when it is detected later. It must be detected at its early stage. If the asthma is detected early then the doctors can also start the treatment early. Controlling the asthma will be easy because of its early detection.

Researchers in (Huffaker et al., 2018) said that detecting the asthma at an early stage is a big challenge. They have used the random forest machine learning model to predict the asthma exacerbation in the children. According to the researchers of (Fadziso, 2018) the early detection of asthma can lead to the better outcomes. They have developed a machine learning algorithm that can help in detection on the basis of daily monitoring data. The importance of early detection of asthma cannot be ignored. As the researchers in (Sly et al., 2008) said that the early detection of the asthma is better instead of doing treatment of the established disease. Machine learning is very helpful in this regard. Researchers in (Messinger, Deterding, & Szefler, 2018) said that a tool that can detect the asthma early can be helpful for the patients and doctors. Doctors will be able to start the medication early to stop the severity of asthma.

RQ 2: Why prediction is required for asthma patients and how machine learning is helpful in this regard?

A prediction or forecast is a statement about the future event or something that is hidden. In machine learning, it is the result of a machine learning algorithm that is based on a particular dataset. These algorithms predict according to the training dataset. Different organizations are using the machine learning predictive algorithm for different purposes. For example, it can help in the decision making process. These machine learning predictive algorithms can
also be proved helpful in the medical sector. As in (Haynes, Wilczynski, & Science, 2010) the researchers said that the computerized based decision support system should be used for clinical decision making. These systems can be created using the artificial intelligence and machine learning.

For asthma patients, machine learning can be used for prediction. For example, through the machine learning it can be predicted whether an asthma patient will need to revisit the hospital. Researchers in (Shin et al., 2018) have used the machine learning approach to predict the patients of asthma disease who will need to revisit the hospital after their initial visit. The accuracy in their prediction was 66%. They first trained the machine learning classification model with the training data set. This training data set includes the sociomarkers, demographic and biomarkers features.

![Figure 2: Sociomarkers and Biomarkers](image)

The researchers in (Das et al., 2018) have used the artificial intelligence and machine learning algorithms for the diagnosis of lung diseases. Asthma must have to be predicted because through the medical tests it is difficult to detect asthma before the age of five years. Researchers in (Sagliani et al., 2019) said that the asthma mostly starts in the school age of a child. It continuously affects the health of a child. Researchers in (Howard et al., 2015) said that the asthma cannot be treated as a single disease. It is actually an umbrella term that has different distinct diseases. If the particular disease is identified then it will make it easy to take the preventive measures. But identifying the particular disease is difficult because all these diseases have the common symptoms i.e. cough, wheeze etc. The researchers have focused on the development of a machine learning technique that can predict the disease. Researchers in (Goto et al., 2018) have focused on using the machine learning approaches for the prediction of asthma disposition. The researchers of (Gaudillo et al., 2019) found that the machine learning is better in predicting and diagnosing asthma like complex diseases. The study showed that the asthma occurrence can be detected using the machine learning. The environment or the pollution in the air also has an effect on the asthma patients. In (Bellinger et al., 2017) the researchers said that the machine learning is helpful for the diseases of air pollution. Machine learning algorithms can detect the environment that is not safe for the patients of asthma so that they can move to a healthy environment. Most of the children are asthma patients because of the dust in the air.

Researchers in (Amaral et al., 2017) have used the machine learning algorithm to detect the airway abstraction of asthma patients. The severity of asthma can be detected using the machine learning algorithms. Researchers in (Finkelstein & cheol Jeong, 2017) predicted the severity of asthma that will occur on day eight by training the model with the data of seven days. If the severity of asthma is already known the preventive measures can be taken. This shows the importance of machine learning algorithms for asthma patients. It is more important to predict when an asthma attack will be occurred instead of predicting who will experience the asthma attack. Because if the occurrence of asthma is already predicted then the doctors can know who needs more medical services. The timing of asthma exacerbation can be predicted through the machine learning algorithms by using the tele monitoring data.

Researchers in (Sanchez-Morillo et al., 2016) said that the use of predictive algorithms can be proved helpful for asthma patients in reducing the asthma exacerbation. The risk of being hospitalized will also be reduced because of early treatment. Machine learning algorithms are trained in a way that they can predict the severity of asthma before it occurs. Some of the common machine learning algorithms that are used in the field of healthcare are Artificial neural networks (Amato et al., 2013; Donepudi, 2018a), Decision trees (Podgorelec et al., 2002), Random forests (Shahn et al., 2015), Bayesian networks (Lucas et al., 2004), K-nearest neighbors (Khamis et al., 2014), Support vector machines (Suthaharan, 2016), Linear
discriminant analysis (Khanmohammadi et al., 2011), K-means clustering (Haraty et al., 2015), Logistic regression (Bagley et al., 2001), Classification and regression trees (Gass et al., 2015). Machine learning algorithms has three different stages. It includes training the algorithm, validating the algorithm and testing the algorithm. The above given supervised machine learning algorithms are better to use for asthma because they can predict the severity according to the trained data that is collected through tele monitoring. The prediction of the algorithm must have good accuracy. For this purpose, a suitable algorithm should be trained with accurate data. Researchers in (Pinnock et al., 2013; Donepudi, 2018b) said that there is a need of the algorithms that can predict the exacerbation reliably so that the doctors can take the preventive measures. The researchers of (Halpin et al., 2011) developed a system for an early prediction about the exacerbation. The system alerts the patients through an automated call.

RQ 3: What are the factors that can be used to train the machine learning algorithm for early diagnosing asthma?

Machine learning algorithm requires a data set before it can predict. For diagnosing the asthma early, a machine learning algorithm will require different data about the patient. Below given factors can be used for this purpose.

Table 2: Factors for early diagnosis

| Age          | Sex          |
|--------------|--------------|
| Height       | Weight       |
| Birth weight | Pregnancy duration |
| Mother smoking during pregnancy | Breast fed |
| Frequency of cold | Frequency of respiratory infection |
| Frequency of Wheeze | Frequency of cough |
| Eczema       | Food allergy |
| Asthma family history | Pharmaceutical allergy |
| Asthma presence in father | Asthma presence in mother |

**CONCLUSION**

As like the other sectors, the medical sector also needs help in decision making. Asthma is a serious disease and there must be a mechanism to predict its severity before it occurs. Only then the doctors will be able to take the preventive measures early. This will be helpful for both the doctors and patients. Machine learning algorithms can perform this prediction. There are different machine learning predictive algorithms are available that can be used for this purpose. First, the algorithm needs to be trained through a training data set. This data set will be having different data or attributes related to the patient. Once the algorithm is trained it can perform the prediction task. The machine learning algorithm can be used for predicting the asthma in children or for predicting the severity of asthma on a particular day.

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