A COMPREHENSIVE RESEARCH PAPER ON DEVELOPMENT OF AN APPROACH FOR BUILDING A CLINICAL DECISION SUPPORT SYSTEM TO IMPROVE THE ACUTE EXACERBATION IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE PATIENTS

MIDTERM EXAMINATION

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Introduction

Chronic Obstructive Pulmonary Disease commonly known as COPD is a globally and rapidly growing healthcare issue due to its elevated mortality and morbidity (Petty, 2006). COPD is a progressive disease in nature and is partly reversible (PAUWELS et al., 2001). It has been identified that the understanding of its pathogenesis, course of treatment and early detection and prognosis has led to new approaches of treatment such as cessation of smoking hazardous substances, prolonged oxygen therapy and surgery has benefitted the COPD patients in the long run (Petty, 2006).

Exacerbations are triggered in a COPD patient due to the complex interactions between the host, viruses, some kinds of bacteria and the idiopathic factors across the environment leading to rise in the level of inflammation in the lungs, triggering the inflammatory pathways and increased level of tissue damage (Sapey, 2006). Acute exacerbations of COPD have a risk associated with increased rate of morbidity and mortality in the patients hence it has been regulated that for further preventing the exacerbations measures of prevention should be initiated before the discharge. An article by Epstein et al., (2019) describes a tool for improvement for the acute exacerbation of COPD patients where the study shows the pre and post results of the implementation of the tool in a healthcare setting. 536 patients participated in the study where 24 months before and 18 months after the tool was implemented the statistics shows that an improvement was seen where an enhancement in the discharge rates from the hospital, outcomes of the patients has increased and thus showing how efficiently a CDSS tool can help in elevating the positive results of treatments and increase the output of positive outcomes.

Problem Description and Importance of Acute Exacerbations in COPD

Acute exacerbations are heterogenous and complex in the patients diagnosed with COPD because it varies from patients to patients where different symptoms such as increased wheezing, increased release of sputum and cough, breathlessness, purulent discharge, elevated fatigue, fever, and other group of symptoms are exhibited which leads to complex combinations of exacerbatory symptoms hence patient management and patient care is utmost important (Sapey, 2006).

Frequency of exacerbations is directly proportional and corresponding to the quality of life a patient has, who is diagnosed with COPD. They are the primary cause for the increased rate of admissions and readmissions in the hospital and healthcare settings. It has been observed that more than 2 acute episodes in a year can led to decline in the health of the patient and reduction in the capacity of exercise. Assessment of clinical conditions of the patients and treating them accordingly is important with the help of available courses of treatment and hence evaluation of the treatment response is considered vital as well (Sapey, 2006).

Background

Clinical Decision Support Systems commonly known as CDSS are designed for management of patients where the major objective is monitoring and assessing the severity of the disease, status of the health of the patients and helping the healthcare professionals in making an informed decision about the diagnosis, prognosis, and treatment of the patients for the elevation of early detection and lesser chance of recurrence of the disease. In an article published in 2019, development of a CDSS tool, an automatic system which can support the clinical decision making of the healthcare professionals for telemonitoring the patients of COPD where the aim was to provide a lesser invasive, patient/user friendly and supportive tool in order to find the solutions of the issues faced such as patient compliance in the telemonitoring and reduce the rate of hospital admissions were given importance. 414 patients were selected for the research and their electronic medical records were studied, discussed, analyzed with data-mining software to build predictive models to achieve best results in terms of accuracy, sensitivity, and specificity. On gaining better understanding as to how the tool works it was concluded that this tool can be used by the healthcare professionals to assess the health of the patients with COPD when the patients are being assessed via telemonitoring. This tool can help in continuous monitoring and evaluation of patients and can be used for any disease other than COPD. Although the limitations for this study are that the performance cannot be compared to other tools and different types of data are needed for understanding the risk associated with other diseases (Iadanza et al., 2019).

Artificial Intelligence is nowadays more trending in healthcare where it helps in the management of the disease and along with that it analyzes the objectives associated with it and how it can improve the outcomes for the betterment of users and its stakeholders. In the research study, a standardized protocol named Global Initiative for Chronic Obstructive Lung Disease

(GOLD) is considered. A scoping review has been done of 67 papers where the disease identification, classification of the disease and prevention of the disease are focused having association with Artificial Intelligence while managing at least one of the clinical phases of COPD. The models generated with the help of AI, in particular the predictive models can be used as a tool for informed decision-making by the healthcare professionals. The limiting feature for this study includes that the findings of the study should include Machine Learning studies to help navigate the better outcomes for the prediction of the disease (De Ramón Fernández et al., 2022).

COPD is a disease which is progressive in nature and the acute exacerbations which happen to the patients have led to several complications and deterioration of the overall quality of health and increased health issues. CDSS has changed the way healthcare professionals take clinical decisions for the patients. In this article, CDSS proposed works on the logic of Machine Learning Algorithms. It understands the past medical history, current medical history, medical information, and a spirometer test and then assesses the severity of COPD in the patient. CDSS helps the healthcare professionals to take a clinical decision based on several factors such as rehabilitation of pulmonary function, treatment plans, and interaction of drugs for management of associated diseases and comorbidities. COPD not only affects physical health but also affects the mental health of the patients. Exacerbatory episodes can affect patients who are aged, by inducing depression, dementia etc. Smoking cessation is also benefitted by the CDSS tool. The Machine Learning Algorithms in turn help in predicting outcomes, diagnosis and henceforth management of the disease. Hence, this ML algorithm contributes to the decision-making process based on the data provided and can work as a way of personalized treatments for each patient rather than just treating the physical health of the patient (Anakal & P. Sandhya, 2023).

COPD is commonly misdiagnosed or not diagnosed at all due to the complex nature of the disease and hence the lack of confirmation in diagnosis leads to increase in the severity of COPD in patients. A study conducted over the period of 6 years among 6325 veterans showed that a CDSS was applied to this cohort of patients where the CDSS served as a guiding tool to the primary care providers in confirmation of the diagnosis of the COPD and improving the spirometry test. Algorithms produced by the CDSS were recorded and data analysis was done which led to a conclusion that CDSS algorithm which inculcated COPD screening, spirometry test can improve the over and underdiagnosis along with the screening rates in a primary healthcare environment (Campos et al., 2023).

Diagnosis of COPD is based on the signs and symptoms of the patient along with the exposure to the causal agents along with several lung-function testing hence diagnostic process becomes complicated because of the lack of resources, lack of awareness, and along with that high rate of misdiagnosis and underdiagnosis. Patients normally ignore the early arrival of symptoms such as cough, sputum etc. leading to delayed diagnosis and delayed treatment. A randomized controlled trial was conducted in inclusion with the general practitioners in Bergen, Norway. GPs were divided into control and intervention groups where the latter were asked to use the digital CDSS tool developed for the management of COPD patients in the out-patients' clinics. At the end of the study, improvements in the diagnosis, uptake of vaccines and usage of spirometry tests were seen in the intervention group and whereas control group showed less efficient results in comparison to that of the intervention group. Along with that, GPs included in the intervention group also kept on using the CDSS tool after the study was over. Hence, the CDSS tool benefited the physicians in the proper diagnosis and giving their patients the high standard of patient care (Kumar, 2021).

Electronic Health Records are an integral part of healthcare since it has been revolutionized from paper system because it is the source of record-keeping of all the medical data of the patients. Lack of standardization in the quality of data recorded leads to poor quality of interventions. Gaps have been discovered in the management of COPD patients because of poor quality of record-keeping. Poor recording leads to deterioration in the surveillance of the disease and hence delayed treatment. Reliability and validity of Electronic Health Records is important to reduce the wrong prognosis along with eliminating the acute exacerbations in COPD patients. Normally, the data on acute exacerbations are written in a free text which leads to retrieval and analysis of data difficult making it more complicated to get a better prognosis and efficient diagnosis. This leads to identification of exacerbation from EHR very unreliable and time-consuming. Hence, EHR plays an important role in identification of acute exacerbation of COPD because surveillance over a longer period and efficient decision-making needs better recording of the data (Harries & White, 2021).

Healthcare professionals have gained understanding and knowledge about diseases and disorders over the years of experience in working in the healthcare field. Hence, with the help of these professionals and their valuable insights CDSS can be regulated to its full extent where the margin of error in the predictions can be reduced to a minimum. Their expertise and experience along with the inputs received in betterment of the CDSS can lead to improvement in the prognosis, diagnosis, and early detection of the COPD even before the diseases advances to later stages where higher levels of treatments and surgeries only remain the option for the patients. Sharing knowledge between the clinicians can help build a CDSS which can formulate new CDR's. Mental Health of the patients get affected by the prolonged treatments of COPD hence the professionals can use their past experiences and help in developing a CDSS tool which can

detect the early symptoms of depression, dementia by focusing on forming standardized protocols and standard operating procedures. When incorporating knowledge of humans and AI algorithms, CDSS system can lead to better outcomes and in turn lead to increased patient safety and elevated quality of life (Global Initiative for Chronic Obstructive Lung Disease, 2023).

Tools and data from open sources can enhance encounters with EHR and with coworkers. These sites frequently offer larger datasets, research results, and established protocols for treating COPD patients' acute exacerbations. Potential gaps in existing clinical practice can be highlighted, highlighting overlooked information that may change a diagnosis or course of therapy, by synthesizing this information. Gathering data can also make it easier to construct AI algorithms for risk assessment or prediction, allowing for early intervention and customized management approaches (Global Initiative for Chronic Obstructive Lung Disease, 2023).

It is essential to consider the restrictions and difficulties related to the practice data that are currently accessible. The accuracy and generalizability of the CDSS can be affected by differences in data quality and accessibility, and certain EHR systems might not capture all pertinent characteristics. Additionally, relying entirely on publicly available data could result in biases or miss context-specific considerations. Therefore, a thorough assessment of the practice data is required to guarantee the validity and efficacy of the CDSS. Developing a CDSS for acute exacerbations in COPD patients requires synthesis and evaluation of practice data, including EHR, colleagues' experiences, and aggregate open-source data and technologies. These data sources can be used to improve diagnosis and treatment approaches by suggesting prediction algorithms, spotting overlooked data, and fine-tuning the decision rules. (Global Initiative for Chronic Obstructive Lung Disease, 2023).

Methods

Acquisition and Analysis of Relevant Information: The analysis of relevant information for the decision rule of addressing the needs for acute exacerbation of COPD in patients particularly male patients can be done via few approaches such as understanding the literature review, Extraction of data, Analysis of data extracted and then consulting the experts such as healthcare professionals to understand the effective management according to the standardized guidelines.

Literature Review: A review in a systematic and effective way of the literature about COPD and its acute exacerbation, emphysema, etiology of the disease, pathogenesis, triggering bio factors and etiological environmental factors should be done to understand the effect on the cohort selected and the overall effect on the patients. Understanding via studying the previous literature, guidelines, standardized protocol, and the effective management with the help of AI and ML can become fruitful for future references.

Extraction of Data: After reviewing and understanding the literature from the past, database extraction according to the relevant information can be done to assess the needs for acute exacerbation. Each symptom can be studied in detail and how different treatments affect the symptoms. Exploration of different treatment options for better outcomes associated with the different risk factors can lead to formation of suitable format leading to formulation of criteria and rules which can be incorporated in CDSS.

Expert opinions from healthcare professionals can become the best guide in the development of CDSS as they normally interact with patients on an everyday basis. Involvement of their medical advice, technical opinions and insights can lead to better development of CDSS. The

data can be gathered by surveys, questionnaires, making them participate in randomized control trials. Hence, this can lead to appropriate and informed clinical decision-making in future.

Refining and addressing the CDR: Clinical Decision Rule can refine with the help of literature review, expert opinions and by incorporation of new databases, understanding the views and opinions of other healthcare stakeholders, involving families and patients, by identifying patterns in the algorithms of machine learning models and with the help of Artificial Intelligence one can enhance the performance of the developed CDR.

CDSS Verification and Validation Proposal: CDSS can be validated with the help of Internal and External Validation where Internal Validation can be obtained with the help of existing databases of the patients and formulation of predictive models and checking their accuracy, sensitivity, specificity. After the Internal Validation seems fruitful, external validation can be done with the help of external sources such as application of CDR to new demographic location such as we can take an age range of male patients and check the validation, we can also check the validation in females. Hence, reliability and validity can be understood with the help of external validation.

Principal Findings

COPD is indeed an underdiagnosed or misdiagnosed disease with high level of morbidity and mortality where the outcomes of the patients can only be increased with the proper treatment options, early diagnosis and by knowing the root cause of acute exacerbations. Complex interactions in the etiological factors can lead to acute exacerbations which when not managed leads to an increase in the ratio of morbidity and mortality. CDSS tool when used for COPD it can decrease the hospitalization rates, admission rates and in turn lowered episodes of acute exacerbations. CDSS tool contribute for decision making and become a guiding force for the healthcare professionals by making the outcomes of the patient care easier and reliable based on the facts, medical history of the patients, and previous medical history of the patients suffering from COPD. When the Machine learning algorithms help in knowing the predictive models related to severity, understanding the results of treatments, drug interactions, it can enhance the quality of life and increase patient safety. Incorporation of standardized guidelines in CDSS tool, accepting expert opinions from the physicians and other stakeholders can improve the collaboration of AI with healthcare leading to formation of a tool that can work towards the betterment of patients suffering from COPD and henceforth reduce the episode of acute exacerbations.

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