INFO-B 642 Clinical Decision Support Systems

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PROJECT GROUP 2

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FINAL PROJECT – CDSS FRAMEWORK

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ASSOCIATION OF SMOKING CESSATION WITH COPD EXACERBATION PREVENTION: CDSS PROTOTYPE

Abstract

Objective: This study explores the association between smoking cessation and COPD exacerbations while developing a Clinical Decision Support System (CDSS) prototype to aid healthcare providers in implementing timely smoking cessation interventions for COPD patients.

Methods: A review of literature related to COPD and smoking was conducted using PubMed/Medline electronic database. Only articles published within the last 10 years focusing on smoking's impact on COPD exacerbations and smoking cessation's benefits were considered. The selected studies were critically appraised to identify key findings.

Results: The literature review reinforces the strong link between smoking and COPD exacerbations, providing concrete evidence for the importance of smoking cessation interventions in COPD management.

CDSS Prototype Development: Based on the findings, a CDSS prototype was developed to prompt healthcare providers with alerts when managing COPD patients with a smoking history. The CDSS utilizes electronic health records to identify at-risk patients and offers evidence-based smoking cessation recommendations.

Conclusion: Smoking cessation is crucial in preventing COPD exacerbations and slowing disease progression. The CDSS prototype aids healthcare providers in providing personalized smoking cessation support, improving COPD management outcomes, and reducing exacerbation rates, leading to better public health outcomes.

Key words: Smoking cessation, Smoking, COPD Exacerbations, Disease progression.

Introduction

Chronic obstructive pulmonary disease (COPD) stands as a formidable global health challenge, inflicting a significant burden on individuals and healthcare systems worldwide. Characterized by chronic and progressive airflow limitation, COPD affects over 300 million people and remains a leading cause of morbidity and mortality (Lopez-Campos et al., 2019). The disease exhibits a complex pathophysiology, encompassing chronic inflammation, airflow obstruction, and lung tissue destruction, leading to debilitating symptoms such as dyspnea, cough, and reduced exercise tolerance (Barnes & Celli, 2015).

One of the hallmark features of COPD is the occurrence of acute exacerbations, which further exacerbate the already compromised lung function and escalate disease severity (Vestbo et al., 2013). Exacerbations are characterized by sudden worsened symptoms and increased respiratory distress, often necessitating hospitalization and negatively impacting patients' quality of life (Donaldson et al., 2002). Understanding the factors that contribute to COPD exacerbations is crucial in formulating effective management strategies to alleviate the disease burden.

Notably, smoking emerges as the single most significant risk factor for the development and progression of COPD (Rabe & Watz, 2017). Prolonged exposure to tobacco smoke induces a cascade of deleterious effects on the respiratory system, leading to airway inflammation, mucus hypersecretion, and structural changes within the lungs (Hogg et al., 2004). The intricate association between smoking and COPD underscores the importance of smoking cessation as a pivotal intervention to curtail disease progression and improve patient outcomes.

In light of the considerable benefits of smoking cessation in reducing the risk of developing COPD, there remains a need to delve further into its impact on exacerbation rates and disease progression. This inquiry leads us to the core **research question:** Does smoking

cessation significantly influence the frequency and severity of acute exacerbations in patients with chronic obstructive pulmonary disease (COPD)?

Addressing these knowledge gaps, this comprehensive literature review seeks to investigate the association between smoking cessation and COPD exacerbations. By conducting a meticulous examination of the evidence concerning smoking cessation's impact on disease progression and exacerbation rates, as well as assessing the effectiveness of existing interventions, this study endeavors to provide valuable insights into enhancing COPD management and patient care. Through a meticulous synthesis of relevant findings, the review aims to pinpoint areas requiring further exploration, foster a deeper comprehension of COPD pathogenesis, and guide the development of targeted interventions to mitigate COPD exacerbations and improve long-term outcomes. By addressing these pivotal research questions, our endeavor seeks to contribute to the advancement of COPD management, ultimately leading to enhanced clinical outcomes and improved quality of life for those grappling with this chronic and debilitating condition.

Objective

The objective of this comprehensive literature review is to investigate the impact of smoking cessation on the frequency and severity of acute exacerbations in patients with chronic obstructive pulmonary disease (COPD). By critically examining the evidence surrounding smoking cessation's influence on disease progression and exacerbation rates, the review seeks to provide valuable insights into enhancing COPD management and patient care. Moreover, the findings of this review can be utilized to develop a cdss prototype in OpenEMR, which can send alerts for patients with COPD diagnosis and smoking history. This tool will aid providers in managing exacerbations and identifying them at an early stage, facilitating timely interventions and better disease management.

Literature review

1. Aim of this literature review:

The aim of this comprehensive literature review is to investigate the relationship between smoking cessation and chronic obstructive pulmonary disease (COPD) exacerbations. By evaluating the impact of smoking cessation on disease progression and exacerbation rates, as well as the effectiveness of current interventions, this study aims to shed light on potential strategies for improving COPD management and patient outcomes. Through a synthesis of relevant findings, we aim to identify gaps in existing research, gain a deeper understanding of COPD, and provide valuable insights to inform future investigations and enhance clinical practice in this critical area.

2. Selection of Studies and Search Strategy:

9 studies were meticulously selected from the PubMed/MEDLINE database to ensure comprehensive coverage of the topic. The inclusion criteria involved human studies conducted in the English language and published within the last ten years. Key search terms, such as "Smoking Cessation*/Methods," "COPD Exacerbations," and "Disease progression," were employed to narrow down the search and retrieve relevant literature. Studies that did not align with the aim and scope of this review were excluded to maintain the quality and relevance of the review.

3. Results:

The literature review encompasses a comprehensive exploration of various aspects of chronic obstructive pulmonary disease (COPD) and smoking cessation.

Rabe and Watz (2017) discussed the global burden of chronic obstructive pulmonary disease (COPD) and highlighted the challenges in managing the disease. They emphasized that

COPD is a major cause of death worldwide, with over 3 million annual fatalities. Despite progress in managing symptoms and preventing acute exacerbations, there has been limited success in slowing disease progression and reducing mortality. To address the burden of COPD effectively, the authors called for a comprehensive approach that includes understanding disease mechanisms, implementing smoking cessation programs, promoting physical activity, and early detection and treatment of comorbidities. They also stressed the importance of global efforts to reduce tobacco use, regulate environmental exposure, and find alternatives to biomass fuel in combating COPD as a significant health-care challenge in the future.

Williams et al. (2022) conducted a study involving 5997 COPD participants, with 62.2% reporting frequent exacerbations. Their findings indicated that smoking, lower income, cold/damp homes, and occupational exposure were associated with a higher risk of exacerbations. Smoking cessation emerged as a crucial intervention, highlighting the need for comprehensive approaches addressing social determinants to improve COPD outcomes.

Riesco et al. (2017) investigated the impact of smoking on COPD phenotypes in 1610 patients. They found higher smoking rates in exacerbator phenotypes. Li et al. (2022) explored the positive effects of long-term smoking cessation on acute exacerbations of COPD (AECOPD) patients. Their study included 125 hospitalized AECOPD patients who were current or former smokers. The results revealed that long-term quitters experienced milder dyspnea and cough, improved lung function, and lower treatment intensity, with comparable improvements in dyspnea and oxygenation to short-term quitters. Notably, AECOPD patients with long-term smoking cessation experienced greater relief in phlegm symptoms, particularly those with mild phlegm issues. The study underscored the significant benefits of early smoking cessation in AECOPD patients, regardless of the number of cigarettes smoked.

In De's study (2020), it is emphasized that smoking continues to have a negative impact on the prognosis of COPD patients, with over one-third of them still smoking. The author recommends a combination of counseling and varenicline pharmacotherapy as an effective approach for smoking cessation in COPD patients. Additionally, the importance of vaccination against influenza and pneumococcus is highlighted to prevent exacerbations in COPD management.

Ito et al. (2014) conducted a study with 93 subjects categorized into four groups: ex-smokers with COPD, smokers with COPD, current smokers, and nonsmokers. The study assessed mucociliary clearance (MCC) using the saccharin transit time (STT) test. The results revealed significantly impaired MCC in smokers with COPD and current smokers compared to ex-smokers with COPD and nonsmokers. Furthermore, the frequency of exacerbations was lower in ex-smokers with COPD than in smokers with COPD, indicating that smoking cessation might positively impact exacerbation rates in COPD patients.

Barnes et al. (2015) provided an insightful overview of COPD, highlighting its characteristics, risk factors, and management. Chronic inflammation, accelerated lung aging, and acute exacerbations triggered by infections are key features of COPD. Inhaled long-acting bronchodilators are the primary treatment option, but the study underscores the need for further research to better understand the disease mechanisms and develop more effective therapies to slow down disease progression.

The study presented by Zuo et al. (2014) delves into the detrimental effects of cigarette smoking (CS) on the immune system and its association with COPD. The findings highlight the strong link between continued tobacco use, oxidative stress, and exacerbation of COPD symptoms, underscoring the significance of comprehensive treatment approaches that

encompass smoking cessation, counseling, and pharmaceutical therapies targeting inflammation and oxidative stress to effectively manage COPD.

Another study by Russell (2014) reviews various interventions for COPD and their impact on prognosis. While some treatments are successful in improving the quality of life and reducing exacerbations, only smoking cessation and long-term oxygen therapy have demonstrated a positive effect on enhancing survival rates. The study emphasizes the need for further advancements in COPD management and the importance of individualized approaches to cater to the diverse needs of patients grappling with this chronic respiratory condition.

The literature review provides valuable insights into the interplay between smoking cessation, COPD exacerbations, disease progression, and global health implications, thereby contributing to a deeper understanding of COPD management and care.

4. Discussion:

The literature review provides a comprehensive analysis of chronic obstructive pulmonary disease (COPD) in relation to smoking cessation and exacerbation management. Across the nine selected studies, a unanimous consensus emerged, highlighting the crucial role of smoking cessation in mitigating the frequency and severity of acute exacerbations in COPD patients and potentially influencing disease progression. Williams et al. (2022) explored factors driving acute exacerbations, emphasizing smoking as a significant contributor. Similarly, Riesco et al. (2017) underscored the importance of smoking cessation in COPD management and its positive impact on disease outcomes. These findings were reinforced by Li et al. (2022), demonstrating favorable effects of long-term smoking cessation on AECOPD patients, leading to symptom reduction and improved lung function. The global burden of COPD was addressed by Rabe and Watz (2017), advocating for comprehensive approaches that include smoking cessation programs to combat the disease. De (2020) further emphasized the significance of

smoking cessation and vaccination in preventing exacerbations and effectively managing COPD. Ito et al. (2014) shed light on the detrimental effects of smoking on mucociliary clearance in COPD patients, highlighting the benefits of smoking cessation in this aspect. Zuo et al. (2014) highlighted the impact of smoking on the immune system and lungs, indicating limited efficacy of most COPD interventions in reducing mortality. In contrast, Barnes et al. (2015) provided an extensive review of current COPD treatments, recognizing the need for improved therapies and early diagnosis. This observation aligns with Russell (2014), which assessed the current literature on smoking cessation, COPD exacerbations, and disease progression, emphasizing the necessity for better treatments and personalized approaches. Although some articles focused on specific aspects, such as immune response (Zuo et al., 2014) and COPD treatments (Barnes et al., 2015), their combined findings present a cohesive picture, underlining the critical role of smoking cessation in COPD exacerbation management and disease progression.

5. Strengths and limitations of the review:

The literature search exhibits several strengths that enhance the credibility and reliability of the findings. Firstly, the search encompasses comprehensive coverage of articles, delving into various aspects of smoking cessation and its impact on COPD exacerbations. This inclusiveness ensures that the study's scope is comprehensive and allows for a deeper understanding of the subject matter. Secondly, the selected articles reflect diverse perspectives and research methodologies. By incorporating studies with different approaches, the search presents a well-rounded view of the relationship between smoking cessation and COPD exacerbations, fostering a more robust and holistic interpretation of the findings. These strengths collectively contribute to the robustness and validity of the literature review, making it a valuable resource for understanding the link between smoking cessation and COPD exacerbations and informing future research and clinical practices. However, there are some

limitations to acknowledge. The search is limited to the PubMed/MEDLINE database, potentially missing relevant studies from other sources. The use of specific keywords might have potentially excluded some relevant studies that utilized different terminology or focused on related aspects of the topic. Additionally, the restriction to English language studies could have led to the omission of valuable non-English literature. Furthermore, the focus on recent publications might overlook seminal works and long-term studies that could provide crucial insights. Considering the heterogeneity of COPD and the diverse interventions studied, comparing outcomes across studies might be challenging.

6. Future implications:

The findings emphasize the importance of tailored smoking cessation programs for COPD patients, addressing social determinants of health, and exploring individualized treatment strategies to optimize patient outcomes. Additionally, future research should focus on developing innovative therapies that can slow disease progression and reduce mortality in COPD patients, as well as adopting a multidisciplinary approach for comprehensive COPD management.

7. Conclusion of the review:

The literature search on smoking cessation and COPD exacerbations reveals the critical significance of smoking cessation in COPD management. It consistently shows positive outcomes, including symptom reduction, improved lung function, and decreased exacerbation risk. The studies also emphasize the multifactorial nature of exacerbations, with socioeconomic factors and living conditions playing a role. While some interventions improve symptom management and exacerbation prevention, there is a need for further research to address COPD progression effectively. A comprehensive approach that includes smoking cessation, addressing

social determinants, and early detection of comorbidities is crucial for enhancing COPD outcomes and patient well-being.

OpenEMR/LibreHealth EHR

LibreHealth EHR proved to be a crucial tool in understanding the clinical manifestation and therapeutic approaches for patients with Chronic Obstructive Pulmonary Disease (COPD). The examination of the EHR data found that patients with COPD frequently experience symptoms like shortness of breath, a persistent cough, wheezing, and increased sputum output. The systemic effects of the disease were further highlighted by the frequent occurrence of headaches, exhaustion, exercise intolerance, and memory impairment. Patients with COPD were treated with an emphasis on determining the severity of their symptoms and the disease's effects on important organs, particularly the heart and lungs. The monitoring of lung function tests, such as spirometry, to determine the severity of airflow restriction and evaluate disease development, was made possible by the EHR data. Cardiac assessments were also carried out to pinpoint potential comorbidities and enhance COPD treatment. The correlation between COPD and other illnesses, such as cardiovascular diseases and mental problems, was one important finding from LibreHealth EHR data. This link underscored the value of treating COPD patients holistically, considering both the pulmonary and systemic elements of the illness. The EHR data also demonstrated the chronic nature of COPD, with numerous patients reporting a persistent case of chronic fatigue syndrome that adversely affected their quality of life. The data analysis highlighted the need for patient education and good self-management techniques to boost coping abilities and general wellbeing. For patients with COPD, the integration of clinical decision assistance into the LibreHealth EHR can enhance evidence-based therapy. In conclusion, LibreHealth EHR was essential in improving patient care and extending our understanding of COPD.

ATLAS Cohort Creation:

Literature Review and Peer reviews have led us to create a cohort suited for the research statement. The cohort which has been created is the most appropriate based on our understanding and research on COPD.

The patient cohort definition is determined as "Patients who are already diagnosed with COPD, with a history of chronic smoking and have at least 3 or more signs and symptoms after the diagnosis".

The inclusion criteria for cohort are.

- Patients who are at least 18 years of age.
- Patients who have medical history of active smoking, chronic smoking, and passive smoking or were former smokers.
- Patients who have diagnosis of Chronic Obstructive Pulmonary Disorder.
- Patients who show atleast 3 or more signs and symptoms such as Shortness of breath, increased sputum, persistent cough, wheezing, tightness of chest, fatigue, weakness, cyanosis, altered mental state and increased respiratory rate which leads to exacerbatory episodes.

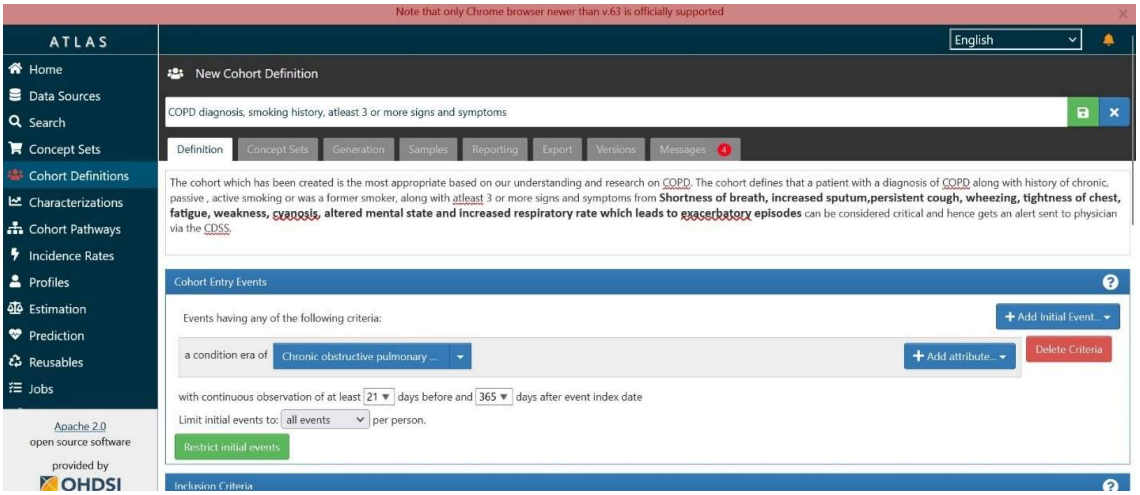
Our CDSS will send an alert to the physician when all the above criteria are fulfilled.

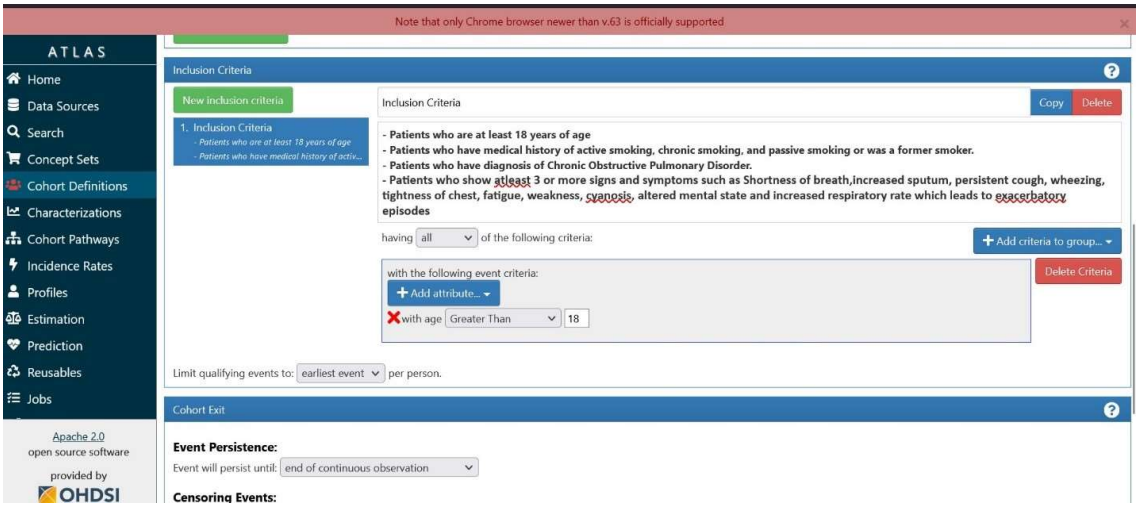
Our cohort exit event includes.

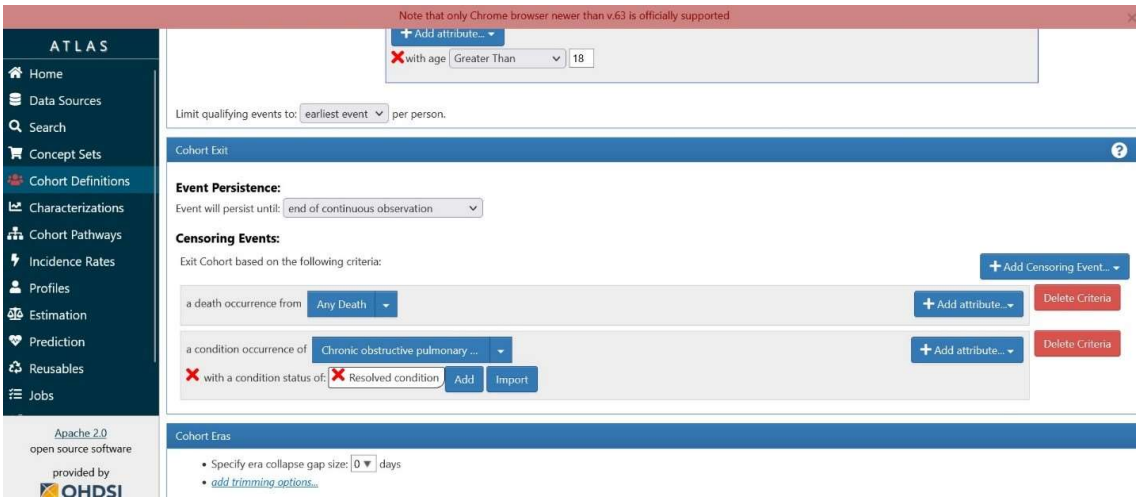
- Death of the patient.
- Failure to Follow-up and further treatment.
- Successful Treatment leading to discontinuation of diagnosis of COPD.

Cohort Creation Procedure:

Creation of cohort was done with the help of ATLAS tool. Various sections such as Home, Data Sources, Concept Sets, Cohort Definitions, Cohort Pathways etc. were seen and then explored. After exploring, a New Cohort Definition was created. “An entry event with inclusion event and cohort exit event with the exclusion criteria were added which came because of literature review and peer reviews.



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Add attribute...
with age Greater Than 18
Limit qualifying events to: earliest event per person.
Cohort Exit
Event Persistence:
Event will persist until: end of continuous observation
Censoring Events:
Exit Cohort based on the following criteria:
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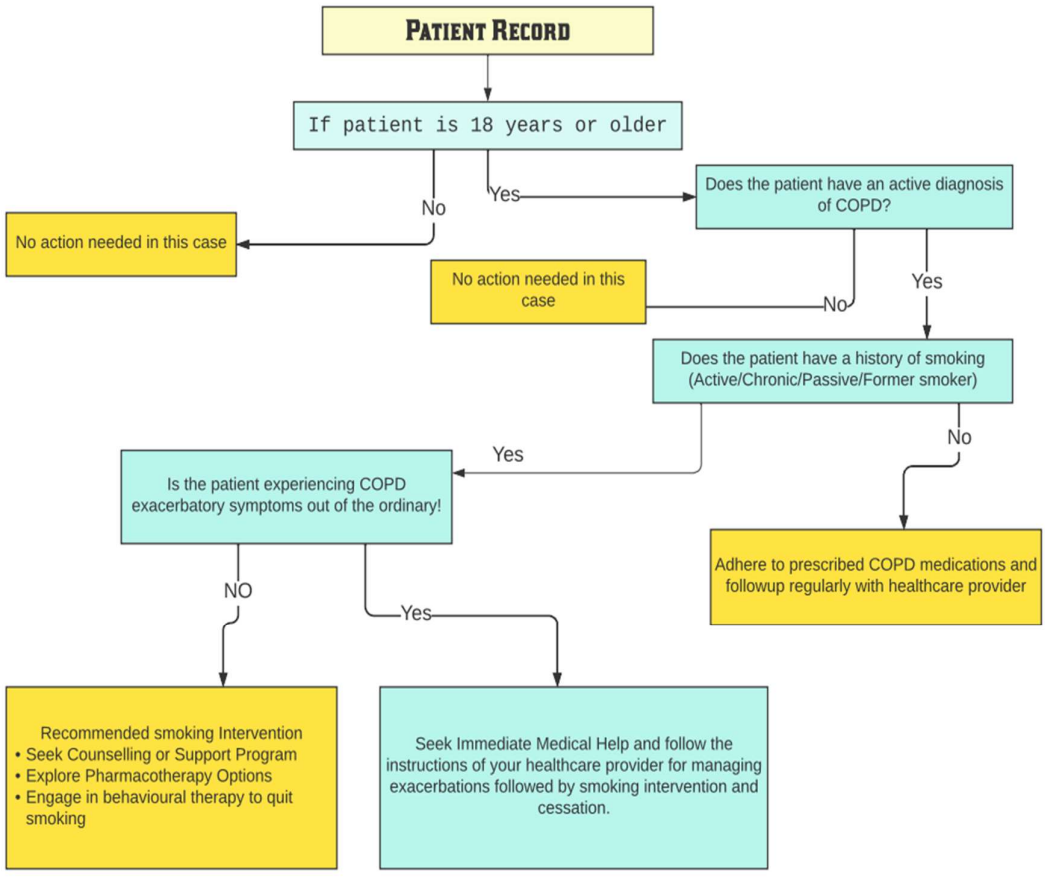
Prototype and development of clinical decision support system

Decision Tree:



The decision tree presented is designed to assist healthcare providers in effectively managing patients aged 18 years and above who have been diagnosed with chronic obstructive pulmonary disease (COPD) and have a history of smoking (current/former/passive). The inclusion of patients aged 18 and above is important, as COPD prevalence is higher in individuals above the age of 60 years, and considering this age group ensures we address potential risk factors and exacerbations in this population.

The first step of the decision tree is to determine the patient's age, ensuring they are 18 years or older. This criterion is critical, as COPD is a condition that tends to affect individuals

as they age, with the prevalence being 2-3 times higher in people above the age of 60 years (Buist et al., 2007; Fukuchi et al., 2004). Therefore, we consider patients who may be at risk or experiencing COPD symptoms at an earlier stage. If the patient has a confirmed COPD diagnosis, we proceed to evaluate their smoking history. For patients with a history of smoking, whether they are current, former, or have been exposed to passive smoking, we move to the next step. However, if the patient does not have a COPD diagnosis, no specific action is needed currently.

For patients with COPD and a smoking history, we inquire about exacerbatory symptoms. If the patient is experiencing any exacerbations, immediate medical attention is required, as exacerbations can be serious and need prompt management. In cases where the patient is not experiencing exacerbatory symptoms, the decision tree recommends "Smoking Intervention." This includes various measures such as seeking counseling or support programs, exploring pharmacotherapy options, and engaging in behavioral therapy to quit smoking. Smoking cessation is a crucial step in managing COPD, as it can significantly benefit lung health and overall well-being.

Finally, for patients with a COPD diagnosis but no smoking history, the recommendation is to adhere to prescribed COPD medications and follow up regularly with a healthcare provider. This ensures proper disease management and monitoring.

By following this decision tree, healthcare providers can tailor interventions based on individual patient characteristics and needs, ultimately leading to improved COPD management and patient outcomes. The emphasis on smoking cessation underscores its importance in COPD management, as quitting smoking can have a profound impact on lung health and the overall quality of life for COPD patients.

Execution of Procedure for CDR Creation: Smoking Intervention and COPD Exacerbation

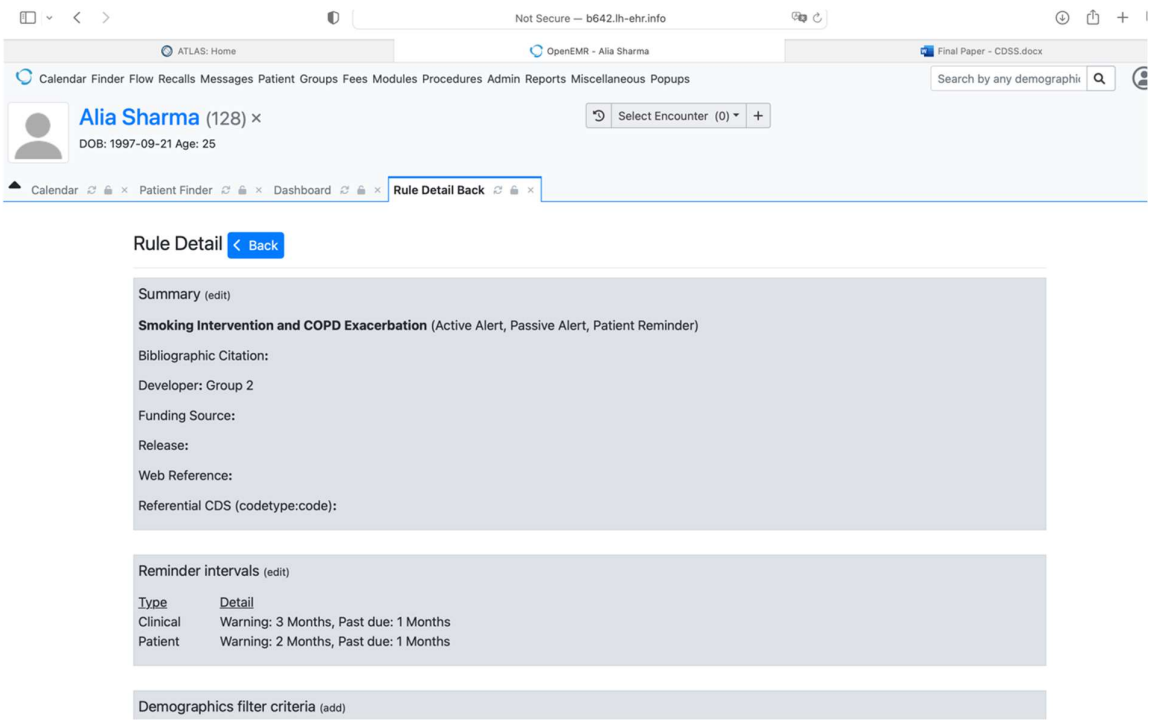
A standardized procedure was established for the creation, implementation, and monitoring of a Clinical Decision Rule (CDR) focused on patients diagnosed with Chronic Obstructive Pulmonary Disorder (COPD) and who had a history of smoking. The procedure's scope extended to patients aged 18 years and older, those with a medical history of active smoking, chronic smoking, passive smoking, or those who had quit smoking, and those diagnosed with COPD.

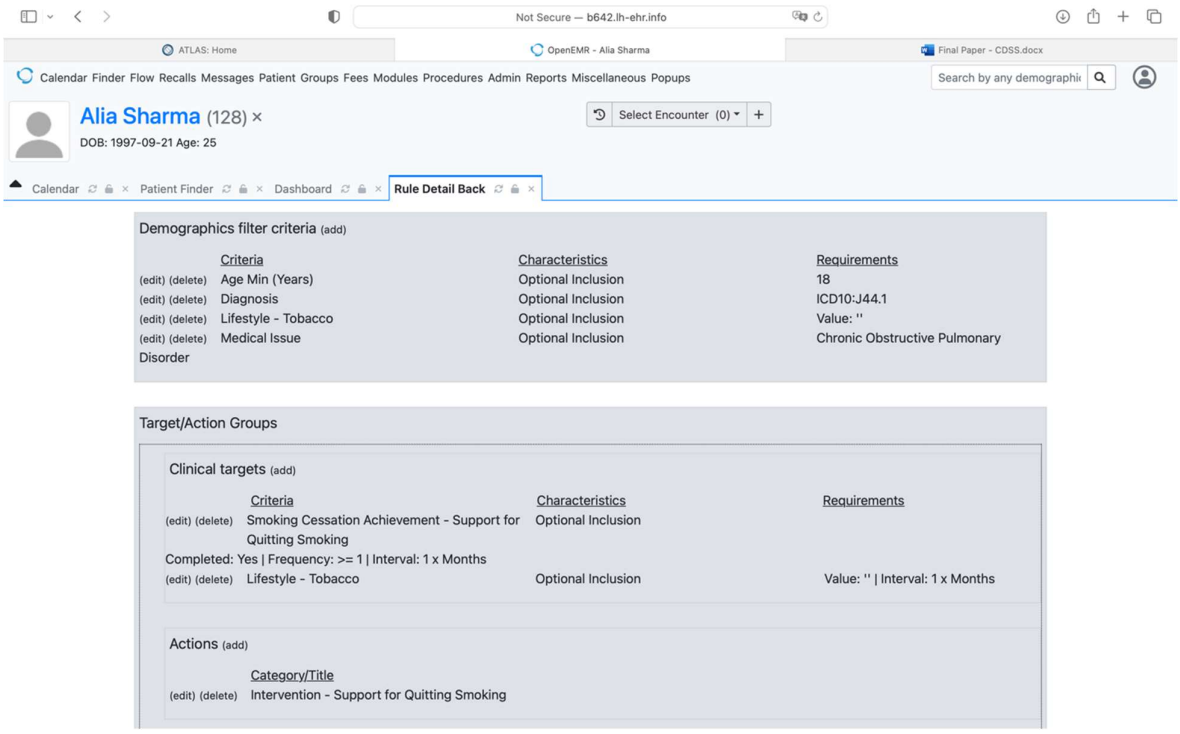
Upon logging into the OpenEMR system with the necessary credentials, navigation was made to the CDR Creation Tool by selecting "Admin" and then "Practice > Rules". Once there, the "Add Rule" button was clicked, leading to the creation of a rule with the description "Smoking Intervention and COPD Exacerbation." Criteria for the patients were then specified based on their minimum age, their smoking history, and their diagnosis of COPD. Both active and passive alerts were set to appear.

Monthly assessment intervals were established. A clinical warning was set to trigger when the Electronic Health Record (EHR) identified a COPD patient who was currently smoking and had not received smoking cessation counseling or resources in the past three months. Additionally, if a patient with COPD continued to smoke, an alert was set to be activated every two months, under the tag "Patient Warning". The clinical targets centered on patients meeting the conditions set forth, with the primary aim being Smoking Cessation Achievement. The action paired with this target was to provide "Support for Quitting Smoking".

The Clinical Decision Support System (CDSS) was configured to generate a CDR alert on the patient's portal upon the patient logging in or during a visit. A patient profile named "Alia Sharma" was created as an example, showcasing a history of smoking and a COPD

diagnosis. The alerts recommended specific interventions, such as quitting smoking, to prevent the progression into exacerbations. The CDSS was designed to perpetually monitor the progress of patients. In scenarios where a patient's condition showed persistence over an extended timeframe or displayed non-compliance, the system generated alerts prompting follow-ups or additional assessments. These alerts served as actionable reminders, guiding healthcare providers in offering necessary interventions aligned with the recommendations.

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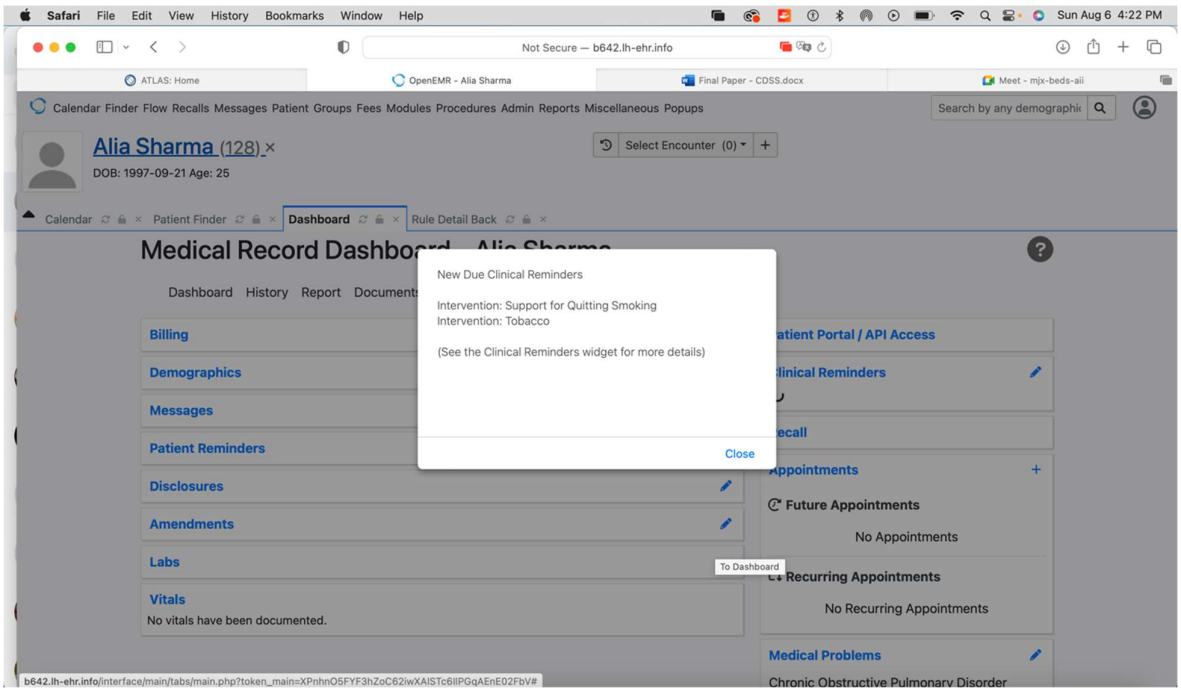
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Intervention: Support for Quitting Smoking
Intervention: Tobacco
(See the Clinical Reminders widget for more details)
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Vitals
No vitals have been documented.
Patient Portal / API Access
Clinical Reminders
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Appointments
Future Appointments
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Chronic Obstructive Pulmonary Disorder
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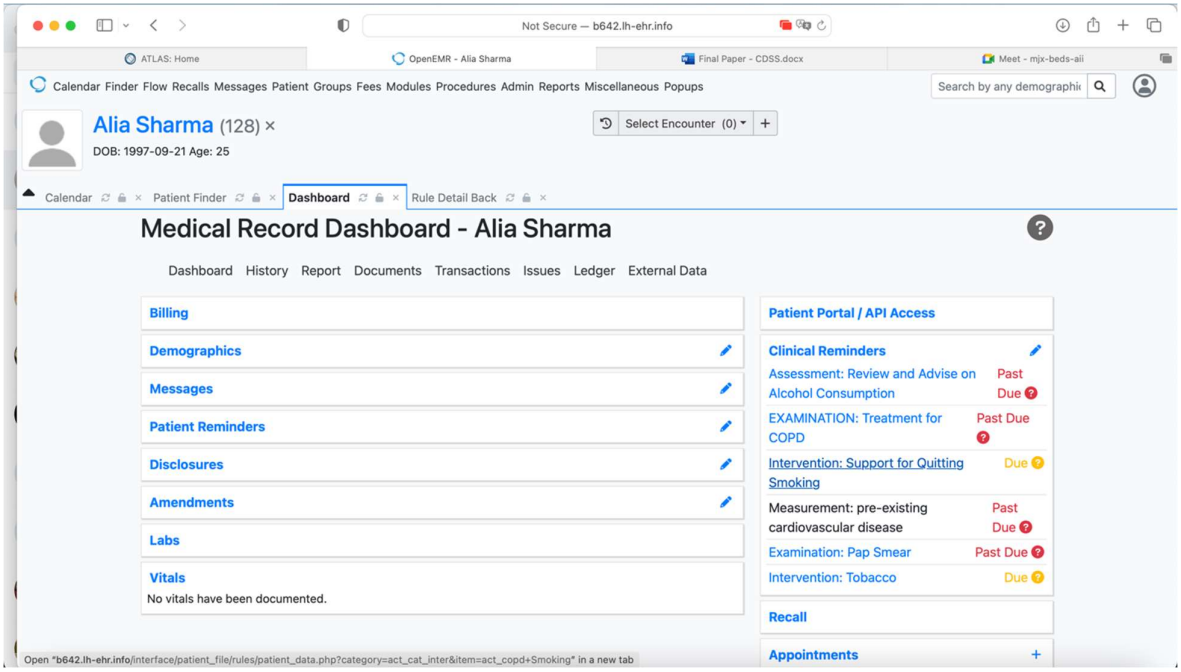
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Labs
Vitals
No vitals have been documented.
Patient Portal / API Access
Clinical Reminders
Assessment: Review and Advise on Alcohol Consumption
Past Due
EXAMINATION: Treatment for COPD
Past Due
Intervention: Support for Quitting Smoking
Due
Measurement: pre-existing cardiovascular disease
Past Due
Examination: Pap Smear
Past Due
Intervention: Tobacco
Due
Recall
Appointments
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Conclusion

In conclusion, the findings of this extensive study highlight the essential connection between quitting smoking and managing COPD symptoms, hence affirming the critical importance of developing effective smoking cessation therapy. Using this information, researchers created a novel prototype of a Clinical Decision Support System (CDSS) to aid healthcare providers in the identification of high-risk COPD patients and the provision of individualized smoking-cessation assistance based on electronic health health information and evidence-based recommendations. This novel strategy has the potential to dramatically enhance the public health outcomes associated with COPD therapy, such as reduced exacerbation rates. New technology and focused treatments are essential to improve patient care and lessen the effects of COPD as worldwide incidence of this disease continues to rise.

In addition, addressing social variables and adopting individualized treatment strategies for people with COPD are emphasized by the in-depth analysis of the relevant literature. The results highlight the importance of an integrated approach to overall COPD care by shedding light on the complicated nature of COPD exacerbations. These findings have major repercussions for public health and patient care. Future research should focus on finding breakthrough drugs to halt disease progression and lower mortality rates in COPD patients, resulting to better COPD treatment and a higher quality of life for people who suffer from the condition.

Understanding the symptoms and causes of COPD has been greatly aided by the incorporation of LibreHealth EHR. The EHR data showed how widespread COPD's effects are and how often symptoms occur, highlighting the need for comprehensive therapy. Incorporating clinical decision assistance into the LibreHealth EHR has improved the quality of care and disease management for COPD patients receiving evidence-based medicines.

The development of a clearly defined patient cohort, informed by a review of the relevant literature and the insights of subject matter experts, also facilitates in-depth studies of subsets of COPD patients. Following and analyzing this cohort will be accurate and thorough because of its well-defined inclusion criteria and objectives. The research was more efficient as a whole thanks in large part to the use of the ATLAS tool for cohort construction. We can expect to learn more about chronic obstructive pulmonary disease (COPD) thanks to the implementation of LibreHealth EHR and the creation of a clearly defined patient cohort, which in turn will lead to better treatment strategies, improved outcomes for patients, and ultimately better public health outcomes for those who live with this severe respiratory condition.

OpenEMR's Clinical Decision Rule (CDR) for managing COPD patients with a smoking history is demonstrated to be effective through a standardized methodology for its development and implementation. Patients at risk can get timely and evidence-based interventions thanks to the CDR's emphasis on smoking intervention and COPD exacerbation prevention. Improved outcomes in COPD management and better patient care are realized through the CDSS's seamless integration inside OpenEMR, which guarantees consistent monitoring and individualized aid for smoking cessation. The procedure's success illustrates the efficacy of CDSS-driven therapies in enhancing care for COPD patients and decreasing the likelihood of exacerbations.

Overall, this field of study results and their practical applications highlight the value of leveraging sophisticated technology to better patient care and public health outcomes and stress the need of smoking cessation in COPD management. We may make significant progress toward reducing the worldwide impact of COPD and enhancing the quality of life of those who suffer from this respiratory ailment if we centre our efforts on evidence-based therapies and individualized methods.

References