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Digital therapeutics for COPD patient self-management: Needs analysis and design study

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Introduction

- COPD is the 4th leading cause of death in Canada, with high Rx burden
  - Early recognition & Rx of exacerbations can reduce hospitalizations & costs & increase QoL
- Theory-driven digital therapeutics can offer personalized & explainable SM & BM resources to patients
  - To prevent & self-manage COPD exacerbations
- Design should be guided by the self-care needs of patients & insights from providers

Objectives

- To develop specifications of digital therapeutic to detect & prevent exacerbations
  - Collect insights from both patients & providers
- To design an AI-driven digital therapeutic as a mobile app prototype that
  - Incorporate COPD guidelines and behavior modification models
  - Integrate data from multiple sources
  - Provide personalized COPD management recommendations

Methods: 1. Qualitative Study for Self-care Needs Analysis

- 2 Separate patient and provider FG sessions at FDCHC
- 2 moderator guides using 3 models (i) CCM for CDM; (ii) SCT for personal, behavioral, environmental factors related to health behavior; (iii) Nielson UH for end-users' usability needs
- Purposive sampling: patients with COPD (n=10) + COPD care providers (n=4).
- Patient session, included 5 min demo of 'COPD manager' app to encourage meaningful discussion
- Audio files and field notes analyzed by ATLAS.ti to perform thematic analysis by two researchers, and discrepancies resolved
- Descriptive analysis performed on the quantitative demographic data

Quantitative Results

- Patients
  - Mean age 68.25 years, balanced in terms of sex, urban, suburban, & rural, most had access to computer & m phone, generally comfortable with technology

- Provider
  - Mean practice: 4 years, moderately confident in implementing behavior change strategies, received behavior change training in the past

Qualitative Results Patient FG

- Unable to determine whether they are getting better or worse between clinical visits
- Sub-optimal medication management and symptom monitoring
- Need for self-tracking and self-monitoring their symptoms
- Smart phones and sensors seen as being useful for self-management for record keeping, feedback and guidance
- Need for integration of biomedical and environmental data, detection of the triggers for exacerbation
- Information personalization, personalized feedback, easy to understand, graphics, and explanations
- Ability to communicate with healthcare providers
- Technology should NOT replace in-person consultations with providers

Qualitative Results Provider FG

- Digital intervention should be
  - Interactive & easy to use
  - Simple language & navigation
  - Personalized content, e.g., exacerbation detection, recommendations and actions plans
    - based on patient's symptoms, disease stage comorbidities, indoor/outdoor environmental factors, socio-demographics, readiness
  - Explanation of the recommended content
  - Inclusion of gaming, rewards, graphics, humor
  - Record keeping, & care task reminders should be simple and voice activated

COPD SM m-app: Functional Specifications

- Used semantic web-based knowledge representation methods
- COPD self-management ontology = COPD CPG + theory-driven BM recommendations + symptom assess. tools
  - Represents concepts about COPD symptoms, exacerbation triggers, patient's environment, & behaviors
- The personalization logic within ontology is represented as Notation3 (N3), e.g.
- {?p : hasColoredPhlegm true}=>{?p : stratified : YellowZone }.

App interface with explanations for recommendations

- SM recom. annotated with descriptions for individual terms & explain the reasoning behind the recom.

- Visual & narrative recom. that stratifies a pt in the yellow zone, with a description of the implications, & reasons for recom. (exertion, phlegm coloration & amount).

"You are stratified into the yellow zone b/c you have moderate activity exertion, colored phlegm, and moderate amount of phlegm. You should follow your action plan immediately. If your symptoms don't improve after 48 hours, seek medical care immediately. You have moderate activity exertion because you put 7 for activity exertion (which lies between 5 and 8)".

Discussion, Future Work, Conclusions

- One reason for the sub-optimal efficacy of existing apps is the lack of needs analysis from users
  - Our study helped us better understand the end-user needs
- COPD app will be extended by integrating wearables, sensors, data analytics, and visualization to preemptively detect an exacerbation via monitoring of physiological parameters and contextualizing them with environmental, & personal triggers
- ML based prediction modeling will analyze the multi-modal data to predict exacerbations

Thank you

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