# Roles of Chatbot on a Decision of Continuous Positive Airway Pressure (CPAP) Purchasing in Adult Patients with Obstructive Sleep Apnea

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**Objective:** Obstructive sleep apnea (OSA) is a common disease in clinical practice. To reduce risks of OSA consequences, a continuous positive airway pressure (CPAP) is needed. Chatbot is an artificial intelligence which is classified as conversational agents. Chatbot may be a helpful tool to assist patients with OSA and reduce physicians' workload regarding a decision on CPAP purchasing. This study aimed to evaluate if chatbot can be a helpful tool on a decision on CPAP purchasing.

**Materials and Methods:** This was an intervention study. The inclusion criteria were adult patients diagnosed as OSA and had an experience on CPAP trial. The primary outcome of the study was a decision on CPAP purchasing after chatbot intervention. All patients were categorized into two groups after chatbot intervention: purchased CPAP and did not purchase CPAP. Factors and outcomes were compared between both groups.

**Results:** There were 29 patients with OSA participated in the present study. Of those, 6 patients (20.69%) decided to purchase CPAP. The CPAP purchasing group had higher visits on chatbot than the non-purchasing group on the following items: Treatment of OSA, What is CPAP?, reimbursement of CPAP, types of CPAP and price. The CPAP purchasing group also spent more times in chatbot than the non-purchasing group (3.83 vs. 3.30 minutes; p=0.678). After chatbot intervention, 2 patients (33.33%) changed a decision of CPAP purchasing from deciding to purchased, while 3 patients who wanted to purchase a CPAP changed their minds. There were 6 patients (20.69%) who did not need to see a doctor after chatbot intervention; mostly in the group who did not purchase CPAP (5 patients; 83.33%).

**Conclusion:** Chatbot is a helpful tool to provide knowledge or cognitive ability on CPAP and may improve a decision of CPAP purchasing.

**Keywords:** Management; Artificial intelligence; Knowledge; Control

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Obstructive sleep apnea (OSA) is a common disease in clinical practice. The prevalence of OSA in general population ranged from 9% to 38% with more prevalent in male or elderly population[1]. The prevalence of OSA in male and female elderly population was 90% and 78%, respectively. OSA is also reported to be associated in several cardiovascular conditions such as diabetes, hypertension, hypertensive crisis, stroke, or coronary artery disease[2-9]. To reduce risks of OSA consequences, a continuous positive airway pressure (CPAP) is needed. From a meta-analysis found that CPAP purchasing rate in patients with OSA varied from 32% to 77.36%[10,11]. Predictors of CPAP purchasing included age, education, income, or smoking.

Previously, marketing theory is focused on 4P: product, price, promotion, and place. Currently, three P and one G are added for marketing principles including people, process, perseverance and green marketing in the digital era[12]. Online or mobile marketing enhances perseverance and green online marketing. Chatbot is an artificial intelligence which is classified as conversational agents. It has been used for customer support in more than 67% of consumers whorldwide with 53% of satisfaction[13]. There are several customers' benefits by chatbot including 24 hour service, instant response, answers to simple questions, or easy communication. Additionally, chatbot may assist customers' purchasing decision. But, there is limited data

of chatbot in purchasing medical devices.

A meta-analysis found that chatbot can be used for several reasons such as self-management or health monitoring[14-17]. As previously reported, a decision to purchase is a complex condition with several predictors[11]. Additionally, attending physicians always have limited time to see each patient. Therefore, chatbot may be a helpful tool to assist patients with OSA and reduce physicians' workload regarding a decision on CPAP purchasing. A systematic review found that there is no previous study evaluated role of chatbot in CPAP purchasing in patients with OSA. This study aimed to evaluate if chatbot can be a helpful tool on a decision on CPAP purchasing.

## Materials and Methods

This was an intervention study conducted at Sleep clinic, Srinagarind Hospital, Khon Kaen University, Khon Kaen, Thailand. The inclusion criteria were adult patients diagnosed as OSA and had an experience on CPAP trial. The CPAP trial was undergone either at home or at the sleep lab. Those who pregnant or had any contraindication for CPAP therapy were excluded. The study period was between April 2022 and July 2022. The present study was approved by Ethicts Committee, Faculty of Medicine, Khon Kaen University (HE641649).

Eligible patients were requested to have a conversation with the chatbot of OSA which is set up on line application. It can be accessed via smartphone or other online devices such as computer or IPAD. There are 12 items on the first page of chatbot of OSA including definition of OSA, causes of OSA, consequences of OSA, treatments of OSA, details of CPAP, advantages of CPAP, principles of using CPAP, cleaning of CPAP, side effects of CPAP, reimbursement of CPAP, and types of CPAP and its price. These details are made to educate patients with OSA according to common questions of previous patients to the physicians. The patients were asked to communicate with chatbot of OSA without time limitations.

Baseline characteristics, co-morbid diseases, symptoms of OSA, perceptions of chatbot, chatbot visits in each category, and time used for chatbot were assessed. The perceptions of chatbot were given in a Likert scale from 1 to 5; 1 indicating strongly disagreed and 5 indicating strongly agree. Chatbot visits were summation of count number in each chatbot item from all patients.

The primary outcome of the study was a decision on CPAP purchasing after chatbot intervention. A decision of CPAP purchasing was also reported by each patient prior to chatbot intervention as purchase, did not purchase, or deciding. A need to see doctor after chatbot intervention was also assessed as well as duration of chatbot visit.

Statistical analyses. All patients were categorized into two groups after chatbot intervention: purchased CPAP and did not purchase CPAP. Studied factors were calculated and reported as mean (SD) for numerical factors and number (percentage) for categorical factors. Differences between both groups were executed by Wilcoxon rank sum test for numerical factors and Fisher Exact test for categorical factors. All statistical analyses were performed by STATA software (College Station, Texas, USA).

## Results

There were 29 patients with OSA participated in the study. Of those, 6 patients (20.69%) decided to purchase CPAP. Regarding baseline characteristics (Table 1), those who purchased CPAP had younger age (33.67 vs. 42.17; p=0.100) and higher proportion of male sex (66.67% vs. 56.52%, p=0.999) than those who did not purchase CPAP.

**Table 1.** Baseline characteristics of patients with obstructive sleep apnea (OSA) who participated in the chatbot study categorized by a decision of continuous positive airway pressure machine (CPAP) purchasing

| Factors | Purchased, n=6 | Did not purchase, n=23 | p-value |
|---|---|---|---|
| Age, years | 33.67 (11.27) | 42.17 (12.22) | 0.100 |
| Male sex | 4 (66.67) | 13 (56.52) | 0.999 |
| Education, college | 2 (33.33) | 16 (69.57) | 0.164 |
| Marital status, single | 5 (83.33) | 8 (36.36) | 0.093 |
| Occupation, civil | 4 (66.67) | 11 (47.83) | 0.999 |
| Income, 10,001 to 15,000 Baht/month | 3 (50.00) | 3 (13.04) | 0.584 |
| Co-morbid diseases | | | |
| Diabetes mellitus | 1 (20.00) | 6 (35.29) | 0.999 |
| Hypertension | 0 | 9 (52.94) | 0.104 |
| Coronary artery disease | 0 | 1 (5.88) | 0.999 |
| Stroke | 0 | 2 (11.76) | 0.999 |
| Arrhythmia | 0 | 1 (5.88) | 0.999 |
| Depression | 1 (20.00) | 1 (5.88) | 0.411 |
| Symptoms of OSA | | | |
| Snoring | 6 (100) | 20 (90.91) | 0.999 |
| Insomnia | 2 (33.33) | 8 (36.36) | 0.999 |
| Unrefreshed sleep | 2 (33.33) | 11 (50.00) | 0.655 |
| Fatigue | 1 (16.67) | 8 (36.36) | 0.630 |
| EDS | 1 (16.67) | 13 (59.09) | 0.165 |
| Palpitation | 0 | 8 (36.36) | 0.141 |
| Headache | 1 (16.67) | 5 (22.73) | 0.999 |
| Dyspnea | 2 (33.33) | 3 (13.64) | 0.285 |
| Nocturia | 5 (83.33) | 16 (69.57) | 0.647 |
| Know CPAP | | | |
| Flyer | 0 | 1 (4.76) | 0.999 |
| Physician | 5 (83.33) | 19 (90.48) | 0.545 |
| Friends/colleages | 2 (33.33) | 1 (4.76) | 0.115 |
| Know chatbot | 1 (16.67) | 3 (14.29) | 0.999 |

Note: Data presented as mean (SD) or number (percentage).

There were comparable results in terms of co-morbid diseases, symptoms of OSA, proportions of patients who know CPAP, and a proportion of patients who know chatbot between the groups who purchased and did not purchase CPAP.

Patients in both groups had comparable perceptions about chatbot and chatbot on a decision of CPAP purchasing (Table 2). The patients who purchased CPAP rated higher scores on the items of chatbot can help to make a decision on CPAP purchasing faster than seeing the doctor (4.0 vs. 3.5; p=0.332) and chatbot can assist you regarding CPAP purchasing (4.0 vs. 3.2; p=0.143) than those who did not purchase CPAP.

The CPAP purchasing group had higher visits on chatbot than the non-purchasing group on the following items (Table 3): Treatment of OSA, What is CPAP?, reimbursement of CPAP, types of CPAP and price. The CPAP purchasing group also spent more times in chatbot than the non-purchasing group (3.83 vs. 3.30 minutes; p=0.678). After chatbot intervention (Table 4), 2 patients (33.33%) changed a decision of CPAP purchasing from deciding to purchased, while 3 patients who wanted to purchase a CPAP changed their minds (13.04%). These differences were significantly different (p=0.029). There were 6 patients (20.69%) who did not need to see a doctor after chatbot intervention; mostly in the group who did not purchase CPAP (5 patients; 83.33%) with a p value of 0.999 (Table 4).

## Discussion

The CPAP purchasing rate in the present study was quite low compared with previous studies (20.69% vs. 32%). This lower rate may explain by study population. First, the age group in the present study was quite young compared with previous studies. The meta-analysis found that the average age of those who purchased CPAP was 56.04 years, while the average age in this study was quite young at 33.67 years (Table 1). The average age of all patients was 40.41 years (SD 12.34). Those young patients may have limited financial status leading to low purchasing rate compared with those older patients. Additionally, symptoms of OSA were reported not frequently such as daytime sleepiness (48.27%), or unrefreshed sleep (44.82%). The low rate of symptoms may lead to low awareness of OSA.

According to the current concepts of consumption of consumer behaviors, the ICABS framework is modified for the digital era[18]. The ICABS stands for information (I), cognition (C), affect (A), behavior (B), and satisfaction (S).

**Table 3.** Chatbot visits in patients with obstructive sleep apnea (OSA) who participated in the chatbot study categorized by a decision of continuous positive airway pressure machine (CPAP) purchasing

| Factors | Purchased n=6 | Did not purchase n=23 | p-value |
|---|---|---|---|
| What is OSA? | 3 (50.00) | 16 (76.19) | 0.319 |
| Causes of OSA | 2 (33.33) | 14 (66.67) | 0.187 |
| Consequences of OSA | 2 (33.33) | 9 (42.86) | 0.999 |
| Treatments of OSA | 4 (66.67) | 11 (52.38) | 0.662 |
| What is CPAP? | 3 (50.00) | 9 (42.86) | 0.999 |
| Advantages of CPAP | 1 (16.67) | 6 (28.57) | 0.999 |
| Principles of using CPAP | 0 | 7 (33.33) | 0.155 |
| Cleaning of CPAP | 0 | 4 (19.05) | 0.545 |
| Side effects of CPAP | 2 (33.33) | 8 (38.10) | 0.999 |
| Reimbursement of CPAP | 5 (83.33) | 10 (47.62) | 0.182 |
| Types of CPAP and price | 3 (50.00) | 8 (38.10) | 0.662 |
| Times in chatbot | 3.83 (3.25) | 3.30 (2.32) | 0.678 |

Note. Data presented as number (percentage).

**Table 2.** Perception of chatbot in patients with obstructive sleep apnea (OSA) who participated in the chatbot study categorized by a decision of continuous positive airway pressure machine (CPAP) purchasing

| Factors | Purchased n=6 | Did not purchase n=23 | p-value |
|---|---|---|---|
| Chatbot can answer and responses to any interesting questions | 4.2 (0.5) | 3.8 (0.7) | 0.262 |
| Chatbot can give information regarding OSA and treatment before seeing the doctor at the hospital | 4.0 (0) | 4.0 (0.9) | 0.720 |
| Chatbot tells you about OSA | 3.4 (0.9) | 3.7 (0.7) | 0.509 |
| Chatbot tells you about OSA treatment | 3.4 (0.9) | 3.6 (0.9) | 0.808 |
| Chatbot gives information easily and conveniently | 4.2 (0.4) | 3.7 (0.8) | 0.215 |
| Chatbot gives fast information than other methods | 4.4 (0.4) | 4.0 (0.9) | 0.488 |
| Chatbot gives the right point of interest quickly | 3.8 (0.8) | 3.9 (0.7) | 0.637 |
| Chatbot gives interesting information | 4.2 (0.4) | 3.8 (0.7) | 0.214 |
| Chtabot is a preference way of searching data | 3.8 (0.4) | 3.8 (0.8) | 0.876 |
| Chotbot provides information about health for you and your beloved ones | 4.4 (0.5) | 3.7 (0.9) | 0.167 |
| Chatbot can help you to make a decision on CPAP purchasing faster than seeing the doctor | 4.0 (1.0) | 3.5 (0.8) | 0.332 |
| Chatbot can assist you regarding CPAP purchasing | 4.0 (1.0) | 3.2 (0.8) | 0.143 |

Note. Data presented as mean (SD) out of 5; 5 indicating strongly agreed and 1 indicating strongly disagreed

**Table 4.** Decision of continuous positive airway pressure machine (CPAP) purchasing and a need to see doctor in patients with obstructive sleep apnea (OSA) before participated in the chatbot study categorized by a decision of CPAP purchasing

| Factors | Purchased CPAP after chatbot intervention, n=6 | Did not purchase CPAP after chatbot intervention, n=23 | p-value |
|---|---|---|---|
| Decision of CPAP purchasing prior to chatbot intervention | | | 0.029 |
| Purchased | 4 (66.67) | 3 (13.64) | |
| Did not purchase | 0 | 5 (21.74) | |
| Deciding | 2 (33.33) | 15 (65.22) | |
| Need to see doctor after chatbot intervention | 5 (83.33) | 18 (78.26) | 0.999 |

Note. Data presented as number (percentage).

These factors are adapted due to advance digital platform. Chatbot is one of digital technology that can provide information (I) for patients with satisfaction (S) without time limitation as seen in the physician office. Chatbot can also have impact on cognitions (C) and behaviors (B) of patients with OSA to study on the disease (OSA) and treatment (CPAP).

There were five patients (17.24%) who changed their minds after chatbot intervention; 2 patients from "deciding" to "purchase" and 3 patients from "purchased" to "did not purchase/deciding". These results may imply that chatbot may be able to assist the patients to find the right answer for them regarding a decision on CPAP purchasing. Additionally, 6 patients (20.69%) did not want to see a doctor. These results may indicate that chatbot may be effectively as doctor. In other words, chatbot may be helpful or save the doctor's time. As previously reported, chatbot is generally acceptable and provide knowledge and cognitive/behavior therapy via conversation messages. Chatbot is acceptable by children with asthma showed by acceptance score of 8 by 11-point Likert scale[19]. Another study in children with asthma and their family member found that chatbot can improve cognitive skill with a completion rate of 75.5%[20]. Therefore, chatbot may improve knowledge and cognitive skill in patients with OSA leading to appropriate decision on CPAP purchasing for each individual.

A previous study on consumer's purchase in Malaysian retail market found that social media may affect consumer decisions[21]. However, it was not statistically significant in the final model with a coefficient of -0.165 (p=0.125). The most important factor associated with consumer decision was perceived value of the product (coefficient 0.593; p<0.05). These results may imply for the purchasing of CPAP that perceived of CPAP value may increase chance of purchasing. Chatbot may be one helpful tool to improve knowledge and perception as it provide CPAP information for those who purchased and did not purchase CPAP (Likert scale of 4.0/5.0 in both groups) as shown in Table 2.

This may be the first study of chatbot on a decision of CPAP purchasing in patients with OSA. However, there are some limitations in the study. First, there is no intervention related to CPAP purchasing or compliance[22-24]. Second, no related personal factor or systematic study design were studied or performed[25-27]. Finally, the study population may be specifically to adult patients with limited sample size; no predictor analysis.

In conclusion, chatbot is a helpful tool to provide knowledge or cognitive ability on CPAP and may improve a decision of CPAP purchasing.

## What is already known on this topic?

Predictors of CPAP purchasing included age, education, income, or smoking.

No previous study on chatbot and CPAP purchasing.

## What this study adds?

Chatbot may be a tool to assist patients with OSA to decide if they would like to purchase CPAP or not.

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## Conflicts of interest

The authors declare no conflict of interest.

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