



Sleep Apnea

How to improve the well-being of
people with sleep apnea?

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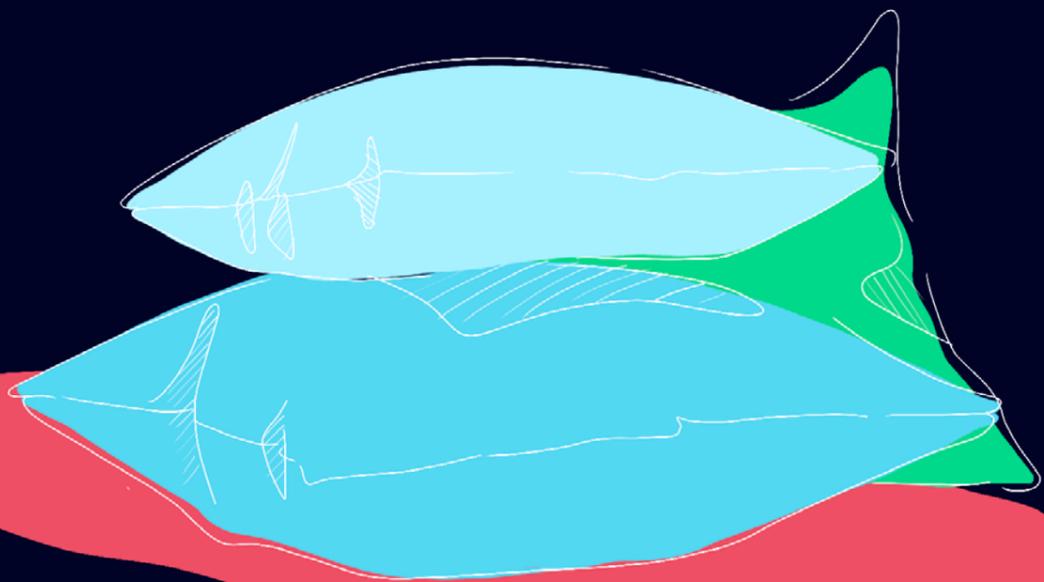
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1. INTRODUCTION



Background

Sleep is fundamental for our well-being. (1) It enables all systems of the body to function effectively. From helping us regain energy, to repair our body, and power the mind. (2) It is advised that every adult sleeps between 7-9 h per night, which makes it more than 30% of every day. (3) However, this crucial activity can be distributed by various sleep disorders and affect overall health, safety, and life quality.

Sleep apnea is a common sleep disorder, and it affects between 2-9% of adults. (4) It affects a person's ability to breathe during sleep and, as a result, leads to life-threatening cardiorespiratory events. Obstructive sleep apnea occurs when the airway at the back of the throat becomes physically blocked. Not only does it entirely prevents from taking a rest at night, but it also overburdens the body. Untreated, it leads to cardiovascular diseases, diabetes, depression, or stroke. (5)

The most used and successful therapy is sleeping with a continuous positive airway pressure machine. Although it maintains airflow to the lungs, the experience of wearing a mask connected with a tube to the loud devices every night is challenging for many users. It takes around 50% of users to drop the treatment despite all the health consequences.(6)

This project investigated those psychological, emotional, physical, and social factors that affect willingness to start and continue sleep apnea therapy. Besides, the topic was analyzed from the perspective of person-focused care. So not look at the user as a patient but look at their lifestyle, sleep experience, and hygiene so, despite the condition of sleep apnea, their life and sleep quality can maintain high. (7)

1. <https://pubmed.ncbi.nlm.nih.gov/31256784/>
2. <https://www.sleepfoundation.org/how-sleep-works>
3. <https://www.sleepfoundation.org/how-sleep-works/how-much-sleep-do-we-really-need>
4. <https://www.msmanuals.com/professional/pulmonary-disorders/sleep-apnea/obstructive-sleep-apnea>
5. <https://www.sleepfoundation.org/sleep-apnea>
6. <https://www.ncbi.nlm.nih.gov/books/NBK535538/>
7. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3140752/>



Figure 1: <https://philipsproductcontent.blob.core.windows.net/assets/20190911/5d9dd027afd1434f9e52aac500fd2374.pdf>
Figure 2: <https://www.lhmeds.com/products/philips-dreamstation-cpap-device>

Obstructive Sleep Apnea Syndrome

Obstructive sleep apnea affects between 2-9% of adults in the United States, though the majority of cases go undiagnosed. (1)(2)

Definition

Obstructive sleep apnea is defined as partial or complete closure of the upper airway during sleep, leading to breathing cessation and lasts more than 10 seconds. (3) The upper airway collapses dynamically during sleep and causes temporary lapses in-breath and reopens during wakefulness. This process represents multiple times.

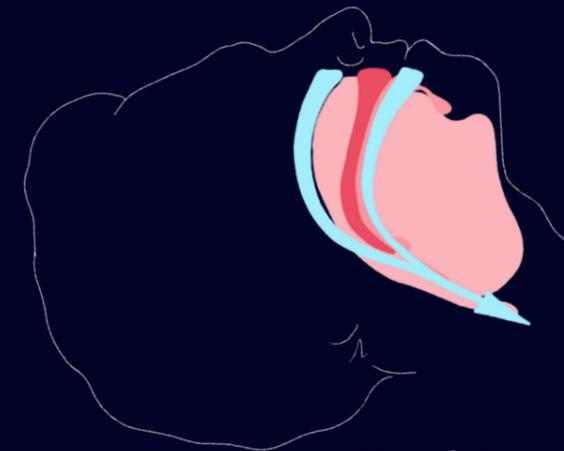
Symptoms (4)

- Loud snoring
- Nocturnal restlessness
- Insomnia with frequent awakenings
- Awakening with choking or gasping
- Vivid or threatening dreams
- Daytime sleepiness
- Lack of concentration
- Morning headaches
- Cognitive deficits
- Changes in mood

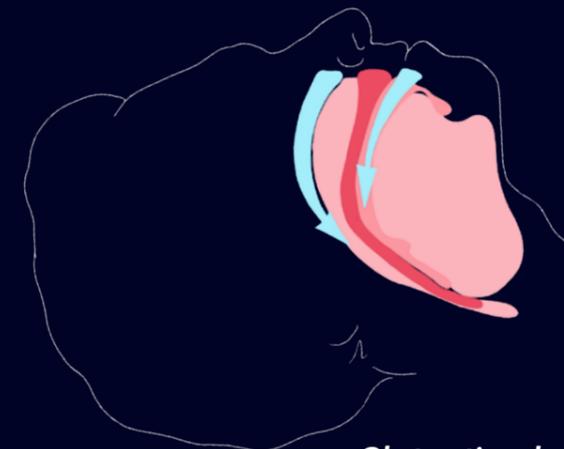
Also, it increases the risks of automobile crashes and loss of employment, and relationships with partner and housemates. (1) Moreover, OSA is associated with hypertension, metabolic syndrome, diabetes, heart failure, coronary artery disease, arrhythmias, stroke, pulmonary hypertension, neurocognitive, and mood disorders.(5)

Causes(4)

- Age and Gender - Although the risk increases with age and is more common in men, it can affect children and adults and people of both sexes. It balances out once women become postmenopausal.
- Obesity
- Upper airway and craniofacial abnormalities
- Neck size (larger neck)

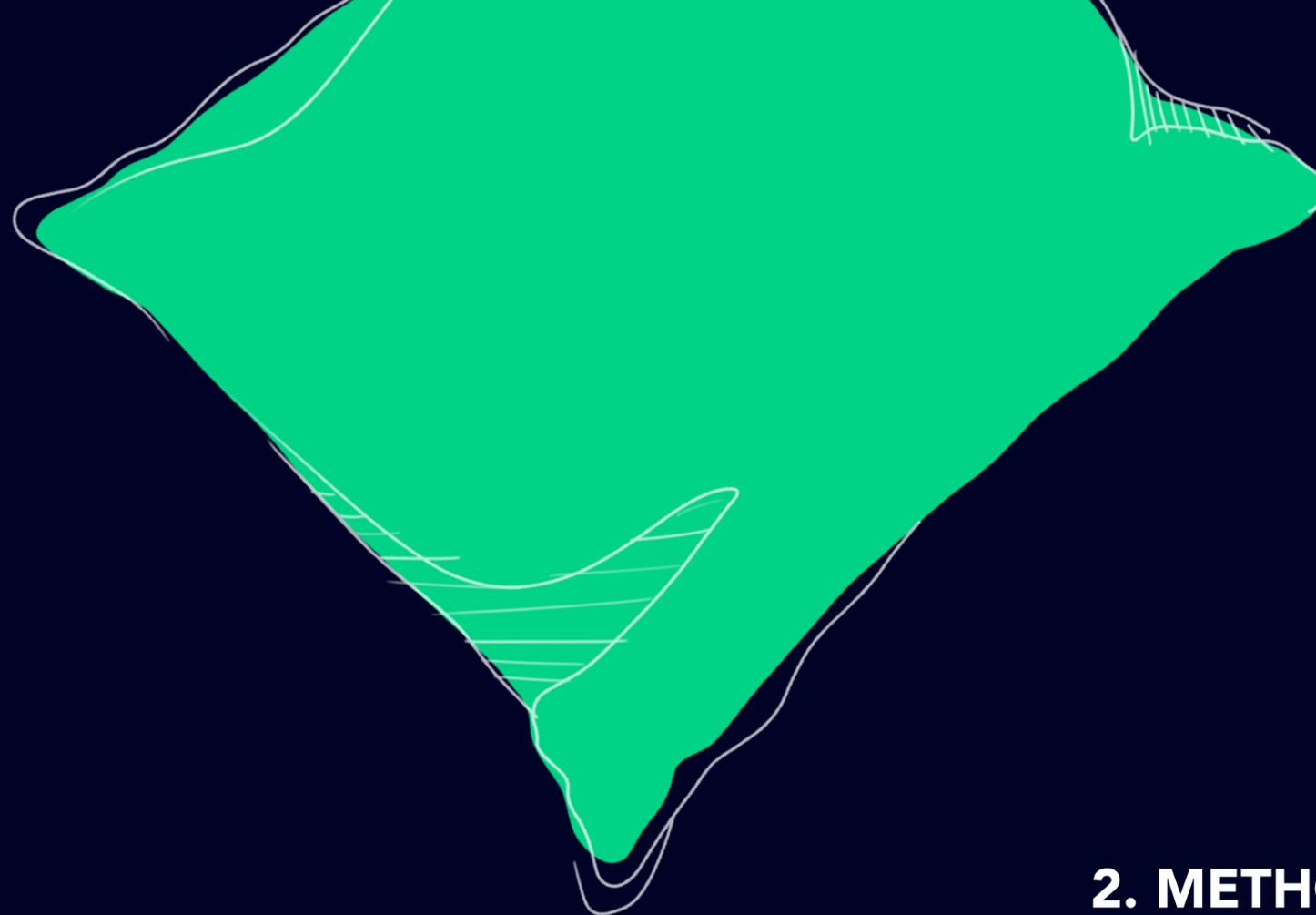


Normal airway

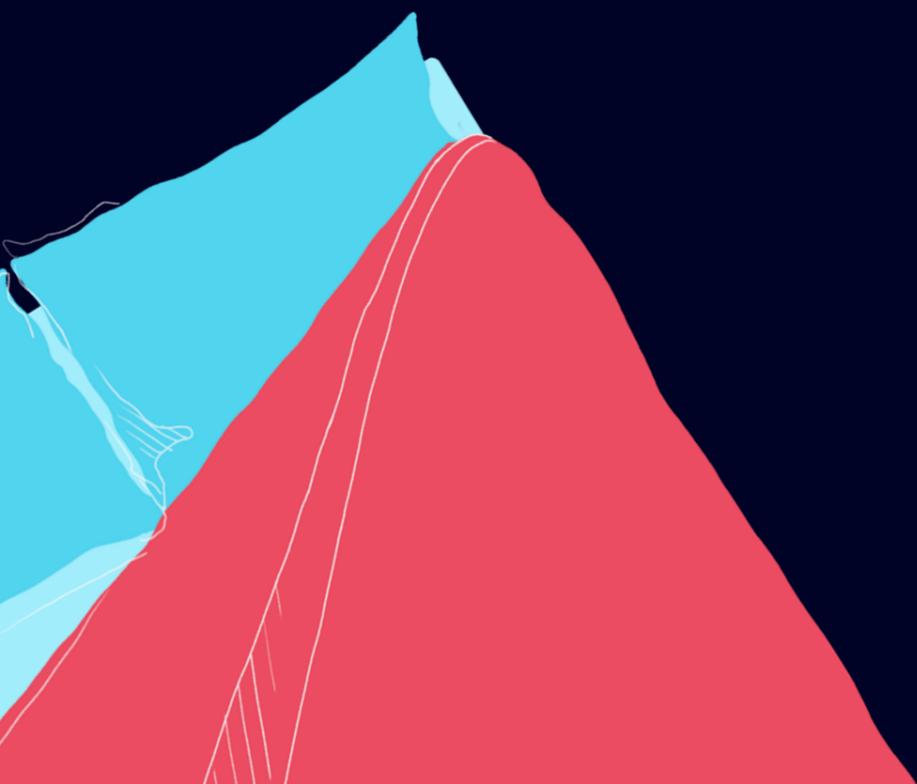


Obstructive sleep apnea

1 <https://pubmed.ncbi.nlm.nih.gov/31509498/>
2 <https://pubmed.ncbi.nlm.nih.gov/31509498/>
3 <https://www.msmanuals.com/professional/pulmonary-disorders/sleep-apnea/obstructive-sleep-apnea>
4 <https://www.sleepfoundation.org/sleep-apnea/obstructive-sleep-apnea>
5 https://www.sciencedirect.com/science/article/pii/S0953620512001525?casa_token=Mjk9c3D_8SUAAAAA:8b3axatp4_IQGY7oy-rZrzc1kUuiuTu1Um3gVovJQz8PriPonhQSp4zKQ_k3qNn2GQW8RedYihY



2. METHOD





Nature and Science of Sleep

Sleep is fundamental for well-being. National Sleep Foundation recommends 7-9 hours of sleep per night for adults. (1) Besides from the duration, the quality of sleep plays an important role. It shouldn't be fragmented or non-restorative. To maintain consistent and uninterrupted sleep, sleep hygiene should be implemented. It includes bedroom setting and sleep-related habits such as the same sleep schedule, relaxing pre-bed routine, and disconnecting from electronic devices. (2) However, even when attention is paid to sleep hygiene, there are factors such as worry/stress, insomnia, shift work disorder, and sleep apnea preventing from obtaining healthy sleep. (3)

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1. <https://www.sleepfoundation.org/how-sleep-works/how-much-sleep-do-we-really-need>
 2. <https://www.sleepfoundation.org/sleep-hygiene>
 3. <https://www.philips.com/c-dam/b2c/master/experience/smartsleep/world-sleep-day/2020/2020-world-sleep-day-report.pdf>

Users

The users of the project are people suffering from obstructive sleep apnea. It includes both women and men at any age, but with a significantly bigger group of adults. Based on the factors that increase OSA's chances, some of them might also have a problem with obesity, use of sedatives, including alcohol, cigarette smoking, and nasal congestion. (1)

User interviews

To better understand this group of people, 11 interviews were conducted. All participants are Polish and were diagnosed with OSA.

Live with OSA

- "I was snoring."
- "I had permanent fatigue."
- "I was always tired."
- "I was falling asleep at different places."
- "People were laughing that I can fall asleep waiting for dinner."
- "I had a blackout while driving."

Good sleep definition

Duration: 6-8h

Results:

"Good sleep - don't feel tired, well-rested, no headaches."

"I wake up, and I'm well-rested."

Conditions:

"Good sleep is only with CPAP for me."

"Firstly, I need the machine next to me. You can't do without it."

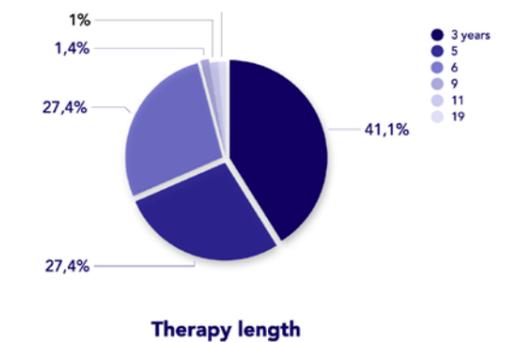
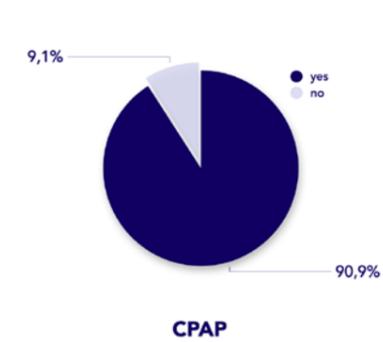
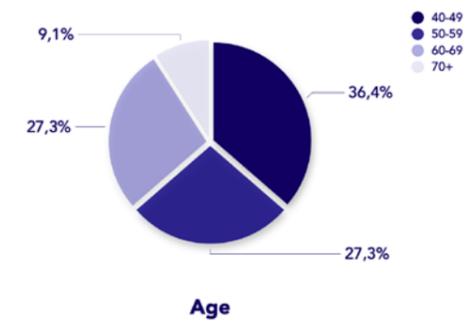
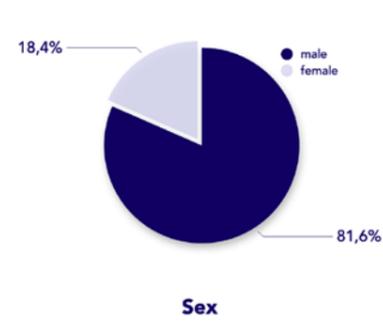
"Calm and quiet."

"Dark."

"Fresh air in the bedroom."



Participants characteristics



1. <https://www.sleepfoundation.org/sleep-apnea>

Context

Users' context is highly defined by the healthcare system they are in (national or private), procedures, and health recommendations. It affects the access to the diagnosis and therapy but also the user expectations. For example, the need to cover the cost of therapy by themselves in Poland often makes patients choose cheaper medical equipment and decrease comfort. However, there is a renting system in Sweden that reduces economic inequalities but limits the device's choice option. Also, COVID-19 has increased differences. In Sweden, the primary testing method is home-based so that it can be safely continued despite the pandemic. Although in Poland, tests happen in the hospital, so the diagnosis has stopped entirely.

Stakeholders

The main stakeholders involved in the project are clinicians such as doctors specialized in pulmonology and nurses, user relatives such as spouse, partner, child, and salesperson.



Clinicians:
pulmonologist
nurse



Salesperson:
sales manager
shop assistant



Relatives:
spouse/partner
children

- issue referral for a sleep test
- diagnose patient
- choose therapy
- educate patient about sleep apnea
- issue referral for CPAP device

- educate clinicians about CPAP devices
- help patient select CPAP device and correct mask
- educate patient how to use and maintain CPAP device

- recognize first sleep apnea syndromes such as snoring
- encourage patient to take a sleep test
- motivate patient to stay in therapy

Poland	Netherlands	Sweden
Purchase device	Purchase device	Rent device
National Healthcare System reimbursement	Insurance reimbursement	Hospital
Device every 5 years	Device every 5 years	Lifetime
Mask every 5 years	Mask every 1 years	Mask every 1 years
High cost	Low cost	Low cost
Hospital diagnosis	-	Home diagnosis
COVID has stoped diagnostics	-	COVID hasn't stoped diagnostics



Interviews with clinicians

Four interviews were conducted with clinicians from Poland and Sweden. They were asked about their experience of treating patients with sleep apnea and their vision of the future of therapy.

Tomasz Januś, Pulmonologist
Edward Szczekliak Hospital, Tarnów, Poland

- Each patient has to be treated individually

"I treat patients, not test results (AHI). There is a wide range of types of patients, so the symptoms are the most important for me."

- Cases beyond doctors reach

"There are patients who say they want to continue the therapy, but they cannot accept CPAP because they have challenges which I cannot recognize and solve."

- Importance of lifestyle changes

"The future is the obesity prevention. Those patients can't gain weight. They have to lose."

Monika Kaleta-Klich, Pulmonologist
Edward Szczekliak Hospital, Tarnów, Poland

- Educate patients

"Patients have to be informed what will happen if they will not use the CPAP device. We have to explain to them the risks of cardiovascular diseases."

- Financial situation defines therapy

"The first question when selecting CPAP device is what is their budget."

Ragnberth Helleday, Pulmonologist
University Hospital, Umeå, Sweden

- Shortage of staff

"We have 5k patients, and we have an ambition to see them every 2nd year - 2,5k patients per year. As a result, we have four years of waiting time for new patients if they are not a priority, 1200 patients are on the waiting list now."

- Communication

"It's nice to visualize the curves and show the data from the sleep test. Graphs help them understand sleep apnea."

- Tele-health

"With new devices, we follow patients' results for the first 3 months. In the future, we could follow the whole treatment via the cloud."

Jonas Backstrom, Nurse
University Hospital, Umeå, Sweden

- Shortage of staff

"We have improved the efficiency, but we still should be 2-3 more nurses."

- Tools to analyze and interpret results

"We have special software to analyze the data from CPAP device. The data is quite good, so we don't need to repeat the sleep test."



Interviews with CPAP salespeople

Two interviews were conducted with sales managers and one with a shop assistant. They were asked about the market of CPAP devices in Poland, patients' expectations towards the equipment and service, and their vision of therapy's future.

Sales Manager 1

- CPAP devices market

"ResMed and Phillips are main competitors."

- Importance of service

"Brand and price are the main selling factors, but service is also important. They want to feel taken care of."

- Future stays with CPAP and telemedicine

"CPAP will still be a golden standard."

Sales Manager 2

- Importance of correct mask selection

"The patient's biggest success is a well-selected mask, and it depends on the salesperson."

- Maintenance problem

"We receive the device back for service, and we are terrified. People don't clean masks, pipes, humidifiers, and filters."

- Telemedicine

"I think that IT systems will be very useful in this matter. The device will send the data to the cloud, and doctors can see that person is not using the device. Then we can contact the person."

CPAP shop assistance

- Just try

"We have a service of renting the device and 3-4 masks before the purchase. They have to check if they can sleep with it."

- Initial worries

"One patient was skeptical while borrowing the device. After the test, he said it the best device, and he bought it the same day."

- Benefits can overcome financial barriers

"If you present all the opportunities to the patients often price becomes negligible."

Awareness

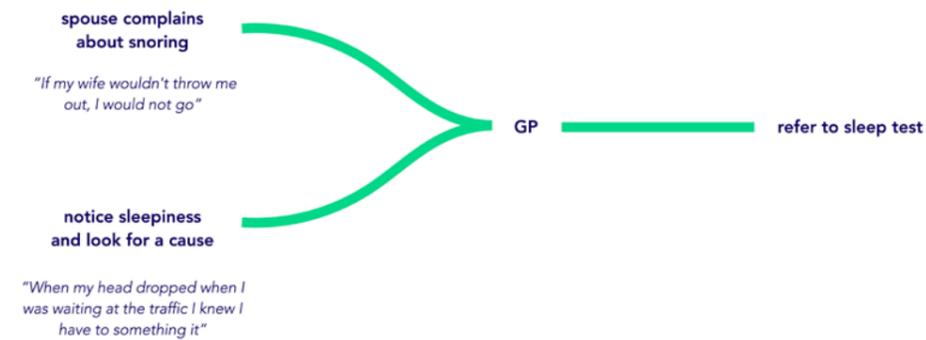
According to Philips' Global Survey, the main reasons for identifying sleep apnea are poor sleep quality, partner/spouse, and noticed that the patient is not breathing or snoring and dangerous situations caused by sleepiness. (1) It overlaps with the findings from user and clinician interviews.

It is important to mention that the awareness of sleep apnea disorder and suspicion of having it, not always leads to taking a sleep test.

"Already a long time ago, I knew I had it. My wife, for a few years, was trying to send me for the test."
Patient

"I knew about it for years but I was postponing it because of lack of time." Patient

For those patients occurrence of dangerous situations such as car accidents caused by sleepiness is the final argument for diagnosing.



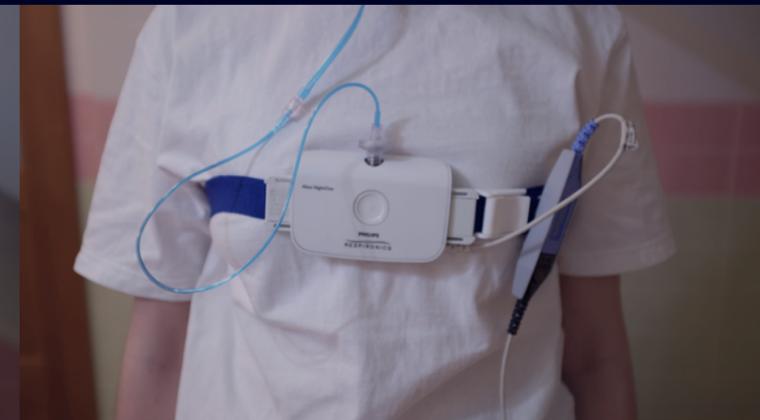
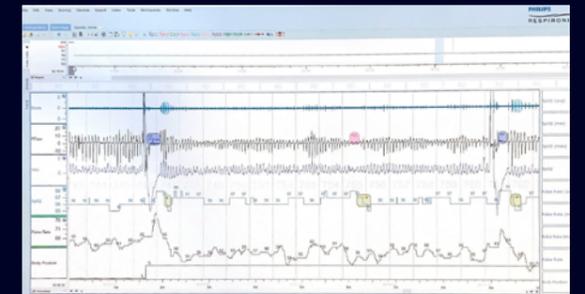
1. <https://www.philips.com/c-dam/b2c/master/experience/smartsleep/world-sleep-day/2020/2020-world-sleep-day-report.pdf>

Diagnosis

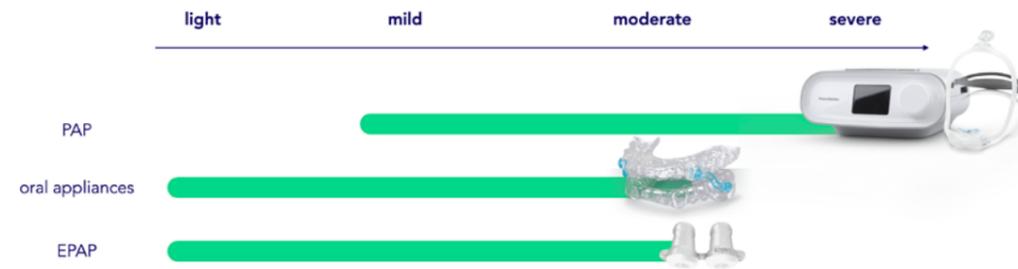
Sleep Test

There are two main types of sleep tests: conducted in the hospital polysomnography and home polygraphy test. In both cases, the collected data is analyzed by software and interpreted by a doctor or a nurse.

I took home a polygraphy test ..to go through the diagnosis process myself. I slept two nights with the Philips Alice NightOne device and had an appointment with a doctor to discuss my results.



METHOD



Types of obstructive sleep apnea

If the patient is diagnosed with OSA, the level of it is defined: light, mild, moderate, or severe. It is done based on the severity of the symptoms and the level of AHI. It is the number of apnea and hypopnea events per hour of sleep. The apneas (pauses in breathing) must last for at least 10 seconds and be associated with decreased blood oxygenation. (1) It is used to indicate the recommended therapy and keep track of the OSA progression.

For patients with light OSA without symptoms, therapy is not required. Patients with mild to moderate OSA have a few options depending on the severity of the systems and other ongoing conditions. For example, CPAP devices, oral appliances, EPAP (Expiratory Positive Airway Pressure), positional therapy, or losing weight. Nevertheless, most of them receive CPAP.

"For patients with mild sleep apnea, we can only suggest CPAP. There is no alternative." Monika Kaleta-Klich, Pulmonologist

For patients with severe apnea, there is only CPAP therapy available.

"Over 30 AHI is severe, and CPAP is the standard. There is no other treatment that really works," Ragnberth Helleday, Pulmonologist.

All doctors indicated that surgery has low efficiency, and only a small group of patients is eligible. However,

new therapies such as simulation therapy are not recognized as a recommended option yet.

Patient Reactions

Expected vs. surprised - Many patients expect the diagnosis as their symptoms are so distinctive and last already for a while. Some of them are already prepared by a GP. However, a group of patients who haven't experienced sleepiness were surprised with the diagnosis or sleep apnea level.

Positive vs. negative - For the majority of the patients, the diagnosis means hope for a better life and relief because they finally know what is causing their sleepiness. Negative emotions are connected with the CPAP device. For example, if they will be able to sleep with it.

"I was hoping to wake up well-rested finally. I was optimistic." Patient

"It got me closer to solve my problems." Patient

Worries:

- expenses
- can't accept that there is no treatment, only therapy
- partner/spouse reaction
- accept wearing something on the face

"Patients are anxious that it is a disorder which cannot be treated, and there is a high chance of having it for life." Tomasz Januś, Pulmonologist

Therapy

According to Philips' Global Survey, 30% of people with sleep apnea somewhat or completely agree that they do not think it is necessary to be treated for sleep apnea, and 39% agree treatment for sleep apnea is worse than the disease itself. (1)

"I would prefer not to have this disorder, but if I'm sentenced to this device, I have no other choice." Patient

CPAP is the most common therapy for OSA. It is also considered the most efficacious. For many users, it improves their sleep and life dramatically.

"After I bought the device, the symptoms disappeared immediately." "I saw a big difference with sleeping with CPAP and the way I have a function during a day" Patient

However, some patients will not accept therapy, while others will not adhere long-term. (2) "It is estimated that between 29% and 83% of patients are not adherent with CPAP ventilation." (3) It often happens to patients who don't have sleepiness syndrome not to experience any improvement in life quality. Simultaneously, their evening routine and sleep quality decrease with the need to use a CPAP device.

"Patients who don't feel the difference in sleep with the therapy are more likely to stop the treatment." Tomasz Januś, Pulmonologist

First 14 days

In the beginning, patients need to get used to the therapy. For those who experience the disappearance of sleepiness, the adaptation process feels better than their regular sleep. However, it is tough as they feel uncomfortable, weird, cannot fall asleep, suffocating with air. If they force themselves through that time, users say that it gets easier with time.

After 90 days

The main challenge is to maintain motivation with time.

"The main problem with the treatment of obstructive sleep apnea syndrome is poor adherence to CPAP in the short term, and even more so in the long term"(2)

"Strong adherence to CPAP at three months (82%) and one year, with a decrease at two years (43%)."(3)

Both studies and interviews indicate the importance of family support as they are associated with improved CPAP adherence. (4)

A discrepancy was found between interviews with clinicians and patients. Doctors strongly advise implementing lifestyle changes such as losing weight. However, none of the interviewed participants mentioned any.

1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3507119/>

1. <https://www.philips.com/c-dam/b2c/master/experience/smartsleep/world-sleep-day/2020/2020-world-sleep-day-report.pdf>

2. <https://pubmed.ncbi.nlm.nih.gov/8793455/>

3. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3218117/>

4. https://www.sciencedirect.com/science/article/pii/S1087079217300448?casa_token=MqXo9W-rdFUAAAA:GnbnPJtCDHCu8izn_-gtJTINoTAFLAzP9oF0-GG3gBp-ZdmchgM1MmBK0ea1JZuPrY5-Vuc3xkk



CPAP therapy

Most people with mild to severe sleep apnea are being prescribed continuous positive airway pressure (CPAP) therapy. With the CPAP device, pressurized air is delivered into a nose to keep breathing passages open and decrease apnea episodes during the night. (1) The main components of CPAP therapy are the CPAP machine, face mask, and connective hose.

The main component of the CPAP device is a motor that takes room air through a filter and pressurized according to settings prescribed by the sleep specialist.

There are several forms of positive airway pressure (PAP) therapy other than CPAP. CPAP machines provide fixed pressure settings, APAP (Autotitrating positive airway pressure) therapy automatically raises or lowers your air pressure as needed during the night, and BPAP (Bilevel positive airway pressure) devices have two alternating levels of pressure for inhale and exhale. (2)



CPAP device



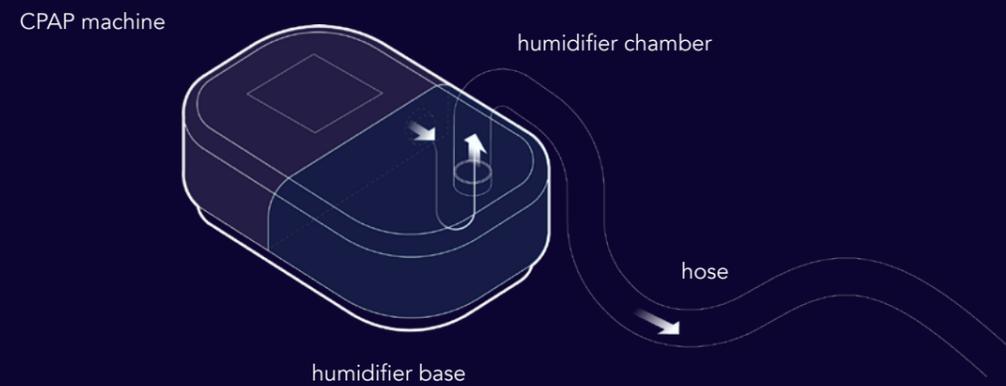
face mask



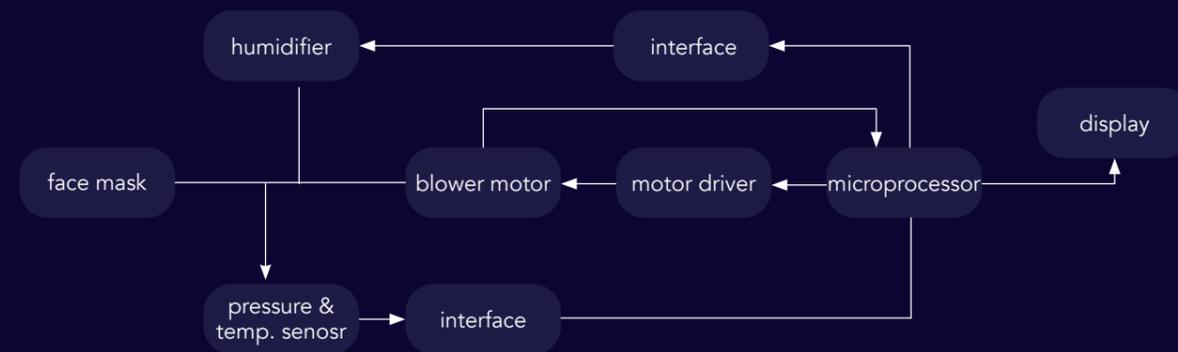
connective hose

1. <https://www.sleepfoundation.org/cpap>
2. <https://sleepeducation.org/patients/cpap/>

CPAP device



components and signal processing



Market analysis

In the market of CPAP devices, there are two leading players: Philips and ResMed. Both companies provide CPAP, APAP, BiPAP, and travel versions of CPAP devices. They also have a wide range of face masks that can be used with competitors' products giving users the freedom to create their own sleep apnea kit.

Comparing those two brands, Philips stands out with the modular design that allows using only CPAP devices or adding humidifiers or battery back. However, the biggest advantage of ResMed devices is the GSM module which sends all the data to the cloud allowing doctors to have full access to patient data. (1) With Philips, data is transferred through Bluetooth to users' phones and accessed by app, yet it is not shared with clinicians. (2)



Philips DreamStation 2
2021



Philips DreamStation
2016



Philips DreamStation Go
2017



ResMed AirSense™ 11
2021-2022



ResMed AirSense™ 10
2014

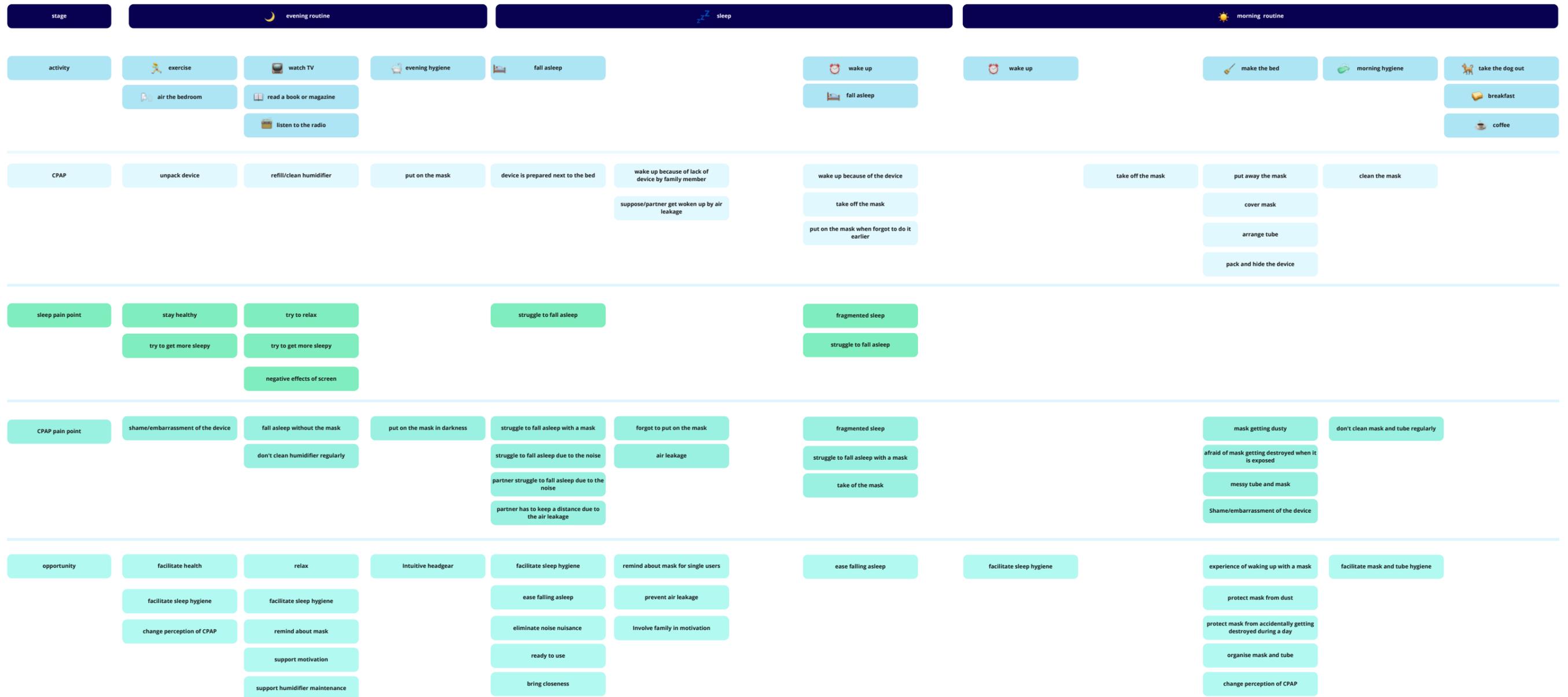


ResMed AirMini
2017

1. <https://www.resmed.co.uk>
2. <https://www.usa.philips.com/healthcare/solutions/sleep>

A Night with CPAP

Based on the user interviews, an overview of the night with CPAP therapy was created. It starts from the evening routine, sleep time to the morning routine. All user activities are divided between regular ones and CPAP related and pain points, respectively.



My night with CPAP

To understand the difficulty of CPAP therapy, I have spent two nights with the CPAP device. I have also tried different masks and evaluated their appearance and comfort with and without air pressure.

The problem I have experienced:

- unable to use a most comfortable nasal mask because of allergy
- overwhelmed with the intensity of the experience
- struggle to breath
- difficulty to fall asleep because of mask discomfort
- staying higly alerted while sleeping because of worrying about the device
- waking up because of mask discomfort
- wake up tired
- unable to fall asleep again with a mask
- pressure ulcers on the nose from the mask
-



Sleep tech

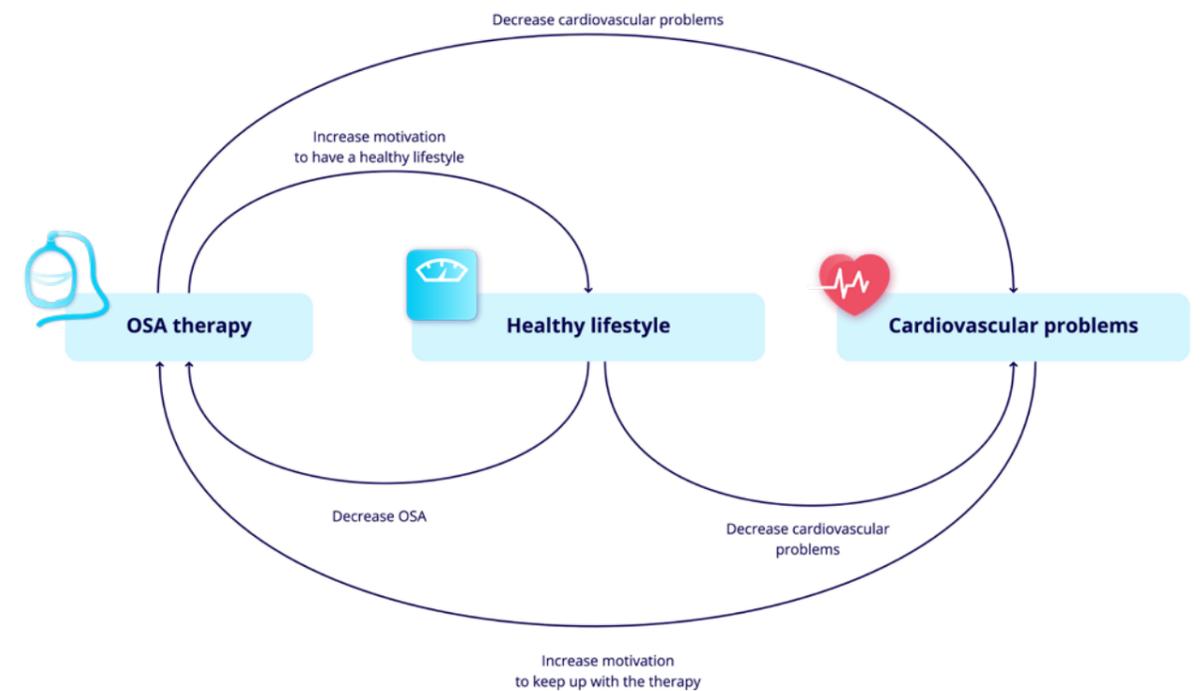
However, most of the patients mention improvements in sleep quality with the use of CPAP, they still struggle with sleep problems. For example, problems to fall asleep caused by the mask discomfort or stress, or waking up in the middle of the night because of the mask or other ongoing conditions. Available sleep tech products were analyzed to investigate possible solutions for those problems. Those products use sounds such as white noise or guided meditation to help fall asleep, light to help with sleep hygiene and aromatherapy for relaxation. Also, some of them help to disconnect from the phone, which has a negative effect on sleep quality.

Many people with sleep apnea also suffer from other ongoing conditions caused, for example, by age or obesity. Sleep-tech has recognized the night as the opportunity to collect health data seamlessly. It includes information about the sleep quality but also heart rate, saturation, and temperature.

There is also a group of products that aim to use patient data and EEG to enhance sleep using slow waves or personal meditation.

Obstructive sleep apnea & health

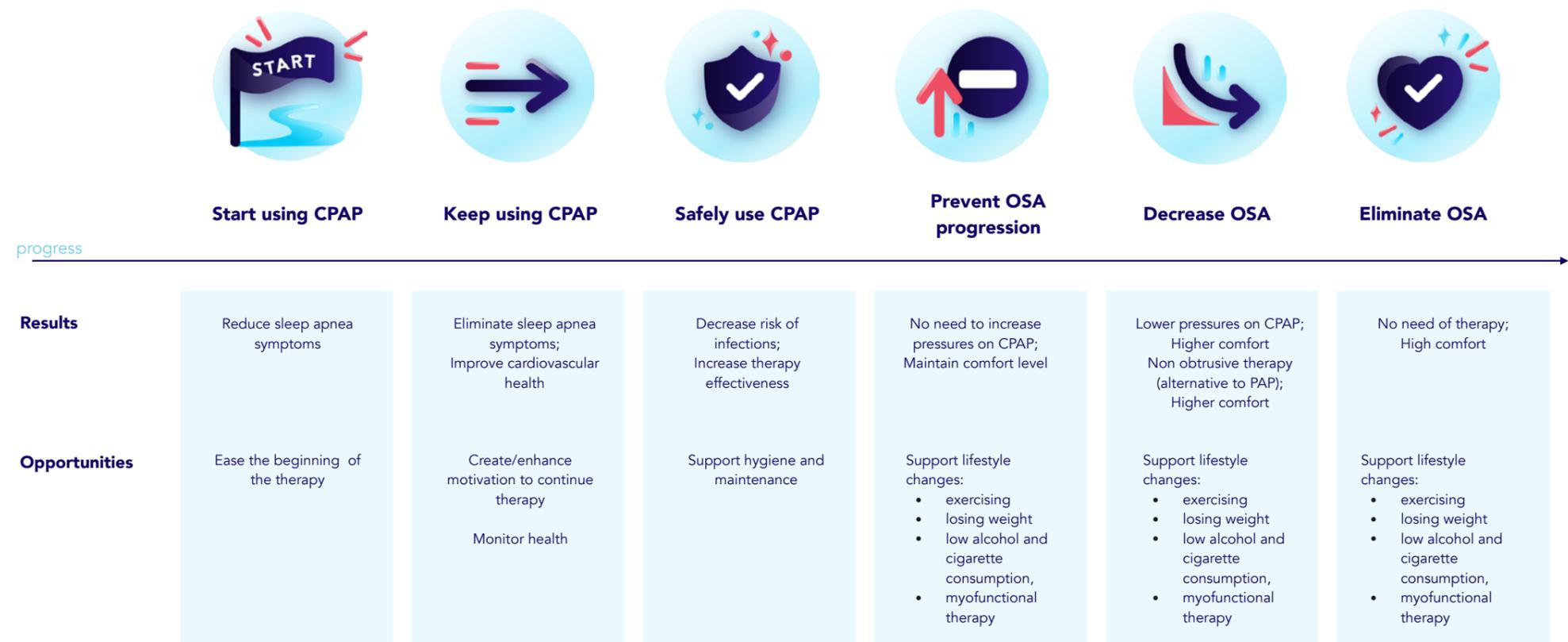
Zooming out of obstructive sleep apnea disorder and looking at those patients more holistically reveals that other aspects of their health are strongly connected. Overweight and an unhealthy lifestyle can cause or enhance obstructive sleep apnea, at the same time, untreated OSA affects cardiovascular health. Change of one of them might affect not only the severity of others but also affects patient's approach and motivation towards the treatment. Looking for the future of obstructive sleep apnea treatment, it is crucial to support patients in all those three elements.



A new approach towards the therapy

All insights from the research were collected and transferred into the list of opportunities. Based on the decision to limit the scope of the therapy, the opportunities were arranged on the timeline. However, a new timeline of the therapy was created, which goes beyond the successful use of CPAP devices and high compliance. Three extra steps were added, which integrate the relation between sleep apnea and lifestyle changes. Together it presents the new approach towards the therapy, which not only focuses on supporting patients to live with their disorder but to prevent progression of it and when it is possible to guide them on the journey to decrease sleep apnea. When apnea is decreased, it increases comfort by reducing required pressure or switching to different, less obstructive therapy (oral devices, position therapy). The ultimate goal of eliminating OSA can be achieved only by a small group of patients. Nonetheless, the device should support patients to regain full health.

With a holistic approach and stating that the therapy goal is patient health, CPAP devices for some patients don't have to be a lifelong therapy, and as a result, the device should guide patients in this thought transition.



Additional interview with doctors

Additional interviews with doctors were conducted to understand better the connection between OSA, cardiovascular health, and lifestyle changes. It included three pulmonologists and one cardiologist.

They all confirmed the strong connection between OAS and cardiovascular health. As a result, only combining information of those two aspects will give the full picture of patient health and might be beneficial for treating them both.

Implementing lifestyle changes is recommended by all doctors to most of the patients. However, only a very small group of patients can implement it successfully to see changes in sleep apnea as it is a challenging process. A new problem was brought up, which often occurs and makes OSA more severe - weight increase.

Lastly, the issue of following patients' OSA progression was brought. However, follow-up visits are recommended, many patients don't follow them. As a result, the progression of their disorder is not monitored.



Cardiovascular Health

+50% of OSA patients have cardiovascular diseases, and half of them are caused by OSA.

"If they accepted CPAP, and use it regularly, we see results, it works!"

Understanding the connection between regular therapy and cardiovascular diseases (HR monitor) can positively affect compliance for some patients (3 out of 4 doctors).

Monitor heart rate.



Lifestyle changes

A very small group of patients manage to lose weight because it is so difficult.

Weight increase is more common than weight loss. It affects around 40-50% OSA patients.

With obesity, we can say that almost all patients have high blood pressure. Many have diabetes, coronary diseases, arrhythmia.



Monitoring progression

Patients rarely come to follow-up visits every 6-12 months.

The cardiovascular patient should come to follow-up visits twice more often (every 3 months instead of 6) to control changes and adjust medication.

It's up to the patient to recognize if something is wrong to contact a doctor about the appointment.

Additional user research / questionnaire

To check how those problems look from the patient's perspective, a short questionnaire was sent to patients. It was filled in by 16 patients.

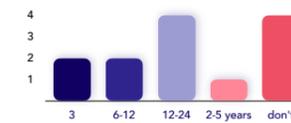
The findings are aligned with insights from doctors. The majority of the patients have ongoing cardiovascular diseases. Also, 80% of all of them were recommended to implement lifestyle changes due to the OSA. The most common change was weight loss.

In terms of check-ups, most of them follow the recommendation. However, there is a group of patients who don't do it regularly or at all.

Check-ups with a doctor

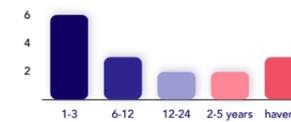


7/18 does know how if their OSA is progressing



frequency of followup appointments

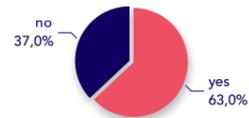
"With national healthcare system it is too complicated"



last appointment

"My appointment was cancelled due to covid restrictions in my hospital"

Cardiovascular diseases

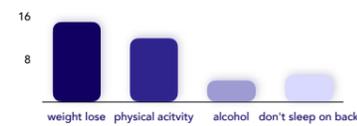


cardiovascular diseases

Lifestyle changes



recommended lifestyle changes

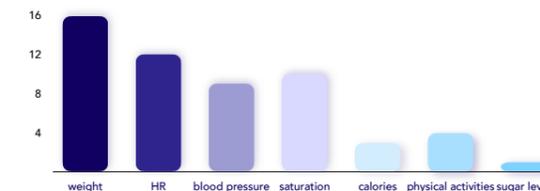


type of lifestyle changes

" I'm trying, but it is vey hard"

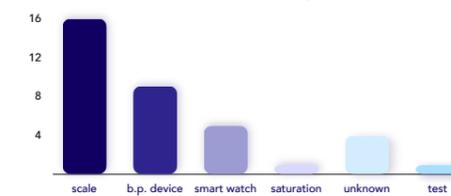
" No" x2

Health monitoring



Which values do you monitor?

ECG



How?

"I have signed up to the metabolic clinic"

Problem definition

CPAP device is the most common therapy for sleep apnea and from the moment of diagnosis stays with a patient till the end of their life. At the same time, it is obtrusive and uncomfortable. Some patients will not accept therapy, while others will not adhere long-term despite the severe health consequences. However, there is no successful and accessible treatment for sleep apnea, some lifestyle changes such as losing weight, exercising, myofunctional therapy, and low alcohol and cigarette consumption can significantly reduce the level of sleep apnea. For some patients, it will mean decreasing the air pressure on the CPAP device and making it easier to tolerate or possibly to change to the less claustrophobic nasal mask. For other patients, it might reduce sleep apnea to the level in which they can switch to less obtrusive treatment such as oral appliances, EPAP, and positional therapy or even eliminate the need for any therapy. So how might we support lifestyle changes with CPAP therapy?

What?

A solution that helps people with sleep apnea to manage their sleep disorder and improve their well-being.

Why?

The research shows a need for a supportive solution for CPAP users because, without external stimulation, therapy adherence decreases, and no action is taken to minimize sleep apnea.

Who?

For people with mild to severe sleep apnea who are undergoing CPAP therapy

Where?

Bedroom environment

Goals & Wishes

Goals:

- Create/enhance motivation to continue therapy
- Support self-management in the therapy
- Support lifestyle changes that can decrease sleep apnea

Wishes:

- Monitor lifestyle changes and health while we are sleeping
- Support sleep hygiene
- Simple usage with low maintenance
- Non-medical appearance
- Be perceived as trustworthy



Motivate to continue the therapy.



Motivate to keep up with lifestyle changes that might decrease the disorder (e.g., lose weight).



Monitor heart rate variability due to common cardiovascular diseases.



The less medical appearance of CPAP device to decrease the stigma of having it in the bedroom.

References

Page 2

1. <https://pubmed.ncbi.nlm.nih.gov/31256784/>
2. <https://www.sleepfoundation.org/how-sleep-works>
3. <https://www.sleepfoundation.org/how-sleep-works/how-much-sleep-do-we-really-need>
4. <https://www.msmanuals.com/professional/pulmonary-disorders/sleep-apnea/obstructive-sleep-apnea>
5. <https://www.sleepfoundation.org/sleep-apnea>
6. <https://www.ncbi.nlm.nih.gov/books/NBK535538/>
7. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3140752/>

Page 4

- 1 <https://pubmed.ncbi.nlm.nih.gov/31509498/>
- 2 <https://pubmed.ncbi.nlm.nih.gov/31509498/>
- 3 <https://www.msmanuals.com/professional/pulmonary-disorders/sleep-apnea/obstructive-sleep-apnea>
- 4 <https://www.sleepfoundation.org/sleep-apnea/obstructive-sleep-apnea>
- 5 https://www.sciencedirect.com/science/article/pii/S0953620512001525?casa_token=Mjk9c3D_8SUAAAAA:8b3axatp4_IQGy7oy-rZrc1kUsiuTu1Um3gVovJQz8PriPonhQSp4zKQ_k3qNn2GQW8RedYlhY

Page 7

- 1 <https://www.reuters.com/article/us-philips-idUSL2131786820071221>
- 2 <https://www.usa.philips.com/healthcare/solutions/sleep-and-respiratory-care>

Page 19

1. <https://www.sleepfoundation.org/how-sleep-works/how-much-sleep-do-we-really-need>
2. <https://www.sleepfoundation.org/sleep-hygiene>
3. <https://www.philips.com/c-dam/b2c/master/experience/smartsleep/world-sleep-day/2020/2020-world-sleep-day-report.pdf>

Page 20

1. <https://www.sleepfoundation.org/sleep-apnea>

Page 28

1. <https://www.philips.com/c-dam/b2c/master/experience/smartsleep/world-sleep-day/2020/2020-world-sleep-day-report.pdf>

Page 30

1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3507119/>

Page 31

1. <https://www.philips.com/c-dam/b2c/master/experience/smartsleep/world-sleep-day/2020/2020-world-sleep-day-report.pdf>
2. <https://pubmed.ncbi.nlm.nih.gov/8793455/>
3. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3218117/>
4. https://www.sciencedirect.com/science/article/pii/S1087079217300448?casa_token=MqXo9W-rdFUAAAAA:GnbnPJtCDHCu8izn_-gtJTINoTAFLAzP9oF0-GG3gBp-ZdmchgM1MmBK0ea1JZuPrY5-Vuc3xkk

Page 33

1. <https://www.sleepfoundation.org/cpap>
2. <https://sleepeducation.org/patients/cpap/>

Page 35

1. <https://www.resmed.co.uk>
2. <https://www.usa.philips.com/healthcare/solutions/sleep>

Page 63

1. <https://psycnet.apa.org/record/2012-17300-000>
2. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4691359/>

Page 94

1. https://www.researchgate.net/publication/309653430_Estimation_of_heart_rate_during_sleep_measured_from_a_gyroscope_embedded_in_a_CPAP_mask

