

Contamination Assessment in Continuous Positive Airway Pressure Devices Using a Complete Disassembly Cleaning Protocol: Two Years of Experience

Tae Jong Kim, BS¹, Kyung Soo Kim, MD, PhD², and Hyun Jin Min, MD, PhD²

¹HAPPY PAP, Hwaseong, Republic of Korea

²Department of Otorhinolaryngology-Head and Neck Surgery, Chung-Ang University College of Medicine, Seoul, Republic of Korea

Background and Objectives: Obstructive sleep apnea (OSA) is a prevalent disorder that is commonly managed with continuous positive airway pressure (CPAP) therapy. Although CPAP is clinically effective, issues related to device hygiene and contamination remain understudied. This study aims to present a practical protocol for CPAP disassembly and cleaning and to report the outcomes of its implementation over a 2-year period.

Methods: We conducted a retrospective chart review of 359 OSA patients prescribed CPAP therapy between 2018 and 2025. Of these, 136 patients participated in a complimentary, comprehensive CPAP cleaning service. Contamination was assessed using a subjective visual analog scale (VAS) following photographic documentation of each device component. The relationship between contamination scores and device usage duration was analyzed.

Results: Patients who received the cleaning service did not differ significantly from the overall cohort in terms of age, sex, apnea-hypopnea index, or average daily usage time, except that they had a significantly shorter total duration of usage. Contamination was found on all device components, including internal parts that are not routinely inspected. Positive correlations between contamination levels and usage duration were statistically significant for every component. The cleaning process required approximately 2 days per device and was feasible for routine clinical implementation.

Conclusion: CPAP devices accumulate visible contamination over time, emphasizing the need for standardized cleaning protocols. Our experience indicates that physician-led education, patient cooperation, and dedicated involvement of paramedical staff are essential in reducing contamination risks. Interdisciplinary collaboration is recommended to develop evidence-based guidelines for CPAP hygiene management.

Keywords: Obstructive sleep apnea; Continuous positive airway pressure; Hygiene; Equipment contamination.

INTRODUCTION

Obstructive sleep apnea (OSA) is a common and multifactorial disorder influenced by genetic, environmental, and developmental factors. Recent global estimates suggest that up to 54% of individuals may be affected, highlighting the widespread nature of this disease [1,2]. Continuous positive airway pressure (CPAP) therapy remains the gold standard for OSA

management and is widely acknowledged for its clinical efficacy [3]. Nevertheless, despite its broad adoption, there is limited research addressing the hygienic challenges and potential microbial contamination associated with CPAP devices.

Relatively few studies have investigated CPAP hygiene, with one prominent report noting bacterial growth in nearly half (48.6%) of sampled devices [4]. However, subsequent research on this topic—particularly studies utilizing practical, non-laboratory-based assessment methods—remains scarce. There is a notable gap in data on contamination that can be evaluated using accessible, non-culture-based procedures.

In an earlier study, we described a practical method for assessing visible contamination of CPAP devices by means of thorough disassembly and cleaning, a process that can be implemented in clinical settings without specialized microbiological expertise [5]. In that earlier study, we evaluated the

Received: June 2, 2025 Revised: June 24, 2025

Accepted: June 27, 2025

Address for correspondence: Hyun Jin Min, MD, PhD, Department of Otorhinolaryngology-Head and Neck Surgery, Chung-Ang University College of Medicine, 102 Heukseok-ro, Dongjak-gu, Seoul 06973, Republic of Korea
Tel: +82-2-6299-1765, Fax: +82-2-825-1765, E-mail: jjinient@cau.ac.kr

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<https://creativecommons.org/licenses/by-nc/4.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

contamination levels present in CPAP machines used regularly by individuals with OSA and investigated variables associated with contamination extent. In the present study, we aim to provide a detailed description of our CPAP cleaning protocol and to share our experience and findings after approximately two years of implementing this cleaning service.

METHODS

Study design

This retrospective chart review included patients diagnosed with OSA and prescribed CPAP therapy at our institution between September 2018 and April 2025. The study protocol was approved by the Institutional Review Board of Chung-Ang University Hospital (Approval No. 2503-018-19568). Eligible participants were those who demonstrated consistent CPAP use for at least 6 months and attended regular outpatient follow-up visits twice yearly. Patients were excluded if their polysomnography data could not be verified, if records of CPAP usage compliance were incomplete, or if information regarding whether CPAP cleaning had been performed was unavailable. At the time of device initiation, patients received education on proper CPAP maintenance according to an institutionally developed protocol, and adherence was monitored during follow-up visits. The recommended hygiene regimen included daily washing of the mask and humidifier chamber with a mild, neutral detergent, followed by air drying to preserve material integrity. The tubing was also cleaned daily in a similar fashion and left to dry naturally. The main device unit was cleaned as needed, with visible dust removed during routine use. In addition, CPAP filters were systematically replaced by clinical personnel at intervals not exceeding 3 months. Beginning in January 2023, our center launched a complimentary, in-house CPAP disassembly and cleaning service, offered to all patients undergoing CPAP therapy. The procedure was performed by two experienced technicians, who documented contamination for each component using photographic evidence (Figs. 1 and 2) and assigned subjective contamination scores on a visual analog scale ranging from 0 (no contamination) to 10 (most severe contamination), following device disassembly and cleaning. Criteria for selecting candidates for the cleaning service included a minimum of 1 year of CPAP device use and informed consent for a 3–5 day turnaround (including approximately 2 days for the cleaning process and an additional 2 to 3 days for round-trip shipping). For patients with over 4 years of device use, options such as device replacement or annual cleaning were generally recommended. After the initial cleaning, no fixed schedule was imposed; additional cleaning was made available upon patient request at any time.

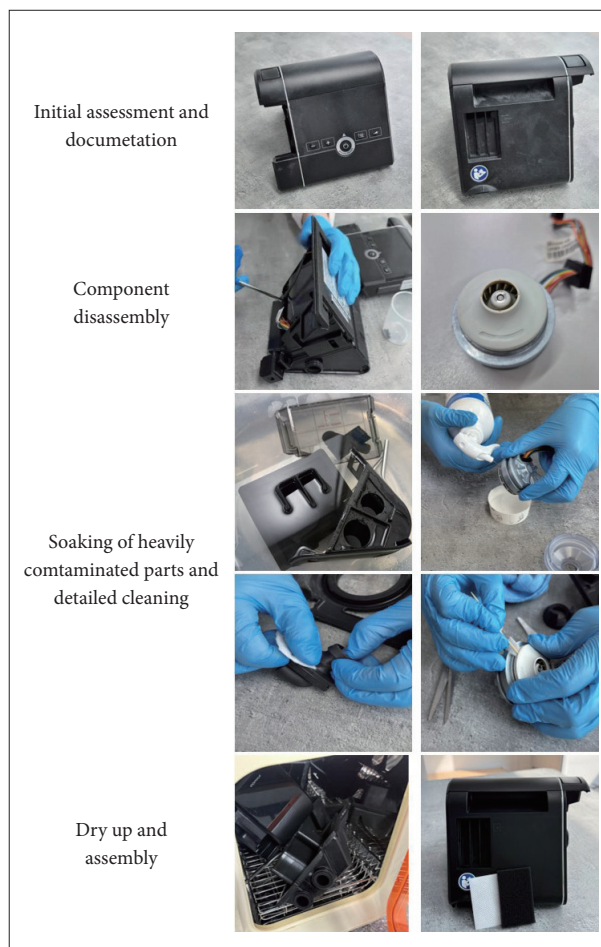


Fig. 1. Photographic documentation of the complete disassembly and cleaning process of continuous positive airway pressure devices according to the protocol. Images illustrate each step of the cleaning protocol, including device collection, initial inspection, component disassembly, soaking of heavily contaminated parts, detailed cleaning of non-soaked parts, and final drying and reassembly.

Protocols of the total complete disassembly and cleaning process of the CPAP device

Day 1

Device collection: The CPAP device was either collected directly from the patient or retrieved via courier service.

Initial assessment: Upon arrival, the device was inspected for external contamination and total usage time was recorded.

Pre-cleaning documentation: Photographs were taken prior to cleaning, if deemed necessary.

Component disassembly: The device was fully disassembled into its individual components (Supplementary Video in the online-only Data Supplement).

Soaking of heavily contaminated parts: Key components prone to buildup, such as the water chamber and blower motor, were soaked for approximately one day in a solution con-

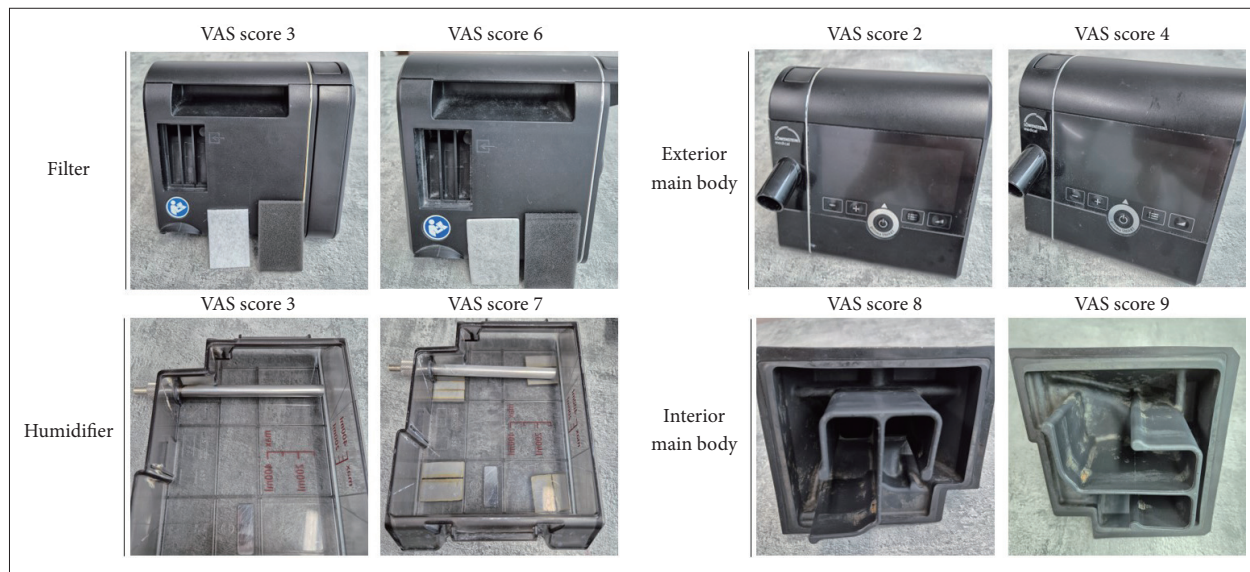


Fig. 2. Representative photograph demonstrating contamination levels on continuous positive airway pressure device components. VAS, visual analog scale.

Table 1. Demographic and clinical characteristics of study participants

Characteristics	Total patients (n=359)	Patients who underwent CPAP cleaning (n=136)	p-value
Age (yr)	55.59±16.60	54.96±12.49	0.865
Male:female	301:58	114:22	0.995
Apnea-hypopnea index	46.35±24.12	44.86±22.63	0.433
Total duration of usage (day)	1,032.58±684.47	921.04±545.18	<0.001
Average daily duration of usage (h)	4.61±1.93	4.82±1.56	0.593

Values are presented as mean±standard deviation. CPAP, continuous positive airway pressure

taining a descaling agent and disinfectant.

Detailed cleaning of non-soaked parts: The remaining components were cleaned using compressed air and alcohol for detailed removal of contaminants.

Day 2

Detailed cleaning of soaked parts: The previously soaked components were thoroughly cleaned and then dried using a medical-grade sterilizing dryer (Figs. 1 and 2).

Statistical analysis

A detailed descriptive analysis was performed to summarize the study data. Continuous variables were expressed as mean values with corresponding standard deviations, while categorical variables were reported as absolute counts. Differences between the two groups were analyzed using the independent t-test and the chi-square test. Relationships between contamination levels and device usage durations were examined using Pearson correlation analysis. All statistical analyses were conducted with GraphPad Prism software.

RESULTS

Medical records from 359 patients diagnosed with OSA were reviewed, among whom 136 received the complimentary disassembly and cleaning service. Patients who received the cleaning service did not differ significantly from the overall cohort in terms of age, sex, apnea-hypopnea index, or average daily usage time, with the exception of a significantly shorter total duration of usage ($p<0.001$) (Table 1).

Among the 136 patients who underwent CPAP cleaning, the average mask usage duration was 10.63 ± 5.95 months, with a corresponding contamination score of 3.47 ± 1.89 . The average tubing usage period was 10.86 ± 6.20 months, with a contamination score of 3.44 ± 2.36 . Filters were used for an average of 2.93 ± 1.00 months, yielding a contamination score of 3.48 ± 2.36 . The mean overall CPAP usage duration was 921.04 ± 545.18 days. Corresponding contamination scores were 4.13 ± 2.51 for the humidifier, 3.30 ± 2.30 for the interior main body, and 3.47 ± 1.88 for the exterior main body (Table 2).

The association between duration of use and contamina-

tion levels for each CPAP component was subsequently examined. Statistically significant positive correlations were observed for all components. The correlation coefficients (r) were as follows: mask contamination ($r=0.4445$, $p<0.001$), tubing ($r=0.2858$, $p=0.007$), filter ($r=0.2048$, $p=0.016$), humidifier ($r=0.2160$, $p=0.011$), exterior main body ($r=0.3358$, $p<0.001$), and interior main body ($r=0.2009$, $p=0.018$) (Fig. 3).

DISCUSSION

The prevalence of OSA and the utilization of CPAP thera-

Table 2. Usage duration and contamination levels of CPAP components in patients who received complete disassembly and cleaning service

Characteristics	Value
Duration of mask usage (mon)	10.63±5.95
Duration of tube usage (mon)	10.86±6.20
Duration of filter usage (mon)	2.93±1.00
Visible contamination of the mask	3.47±1.89
Visible contamination of the tube	3.44±2.36
Visible contamination of the filter	3.48±2.36
Visible contamination of the humidifier	4.13±2.51
Visible contamination of the interior main body	3.30±2.30
Visible contamination of the exterior main body	3.47±1.88

Values are presented as mean±standard deviation. CPAP, continuous positive airway pressure

py have increased substantially in recent years [6]. Despite this growth, standardized protocols or evidence-based guidelines for the hygienic maintenance of CPAP devices remain lacking. This gap is concerning given the risks of contamination, such as microbial colonization, and the associated secondary health complications. To address this issue, we developed and implemented a comprehensive, complimentary CPAP disassembly and cleaning protocol at our institution—representing the first systematic report to detail such a protocol and its clinical application over an extended period.

Over approximately 2 years, 136 cleaning procedures were conducted using this protocol, yielding several key observations. First, the complete cleaning process required about two days per device, including disassembly and reassembly, immersion in sterilizing solutions, drying with medical-grade equipment, detailed cleaning, and packaging. In our experience over the past two years, repeated incidents of CPAP device malfunction occurred when sensor tubes were not adequately dried during the cleaning process. This finding underscores the importance of involving experienced technicians in the cleaning procedure to ensure proper handling and to prevent equipment failure. We also identified specific vulnerabilities of the device related to the home environment. For example, when a humidifier emitting mineral dust was used in the same area as the CPAP device, frequent motor failures occurred due to dust infiltrating the motor. This highlights the importance

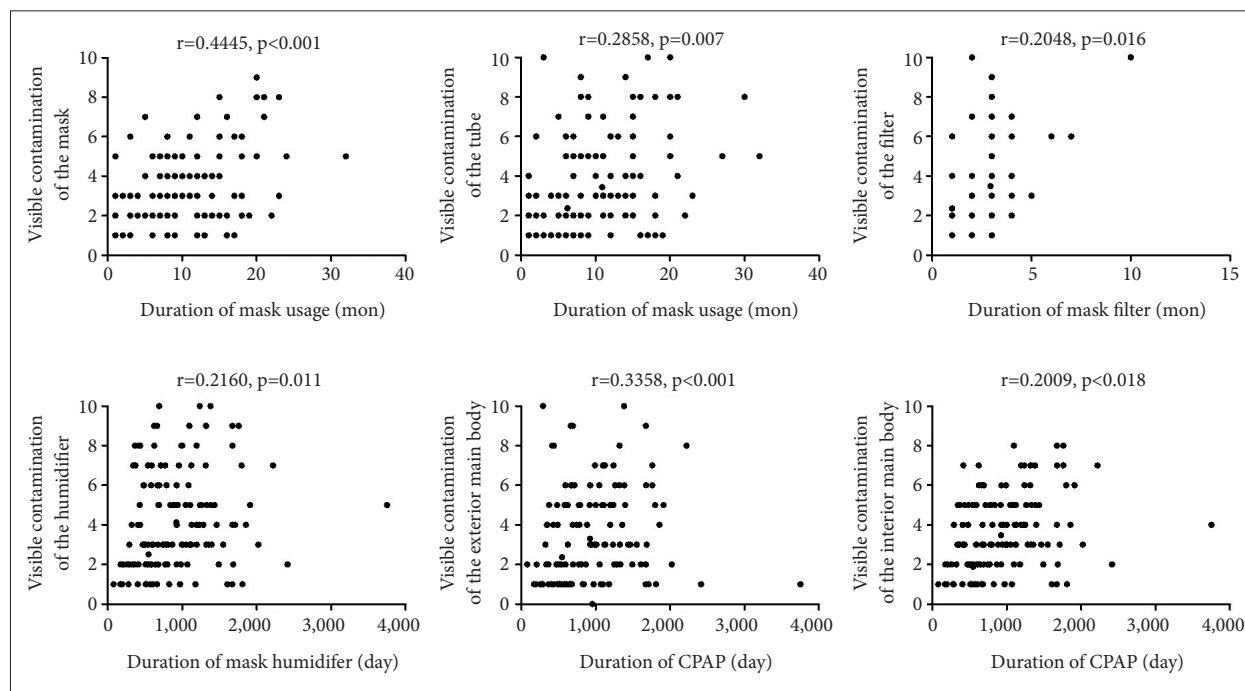


Fig. 3. Correlation between duration of use and contamination levels of CPAP components. Scatter plots depict the relationship between usage duration (in months or days) and contamination scores for various CPAP parts, including the mask, tubing, filter, humidifier, interior main body, and exterior main body. Correlation coefficients (r) and p -values are reported for each component. CPAP, continuous positive airway pressure.

of active physician-led education, patient cooperation, and the specialized involvement of paramedical staff in device maintenance. Secondly, contamination was observed not only on external components, such as masks and tubing, but also on internal parts like filters and blower motors, which are often overlooked in routine cleaning. Interestingly, the humidifier exhibited the highest level of contamination (Table 2). Because the humidifier operates in a consistently moist environment with daily water replenishment—conditions conducive to microbial growth—it may be especially prone to contamination. Therefore, we suggest that future humidifier designs incorporate white or transparent materials to enable patients to more easily monitor contamination levels during home use. Third, significant positive correlations were found between cumulative usage duration and contamination severity across all components, underscoring the need for usage monitoring, component-specific hygiene management, and timely replacement. The establishment of clear and standardized guidelines for the timing of CPAP component replacement based on usage, alongside comprehensive cleaning procedures, is strongly warranted.

This study has several limitations, including reliance on a subjective contamination scoring system without standardized criteria or formal validation of inter-rater reliability. Although we previously evaluated the microbiome and mycobiome of CPAP devices, such analyses are time-consuming and costly. As a result, we explored more accessible assessment methods for clinical use; however, identifying a suitable objective marker remains challenging [7]. In addition, the single-center design limits generalizability, and the absence of a control group precludes meaningful conclusions regarding clinical improvement resulting from cleaning. Finally, the current study did not account for various external factors that may influence CPAP contamination, such as usage environment and storage conditions. This limitation may have contributed to the predominantly weak to moderate correlation coefficients observed ($r=0.2-0.4$), and the potential impact of these unmeasured variables on contamination levels cannot be ruled out. Future research should incorporate quantitative microbiological analyses, standardized contamination metrics, and multicenter validation to build upon these preliminary findings.

Despite these constraints, this study presents the first comprehensive protocol for the complete disassembly and cleaning of CPAP devices, demonstrating its feasibility and clinical relevance over an extended period. Future investigations should focus on developing standardized, objective contamination assessment tools and multicenter validation of cleaning protocols, ultimately aiming to establish evidence-based guidelines that enhance patient safety and treatment efficacy in

OSA patients.

Supplementary Video Legend

Video 1. The process of continuous positive airway pressure component disassembly.

Supplementary Materials

The online-only Data Supplement is available with this article at <https://doi.org/10.18787/jr.2025.00027>.

Availability of Data and Material

Data from this study are available from the corresponding author upon reasonable request. The data are not publicly available.

Conflicts of Interest

Hyun Jin Min who is on the editorial board of the *Journal of Rhinology* was not involved in the editorial evaluation or decision to publish this article. All remaining authors have declared no conflicts of interest.

Author Contributions

Conceptualization: Kyung Soo Kim, Hyun Jin Min. **Data curation:** Tae Jong Kim. **Formal analysis:** Hyun Jin Min. **Methodology:** Tae Jong Kim, Kyung Soo Kim. **Writing—original draft:** Tae Jong Kim, Hyun Jin Min. **Writing—review & editing:** Hyun Jin Min.

ORCID iDs

Tae Jong Kim	https://orcid.org/0009-0006-1591-0252
Kyung Soo Kim	https://orcid.org/0000-0003-2637-0555
Hyun Jin Min	https://orcid.org/0000-0003-3075-1350

Funding Statement

None

Acknowledgments

We are very thankful to Jin Sun Kim (HAPPY PAP, Gyeonggi Province, South Korea) for their considerable CPAP device cleaning service provided for OSA patients.

REFERENCES

- 1) Strollo PJ Jr, Rogers RM. Obstructive sleep apnea. *N Engl J Med* 1996; 334(2):99-104.
- 2) de Araujo Dantas AB, Gonçalves FM, Martins AA, Alves GÁ, Stechman-Neto J, Corrêa CC, et al. Worldwide prevalence and associated risk factors of obstructive sleep apnea: a meta-analysis and meta-regression. *Sleep Breath* 2023;27(8):2083-109.
- 3) Chang JL, Goldberg AN, Alt JA, Mohammed A, Ashbrook L, Auckley D, et al. International Consensus Statement on Obstructive Sleep Apnea. *Int Forum Allergy Rhinol* 2023;13(9):1061-482.
- 4) Chin CJ, George C, Lannigan R, Rotenberg BW. Association of CPAP bacterial colonization with chronic rhinosinusitis. *J Clin Sleep Med* 2013;9(7):747-50.
- 5) Choi JH, Kwak IY, Kim KS, Min HJ. Level of contamination of positive airway pressure devices used in obstructive sleep apnea. *Clin Exp Otorhinolaryngol* 2024;17(2):160-7.
- 6) Park DH, Choi H, Nam K, Lee SH, Seo MY. Prognostic factors related to sleep quality in patients with obstructive sleep apnea after positive airway pressure therapy. *J Rhinol* 2024;31(2):86-92.
- 7) Min HJ, Choi BY, Sul WJ, Cho HJ. Microbiome and mycobiome analyses of continuous positive airway pressure devices. *Clin Exp Otorhinolaryngol* 2024;17(4):292-301.