

# Performance Report




Product Name: Soteria One Point Zero

Software Version No.: 1.0

Document No.: OPZ-018

Revision No.: 01

Publication Date: 2019/05/02

Approver:  2019.5.2  
Reviewer:  2019/5/2  
Author:  2019.5.2  
(Signature and Date)



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## **1. Introduction**

This document describes the performance of Soteria One Point Zero (version no.: 1.0). This report is prepared with the consideration of following references:

- Software as a Medical Device (SAMD): Clinical Evaluation – Guidance for Industry and Food and Drug Administration Staff (December 8, 2017);
- Clinical Evaluation: A Guide for Manufacturers and Notified Bodies Under Directives 93/42/EEC and 90/385/ECC (MEDDEV 2.7/1 revision 4)

## **2. Purpose of the report**

This performance report is a late-development-stage report. The goal is to establishing a baseline of the product performance and as an evidence that Soteria One Point Zero can be used safely and efficiently.

## **3. Product description**

Soteria One Point Zero is a cloud based stand-alone software platform designed to display and analyze head and neck medical images. The software utilizes automatic airway detection algorithm / manual airway selection, 3-D model reconstruction, and computational fluid dynamics (CFD) to simulate and calculate for flow characteristics include flow velocity and pressure within the airway. These information can be used to determine if the airway is obstructed and at which location.

## **4. Intended use**

Soteria One Point Zero is a cloud based stand-alone software platform designed to display and analyze head and neck medical images.

## **5. Indication for use**

Soteria One Point Zero is a cloud based stand-alone software platform designed to display and analyze head and neck medical images (DICOM compatible images) for airway flow

characteristics including flow velocity and pressure within the airway. These results are intended to be used along with patient's clinical history, as well as physicians' professional judgment. These information are not for immediate diagnostic nor treatment use, they are used to determine if the airway is obstructed and at which location.

## **6. Method**

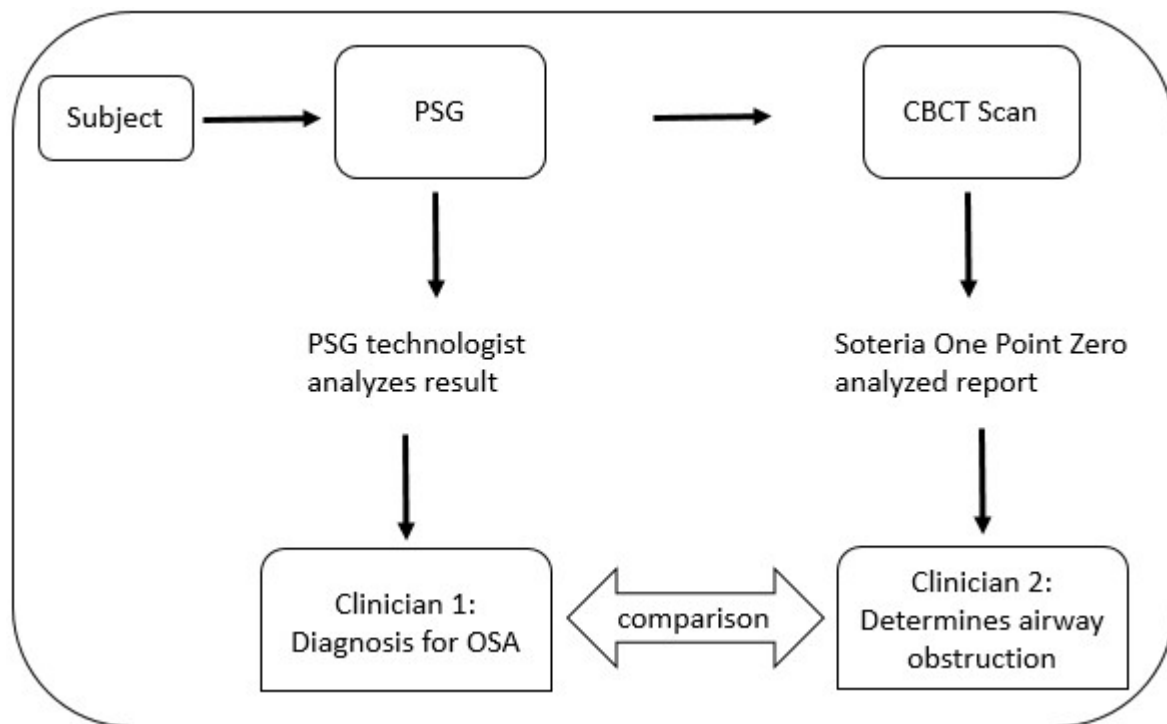
This study included 200 subjects from different sites, sites include Chang-Gang Memorial Hospital (Taoyuan, Taiwan, with 89 subjects), China Medical University Hospital (Taichung, Taiwan, with 71 subjects), and Kaohsiung Medical University Hospital (Kaohsiung, Taiwan, with 40 subjects). Subjects were grouped into control group (subject without obstructive sleep apnea, OSA) and OSA group by the diagnosis.

Obstructive sleep apnea is a common sleep disorder of adults and children, it is characterized by repetitive transient reversible upper airway obstructions during sleep. In general, patient with OSA has narrower upper airway compare with subject without OSA. According to American Academy of Sleep Medicine (AASM), OSA is diagnosed by using the polysomnography (PSG) result plus clinical symptoms, this is currently the gold standard for OSA diagnosis. The result of PSG is presented as apnea hypopnea index or AHI and it is defined as number of apnea (complete cessation of airflow for at least 10 seconds) or hypopnea (airflow decreases by 50% for 10 seconds or decreases by 30% if there is an associated decrease in the oxygen saturation or an arousal from sleep) in an hour. The severity of OSA is classified by AHI where  $AHI < 5$  per hour is considered as normal or minimal,  $AHI \geq 5$ , but  $< 15$  per hour is mild,  $AHI \geq 15$ , but  $< 30$  per hour is moderate, and  $AHI \geq 30$  per hour is considered as severe.

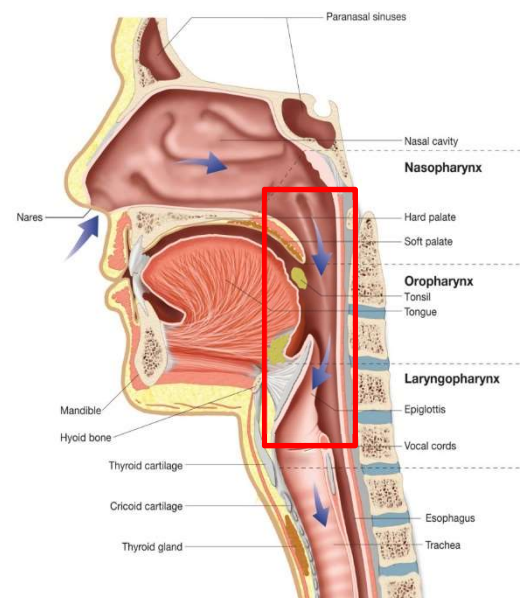
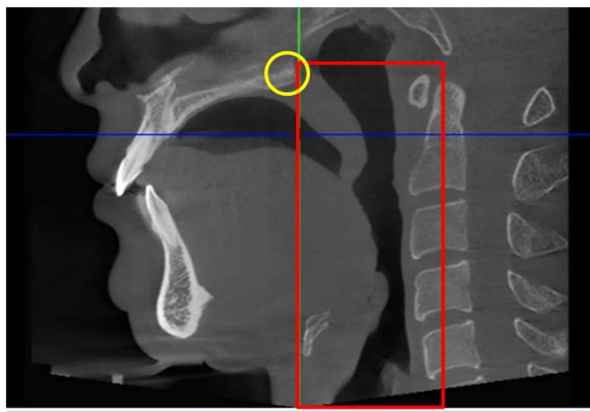
The study procedure flow chart is shown in Figure 1, subject first get diagnosis by the first clinician with gold standard method. The same subject then takes the Cone Beam Computed Tomography (CBCT) scan, the scanned image is analyzed by the software and the report is presented to the second clinician and the clinician determines if subject's

airway is obstructed. Finally the results from the first and the second clinicians are compared.

The specification of CBCT scan is shown in Figure 2.



**Figure 1.** Study flow chart



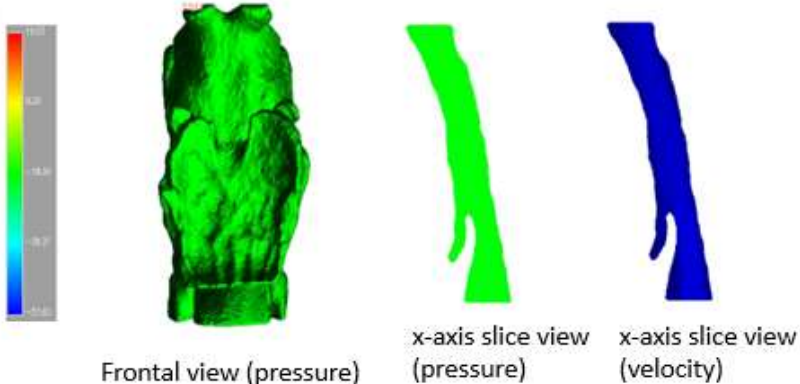
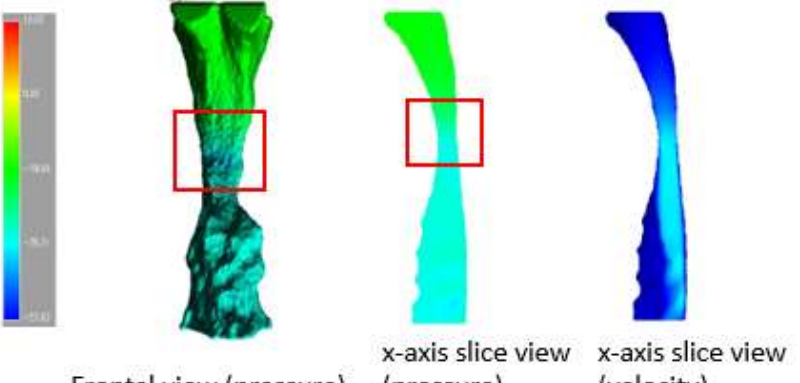
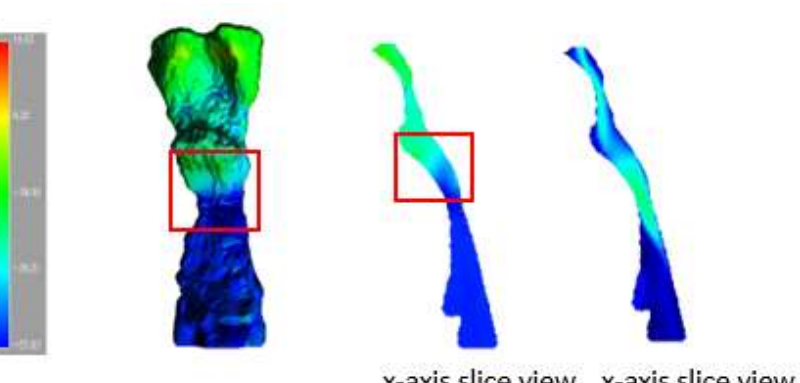
**Figure 2.** The region of CBCT scan.

The red rectangle region is around 7-9cm;

Pixel size: 0.06cm \* 0.06cm \* 0.06cm;

The criteria for determine subject with or without airway obstruction is shown in Table 1 below:

**Table 1.** Criteria for determine subject with or without airway obstruction

Software report	Condition
 <p>Frontal view (pressure)</p> <p>x-axis slice view (pressure)</p> <p>x-axis slice view (velocity)</p>	<p>The color distribution shows a uniform color which means minimal pressure or velocity change. The interpretation is the air flow through this section of the airway smoothly without obstruction</p> <p><b>Condition = Without obstruction</b></p>
 <p>Frontal view (pressure)</p> <p>x-axis slice view (pressure)</p> <p>x-axis slice view (velocity)</p>	<p>The color distribution showed color difference at the section boxed in red which means pressure difference at that location. The interpretation is the air flow through that section with some obstruction causing change of the pressure and velocity.</p> <p><b>Condition = Airway obstruction</b></p>
 <p>Frontal view (pressure)</p> <p>x-axis slice view (pressure)</p> <p>x-axis slice view (velocity)</p>	<p>The color distribution showed a sharp color change from green to dark blue at the section boxed in red which means a large pressure difference at that location. The interpretation is the air flow through this section of the airway with obstruction causing sharp change of the pressure and velocity.</p> <p><b>Condition = Airway obstruction</b></p>

## 7. Selection and Exclusion of Subjects

Selection Criteria:

1. Male or female subjects age equal to or above 20, equal to or below 65
2. Polysomnography (PSG) study, with study time for at least 5 hours or above
3. BMI equal to or less than 30

Exclusion Criteria:

1. Severe uncontrollable cardiovascular, neurological or metabolic diseases
2. Cannot take x-ray examination
3. Pregnant or possible pregnant women
4. Central sleep apnea
5. Subject had head and neck surgery (may affect the scanning result)

Discontinuation of study:

If subject is not feeling well during any part of study, subject can decide to terminate the study

## 8. The specification of CBCT scanner

The specification of CBCT scanner used is shown in Table 2.

**Table 2.** Specification of CBCT scanner

X-ray Tube	Voltage	60~120kV
	Current	1~20mA
Focal Spot Size		0.3~0.5mm
Signal Gray Scale		12~16bit
Image Detector		<40cm×40cm
Source to Detector Distance		>50cm
Source to Patient Distance		>48cm
Field Of View(FOV)		(6~23)×(6~23)
Scan Time(s)		<30
Image Acquisition		180°~360°
Reconstruction Time(s)		<120
DICOM File Size		50M~2G
Voxel Size		<0.4mm×0.4mm×0.4mm

## 9. Assessment of Efficacy

This study is to use the criteria shown in Table 1 to determine if the airway of the subject is obstructed. The comparison is done by compare the clinician determined result using the



software vs. gold standard diagnostic result. If the accuracy of the result determined by clinician using the software compared with gold standard diagnostic result is 70% or above, it is considered as effective.

## 10. Statistics

The validity of the index test is measured with sensitivity and specificity shown in two-by-two table below

**Table 3.** 2x2 table

		Results of Gold Standard Test		
		Present Disease	Absent Disease	Row Total
Result of Index Test	Positive	a True-Positive	b False-Positive	a+b
	Negative	c False-Negative	d True-Negative	c+d
Column Total		a+c	b+d	a+b+c+d

Cell “a” we enter those who have positive results for the index test and the gold standard test also tested positive. These are the true positive.

Cell “b” we enter those who have positive results for the index test but do not test positive according to the gold standard test. These are false positive.

Cell “c” we enter those who have negative results for the index test but positive results on the gold standard test. These are false negative.

Cell “d” we enter those who have negative results for the index test and the gold standard test also test negative. These are the true negative.

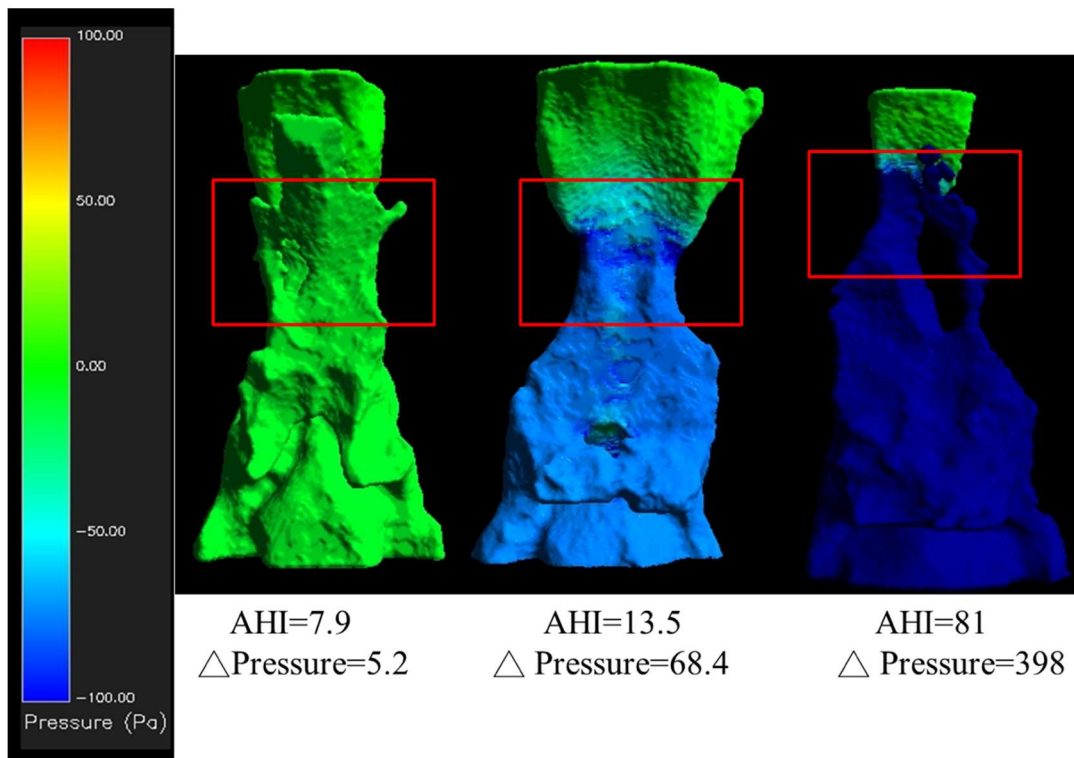
Sensitivity is the ability of a test to correctly identify an individual as positive, it is also called true positive rate.  $\text{Sensitivity} = a/(a+c)$  which is probability of being tested positive when disease is present. Specificity is the ability of a test to correctly identify an individual as negative, it is also called true negative rate.  $\text{Specificity} = d/(b+d)$  which is probability of being tested negative when disease is absent. Accuracy is the sum of the true positive and the true negative among all tested.  $\text{Accuracy} = (a+d)/(a+b+c+d)$ .

## 11. Assessment of Safety

The specification of CBCT is shown in table 2. In accordance with the scanning area (Figure 2), the maximum dosage per scan is approximately  $120\mu\text{Sv}$ . According to the international commission on radiological protection, ICRP, the limitation of radiation dosage for an adult is  $5\text{ mSv}$  ( $5000\mu\text{Sv}$ ) per year. Therefore, as long as subject does not expose to radiation exceeding the mentioned limitation, there should be no harm from the radiation.

## 12. Results

Figure 3 shows the air flow pressure color distribution of subject's airway with AHI of 7.9, 13.5, and 81. As AHI gets higher, the pressure difference (color difference) is also higher. It can clearly seen the largest pressure difference is at the location where the airway is narrowest (boxed in red).



**Figure 3.** The airflow pressure color distribution of subjects with different AHI

Table 4 shows the relative physiological data, subjects are divided into Group 1 ( $\text{AHI} < 5$ ) 63 subjects, Group 2 ( $5 \leq \text{AHI} < 15$ ) 8 subjects, Group 3 ( $15 \leq \text{AHI} < 30$ ) 42 subjects, and Group 4 ( $\text{AHI} \geq 30$ ) 87 subjects.

**Table 4.** The relative physiological data of subjects

		Group1(AHI<5)	Group2(5<AHI<15)	Group3(15<AHI<30)	Group4(AHI>30)
case		63	8	42	87
Sex	Male	42	6	33	58
	Female	21	2	9	29
Age		49.4±12.2	39.4 ±12.7	49.3 ±12.2	54.3 ±12.5
AHI		1.9 ±1.5	8.9 ±3.3	20.7±4.1	55.2 ± 15.7

Table 5 shows that doctor use the report from Soteria One Point Zero to evaluate whether subject's airway has obstruction and got sensitivity, specificity, and accuracy above 80%.

**Table 5.** Compare PSG (gold standard) with doctor use the report from Soteria One Point Zero

		PSG Diagnosis (AHI≥5 is positive)		
		Positive (AHI≥5)	Negative (AHI<5)	Row Total
Doctor's evaluation use report from Soteria One Point Zero	Positive	121	8	129
	Negative	16	55	71
Column Total		137	63	200

Sensitivity=121/137=0.88

Specificity=55/63=0.87

Accuracy = ( 121+55 ) /200=0.88

## 13. Conclusion

This study is a blind test with OSA patient and we conclude the report from Soteria One Point Zero is helpful to doctors to determine if subjects has airway obstruction and with accuracy of 88%.

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