July 6, 2021

Acurable Limited
Esther Rodriguez-Villegas
CSO
Finsgate, 5-7 Cranwood Street
London, London EC1V 9EE
United Kingdom

Re: K210480
    Trade/Device Name: AcuPebble SA100
    Regulation Number: 21 CFR 868.2375
    Regulation Name: Breathing Frequency Monitor
    Regulatory Class: Class II
    Product Code: MNR
    Dated: May 28, 2021
    Received: June 4, 2021

Dear Esther Rodriguez-Villegas:

We have reviewed your Section 510(k) premarket notification of intent to market the device referenced above and have determined the device is substantially equivalent (for the indications for use stated in the enclosure) to legally marketed predicate devices marketed in interstate commerce prior to May 28, 1976, the enactment date of the Medical Device Amendments, or to devices that have been reclassified in accordance with the provisions of the Federal Food, Drug, and Cosmetic Act (Act) that do not require approval of a premarket approval application (PMA). You may, therefore, market the device, subject to the general controls provisions of the Act. Although this letter refers to your product as a device, please be aware that some cleared products may instead be combination products. The 510(k) Premarket Notification Database located at https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/pmn.cfm identifies combination product submissions. The general controls provisions of the Act include requirements for annual registration, listing of devices, good manufacturing practice, labeling, and prohibitions against misbranding and adulteration. Please note: CDRH does not evaluate information related to contract liability warranties. We remind you, however, that device labeling must be truthful and not misleading.

If your device is classified (see above) into either class II (Special Controls) or class III (PMA), it may be subject to additional controls. Existing major regulations affecting your device can be found in the Code of Federal Regulations, Title 21, Parts 800 to 898. In addition, FDA may publish further announcements concerning your device in the Federal Register.

Please be advised that FDA's issuance of a substantial equivalence determination does not mean that FDA has made a determination that your device complies with other requirements of the Act or any Federal statutes and regulations administered by other Federal agencies. You must comply with all the Act's

requirements, including, but not limited to: registration and listing (21 CFR Part 807); labeling (21 CFR Part 801); medical device reporting (reporting of medical device-related adverse events) (21 CFR 803) for devices or postmarketing safety reporting (21 CFR 4, Subpart B) for combination products (see https://www.fda.gov/combination-products/guidance-regulatory-information/postmarketing-safety-reporting-combination-products); good manufacturing practice requirements as set forth in the quality systems (QS) regulation (21 CFR Part 820) for devices or current good manufacturing practices (21 CFR 4, Subpart A) for combination products; and, if applicable, the electronic product radiation control provisions (Sections 531-542 of the Act); 21 CFR 1000-1050.

Also, please note the regulation entitled, "Misbranding by reference to premarket notification" (21 CFR Part 807.97). For questions regarding the reporting of adverse events under the MDR regulation (21 CFR Part 803), please go to https://www.fda.gov/medical-devices/medical-device-safety/medical-device-reporting-mdr-how-report-medical-device-problems.

For comprehensive regulatory information about medical devices and radiation-emitting products, including information about labeling regulations, please see Device Advice (https://www.fda.gov/medical-devices/device-advice-comprehensive-regulatory-assistance) and CDRH Learn (https://www.fda.gov/training-and-continuing-education/cdrh-learn). Additionally, you may contact the Division of Industry and Consumer Education (DICE) to ask a question about a specific regulatory topic. See the DICE website (https://www.fda.gov/medical-devices/device-advice-comprehensive-regulatory-assistance/contact-us-division-industry-and-consumer-education-dice) for more information or contact DICE by email (DICE@fda.hhs.gov) or phone (1-800-638-2041 or 301-796-7100).

Sincerely,

Rachana Visaria, Ph.D.
Assistant Director
DHT1C: Division of ENT, Sleep Disordered
     Breathing, Respiratory and
     Anesthesia Devices
OHT1: Office of Ophthalmic, Anesthesia,
     Respiratory, ENT and Dental Devices
Office of Product Evaluation and Quality
Center for Devices and Radiological Health

Enclosure

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Food and Drug Administration

Indications for Use

Form Approved: OMB No. 0910-0120
Expiration Date: 06/30/2020
See PRA Statement below.

510(k) Number *(if known)*

Device Name
AcuPebble SA100

Indications for Use *(Describe)*

AcuPebble SA100 is indicated to sense, record, and interpret a patient's physiological signals (including respiratory pattern) during sleep for the purpose of prescreening patients for obstructive sleep apnea (OSA) syndrome. The device is designed for use in home-screening of adults with suspected possible sleep breathing disorders (although it can also be used in clinic). Results are used to assist the healthcare professional's in the patient's evaluation.

The system is not intended as a substitute for full polysomnography when additional parameters such as sleep stages, limb movements, or EEG activity are required.

Type of Use *(Select one or both, as applicable)*

☒ Prescription Use (Part 21 CFR 801 Subpart D)   ☐ Over-The-Counter Use (21 CFR 801 Subpart C)

CONTINUE ON A SEPARATE PAGE IF NEEDED.

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510(k) Summary

This summary of 510(k) safety and effectiveness information is being submitted in accordance with the requirements of 21 CFR §807.92.

510(k) Submitter:	Acurable Limited Finsgate 5-7 Cranwood Street London EC1V 9EE United Kingdom
Contact person:	Professor Esther Rodriguez-Villegas CSO Acurable Ltd 5th Floor, 21 Knightsbridge, London SW1X 7LY, UK esther@acurable.com +442075946193
Date summary prepared:	July 6, 2021
Trade Name:	AcuPebble SA100
Product Classification Name:	Ventilatory effort recorder
Regulation number:	21 CFR §868.2375 (Breathing Frequency Monitor)
Product Code:	MNR
Classification Panel:	Anaesthesiology
Device Classification:	Class II

1. INTENDED USE / INDICATIONS FOR USE

AcuPebble SA100 is indicated to sense, record, and interpret a patient's physiological signals (including respiratory pattern) during sleep, for the purpose of prescreening patients for obstructive sleep apnea (OSA) syndrome. The device is designed for use in home-screening of adults with suspected possible sleep breathing disorders. Results are used to assist the healthcare professional in the patient's evaluation.

The system is not intended as a substitute for full polysomnography when additional parameters such as sleep stages, limb movements, or EEG activity are required.

2. DEVICE DESCRIPTION

AcuPebble SA100 comprises a sensor that is worn on the front of the neck around the suprasternal notch area (the "AcuPebble SA100 sensor"), a mobile device app that guides the patient through the steps of the test, collects the data from the sensor, and uploads them in the cloud (the "AcuPebble SA100 app"), and a cloud-based analysis software (the "AcuPebble SA100 algorithms". The "AcuPebble SA100 Sensor" consists of a small biocompatible enclosure with very low power sensors and electronics inside. It is attached to the front of the neck (somewhere between the Adam's apple and the suprasternal notch area) by single-use biocompatible adhesive tape. The sensor measures physiological body sounds. The data sensed is streamed via a Bluetooth link to the "AcuPebble SA100 app" on a smart device (mobile phone/tablet). The data can be uploaded into the cloud where it is analyzed, any time after the sleep study test is finished at the tap of a button in the app. AcuPebble SA100 signal processing algorithms produce a number of OSA diagnostic traces and parameters. These can be accessed by the Health Care Professional through a healthcare professional portal, which can be accessed from any computer or smart device with an Internet connection.

AcuPebble SA100 is not intended to be used with patients with pacemakers or other implantable devices, or with patients with known or suspected arrhythmias. This device has not been validated in patients with congestive heart failure or patients with neuromuscular disorders. Patients with significant cardiopulmonary or neurological disorders need to be excluded from using the device.

3. PREDICATE DEVICE

The predicate device is shown in the Table below:

K number	Product Code	Class	Device Name
K173974	MNR	II	**Drowzle**

4. SUMMARY OF COMPARISON TO PREDICATE

	DEVICE SUBJECT OF THIS APPLICATION **AcuPebble SA100** by Acurable Ltd	PREDICATE DEVICE (1) **Drowzle** by Resonea, K173974	REFERENCE DEVICE(1) **NightOwl**, K191031, by Ectosense	REFERENCE DEVICE (2) **Sleep Strip II**, K112822 (Note: this device was claimed as predicate of Drowzle (predicate (1) in this application)
Indications for use	AcuPebble SA100 is indicated to sense, record, and interpret a patient's physiological signals (including respiratory pattern) during sleep for the purpose of prescreening patients for obstructive sleep apnea (OSA) syndrome. The device is designed for use in home-screening of adults with suspected possible sleep breathing disorders. Results are used to assist the healthcare professional in the patient's evaluation. The system is not intended as a substitute for full polysomnography when additional parameters such as sleep stages, limb movements, or EEG activity are required.	DROWZLE is indicated to record a patient's respiratory pattern during sleep for the purpose of prescreening patients for obstructive sleep apnea (OSA) syndrome. The device is designed for use in home-screening of adults with suspected possible sleep breathing disorders. Results are used to assist the healthcare professional in determining the need for further diagnosis and evaluation. The system is not intended as a substitute for full polysomnography when additional parameters such as sleep stages, limb movements, or EEG activity are required.	The NightOwl is a wearable device intended for use in the recording, analysis, displaying, exporting, and storage of biophysical parameters to aid in the evaluation of sleep-related breathing disorders of adult patients suspected of sleep apnea. The device is intended for the clinical and home setting use under the direction of a Healthcare Professional (HCP).	The SleepStrip II is intended to measure apnea hypopnea events during sleep for the purpose of prescreening patients for sleep apnea syndrome. The device is intended to be used by adult patients as prescribed by a physician in either home, hospital or facility use settings.
COMPARISON	**Substantially equivalent**			
Regulation number	868.2375	868.2375	868.2375	868.2375
COMPARISON	**Same**			
Product Code	MNR	MNR	MNR	MNR
COMPARISON	**Same**			

Generic Device Name	Ventilatory Effort Recorder	Ventilatory Effort Recorder	Ventilatory Effort Recorder	Ventilatory Effort Recorder
COMPARISON	Same			
Prescription	Prescription	Prescription	Prescription	Prescription
COMPARISON	Same			
Target population	Adults	Adults	22 years old and older	Adults
COMPARISON	Substantially equivalent			
Intended environment for use	Primarily home environment, although it can be used in healthcare environments	Home Environment	Clinical and Home environment	Home or healthcare settings
COMPARISON	Substantially equivalent			
Sensor placement	Front of the Neck	Smartphone placed within 24 inches of pillow	The photoplethysmography (PPG) sensor and accelerometer components are worn on the fingertip.	Over the lip, under the nose
COMPARISON	The sensor is placed in a different location which is directly contacting the patient compared to the predicate which is not directly contacting the patient. This is similar to the reference device which has direct contact. Having AcuPebble SA100 in contact with the body does not raise different safety or effectiveness questions (see conformity with consensus standards.)			
Sensing elements	Microphones	Microphones	LEDs/ accelerometer	Pressure sensor
COMPARISON	Same			
Patient contact	Yes	No	Yes	Yes
COMPARISON	Different but justified. Refer to the clinical validation data showing the equivalent performance of AcuPebble SA100 with respect to the predicate. Also, this type of contact approach has been used by the reference devices.			
Means of attachment	Adhesive (patient self-applied)	NA	Adhesive (patient self-applied)	Adhesive (patient self-applied)
COMPARISON	Different but it is justified. Refer to the clinical validation data showing equivalent performance of AcuPebble SA100 with respect to the predicate. Also, substantially equivalent means of attachment to Reference Devices.			

Sleep night use	Multiple nights possible	Multiple nights possible	Multiple nights possible	Single use
COMPARISON	**Same**			
Portability	Yes (Wearable)	NA	Yes (wearable)	Yes (wearable)
Comparison	Not direct comparison with the predicate but Reference Devices are also wearable			
Size and weight	29.5mm diameter x 16mm height 7g	NA	19x28x11mm 6g	Exact dimensions unknown but from photos it looks similar in volume (with different form factor)
Recording device	Mobile device records sound streamed from the sensor and uploads them into a cloud-based server	Mobile device records sound and uploads them into a cloud-based server	Mobile device records data streamed from the sensor and uploads them into a cloud-based server	Contained in the device
Comparison	**Same**			
Channels to determine features leading to diagnostic indexes	Sounds (Cardiac features, respiratory features, movement features))	Sounds (absence of them)	PAT, pulse rate, oxygen saturation, movement	Airflow
COMPARISON	**Substantially equivalent**			
Calculated OSA indexes	ACU-AHI (with 3% desaturation criteria), ACU-AHI (with 4% desaturation criteria), ACU-ODI (for 3% and 4% desaturation criteria)	Proprietary Resonea Index	AHI (from PAT), oximetry	AHI with 4% desaturation criteria
COMPARISON	**Substantially equivalent**			
Clinical Metrics Reported	Calculated AHI/ODI indexes as per AASM definitions (and level of OSA severity for each index, following the AASM thresholds (i.e. 0-5, 5-15, 15-30 and >30); average heart (pulse).	Number of breathing sound gaps >10 seconds; Average number of >10 second breathing sound gaps per hour; Risk classification based on standard questionnaires:	Calculated AHI index from PAT. they output validated oximetry values and from there the ODI can be obtained.	Counts apnea/hypop nea events

		STOP-BANG Epworth Sleepiness Scale; Calculated Resonea Index		
COMPARISON	**Substantially equivalent**			
Data Transfer	From the sensor to the mobile phone using Bluetooth and from the phone to the cloud (server) through a smartphone by wireless connection.	Wireless connection	From the sensor to the mobile phone using Bluetooth and from the phone to the cloud (server) through a smartphone by wireless connection.	Not applicable
COMPARISON	**Substantially equivalent**			
Microcontroller+Communication chip	Nordic nRF52832 (Bluetooth communication)	NA	Nordic nRF52832 (Bluetooth communication)	NA
Comparison	**Substantially equivalent**			
Sensor Power Source	Rechargeable lithium polymer battery	NA	Rechargeable lithium ion battery	Battery
COMPARISON	**Substantially equivalent**			
Sensor Software	Firmware is limited to control the recording and communications processes. No presentation of test results to the patient. Data analyzed and presented in a separate software suite.	NA	Firmware is limited to control the recording and communications processes. No presentation of test results to the patient. Data analyzed and presented in a separate software suite.	Not applicable
COMPARISON	**Same as Reference Device (1)** (Not directly comparable to Predicate because there is not a worn part of the system)			
Analysis Software - location	Analysis performed off the recording device, exclusively cloud-based, by the proprietary software.	Analysis performed off the recording device, exclusively cloud-based by the proprietary software.	Analysis performed off the recording device, exclusively cloud-based by the proprietary software.	Analysis performed in the device
COMPARISON	**Same**			
Display type	Smartphone (or tablet) for patients; smartphone (or tablet) or computer screen for	Smartphone	Smartphone for patients. For healthcare professionals, one or several of:	LED display

			smartphone (or tablet) or computer screen (unclear which ones)	
COMPARISON	**Substantially equivalent**			
Patient connection	Device has no galvanic connections to mains as it is a battery-operated device.	NA	Device has no galvanic connections to mains as it is a battery-operated device.	Device has no galvanic connections to mains as it is a battery-operated device.
COMPARISON	**Same as the Reference Devices**			
Sterilization	Non sterile	Not applicable	Non sterile	Non sterile
COMPARISON	**Same as the Reference Devices**			
Heart/Pulse Rate Output Range	50-120bmp	NA	50-118bmp	NA
COMPARISON	**Substantially Equivalent to the reference device** (the difference is not significant)			
Heart/Pulse Rate validation accuracy	3.62 bpm (patients signals from 50bpm-110bpm during a night sleep), 0.664 (artificial signals as per clause 201.12.1.101.15 of IEC 60601-2-27:2011, from 50bpm to 120bpm)	NA	2.26bmp	NA
COMPARISON	**Substantially Equivalent to the reference device** (the difference is not significant when taking into account the intended use)			
Reusability/ Reprocessing	Yes (cleaning after use)	Yes (cleaning after use)	Yes (cleaning after use)	No
COMPARISON	**Substantially Equivalent**			

5. PERFORMANCE DATA

Biocompatibility

Theenclosure of AcuPebble SA100 has undergone biocompatibility testing as per the recognized consensus standard ISO 10993 (Biological Evaluation of Medical Devices) with passing results.

The adhesive is also medical grade, and was tested as per ISO 10993, with passing results. The tests conducted were: in vitro cytotoxicity; mem elution; primary skin irritation; Guinea pig sensitization.

General Requirements for Safety and Electromagnetic Compatibility (EMC)

AcuPebble SA100 has been tested and found to comply with the following recognized consensus standards:

·   IEC 60601-1:2006 +A11:2011+A1:2013- Medical electrical equipment - Part 1: General requirements for basic safety and essential performance.

·   IEC 60601-1-2:2015- Medical electrical equipment - Part 1-2: General requirements for basic safety and essential performance - Collateral Standard: Electromagnetic disturbances - Requirements and tests.

Home Healthcare Environment Safety

AcuPebble SA100 has been tested and found to comply with the following recognized consensus standard:

●   IEC 60601-1-11:2015: Medical electrical equipment - Part 1-11: General requirements for basic safety and essential performance - Collateral Standard: Requirements for medical electrical equipment and medical electrical systems used in the home healthcare environment.

Usability

AcuPebble SA100 has been developed, tested and complies with the following recognized consensus standards:

●   IEC 62366-1:2015 Medical devices-Part 1: Application of usability engineering to medical devices
●   IEC60601-1-6: 2013Medical electrical equipment - Part 1-6: General requirements for basic safety and essential performance - Collateral standard: Usability.

Risk Management

AcuPebble SA100 risk management complies with the recognised consensus standard ISO 14971:2012 "Application of risk management to medical devices".

Quality Management

Acurable is ISO 13485:2016 certified by MTIC InterCert SRL.

Software Verification and Validation Testing

AcuPebble SA100 has been tested and found to comply with the recognised consensus standard IEC 62304:2006/A1:2016 ("Medical device software - Software life cycle processes"). The software level of concern is moderate.

Acurable Software Verification and Validation Testing included 3 levels of testing, as defined in the Verification and Validation Plan:

- Unit testing at component level
- Integration testing at component level
- Full system or end-to-end testing at product level.

Additionally, usability testing is carried out for system validation purposes.

Clinical Validation

An accuracy validation clinical study, in compliance with the recognized consensus standard ISO 14155:2011 (*"Clinical investigation of medical devices for human subjects - Good clinical practice"*) was carried out to further support the substantial equivalence claims. The Clinical Investigations were hence conducted in accordance with good clinical practice (GCP) as described in 21 CFR 812.28(a)(1). The study involved 150 consecutive evaluation patients. A summary of the outcomes of the study is presented in the table below.

Diagnostic index	Positive Predictive Value (PPV)	Negative Predictive Value (NPV)	Positive Likelihood Ratio (LR+)	Negative Likelihood Ratio (LR-)
AHI3 (AHI as defined by the AASM for airflow reductions and 3% desaturations)	94.44% (CI 84.78%- 98.11%)	95.83% (CI 89.94%- 98.34%)	29.36 (CI 9.62 to 89.64)	0.08 (CI 0.03 to 0.19)
AHI4 (As above, but for 4% desaturations)	94.00% (CI 83.69%- 97.95%)	98.00% (CI 92.65% to 99.48%)	32.29 (CI 10.58 to 98.59)	0.04 (CI 0.01 to 0.16)
ODI3 (ODI considering 3% desaturations)	93.42% (CI 85.87%- 97.07%)	90.54% (CI 82.48%- 95.11%)	13.11 (CI 5.61 to 30.62)	0.10 (CI 0.05 to 0.20)
ODI4 (ODI considering 4% desaturations)	85.71% (CI 75.50%- 92.11%)	98.94% (CI 93.03%- 99.85%)	12.37 (CI 6.35-24.08)	0.02 (CI 0.00-0.15)

The diagnostic criteria were based on the established thresholds, for OSA (i.e. 5, 15 and 30).

The performance of heart rate output was evaluated for the same 150 patients, using as an index test the heart rate obtained from the PPG signal of the polygraphy system.

The following table lists the percentage of subjects with bias and standard deviation within a certain range.

Heart Rate- Percentage of subjects with bias and standard deviations within different ranges					
Bias (μ)			Standard Deviation (σ)		
≤ ±1 bpm	=≤ ±3 bpm	≤ ±5 bpm	≤ 2 bpm	≤ 5 bpm	≤ 8 bpm
62.0%	94.0%	98.7%	28.7%	93.3%	98.7%

6. CONCLUSION

Based on the performance data and testing in conformance to consensus standards, AcuPebble SA100 has been demonstrated to be substantially equivalent to the predicate device.