Eko.ai Pte. Ltd d/b/a Us2.ai
Hui Qun Tay
RAQA Manager
2 College Road, #02-00
Singapore

April 1, 2024

Re: K233676
Trade/Device Name: Us2.v2
Regulation Number: 21 CFR 892.2050
Regulation Name: Medical image management and processing system
Regulatory Class: Class II
Product Code: QIH
Dated: February 29, 2024
Received: February 29, 2024

Dear Hui Qun Tay:

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 (the 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 available 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.

Additional information about changes that may require a new premarket notification are provided in the FDA guidance documents entitled "Deciding When to Submit a 510(k) for a Change to an Existing Device" (https://www.fda.gov/media/99812/download) and "Deciding When to Submit a 510(k) for a Software Change to an Existing Device" (https://www.fda.gov/media/99785/download).

Your device is also subject to, among other requirements, the Quality System (QS) regulation (21 CFR Part 820), which includes, but is not limited to, 21 CFR 820.30, Design controls; 21 CFR 820.90, Nonconforming product; and 21 CFR 820.100, Corrective and preventive action. Please note that regardless of whether a change requires premarket review, the QS regulation requires device manufacturers to review and approve changes to device design and production (21 CFR 820.30 and 21 CFR 820.70) and document changes and approvals in the device master record (21 CFR 820.181).

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 Part 803) for devices or postmarketing safety reporting (21 CFR Part 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 Part 4, Subpart A) for combination products; and, if applicable, the electronic product radiation control provisions (Sections 531-542 of the Act); 21 CFR Parts 1000-1050.

Also, please note the regulation entitled, "Misbranding by reference to premarket notification" (21 CFR 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,

Jessica Lamb, Ph.D.
Assistant Director
Imaging Software Team
DHT 8B: Division of Radiological Imaging Devices and Electronic Products
OHT 8: Office of Radiological Health
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: 07/31/2026
See PRA Statement below.

510(k) Number *(if known)*
K233676

Device Name
Us2.v2

Indications for Use *(Describe)*
Us2.v2 software is used to process acquired transthoracic cardiac ultrasound images, to analyze and make measurements on images in order to provide automated estimation of several cardiac structural and functional parameters, including left/ right atrial and ventricular linear dimensions, volumes, systolic function and diastolic function, measured by B mode, M mode and Doppler (PW, CW, tissue) modalities. The data produced by this software is intended to be used to support qualified cardiologists, sonographers, or other licensed professional healthcare practitioners for clinical decision-making. Us2.v2 is indicated for use in adult patients.

Please note the following limitations:

- Poor image capture will lead to poor annotations and subsequent measurements. Multiple image quality algorithms are used to filter out images of poor quality.
- Our software complements good patient care and does not exempt the user from the responsibility to provide supervision, clinically review the patient, and make appropriate clinical decisions.
- If no gender is present, female referenced guideline values will be used for conclusions.
- If Body Surface Area (BSA) is not present, indexed values cannot be provided.
- During image acquisition, inappropriate use of the echo machine, use of non-cardiac ultrasound probes, use of suboptimal settings (e.g. gain, contrast, depth), or lack of electrocardiogram capture may lead to lower accuracy of the software.

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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"An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB number."

5 510(k) Summary

K233676

Table 5-1. Subject Device Overview.

Submitter's Name:	Eko.ai Pte. Ltd. (d/b/a Us2.ai)
Address:	2 College Road, #02-00, Singapore 169850
Contact Person:	Hui Qun, Tay
Title:	Regulatory Affairs and Quality Assurance Manager
Telephone Number:	+65 83994056
Fax Number:	+65 83994056
Email:	huiqun@us2.ai
Date Summary Prepared:	Nov 9, 2023
Device Proprietary Name:	Us2.v2
Model Number:	V 2.0.0
Common Name:	Us2.v2
Classification Number:	21 CFR 892.2050
Classification Name:	Automated Radiological Image Processing Software
Product Code:	QIH
Device Class:	Class II
Predicate Device	Trade name: Us2.v1 Manufacturer: Eko.ai Pte Ltd 2 College Road, #02-00 Singapore 169850 Regulation Number: 21 CFR 892.2050 Regulation Name: System, Image Processing, Radiological Device Class: Class II Product Code: QIH 510(k) Number: K210791 510(k) Clearance Date: Jul 27, 2021

5.1 Device Description

Us2.v2 is an image post-processing analysis software device used for viewing and quantifying cardiovascular ultrasound images in DICOM format. The device is intended to aid diagnostic review and analysis of echocardiographic data, patient record management and reporting.

The primary intended function of Us2.v2 is to automatically provide clinically relevant and reproducible quantitative echocardiographic measurements, while reducing echocardiographic analysis time. In doing so, the primary benefit of Us2.v2 is to improve clinical echocardiographic workflow, enabling clinicians to generate and edit reports faster, with precision and with full control.

Because Us2.v2 measurements cover the minimum echocardiographic dataset for a standard adult echocardiogram (by European Society of Cardiovascular Imaging, British Society of Echocardiography and American Society of Echocardiography guidelines), our software is applicable to the vast majority of adult transthoracic echocardiograms.

Our current software aims to automate measurements of cardiac dimensions and left ventricular function and are applicable regardless of normal or disease states. We specifically indicate that our current product will not be reporting measurements associated with intra-cardiac lesions (e.g. tumours, thrombi), nor complex adult congenital heart disease.

The software provides automated markup and analysis to generate a full report, on which a qualified sonographer/ reviewing physician could perform edits/ revise the markup on the echocardiographic image measurement during their approval process. The markup includes: the cardiac segments captured, measurements of distance, time, area and blood flow, quantitative analysis of cardiac function, and a summary report.

The software allows the sonographer to enter their markup manually. It also provides automated markup and analysis, which the sonographer may choose to accept outright, to accept partially and modify, or to reject and ignore. Machine learning based view classification and border detection form the basis for this automated analysis. Additionally, the software has features for organizing, displaying and comparing to reference guidelines the quantitative data from cardiovascular images acquired from ultrasound scanners.

5.2 Indications for Use

Us2.v2 software is used to process acquired transthoracic cardiac ultrasound images, to analyze and make measurements on images in order to provide automated estimation of several cardiac structural and functional parameters, including left/ right atrial and ventricular linear dimensions, volumes, systolic function and diastolic function, measured by B mode, M mode and Doppler (PW, CW, tissue) modalities. The data produced by this software is intended to be used to support qualified cardiologists, sonographers, or other licensed professional healthcare practitioners for clinical decision-making. Us2.v2 is indicated for use in adult patients.

Please note the following limitations:

- Poor image capture will lead to poor annotations and subsequent measurements. Multiple image quality algorithms are used to filter out images of poor quality.
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- During image acquisition, inappropriate use of the echo machine, use of non-cardiac ultrasound probes, use of suboptimal settings (e.g. gain, contrast, depth), or lack of electrocardiogram capture may lead to lower accuracy of the software.

5.3 Summary of Technological Characteristics Comparison

Table 5-2 shows the similarities and differences between the technological characteristics of the two products. Testing demonstrates that the differences do not raise new questions of safety or effectiveness.

Table 5-2. Summary of Technological Characteristics Comparison.

Topic	Predicate Device (Us2.v1)	Subject Device (Us2.v2)
Physical Characteristics	Software package that operates utilizing off-the-shelf hardware	Same
DICOM Standard Compliance	The software processes DICOM compliant image data	Same
Modalities	Cardiac echocardiogram	Same
User Interface	The software is designed for use on a personal computer that has been received images from a compatible	Same
Automation level	Fully automated, including clip selection	Same
User confirmation/ rejection of result	Yes	Yes
Manual editing of automated result by user	Yes (in application)	Same
Automated calculations	LV DecT LV MV-A LV MV-Adur LV MV-E LV e' lateral LV e' septal LV a' lateral LV a' septal LV s' lateral LV s' septal LV LVEDV MOD biplane LV LVEF MOD biplane LV LVESV MOD biplane LV LVSV MOD biplane LV IVsD LV LVIDd LV LVIDs LV LVPWd LV E/e' mean RV RVIDd LA LAESV MOD biplane RA Raa TrV Tr Vmax	Same as the predicate plus: LV LV GLS LV A4C LV GLS LV A3C LV GLS LV A2C LV GLS LV LV Regional Strain RV TAPSE RV RV E' RV RV A' RV RV S' Aorta Sinotubular Junction Aorta Sinus valsalva LVOT LVOT Diameter LVOT PW LVOT Vmax LVOT PW LVOT VTI LVOT PW LVOT Pmax LVOT PW LVOT Pmean AoV CW AoV Vmax AoV CW AoV VTI AoV CW AoV Pmax AoV CW AoV Pmean AoV AVA AoV VR

5.4 Performance Data

Us2.v2 was developed and tested in accordance with Us2.ai's Design Control processes. The device has been subject to extensive safety and performance testing. Non-clinical verification and validation test results have confirmed that the device meets its design requirements and intended use. Specifically, software verification was conducted at unit, module, and system integration levels. Risk management analysis generated multiple risk mitigation measures and verification activities. Cybersecurity Analysis and Data Security testing were conducted to ensure that robust measures for safeguarding data and protected health information of patients are included into the software design. A Human Factors/Usability Engineering study was performed according to the principles of AAMI/ANSI HE75 to validate the device's usability within the intended user population.

Us2.v2 has chosen to perform the following bench study to validate its performance in real-world conditions. The automated analysis generated by Us2.v2 will be compared head-to-head against manual analysis (of the same patient data and the same images) generated by trained echocardiography technicians or cardiologists, both in "gold standard" reference echo core labs and "real world" clinical settings. Test datasets are strictly segregated from algorithm training datasets, as they are from completely separate cohorts. Two statistical metrics, Root Mean Square Error (RMSE) and Intraclass Correlation Coefficient (ICC) are used to evaluate the performance of the Us2.v2 measurements against expert human measurements.

5.4.1 Clinical Cohorts

The clinical characteristics of US-based cohorts used in Us2.v2 testing are outlined in the table below.

Clinical characteristic	**Dataset 1 (n=3029)**	**Dataset 2 (n=260)**	**Dataset 3 (n=192)**
Age, years, mean ± SD	73.7±8.4	67.5±9.4	74±9
Gender, male	1425 (47.1%)	141 (54.2%)	84 (44. 2%)
Ethnicity, n (%)			
- African American	758 (25%)	121 (46.5%)	7 (3.7%)
- White	1207 (39.9%)	49 (18.8%)	167 (87.9%)
- Hispanic	657 (21.7%)	67 (25.8%)	0 (0%)
- Others	407 (13.4%)	20 (7.7%)	16 (8.4%)

Us2.ai software has been tested on data from 8 ultrasound device vendors, representing the manufacturers most widely used in US current clinical practice.

5.4.2 Results for Left Ventricular Strain

We used the GE EchoPac as a comparator device as it is one of the most widely used, FDA-cleared Left Ventricular strain devices in the world. Clinically, measurements from any strain device are used interchangeably (Farsalinos et al., 2015, p. 1171-1181).

Acceptance criteria were based on Root Mean Square Error against reference values generated using the comparator device. Performance was tested on Dataset 1 described in 5.4.1.

Measurement	RMSE
Global Longitudinal Strain	2.6 - 4.12
Regional Longitudinal Strain	4.84 - 9.54

5.4.3 Results for Other Us2.v2 Measurements

Dataset 1

Measurement	ICC lower 95% CI	ICC
LVOT Diameter (mm)	0.77	0.78
RV a' (cm/s)	0.84	0.85
RV e' (cm/s)	0.85	0.86
RV s' (cm/s)	0.89	0.90
TAPSE (mm)	0.72	0.74

Dataset 2 + Dataset 3

Measurement	ICC lower 95% CI	ICC
AoV Pmax (mmHg)	0.95	0.96
AoV Pmean (mmHg)	0.97	0.98
AoV Vmax (m/s)	0.98	0.98
AoV VTI (cm)	0.96	0.97
AVA (cm^2)	0.78	0.82
LVOT Pmax (mmHg)	0.88	0.90
LVOT Pmean (mmHg)	0.90	0.91
LVOT Vmax (m/s)	0.91	0.92
LVOT VTI (cm)	0.89	0.91
VR	0.93	0.94
Sinotub Junction (mm)	0.74	0.78
Sinus Valsalva (mm)	0.78	0.82

5.5 Substantial Equivalence Conclusion

Us2.v2 is an image processing software which has similar intended use and indications for use statement as the predicate device. The two devices have similar technological characteristics: both use machine learning algorithms to automate the measurement of transthoracic cardiac images. Though the subject device provides more measurements than the predicate, this does not in and of itself produce different questions of safety and effectiveness. This 510(k) submission includes information on the Us2.v2 technological characteristics, as well as performance data and verification and validation activities. Despite the subject device providing more measurements than the predicate, the enclosed information demonstrates that Us2.v2 is as safe and effective as the predicate, and does not raise different questions of safety and effectiveness.