Innolitics, LLC
℅ Meritxell Martinez
Project Manager and Regulatory Specialist
1101 West 34th St
Austin, Texas 78705

February 28, 2024

Re: K232613
Trade/Device Name: CT Cardiomegaly
Regulation Number: 21 CFR 892.2050
Regulation Name: Medical image management and processing system
Regulatory Class: Class II
Product Code: QIH
Dated: January 30, 2024
Received: January 30, 2024

Dear Meritxell Martinez:

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,

for

Jessica Lamb, Ph.D.
Assistant Director
Imaging Software Team
DHT8B: Division of Radiological Imaging
Devices and Electronic Products
OHT8: 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: 06/30/2023
See PRA Statement below.

510(k) Number *(if known)*
K232613

Device Name
CT Cardiomegaly

Indications for Use *(Describe)*
CT Cardiomegaly is a command line software application intended to be run on its own or as part of another medical device to automatically calculate linear and area based cardiothoracic ratio (CTR) from a CT image containing the heart.

CT Cardiomegaly is designed to measure the maximal transverse diameter of heart and maximal inner transverse diameter of thoracic cavity and calculate the CTR from an axial CT slice containing the heart using a non-adaptive machine learning algorithm.

Intended users of the software are aimed to the physicians or other licensed practitioners in the healthcare institutions, such as clinics, hospitals, healthcare facilities, residential care facilities and long-term care services.

The system is suitable for adults and transitional adolescents (18 to 21 years old but treated as an adult).

Its results are not intended to be used on a stand-alone basis for clinical-decision making or otherwise preclude clinical assessment of any disease.

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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Body Check	CT Cardiomegaly 510(k) Summary

K232613

1. Administrative Information

Submitter Name	Innolitics LLC
Address	1101 West 34th St #550, Austin, TX 78705, US
Phone Number	+1 (512) 967-6088
Fax Number	N/A
Company Representative	Meritxell Martinez
Additional Company Representatives	Yujan Shrestha, MD Ethan Ulrich Andrew Smith, MD, PhD Steven Rothenberg, MD Jim Luker, RN, MS
Email	fda@innolitics.com
Date Summary Prepared	January 30th, 2024
Documentation Prepared Using	Innolitics Medtech OS Framework

2. Subject Device Information

Trade Name	CT Cardiomegaly
Subject Device K Number	K232613
Common Name	Automated Radiological Image Processing Software
Product Code	QIH
Regulation Number	892.2050
Regulatory Class	Class II
Review Panel	Radiology

3. PREDICATE DEVICE INFORMATION

Predicate Device Name	EFAI Intelligent Cardiothoracic Ratio (iCTR) Assessment System
Predicate Device K Number	K212624
Common Name	EFAI iCTR
Product Code	QIH
Regulation Number	892.2050
Regulatory Class	Class II
Review Panel	Radiology

4. DEVICE DESCRIPTION

The CT Cardiomegaly application is a software only (SaMD) medical device which includes automated algorithms and non-adaptive machine learning to analyze chest computed tomography (CT) images. CT Cardiomegaly is a command line software intended to be run on its own or as part of another medical device.

CT Cardiomegaly scans the existing images for the presence of specific anatomical structures (i.e., heart and chest cavity). If the target structures are present, the software segments and performs automated measurements which may be helpful in assisting with the detection of certain diseases and/or conditions (i.e., cardiomegaly). The quantitative information is provided to the clinician in the form of a summary report. The clinician (using all available information) then decides if further diagnostic work-up, analysis or measurements are indicated.

The results from CT Cardiomegaly are not intended to be used as the primary input for clinical-decision making or diagnosis.

A reference standard was created to train the machine learning algorithms in CT Cardiomegaly. Data for training and testing were sampled from this database based on exclusion criteria. Data was also selected to ensure no site was shared by training and testing cohorts. The training dataset included 1600 unique patient cases from 267 unique sites across 20 U.S. states.

5. INDICATIONS FOR USE

CT Cardiomegaly is a command line software application intended to be run on its own or as part of another medical device to automatically calculate linear and area based cardiothoracic ratio (CTR) from a CT image containing the heart.

CT Cardiomegaly is designed to measure the maximal transverse diameter of heart and maximal inner transverse diameter of thoracic cavity and calculate the CTR from an axial CT slice containing the heart using a non-adaptive machine learning algorithm.

Intended users of the software are aimed to the physicians or other licensed practitioners in the healthcare institutions, such as clinics, hospitals, healthcare facilities, residential care facilities and long-term care services.

The system is suitable for adults and transitional adolescents (18 to 21 years old but treated as an adult).

Its results are not intended to be used on a stand-alone basis for clinical-decision making or otherwise preclude clinical assessment of any disease.

5.1. Indications for Use Equivalence Discussion

Both the subject (CT Cardiomegaly) and predicate device (EFAI Intelligent Cardiothoracic Ratio (iCTR) Assessment System) have similar indications for use, with the exception that the subject device analyzes CT images while the predicate device is limited to X-ray images.

Another difference between the indications for use for both devices is that the predicate uses an artificial intelligence algorithm using an unknown framework while the subject device utilizes a non-adaptive machine learning algorithm using the MONAI framework.

However, these are differences in technological characteristics that do not affect safety and effectiveness of the device, and have been supported with appropriate verification and validation testing.

6. COMPARISON OF TECHNOLOGICAL CHARACTERISTICS

Characteristic	**CT Cardiomegaly**	**EFAI Intelligent Cardiothoracic Ratio (iCTR) Assessment System (K212624)**	**Substantial Equivalence Discussion**
Manufacturer	Innolitics LLC	Ever Fortune. AI Co., Ltd.	N/A

Characteristic	CT Cardiomegaly	EFAI Intelligent Cardiothoracic Ratio (iCTR) Assessment System (K212624)	Substantial Equivalence Discussion
Regulation Number	892.2050	892.2050	Same
Regulatory Class	Class II	Class II	Same
Product Code	QIH	QIH	Same
Regulation Name	Medical image processing and management system	Medical image processing and management system	Same
Device Property	SaMD	SaMD	Same
Intended Use/ Indications for Use	CT Cardiomegaly is software intended to be run on its own or as part of another medical device to automatically calculate linear and area based cardiothoracic ratio (CTR) from a CT image containing the heart. CT Cardiomegaly is designed to measure the maximal transverse diameter of heart and maximal inner transverse diameter of thoracic cavity and calculate the CTR from an axial CT slice containing the heart using a non-adaptive machine learning algorithm. Intended users of the software are aimed to the physicians or other licensed practitioners in the healthcare institutions, such as clinics, hospitals, healthcare facilities, residential care facilities and long-term care services. The system is suitable for adults and transitional adolescents (18 to 21 years old but treated as an adult). Its results are not intended to be used on a stand-alone basis for clinical-decision	EFAI Intelligent Cardiothoracic Ratio Assessment System (or iCTR) is a software for use by hospital and clinics to automatically assess the cardiothoracic ratio (CTR) of a chest X-ray image from the X-ray imager subject. The iCTR is designed to measure the maximal transverse diameter of heart and maximal inner transverse diameter of thoracic cavity and calculate the CTR of a chest X-ray image in posterior-anterior (PA) chest view using an artificial intelligence algorithm. Intended users of the software are aimed to the physicians or other licensed practitioners in the healthcare institutions, such as clinics, hospitals, healthcare facilities, residential care facilities and long-term care services. The system is suitable for adults between 20 - 80 years of age. Its results are not intended to be used on a stand-alone basis for clinical-decision making or otherwise preclude clinical assessment	Both the subject (CT Cardiomegaly) and predicate device (iCTR) have identical indications for use, with the exception that the subject device analyzes CT images while the predicate device is limited to X-ray images. Another difference between the indications for use for both devices is that the predicate uses artificial intelligence algorithms using an unknown framework while the subject device utilizes non-adaptive machine learning algorithms using the MONAI framework. However, these differences in technological characteristics do not affect safety and effectiveness of the device, and have been supported with verification and validation testing.

Characteristic	CT Cardiomegaly	EFAI Intelligent Cardiothoracic Ratio (iCTR) Assessment System (K212624)	Substantial Equivalence Discussion
	making or otherwise preclude clinical assessment of any disease.	of cardiothoracic ratio (CTR) cases.	
Technical Characteristics			
Input	CT image study	Post-anterior (PA) view chest X-ray image	The input for the predicate device is a 2-dimensional chest X-ray image, while the subject device's input is an entire CT study. The subject device will select out of the CT study an axial slice containing the heart, if present, and perform measurements. The main difference is that the predicate operates on images that are post-anterior (PA) view chest X-ray, while the subject device's operates on images that are axial CT. Nonetheless, this difference in imaging modality does not raise any new concerns and has been verified and validated in testing.
Output files	PDF and JSON Reports	Reports, DICOM Secondary Capture series	The output format of the predicate device includes reports and DICOM secondary capture series, while the subject device's only output format is a report (in both PDF and JSON format). Thus, the subject device's output format is a subset of the predicate's available output formats (i.e., report). This lack of a feature does not raise any new concerns.
Output measurements	Linear-based CTR and area-based CTR	Linear-based CTR	The predicate device outputs a linear-based CTR measurement while the subject device outputs both linear and area-based CTR measurements. Although this output measurement of area-based CTR is not included in the predicate device, it does not raise different questions of safety or effectiveness and has been properly verified and validated in testing.
Report Structure	Report will be output in the PDF and JSON file format which is structured with following	Report will be output in the DICOM and JSON file format which is structured with following	Both devices produce reports that output CTR and patient information. One of the main differences between both devices is that the predicate only

Characteristic	CT Cardiomegaly	EFAI Intelligent Cardiothoracic Ratio (iCTR) Assessment System (K212624)	Substantial Equivalence Discussion
	information: 1) CTR (both linear and area-based) 2) Patient information 3) Reference value(s)	information and function tool: 1) CTR 2) adjustable annotation line (maximal inner border diameter of thoracic cavity and maximal diameter of heart) 3) the trajectory of CTR (including chest X-ray) 4) Patient information	has one CTR output, while the subject device outputs both linear-based CTR and area-based CTR. This difference is further discussed in the row above. Additionally, the predicate device presents the feature to modify the annotation line, which is not available in the subject device. However, CT Cardiomegaly 's indications for use explicitly state that the results produced by the device are not intended to be solely relied upon for clinical decision-making, nor do they replace the need for clinical assessment of any disease. Furthermore, the user manual of the device contains instructions mandating healthcare professionals to review the results presented in the report. Both devices produce reports that contain relevant patient information. The predicate device includes a trajectory of the CTR in the report. The subject device includes segmentations of the heart area and inner chest area. Lastly, the subject device introduces a feature to have user-specified reference value(s) stated in the report. The healthcare professional is able to set reference value(s) linear and area-based CTR, based on published literature or their practice of medicine. This feature is not found in the predicate device, but has been properly verified and validated.
Intended Users	Physicians or other licensed practitioners in the healthcare institutions	Physicians or other licensed practitioners in the healthcare institutions	Same
Target Population	Adults and transitional adolescents (18 to 21 years old but treated as an adult)"	Adults of 20-80 years old	Both devices have similar intended target populations. The subject device's patient population age range has been supported by appropriate performance testing.

Characteristic	CT Cardiomegaly	EFAI Intelligent Cardiothoracic Ratio (iCTR) Assessment System (K212624)	Substantial Equivalence Discussion
Location of anatomical structures	Chest	Chest	Same
Imaging Modality	Computed Tomography (CT)	Chest X-ray in Digital Radiography (DR)	Although the predicate and subject device are compatible with different imaging modalities, this technological difference does not raise new questions of safety or effectiveness. Additionally, this difference has been properly supported with verification and validation testing.
Intended Use Environment	Healthcare institutions (Clinics, hospitals, healthcare facilities, residential care facilities and long-term care services)	Healthcare institutions (Clinics, hospitals, healthcare facilities, residential care facilities and long-term care services)	Same
Software device that operates on off-the-shelf hardware	Yes	Yes	Same
Software devices uses software algorithms for image	Yes	Yes	Same
Diameter Measurement	Yes - Automated	Yes - Automated	Same, with the main difference that diameter measurements are performed on an axial slice of the CT series for the subject device (not on chest x-ray, as done for the predicate).
Storage	Saved in JSON and PDF file format	Saved in JSON and DICOM file format text for DICOM and DICOM file format	Both devices store study reports in machine-readable JSON format. The predicate device also stores files in DICOM format. On the other hand, the subject device also outputs reports in PDF format. This difference in file format does not raise any new questions of safety or effectiveness, and is

Characteristic	CT Cardiomegaly	EFAI Intelligent Cardiothoracic Ratio (iCTR) Assessment System (K212624)	Substantial Equivalence Discussion
			supported by verification and validation testing.
Software Requirement	Ubuntu 20.04.5 LTS (provided as a Docker container) Docker 23.0.1 or above	Ubuntu 18.04 (Web browser : chrome 88.0.4324.182 or above)	Both devices have similar software requirements. The subject device requires a newer version of the operating system that runs inside a container. The main difference is that the predicate device is intended to run on a web browser while the subject device is a command line software intended to be run on its own or as part of another medical device. This technological difference does not raise any new questions of safety or effectiveness, and is supported by verification and validation testing.
Algorithm type	Machine learning based algorithm (non-adaptive)	Artificial Intelligence	Same. Machine learning based algorithm is a subset of artificial intelligence.

7. PERFORMANCE DATA

7.1. Software Verification and Validation Testing

Software verification and validation testing were conducted, and documentation was provided as recommended by FDA's Guidance for Industry and FDA Staff, "Guidance for the Content of Premarket Submissions for Device Software Functions".

The software verification and validation testing verified that the design requirements were successfully met. The Intended use and user needs were successfully validated.

As the intended use, functionality and performance of CT Cardiomegaly and predicate device are equivalent, the result of the performance testing is evidence that CT Cardiomegaly performs in an equivalent manner to the EFAI Intelligent Cardiothoracic Ratio (iCTR) Assessment System.

7.2. Performance Assessment

A technical performance assessment was performed for CT Cardiomegaly to validate the accuracy for both linear-based CTR (i.e., Cardiothoracic Index) and area-based CTR (i.e., Heart to Chest Area Ratio) against the measurements provided by human readers using manual segmentation tools (i.e., reference standard).

7.2.1. Reference Standard

The reference standard for this assessment was established by three board-certified radiologists. Each radiologist provided a segmentation for the heart and the inner chest independently from the other radiologists. Measurement agreement among the three radiologists was very high for all measured values.

7.2.2. Training and Testing Dataset

Data was sampled from a database curated by the University of Alabama at Birmingham of over 8,000 imaging studies from over 300 unique imaging sites. Data for training (1600 cases) and testing (275 cases) were sampled from this database based on exclusion criteria. Data was also selected to ensure no site was shared by training and testing cohorts.

The testing dataset included 275 unique patients cases from sites across 12 U.S. states. Subgroups and confounders present in the dataset included patient demographics (age, sex, race, ethnicity), confounding conditions, and imaging characteristics (protocol, slice thickness, scanner manufacturer, presence or absence of contrast, kVp). Images were representative of numerous scanner manufacturers (e.g., GE, Siemens, Philips, Canon Medical Systems, Toshiba, Siemens Healthineers, United Imaging Healthcare) and imaging protocols (i.e., abdominal CT, chest CT, PET/CT and high-resolution chest CT). The data consisted of 142 male and 133 female patients of different ethnicities aged 18-96 (median 62) years. Detailed subgroup analysis are reported in the labeling.

7.2.3. Primary Endpoints

Primary endpoints involved calculating the difference between the average measurement of the human readers and the subject device's measurement. The experimental unit was per patient. Clinical performance testing showed strong agreement with physician-derived measurements, with an average difference less than 0.01. Additional analysis including the Bland Altman plot and Limits of agreement were also conducted and reported in labeling. The 95% limits of agreement were [-0.033, 0.035] and [-0.028, 0.035] for Cardiothoracic Ratio and Heart to Chest Area Ratio, respectively.

Measurement	Mean Absolute Difference [95% CI]	Mean Difference [95% CI]	Mean Difference Target	Standard Deviation of Differences	Result
Cardiothoracic Ratio	0.009 [0.007, 0.011]	0.0012 [-0.0008, 0.0033]	< 0.0100	0.0172	Pass
Heart to Chest Area Ratio	0.009 [0.007, 0.010]	0.0036 [0.0017, 0.0055]	< 0.0100	0.0161	Pass

7.2.4. Secondary Endpoints

Secondary endpoints of the clinical performance assessment included the precision of selecting the slice where the heart area is the largest (key heart slice detection) and the accuracy of heart and inner chest segmentations.

Key Heart Slice Detection

Value	Mean Difference [95% CI]	Mean Difference Target	Standard Deviation of Differences	Result
Key Slice Position	0.46 mm [-0.49, 1.41]	< 5 mm	0.49 mm	Pass

Segmentation Comparison

Anatomical Structure	Observed Dice [95% CI]
Heart	0.95 [0.950, 0.956]
Inner Chest	0.98 [0.982, 0.984]

8. CONCLUSION

CT Cardiomegaly is substantially equivalent to the identified predicate device EFAI Intelligent Cardiothoracic Ratio (iCTR) Assessment System (K212624). Specifically, CT Cardiomegaly has similar indications for use and technological characteristics compared to the previously cleared predicate device. The minor differences in the technological characteristics of CT Cardiomegaly and EFAI Intelligent Cardiothoracic Ratio (iCTR) Assessment System (e.g., including the identification of target anatomical structures and modalities supported) do not raise new issues of safety or effectiveness. The performance tests have been completed and successfully support the device performance. Therefore, CT Cardiomegaly is substantially equivalent to the predicate device.