October 20, 2022

Siemens Medical Solutions USA, Inc.
℅ Kira Kuzmenchuk
Regulatory Affairs Manager
40 Liberty Blvd.
MALVERN PA 19355

Re: K222361
Trade/Device Name: AI-Rad Companion (Musculoskeletal)
Regulation Number: 21 CFR 892.1750
Regulation Name: Computed Tomography X-Ray System
Regulatory Class: Class II
Product Code: JAK
Dated: October 4, 2022
Received: October 12, 2022

Dear Kira Kuzmenchuk:

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,

Laurel Burk, Ph.D.
Assistant Director
Diagnostic X-Ray Systems Team
DHT8B: Division of 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)*

K222361

Device Name

AI-Rad Companion (Musculoskeletal)

Indications for Use *(Describe)*

AI-Rad Companion (Musculoskeletal) is an image processing software that provides quantitative and qualitative analysis from previously acquired Computed Tomography DICOM images to support radiologists and physicians from emergency medicine, specialty care, urgent care, and general practice in the evaluation and assessment of musculoskeletal disease.

It provides the following functionality:

- Segmentation of vertebras
- Labelling of vertebras
- Measurements of heights in each vertebra and indication if they are critically different
- Measurement of mean Hounsfield value in volume of interest within vertebra.

Only DICOM images of adult patients are considered to be valid input.

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.

510(k) SUMMARY
FOR
AI-RAD COMPANION (Musculoskeletal)
SW version VA20

Submitted by:
Siemens Medical Solutions USA, Inc.
40 Liberty Boulevard
Malvern, PA 19355
Date Prepared: October 20, 2022

This summary of 510(k) safety and effectiveness information is being submitted in accordance with the requirements of Safe Medical Devices Act of 1990 and 21 CFR §807.92.

1. Submitter

Importer/Distributor

Siemens Medical Solutions USA, Inc.
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2. Contact Person

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3. Device Name and Classification

Product Name: AI-Rad Companion (Musculoskeletal)
Trade Name: AI-Rad Companion (Musculoskeletal)

Classification Name:	Computed Tomography X-Ray System
Classification Panel:	Radiology
CFR Section:	21 CFR §892.1750
Device Class:	Class II
Product Code:	JAK

4. Predicate Device

Product Name:	AI-Rad Companion (Musculoskeletal)
Propriety Trade Name:	AI-Rad Companion (Musculoskeletal)
510(k) Number:	K193267
Clearance Date:	March 16, 2020
Classification Name:	Computed Tomography X-Ray System
Classification Panel:	Radiology
CFR Section:	21 CFR §892.1750
Device Class:	Class II
Primary Product Code:	JAK
Recall Information:	N/A

5. Indications for Use

AI-Rad Companion (Musculoskeletal) is an image processing software that provides quantitative and qualitative analysis from previously acquired Computed Tomography DICOM images to support radiologists and physicians from emergency medicine, specialty care, urgent care, and general practice in the evaluation and assessment of musculoskeletal disease.

It provides the following functionality:

- Segmentation of vertebras
- Labelling of vertebras
- Measurements of heights in each vertebra and indication if they are critically different
- Measurement of mean Hounsfield value in volume of interest within vertebra.

Only DICOM images of adult patients are considered to be valid input.

6. Device Description

AI-Rad Companion (Musculoskeletal) SW version VA20 is an enhancement to the previously cleared device AI-Rad Companion (Musculoskeletal) K193267 that utilizes deep learning algorithms to provide quantitative and qualitative analysis to computed tomography DICOM images to support qualified clinicians in the evaluation and assessment of the spine.

As an update to the previously cleared device, the following modifications have been made:

- Enhanced AI Algorithm
  The vertebrae segmentation accuracy has been improved through retraining the algorithm.

- DICOM Reports
  The reports generated out of the system have been enhanced to support both human and machine-readable formats. Additionally, an update version of the system changed the DICOM structured report format to TID 1500 for applicable content.

- Architecture Enhancement for on premise Edge deployment
  The system supports the existing cloud deployment as well as an on premise "edge" deployment. The system remains hosted in the teamplay digital health platform and remains driven by the AI-Rad Companion Engine. Now the edge deployment implies that the processing of clinical data and the generation of results can be performed on-premises within the customer network. The edge system is fully connected to the cloud for monitoring and maintenance of the system from remote.

7. Substantially Equivalent (SE) And Technological Characteristics

The intended use of the predicate device and the subject device are equivalent. The subject device, AI-Rad Companion (Musculoskeletal) VA20 is substantially equivalent with regard to the intended use and technical characteristics compared to the predicate device, AI-Rad Companion (Musculoskeletal) (K193267), with respect to the software features, functionalities, and core algorithms. The additional features, enhancements and improvements provided in AI-Rad Companion (Musculoskeletal) VA20 increase the usability and reduce the complexity of the imaging workflow for the clinical user.

The risk analysis and non-clinical data support that both devices perform equivalently and do not raise different questions of the safety and effectiveness.

The comparison between the above referenced predicate device are listed at a high-level in the following table.

Feature	**Subject Device AI-Rad Companion (Musculoskeletal) VA20**	**Predicate Device AI-Rad Companion (Musculoskeletal) (**K193267**)**
Modality	CT	CT
Detection of Vertebrae	Detection of Vertebras	Detection of Vertebras
Labeling of Vertebrae	Labeling of Vertebras	Labeling of Vertebras
Segmentation of Vertebrae	Deep learning based segmentation of vertebras	Deep learning based segmentation of vertebras

Measurement of Heights	Distance measurements based on segmentation results and comparison with neighboring measurements	Distance measurements based on segmentation results and comparison with neighboring measurements
Measurement of Hounsfield (HU) Values	HU measurements based on segmentation results	HU measurements based on segmentation results
Algorithm	Deep learning image to image network for 3D segmentation	Deep learning image to image network for 3D segmentation
Deployment	Cloud and on-premise deployment	Cloud deployment
Reports	Quantitative, Structured and Text reports with DICOM secondary capture & TID 1500 in both human and machine readable formats.	Quantitative, Structured and Text reports with DICOM secondary capture images

Table 1: Technological Comparisons

The conclusions from all verification and validation data suggest that these enhancements are equivalent with respect to safety and effectiveness of the predicate device. These modifications do not change the intended use of the product. Siemens is of the opinion that AI-Rad Companion (Musculoskeletal) VA20 is substantially equivalent to the currently marketed device, AI-Rad Companion (Musculoskeletal) (K193267).

8. Nonclinical Tests

Non-clinical tests were conducted to test the functionality of AI-Rad Companion (Musculoskeletal). Software validation and bench testing have been conducted to assess the performance claims as well as the claim of substantial equivalence to the predicate device.

AI-Rad Companion has been tested to meet the requirements of conformity to multiple industry standards. Non-clinical performance testing demonstrates that AI-Rad Companion (Musculoskeletal) complies with the FDA guidance document, "Guidance for the Content of Premarket Submissions for Software Contained in Medical Devices" (May 11, 2005) as well as with the following voluntary FDA recognized Consensus Standards listed in **Table 2.**

Recognition Number	Product Area	Title of Standard	Reference Number and Date	Standards Development Organization
5-114	General	Medical Devices – Application of usability engineering to medical devices [including Corrigendum 1 (2016)]	62366-1: 2015-02	IEC
5-125	General	Medical Devices – application of risk management to medical devices	14971:2007	ISO

13-79	Software/ Informatics	Medical device software – software life cycle processes [Including Amendment 1 (2016)]	62304: 2006/A1:2016	AAMI ANSI IEC
12-300	Radiology	Digital Imaging and Communications in Medicine (DICOM) Set	PS 3.1 – 3.20 (2016)	NEMA
12-261	Radiology	Information Technology – Digital Compression and coding of continuous -tone still images: Requirements and Guidelines [including: Technical Corrigendum 1(2005)]	10918-1 1994-02-15	ISO IEC
5-134	General	Medical devices – symbols to be used with information to be supplied by the manufacturer – Part 1: General Requirements	15223-1 Fourth edition 2021-07	ISO IEC
13-97	Software/ Informatics	Health software – Part 1: General requirements for product safety	82304-1 Edition 1.0 2016-10	IEC

Table 2: List of recognized standards

Verification and Validation

Software documentation for a Moderate Level of Concern software, per FDA's Guidance Document "Guidance for the Content of Premarket Submissions for Software Contained in Medical Devices" issued on May 11, 2005, is also included as part of this submission. The performance data demonstrates continued conformance with special controls for medical devices containing software. Non-clinical tests were conducted on the subject device during product development.

Software "bench" testing in the form of Unit, System and Integration tests were performed to evaluate the performance and functionality of the new features and software updates. All testable requirements in the Requirement Specifications and the Risk Analysis have been successfully verified and traced in accordance with the Siemens Healthineers DH product development (lifecycle) process. Human factor usability validation is addressed in system testing and usability validation test records. Software verification and regression testing have been performed successfully to meet their previously determined acceptance criteria as stated in the test plans.

Siemens Healthineers adheres to the cybersecurity requirements as defined the FDA Guidance "Content of Premarket Submission for Management of Cybersecurity in Medical Devices: Guidance for Industry and Food and Drug Administration Staff" (October 18, 2018) by implementing a process of preventing unauthorized access, modifications, misuse or denial of use, or the unauthorized use of information that is stored, accessed, or transferred from a medical device to an external recipient.

9. Performance Software Validation

To validate the AI-Rad Companion (Musculoskeletal) VA40 software from a clinical perspective, the algorithm contained in the product underwent a scientific evaluation. The results of clinical data-based software validation for the subject device AI-Rad Companion (Musculoskeletal) demonstrated equivalent performance in comparison to the reference device. A complete scientific evaluation report is provided in support of the device modifications.

Performance testing for AI-Rad Companion (Musculoskeletal) was performed on 140 subjects (clinically relevant patient data shown in Table 2) during product development. Additionally, the segmentation and height measurements of the thoracic vertebral bodies were reassessed for accuracy.

Acceptance Criteria

Validation Type	Acceptance Criteria
Mislabeling of Vertebrae or absence of height measurement	Ratio of cases that are mislabeled or missing measurements shall be <10% of all cases
Inter-reader variability: heights calculated by AIRC & the ground truth should be within the LoA reported	For cases with slice thickness ≤1.0 mm, the difference should be within the LoA for ≥95% of cases
	For cases with slice thickness >1.0mm, the difference should be within the LoA for ≥85% of cases
Consistency of height and density measurement across critical sub-groups	For each sub-group, the ratio of measurements within the corresponding LoA should not drop by more than 5% compared to the ratio for all data sets

Table 2: Acceptance Criteria Information

Summary Performance Data

Validation Type	Results
Mislabeling of Vertebrae or absence of height measurement	Failure Rate of 8.6%
Inter-reader variability: heights calculated by AIRC & the ground truth should be within the LoA reported	For cases with slice thickness ≤1.0 mm, the difference was 95.5%
	For cases with slice thickness >1.0mm, the difference was 92.6%
Consistency of height and density measurement across critical sub-groups	Overall failure rate of the subject device was consistent with the predicate as well as having the results of all sub-group analysis rated equal or superior to the predicate

Table 3: Summary Performance Data

Testing Data Information

# data sets	140 Chest CTs (1,553 thoracic vertebrae)
Pathologies / Patient info	KUM (N=80): Primary indications: Lung/airways 10; infect focus 10; malignancy 22, follow-up 10; (cardio-)vascular 14; ischemia 2; bleeding 4; trauma 1; lymph nodes 3; inflammation 1; unknown 3. NLST (N=60): Comorbidities: diabetes 7; heart disease 10; hypertension 24; cancer 9; emphysema/COPD 14; asthma 2; pneumonia 13; chron. bronchitis 1. Smoking history (pack years): median: 47, IQR: [38, 70]
Sex	male: 47, female: 93
Age [yrs]	≤55: 16, (55, 65]: 59, (65, 75]: 38, >75: 25 median: 65, IQR: [60, 72]
Manufacturer	GE: 32, Philips: 20, Siemens: 68, Toshiba: 20
Slice Thickness [mm]	≤1.0: 60, (1.0, 1.5]: 24, (1.5, 2.0]: 56
Dose	KUM: CTDIVol [mGy]: median 4.8, IQR: [1.3, 10.7] NLST: low dose (screening)
Reconstruction method	Filtered backprojection: 107 Iterative reconstruction: 33
Reconstruction kernel	soft: 25, medium: 68, hard: 47
Contrast Enhancement	enhanced: 59, native: 81

Table 4: Testing Data Information

Standard Annotation Process

For ground truth annotations, four board-certified radiologists were selected. Vertebra heights and average density (HU) values were measured manually and loaded into the application and automatic detection and labelling was performed. The 140 cases were randomly distributed across the four readers such that each case was read independently by two radiologists in randomized order. For outliers, a third annotation was blindly provided by one of the radiologist who had not annotated before. The ground truth was generated by the average of the two most concordant measurements. For all other cases, the mean of the two annotations were used as ground truth.

Testing & Training Data Independence

The training data used for the training of the post-processing algorithm is independent of the data used to test the algorithm.

10. Clinical Tests

No clinical tests were conducted to test the performance and functionality of the modifications introduced within AI-Rad Companion (Musculoskeletal). Verification and validation of the enhancements and improvements have been performed and these modifications have been validated for their intended use. The data from these activities were used to support the subject device and the substantial equivalence argument.

No animal testing has been performed on the subject device.

11. Safety and Effectiveness

The device labeling contains instructions for use and any necessary cautions and warnings to ensure safe and effective use of the device.

Risk management is ensured via ISO 14971:2019 compliance to identify and provide mitigation of potential hazards in a risk analysis early in the design phase and continuously throughout the development of the product. These risks are controlled via measures realized during software development, testing and product labeling.

Furthermore, the device is intended for healthcare professionals familiar with the post processing of CT images.