Gleamer
℅ Antoine Tournier
Head of Quality & Regulatory Affairs
5 Avenue du Général de Gaulle
Saint Mandé, 94160
FRANCE

March 2, 2023

Re: K222176
Trade/Device Name: BoneView 1.1-US
Regulation Number: 21 CFR 892.2090
Regulation Name: Radiological computer assisted detection and diagnosis software for fracture
Regulatory Class: Class II
Product Code: QBS
Dated: January 31, 2023
Received: February 1, 2023

Dear Antoine Tournier:

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 and Part 809); 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,

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)*

K222176

Device Name

BoneView 1.1-US

Indications for Use *(Describe)*

BoneView 1.1-US is intended to analyze radiographs using machine learning techniques to identify and highlight fractures during the review of radiographs of:

Study Type (Anatomical Area of Interest)	Compatible Radiographic View(s)	Patient population*
Ankle	Frontal, Lateral, Oblique	Adults & Children/Adolescents
Foot	Frontal, Lateral, Oblique	Adults & Children/Adolescents
Knee	Frontal, Lateral	Adults & Children/Adolescents
Tibia/Fibula	Frontal, Lateral	Adults & Children/Adolescents
Wrist	Frontal, Lateral, Oblique	Adults & Children/Adolescents
Hand	Frontal, Oblique	Adults & Children/Adolescents
Elbow	Frontal, Lateral	Adults & Children/Adolescents
Forearm	Frontal, Lateral	Adults & Children/Adolescents
Humerus	Frontal, Lateral	Adults & Children/Adolescents
Shoulder	Frontal, Lateral, Axillary	Adults & Children/Adolescents
Clavicle	Frontal	Adults & Children/Adolescents
Pelvis	Frontal	Adults only
Hip	Frontal, Frog Leg Lateral	Adults only
Femur	Frontal, Lateral	Adults only
Ribs	Frontal Chest, Rib series	Adults only
Thoracic Spine	Frontal, Lateral	Adults only
Lumbosacral Spine	Frontal, Lateral	Adults only

**Adults are patient aged above 21 years old and Children/Adolescents are patients aged from 2 to 21 years old.*

BoneView 1.1-US is intended for use as a concurrent reading aid during the interpretation of radiographs. BoneView 1.1-US is for prescription use only.

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.

Date prepared: January 31th, 2023

In accordance with 21 CFR 807.87(h) and 21 CFR 807.92 the 510(k) Summary for BoneView 1.1-US is provided below.

1. Submitter

Submitter	**GLEAMER SAS** 5, avenue du Général de Gaulle 94160 Saint-Mandé - FRANCE
Primary Contact Person	**Antoine Tournier** Head of Quality & Regulatory Affairs Tel: 0033 6 15 81 23 45 Email: antoine.tournier@gleamer.ai
Secondary Contact Perso	**Christian Allouche** CEO Tel: 0033 6 58 53 70 46 Email: christian@gleamer.ai

2. Device

Trade Name	BoneView 1.1-US
510(k) reference	K222176
Common Name	Radiological computer assisted detection/diagnosis software for fracture
Regulation	21 CFR 892.2090
Product Code	QBS
Classification	Class II

3. Predicate Device

Predicate Device	Gleamer BoneView
510(k) reference	K212365

4. Device Description

BoneView 1.1-US is a software-only device intended to assist clinicians in the interpretation of:

- limbs radiographs of children/adolescents and
- limbs, pelvis, rib cage, and dorsolumbar vertebra radiographs of adults.

BoneView 1.1-US can be deployed on-premise or on cloud and be connected to several computing platforms and X-ray imaging platforms such as X-ray radiographic systems, or PACS. More precisely, BoneView 1.1-US can be deployed:

- In the cloud with a PACS as the DICOM Source
- On premise with a PACS as the DICOM Source
- On premise with an X-ray system as the DICOM Source

After the acquisition of the radiographs on the patient and their storage in the DICOM Source, the radiographs are automatically received by BoneView 1.1-US from the user's DICOM Source through an intermediate DICOM node (for example, a specific Gateway, or a dedicated API). The DICOM Source can be the user's image storage system (for example, the Picture Archiving and Communication System, or PACS), or other radiological equipment (for example X-ray systems).

Once received by BoneView 1.1-US, the radiographs are automatically processed by the AI algorithm to identify regions of interest. Based on the processing result, BoneView 1.1-US generates result files in DICOM format. These result files consist of a summary table and result images (annotations on a copy of the original images or annotations to be toggled on/off). BoneView 1.1-US does not alter the original images, nor does it change the order of original images or delete any image from the DICOM Source.

Once available, the result files are sent by BoneView 1.1-US to the DICOM Destination through the same intermediate DICOM node. Similar to the DICOM Source, the DICOM Destination can be the user's image storage system (for example, the Picture Archiving and Communication System, or PACS), or other radiological equipment (for example X-ray systems). The DICOM Source and the DICOM Destination are not necessarily identical.

The DICOM Destination can be used to visualize the result files provided by BoneView 1.1-US or to transfer the results to another DICOM host for visualization. The users are then able to use them as a concurrent reading aid to provide their diagnosis.

The general layout of images processed by BoneView is comprising:

① The "summary table" – it is a first image that is derived from the detected regions of interest in the following result images and that displays the results of the overall study along with the Gleamer – BoneView logo. This summary can be configured to be present or not.

② The result images – they are provided for all the images that were processed by BoneView and contain:

- Around the Regions of Interest (if any), a rectangle with a solid or dotted line depending on the confidence of the algorithm (see below)
- Around the entire image, a white frame showing that the images were processed by BoneView
- Below the image:
    - The Gleamer – BoneView logo
    - The number of Regions of interest that are displayed in the result image
    - (if any) The caution message if it was identified that the image was not part of the indication for use of BoneView

The training of BoneView was performed on a training dataset of 44,649 radiographs, representing 151,096 images (52.4% of males, with age: range [0 – 109]; mean 42.4 +/- 24.6) for all anatomical areas of interest in the Indications for Use and from various manufacturers. BoneView has been designed to solve the problem of missed fractures including subtle fractures, and thus detects fractures with a high sensitivity. In this regard, the display of findings is triggered by a "high-sensitivity operating point" (DOUBT FRACT) that will enable the display of a dotted-line bounding box around the region of interest. Additionally, the users need to be confident that when BoneView identifies a fracture, it is actually a fracture. In this regard, an additional information is introduced to the user with a "high-specificity operating point" (FRACT).

These two operating points are implemented in the User Interface as follow:

- Dotted-line Bounding Box: suspicious area / subtle fracture (when the level of confidence of the AI algorithm associated with the finding is above "high-sensitivity operating point" and below "high-specificity operating point") displayed as a dotted bounding box around the area of interest
- Solid-line Bounding Box: definite or unequivocal fractures (when the level of confidence of the AI algorithm associated with the finding is above "high-specificity operating point") displayed as a solid bounding box around the area of interest

BoneView can provide 4 levels of results:

- FRACT: BoneView identified at least one solid-line bounding box on the result images,
- DOUBT FRACT: BoneView did not identify any solid-line bounding box on the result images but it identified at least one dotted-line bounding box in the result images,
- NO FRACT: BoneView did not identify any bounding box at all in the result images,
- NOT AVAILABLE: BoneView identified that the original images are out of its Indications for Use

5. Intended use/Indications for use

BoneView 1.1-US is intended to analyze radiographs using machine learning techniques to identify and highlight fractures during the review of radiographs of:

Study Type (Anatomical Area of Interest)	Compatible Radiographic View(s)	Patient population*
Ankle	Frontal, Lateral, Oblique	Adults & Children/Adolescents
Foot	Frontal, Lateral, Oblique	Adults & Children/Adolescents
Knee	Frontal, Lateral	Adults & Children/Adolescents
Tibia/Fibula	Frontal, Lateral	Adults & Children/Adolescents
Wrist	Frontal, Lateral, Oblique	Adults & Children/Adolescents
Hand	Frontal, Oblique	Adults & Children/Adolescents
Elbow	Frontal, Lateral	Adults & Children/Adolescents
Forearm	Frontal, Lateral	Adults & Children/Adolescents
Humerus	Frontal, Lateral	Adults & Children/Adolescents
Shoulder	Frontal, Lateral, Axillary	Adults & Children/Adolescents
Clavicle	Frontal	Adults & Children/Adolescents
Pelvis	Frontal	Adults only
Hip	Frontal, Frog Leg Lateral	Adults only
Femur	Frontal, Lateral	Adults only
Ribs	Frontal Chest, Rib series	Adults only
Thoracic Spine	Frontal, Lateral	Adults only
Lumbosacral Spine	Frontal, Lateral	Adults only

**Adults are patient aged above 21 years old and Children/Adolescents are patients aged from 2 to 21 years old.*

BoneView 1.1-US is intended for use as a concurrent reading aid during the interpretation of radiographs. BoneView 1.1-US is for prescription use only.

6. Substantial equivalence

Features and Characteristics	Subject Device Gleamer BoneView 1.1-US	Predicate Device Gleamer BoneView 1.0-US
Regulation Information		
Regulation Number/Name	21 CFR 892.2090 / Radiological Computer Assisted Detection and Diagnosis Software for Fracture	Same
Product Code	QBS	Same

Features and Characteristics	Subject Device Gleamer BoneView 1.1-US	Predicate Device Gleamer BoneView 1.0-US
Regulation Description	A radiological computer assisted detection and diagnostic software for suspected fracture is an image processing device intended to aid in the detection, localization, and/or characterization of fracture on acquired medical images (e.g. radiography, MR, CT). The device detects, identifies, and/or characterizes fracture based on features or information extracted from images, and may provide information about the presence, location, and/or characteristics of the fracture to the user. Primary diagnostic and patient management decisions are made by the clinical user.	Same
Intended Use	The device is intended to aid in the detection, localization, and characterization of fractures on acquired medical images (per 21 CFR 892.2090 Radiological Computer Assisted Detection and Diagnosis Software For Fracture).	Same
Indications for Use		
Image Modality	2D Xray Images	Same
Clinical Finding and Clinical Output	Fracture To inform the primary diagnostic and patient management decisions that are made by the clinical user.	Same
Mode of action	Image processing software using machine learning to aid in identifying and highlighting fractures during the review of radiographs.	Same

Features and Characteristics	Subject Device Gleamer BoneView 1.1-US	Predicate Device Gleamer BoneView 1.0-US
Patient population and Anatomic Areas of Interest	Adults (greater than 21 years of age) and Children/Adolescents (between 2 years of age and 21 years of age): • Ankle • Foot • Knee • Tibia/Fibula • Wrist • Hand • Elbow • Forearm • Humerus • Shoulder • Clavicle Adults (greater than 21 years of age) only: • Pelvis • Hip • Femur • Ribs • Thoracic Spine • Lumbosacral Spine	Adults (greater than 21 years of age) only: • Ankle • Foot • Knee • Tibia/Fibula • Femur • Wrist • Hand • Elbow • Forearm • Humerus • Shoulder • Clavicle • Pelvis • Hip • Ribs • Thoracic Spine • Lumbosacral Spine
Intended Users	The intended users of BoneView are clinicians with the authority to diagnose fractures in various settings including primary care (e. g., family practice, internal medicine), emergency medicine, urgent care, and specialty care (e. g. orthopedics), as well as radiologists who review radiographs across settings.	Same
Software and Technical Information		
Machine Learning Methodology	Supervised Deep Learning	Same
Image Source	DICOM Source (e.g., imaging device, intermediate DICOM node, PACS system, etc.)	Same

Features and Characteristics	Subject Device Gleamer BoneView 1.1-US	Predicate Device Gleamer BoneView 1.0-US
Image Viewing	PACS system Image annotations made on copy of original image or image annotations toggled on/off	Same
Deployment Platform	Deployment on-premise or on cloud and connection to several computing platforms and X-ray imaging platforms such as X-ray radiographic systems, or PACS	Same
Privacy	HIPAA Compliant	Same
Software Level of Concern	Moderate	Same

7. Performance data

7.1. Biocompatibility Testing

As a standalone software, BoneView has no direct or indirect patient or user contacting components. Therefore, biocompatibility information is not required for this device.

7.2. Software Verification and Validation Testing

BoneView is a standalone software that is considered a moderate level of concern as per the guidance document from the FDA: "Guidance for the Content of Premarket Submissions for Software Contained in Medical Devices". Indeed, a failure or latent design flaw of BoneView could directly result in minor injury to the patient or operator.

Consequently, software verification and validation testing were conducted and documented as per the requirements of the abovementioned FDA guidance document for a moderate level of concern device.

7.3. Electrical safety and Electromagnetic compatibility Testing

As a standalone software, BoneView is not subject to electromagnetic compatibility or electrical safety testing activities. Therefore, Electrical safety and Electromagnetic compatibility information is not required for this device.

7.4. Bench Testing

7.4.1. Testing for the children/adolescent population

In order to include the children and adolescents population in the indications for use of BoneView 1.1-US, Gleamer performed a standalone performance testing on a dataset of 2,000 radiographs (52.8% of males, with age: range [2 – 21]; mean 11.54 +/- 4.7) for all anatomical areas of interest in the Indications for Use for the children and adolescents population and from various manufacturers (Canon, Fujifilm, GE Healthcare, Konica Minolta, Philips, Primax, Samsung, Siemens). This dataset was independent of the data used for model training, tuning, and establishment of device operating points.

The overall goal of the conducted study was to compare the diagnostic performances of BoneView 1.1-US on the children/adolescents clinical performance study dataset to the diagnostic performances of BoneView on the adult clinical performance study dataset (included in the submission of the predicate device).

The results of the study demonstrated that BoneView 1.1-US detects fractures in radiographs with similar performances on the adult population and on the children/adolescents population:

Sensitivity (with 95% Clopper-Pearson CI) and Specificity (with 95% Clopper-Pearson CI) of BoneView 1.1-US at the examination-level at the high-sensitivity operating point on the children/adolescents clinical performance study dataset VS adult clinical performance study dataset

Operating Point	Dataset	Sensitivity	Specificity
High-sensitivity operating point (DOUBT FRACT)	Adult clinical performance study dataset	**0.928 [0.919 - 0.936]**	0.811 [0.8 - 0.821]
	Children/adolescents clinical performance study dataset	**0.909 [0.889 - 0.926]**	0.821 [0.796 - 0.844]
	95% confidence interval on the difference	**-0.019 [-0.039 - 0.001]**	0.010 [-0.016 - 0.037]

Sensitivity (with 95% Clopper-Pearson CI) and Specificity (with 95% Clopper-Pearson CI) of BoneView 1.1-US at the examination-level at the high-specificity operating point on the children/adolescents clinical performance study dataset VS adult clinical performance study dataset

Operating Point	Dataset	Specificity	Sensitivity
High-specificity operating point (FRACT)	Adult clinical performance study dataset	**0.932 [0.925 - 0.939]**	0.841 [0.829 - 0.853]
	Children/adolescents clinical performance study dataset	**0.965 [0.952 - 0.976]**	0.792 [0.766 - 0.817]
	95% confidence interval on the difference	**0.033 [0.019 - 0.046]**	-0.049 [-0.079 - -0.021]

In addition to the equivalence of performances with the performances on the adult population, the results of the standalone testing demonstrated that BoneView detects fractures in radiographs with high sensitivity and high specificity:

Specificity (with 95% Clopper-Pearson CI) and Sensitivity (with 95% Clopper-Pearson CI) of BoneView at the examination-level at the high-sensitivity operating point and high-specificity operating point on the children/adolescents clinical performance study dataset

	High-sensitivity operating point		High-specificity operating point	
Standalone Performance	Specificity – 95% Clopper-Pearson CI	Sensitivity – 95% Clopper-Pearson CI	Specificity – 95% Clopper-Pearson CI	Sensitivity – 95% Clopper-Pearson CI
Global n(positive)= 1,000 n(negative)= 1,000	0.821 [0.796 - 0.844]	**0.909 [0.889 - 0.926]**	**0.965 [0.952 - 0.976]**	0.792 [0.766 - 0.817]

Specificity (with 95% Clopper-Pearson CI) and Sensitivity (with 95% Clopper-Pearson CI) of BoneView at the examination-level for the subgroup analysis of anatomical areas of interest at the high-sensitivity operating point and high-specificity operating point on the children/adolescents clinical performance study dataset

	High-sensitivity operating point DOUBT FRACT		High-specificity operating point FRACT	
Anatomical Areas of Interest	Specificity – 95% Clopper-Pearson CI	Sensitivity – 95% Clopper-Pearson CI	Specificity – 95% Clopper-Pearson CI	Sensitivity – 95% Clopper-Pearson CI
Ankle n(positive)= 88 n(negative)= 157	TP=75 | FP=38 | TN=119 | FN=13		TP=57 | FP=11 | TN=146 | FN=31	
	0.758 [0.683 - 0.823]	**0.852 [0.761 - 0.919]**	**0.93 [0.878 - 0.965]**	0.648 [0.539 - 0.747]
Clavicle n(positive)= 113 n(negative)= 45	TP=110 | FP=9 | TN=36 | FN=3		TP=108 | FP=1 | TN=44 | FN=5	
	0.8 [0.654 - 0.904]	**0.973 [0.924 - 0.994]**	**0.978 [0.882 - 0.999]**	0.956 [0.9 - 0.985]
Elbow n(positive)= 96 n(negative)= 120	TP=87 | FP=32 | TN=88 | FN=9		TP=60 | FP=2 | TN=118 | FN=36	
	0.733 [0.645 - 0.81]	**0.906 [0.829 - 0.956]**	**0.983 [0.941 - 0.998]**	0.625 [0.52 - 0.722]
Foot n(positive)= 151 n(negative)= 173	TP=129 | FP=47 | TN=126 | FN=22		TP=113 | FP=12 | TN=161 | FN=38	
	0.728 [0.656 - 0.793]	**0.854 [0.788 - 0.906]**	**0.931 [0.882 - 0.964]**	0.748 [0.671 - 0.815]
Forearm	TP=59 | FP=5 | TN=35 | FN=6		TP=53 | FP=1 | TN=39 | FN=12	

	High-sensitivity operating point DOUBT FRACT		High-specificity operating point FRACT	
Anatomical Areas of Interest	Specificity – 95% Clopper-Pearson CI	Sensitivity – 95% Clopper-Pearson CI	Specificity – 95% Clopper-Pearson CI	Sensitivity – 95% Clopper-Pearson CI
n(positive)= 65 n(negative)= 40	0.875 [0.732 - 0.958]	**0.908 [0.81 - 0.965]**	**0.975 [0.868 - 0.999]**	0.815 [0.7 - 0.901]
Hand n(positive)= 188 n(negative)= 160	TP=174 | FP=18 | TN=142 | FN=14		TP=154 | FP=6 | TN=154 | FN=34	
	0.887 [0.828 - 0.932]	**0.926 [0.878 - 0.959]**	**0.963 [0.92 - 0.986]**	0.819 [0.757 - 0.871]
Humerus n(positive)= 24 n(negative)= 12	TP=24 | FP=4 | TN=8 | FN=0		TP=22 | FP=1 | TN=11 | FN=2	
	0.667 [0.349 - 0.901]	**1.0 [0.858 – 1.0]**	**0.917 [0.615 - 0.998]**	0.917 [0.73 - 0.99]
Knee n(positive)= 43 n(negative)= 167	TP=36 | FP=12 | TN=155 | FN=7		TP=20 | FP=4 | TN=163 | FN=23	
	0.928 [0.878 - 0.962]	**0.837 [0.693 - 0.932]**	**0.976 [0.94 - 0.993]**	0.465 [0.312 - 0.623]
Shoulder n(positive)= 85 n(negative)= 103	TP=80 | FP=21 | TN=82 | FN=5		TP=79 | FP=2 | TN=101 | FN=6	
	0.796 [0.705 - 0.869]	**0.941 [0.868 - 0.981]**	**0.981 [0.932 - 0.998]**	0.929 [0.853 - 0.974]
Tibia/Fibula n(positive)= 58 n(negative)= 40	TP=50 | FP=7 | TN=33 | FN=8		TP=43 | FP=1 | TN=39 | FN=15	
	0.825 [0.672 - 0.927]	**0.862 [0.746 - 0.939]**	**0.975 [0.868 - 0.999]**	0.741 [0.61 - 0.847]
Wrist n(positive)= 141 n(negative)= 90	TP=136 | FP=20 | TN=70 | FN=5		TP=127 | FP=4 | TN=86 | FN=14	
	0.778 [0.678 - 0.859]	**0.965 [0.919 - 0.988]**	**0.956 [0.89 - 0.988]**	0.901 [0.839 - 0.945]

Additionally, the performance of BoneView 1.1-US on the children and adolescents population was validated for potential confounders including weight-bearing and non-weight bearing bone fractures and different X-ray system manufacturers.

7.4.2. Testing for adult population

BoneView 1.1-US is using the same AI algorithm than the predicate device: BoneView 1.0-US (K212365). Thus, the bench testing (standalone testing) on the adult population described in the 510(k) submission of the predicate device are still valid and applicable to BoneView 1.1-US and are provided here for reference.

Gleamer performed a standalone performance testing on a dataset of 8,918 radiographs (47.2% of males, with age: range [21 – 113]; mean 52.5 +/- 19.8) for all anatomical areas of interest in the Indications for Use and from various manufacturers (Agfa, Fujifilm, GE Healthcare, Kodak, Konica Minolta, Philips, Primax, Samsung, Siemens). This dataset was independent of the data used for model training, tuning, and establishment of device operating points.

The results of the standalone testing demonstrated that BoneView detects fractures in radiographs with high sensitivity and high specificity:

Specificity (with 95% Clopper-Pearson CI) and Sensitivity (with 95% Clopper-Pearson CI) of BoneView at the examination-level at the high-sensitivity operating point and high-specificity operating point on the merged datasets

	High-sensitivity operating point		High-specificity operating point	
Standalone Performance	Specificity – 95% Clopper-Pearson CI	Sensitivity – 95% Clopper-Pearson CI	Specificity – 95% Clopper-Pearson CI	Sensitivity – 95% Clopper-Pearson CI
Global n(positive)= 3,886 n(negative)= 5,032	0.811 [0.8 - 0.821]	**0.928 [0.919 - 0.936]**	**0.932 [0.925 - 0.939]**	0.841 [0.829 - 0.853]

Specificity (with 95% Clopper-Pearson CI) and Sensitivity (with 95% Clopper-Pearson CI) of BoneView at the examination-level for the subgroup analysis of anatomical areas of interest at the high-sensitivity operating point and high-specificity operating point on the merged datasets

	High-sensitivity operating point DOUBT FRACT		High-specificity operating point FRACT	
Anatomical Areas of Interest	Specificity – 95% Clopper-Pearson CI	Sensitivity – 95% Clopper-Pearson CI	Specificity – 95% Clopper-Pearson CI	Sensitivity – 95% Clopper-Pearson CI
Ankle n(positive)= 378 n(negative)= 805	0.784 [0.754 - 0.812]	**0.95 [0.923 - 0.969]**	**0.897 [0.874 - 0.917]**	0.899 [0.865 - 0.928]
Clavicle n(positive)= 147 n(negative)= 255	0.757 [0.699 - 0.808]	**0.905 [0.845 - 0.947]**	**0.929 [0.891 - 0.958]**	0.83 [0.759 - 0.887]
Elbow n(positive)= 145 n(negative)= 227	0.718 [0.655 - 0.776]	**0.924 [0.868 - 0.962]**	**0.899 [0.852 - 0.935]**	0.531 [0.446 - 0.614]
Femur n(positive)= 63 n(negative)= 161	0.733 [0.658 - 0.799]	**0.937 [0.845 - 0.982]**	**0.944 [0.897 - 0.974]**	0.825 [0.709 - 0.909]
Foot n(positive)= 985 n(negative)= 1,097	0.793 [0.768 - 0.817]	**0.934 [0.917 - 0.949]**	**0.924 [0.907 - 0.939]**	0.874 [0.852 - 0.894]

	High-sensitivity operating point DOUBT FRACT		High-specificity operating point FRACT	
Anatomical Areas of Interest	Specificity – 95% Clopper-Pearson CI	Sensitivity – 95% Clopper-Pearson CI	Specificity – 95% Clopper-Pearson CI	Sensitivity – 95% Clopper-Pearson CI
Forearm n(positive)= 94 n(negative)= 102	0.676 [0.577 - 0.766]	**0.989 [0.942 - 1.0]**	**0.912 [0.839 - 0.959]**	0.851 [0.763 - 0.916]
Hand n(positive)= 1,168 n(negative)= 1,003	0.809 [0.783 - 0.832]	**0.966 [0.954 - 0.975]**	**0.917 [0.898 - 0.934]**	0.915 [0.898 - 0.931]
Hip n(positive)= 145 n(negative)= 235	0.77 [0.711 - 0.822]	**0.938 [0.885 - 0.971]**	**0.953 [0.918 - 0.976]**	0.793 [0.718 - 0.856]
Humerus n(positive)= 114 n(negative)= 175	0.731 [0.659 - 0.796]	**0.904 [0.834 - 0.951]**	**0.92 [0.869 - 0.956]**	0.833 [0.752 - 0.897]
Knee n(positive)= 128 n(negative)= 1,045	0.889 [0.868 - 0.907]	**0.891 [0.823 - 0.939]**	**0.975 [0.964 - 0.984]**	0.797 [0.717 - 0.863]
Lumbosacral Spine n(positive)= 125 n(negative)= 209	0.737 [0.672 - 0.795]	**0.776 [0.693 - 0.846]**	**0.947 [0.908 - 0.973]**	0.6 [0.509 - 0.687]
Pelvis n(positive)= 230 n(negative)= 479	0.745 [0.704 - 0.784]	**0.887 [0.839 - 0.925]**	**0.939 [0.914 - 0.959]**	0.743 [0.682 - 0.799]
Ribs n(positive)= 252 n(negative)= 95	0.684 [0.581 - 0.776]	**0.753 [0.7 - 0.802]**	**0.926 [0.854 - 0.97]**	0.488 [0.425 - 0.552]
Shoulder n(positive)= 255 n(negative)= 586	0.782 [0.746 - 0.814]	**0.929 [0.891 - 0.958]**	**0.947 [0.926 - 0.964]**	0.851 [0.801 - 0.892]
Thoracic Spine n(positive)= 74 n(negative)= 105	0.676 [0.578 - 0.764]	**0.878 [0.782 - 0.943]**	**0.905 [0.832 - 0.953]**	0.689 [0.571 - 0.792]
Tibia/Fibula n(positive)= 72 n(negative)= 184	0.712 [0.641 - 0.776]	**0.972 [0.903 - 0.997]**	**0.815 [0.751 - 0.869]**	0.931 [0.845 - 0.977]

	High-sensitivity operating point DOUBT FRACT		High-specificity operating point FRACT	
Anatomical Areas of Interest	Specificity – 95% Clopper-Pearson CI	Sensitivity – 95% Clopper-Pearson CI	Specificity – 95% Clopper-Pearson CI	Sensitivity – 95% Clopper-Pearson CI
Wrist n(positive)= 573 n(negative)= 502	0.771 [0.732 - 0.807]	**0.97 [0.953 - 0.983]**	**0.892 [0.862 - 0.918]**	0.934 [0.91 - 0.953]

Additionally, the performance of BoneView was validated for potential confounders including weight-bearing and non-weight bearing bone fractures and different X-ray system manufacturers.

7.5. Animal Studies

No animal studies were conducted in support of the 510(k) submission of BoneView.

7.6. Clinical Studies

No clinical studies were conducted in support of the 510(k) submission of BoneView 1.1-US.

BoneView 1.1-US is based on the same AI algorithm than the predicate device: BoneView 1.0-US (K212365). Thus, the clinical performance described in the 510(k) submission of the predicate device are still valid and applicable to BoneView 1.1-US, for both the adult and children adolescent population. The results are provided here for reference.

Gleamer conducted a fully-crossed multiple reader, multiple case (MRMC) retrospective reader study to determine the impact of BoneView on reader performance in diagnosing fractures. The primary objective of the study was to determine whether the diagnostic accuracy of readers aided by BoneView is superior to the diagnostic accuracy of readers unaided by BoneView as determined by the Specificity/Sensitivity pair (primary endpoint).

The clinical validation study design was the following:

- 24 clinical readers each evaluated a dataset of 480 cases (31.9% of males, with age: range [21 – 93]; mean 59.2 +/- 16.4) in BoneView's Indications for Use and from various manufacturers (GE Healthcare, Kodak, Konica Minolta, Philips, Samsung) under both Aided and Unaided conditions.
- This dataset was independent of the data used for model training, tuning, and establishment of device operating points.
- Each case had been previously evaluated by a panel of three U.S. board-certified radiologists who assigned a ground truth label indicating the presence or absence of a fracture and its location.
- Cases are from all the anatomical areas of interest included in BoneView's Indications for Use.
- The MRMC study consisted of two independent reading sessions separated by a washout period of at least one month in order to avoid memory bias.
- For each case, each reader was required to provide a determination of the presence or absence of a fracture and provide its location.

The results of the study found that the diagnostic accuracy of readers in the intended use population is superior when aided by BoneView than when unaided by BoneView, as measured at the task of fracture detection using the Specificity/Sensitivity pair.

In particular, the study results demonstrated:

- Reader specificity improved significantly from 0.906 (95% bootstrap CI: 0.898-0.913) to 0.956 (95% bootstrap CI: 0.951-0.960): **+5% increase of the Specificity**
- Reader sensitivity improved significantly from 0.648 (95% bootstrap CI: 0.640-0.656) to 0.752 (95% bootstrap CI: 0.745-0.759): **+10.4% increase of the Sensitivity**

Additionally, subgroup analysis was carried out by anatomical areas of interest, listed in the Indications for Use. The subgroup analysis found that the Sensitivity and Specificity were higher for Aided reads versus Unaided reads for all of the anatomical areas of interest.

8. Conclusion

BoneView 1.1-US and BoneView 1.0-US predicate device have the same intended use and technological characteristics. Only the indications for use are different with the inclusion of children and adolescents in the intended patient population.
Performance testing was conducted to validate the performance of BoneView 1.1-US on the new patient population. The results of the testing show that the device performs as intended and the differences in indications for use including the new patient population of children and adolescents does not raise different questions of safety or effectiveness as compared with the predicate device.
Therefore, BoneView 1.1-US subject device and BoneView 1.0-US predicate device (K212365) are substantially equivalent.