Icometrix NV
℅ Dirk Smeets
VP Clinical Applications
Kolonel Begaultlaan 1b/12
3012 Leuven
BELGIUM

February 28, 2020

Re: K192962
Trade/Device Name: icobrain-ctp
Regulation Number: 21 CFR 892.2050
Regulation Name: Picture archiving and communications system
Regulatory Class: Class II
Product Code: LLZ
Dated: January 24, 2020
Received: January 27, 2020

Dear Dirk Smeets:

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,

For

Thalia T. Mills, Ph.D.
Director
Division of Radiological Health
OHT7: Office of In Vitro Diagnostics
and 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: 06/30/2020
See PRA Statement below.

510(k) Number *(if known)*
K192962

Device Name
icobrain ctp

Indications for Use *(Describe)*
icobrain ctp is an image processing software package to be used by trained professionals, including but not limited to physicians and medical technicians. The software runs on a standard "off-the-shelf" computer or a virtual platform, such as VMware, and can be used to perform image processing, analysis, and communication of computed tomography (CT) perfusion scans of the brain. Data and images are acquired through DICOM-compliant imaging devices.

icobrain ctp provides both analysis and communication capabilities for dynamic imaging datasets that are acquired with CT Perfusion imaging protocols. Analysis includes calculation of parameters related to tissue flow (perfusion) and tissue blood volume. Results of image processing which include CT perfusion parameter maps generated from a raw CTP scan are exported in the standard DICOM format and may be viewed on existing radiological imaging viewers.

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.

This section applies only to requirements of the Paperwork Reduction Act of 1995.

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5.1 Submitter

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Date Prepared:	28 Feb 2020

5.2 Device

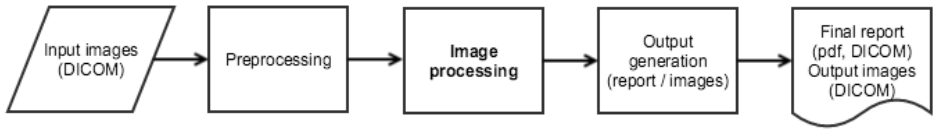
Device Trade Name:	ico**brain** ctp
Common Name	Medical Image Processing Software
Classification Name	System, Image processing, Radiological
Number	892.2050
Product Code:	LLZ
Classification Panel:	Radiology

5.3 Predicate Device

Item	**Description**
510(k) Number	K180161
Device Name	Viz CTP
Original Applicant	Viz.ai, Inc.
Regulation Number	21 CFR 892.2050
Classification Product Code	LLZ
510k Review Panel	Radiology

5.4 Device Description

The following flowchart illustrates the overall architecture of ico**brain** ctp.



The input images are CT perfusion images. During the pre-processing, each scan is loaded from the DICOM format: the image data and relevant dicom tags are extracted. The image processing block calculates the perfusion parameters and the volumes of the Tmax abnormality (defined as tissue with delayed arrival) and the CBF abnormality (defined as tissue with delayed arrival and critically decreased cerebral blood flow). Finally, the computed measurements are summarized into an electronic report. Optionally if requested, Tmax and CBF abnormalities segmentations are overlaid on the input images and image volumes of perfusion parameters maps are sent.

Output of ico**brain** ctp:

Report:

- volume of brain tissue with elevated time to maximum residual function (Tmax abnormality)
- volume of brain tissue with elevated time to maximum residual function and decreased cerebral blood flow (CBF abnormality)
- mismatch volume (difference between Tmax abnormality and CBF abnormality volumes)
- ratio between Tmax abnormality volume and CBF abnormality volume
- the time series of the arterial input function, venous output function and the averaged time density curves in the parenchymal tissue
- the time points/image volumes of the CTP that were excluded because of artefacts (if any)
- temporal mean of the input CT input images with corresponding perfusion parameter maps (time to maximum residual function, cerebral blood flow, cerebral blood volume, mean transit time) at various slices

5.5 Indications for Use

ico**brain** ctp is an image processing software package to be used by trained professionals, including but not limited to physicians and medical technicians. The software runs on a standard "off-the-shelf" computer or a virtual platform, such as VMware, and can be used to perform image processing, analysis, and communication of computed tomography (CT) perfusion scans of the brain. Data and images are acquired through DICOM-compliant imaging devices.

ico**brain** ctp provides both analysis and communication capabilities for dynamic imaging datasets that are acquired with CT Perfusion imaging protocols. Analysis includes calculation of parameters related to tissue flow (perfusion) and tissue blood volume. Results of image processing which include CT perfusion parameter maps generated from a raw CTP scan are exported in the standard DICOM format and may be viewed on existing radiological imaging viewers.

5.6 Comparison with predicate device

	Device to market	Proposed predicate device	Proposed Reference device
Device Trade Name	ico**brain** ctp	Viz CTP	RAPID
Common Name	Medical Image Processing Software	Picture archiving and communications system	Picture archiving and communications system
510(k) Number	K192962	K180161	K121447
Manufacturer	ico**metrix** NV Kolonel Begaultlaan 1b / 12 3012 Leuven BELGIUM	Viz.ai, Inc. 855 El Camino Real Suite 13A-252 Palo Alto, CA 94301	iSchemaView, Inc. 323 Olmsted Road Stanford, CA 94305
Regulation Number	21 CFR 892.2050	21 CFR 892.2050	21 CFR 892.2050
Device Classification Name	System, Image processing, Radiological	System, Image processing, Radiological	System, Image processing, Radiological
Product Code	LLZ	LLZ	LLZ
Regulatory Class	II	II	II
Classification Panel	Radiology	Radiology	Radiology
Indications for use	ico**brain** ctp is an image processing software package to be used by trained professionals, including but not limited to physicians and medical technicians. The software runs on a standard "off-the-shelf" computer or a virtual platform, such as VMware, and can be used to perform image processing, analysis, and communication of computed tomography (CT) perfusion scans of the brain. Data and images are acquired through DICOM-compliant imaging devices. ico**brain** ctp provides both analysis and communication capabilities for dynamic imaging datasets that are acquired with CT Perfusion imaging protocols. Analysis includes calculation of parameters related to tissue flow (perfusion) and tissue blood volume. Results of image processing which include CT perfusion parameter maps generated from a raw CTP scan are exported in the standard DICOM format and may be viewed on existing radiological imaging viewers.	Viz CTP is an image processing software package to be used by trained professionals, including but not limited to physicians and medical technicians. The software runs on a standard "off-the-shelf" computer or a virtual platform, such as VMware, and can be used to perform image processing, analysis, and communication of computed tomography (CT) perfusion scans of the brain. Data and images are acquired through DICOM-compliant imaging devices. Viz CTP provides both analysis and communication capabilities for dynamic imaging datasets that are acquired with CT Perfusion imaging protocols. Analysis includes calculation of parameters related to tissue flow (perfusion) and tissue blood volume. Results of image processing which include CT perfusion parameter maps generated from a raw CTP scan are exported in the standard DICOM format and may be viewed on existing radiological imaging viewers.	iSchemaView's RAPID is an image processing software package to be used by trained professionals, including but not limited to physicians and medical technicians. The software runs on a standard "off-the-shelf" computer or a virtual platform, such as VMware, and can be used to perform image viewing, processing and analysis of brain images. Data and images are acquired through DICOM compliant imaging devices. iSchemaView's RAPID provides both viewing and analysis capabilities for functional and dynamic imaging datasets acquired with CT Perfusion and MRI including a Diffusion Weighted MRI (DWI) Module and a Dynamic Analysis Module (dynamic contrast enhanced imaging data for MRI and CT).
PACS functionality			

Basic PACS functions	Yes	Yes	Yes
Computer platform	Standard "off-the-shelf" computer or a virtual platform.	Same	Same
DICOM compliance	Yes	Yes	Yes
Functional overview	ico**brain** ctp is a software package that provides for the quantification and visualization of the perfusion of tissue based on dynamic contrast enhanced CT images.	Same	Automatic analysis for functional and dynamic imaging datasets acquired with CT Perfusion and MRI including a Diffusion Weighted MRI (DWI) Module and a Dynamic Analysis Module (dynamic contrast enhanced imaging data for MRI and CT).
Data Acquisition	Acquires medical image data from DICOM compliant imaging devices and modalities.	Same	Same
Data/Image Types	Computed Tomography (CT)	Same	CT and MR scanner
Acquisition and Modalities Features			
CT	CT Perfusion	Yes	Yes
Computed Parameter Maps			
Perfusion CT	Cerebral Blood Flow (CBF)	Yes	Yes
	Cerebral Blood Volume (CBV)	Yes	Yes
	Mean Transit Time (MTT)	Yes	Yes
	Tissue residue function time to peak (TMax)	Yes	Yes
Measurements/Tools			
	Arterial Input Function (AIF) / Venous Output Function (VOF)	Same	Same
	Brain mask	Same	Same
	Export perfusion files to PACS and DICOM file systems	Same	Same
	Acquire, transmit, process, and store medical images	Same	Same
Volumetry			
Default Tmax abnormality	Tmax > 6s	Same	Same
Default CBF abnormality	CBF < 30%	Same	Same
Default Mismatch volume	(Tmax > 6s) - (CBF < 30%)	Same	Same
Default Mismatch ratio	(Tmax > 6s) / (CBF < 30%)	Same or not shown	Same
User adjustable	No	Yes	Yes
Validation			

Description	ico**brain** ctp was tested:
	• on a simulated dataset (digital phantom) generated by simulating tracer kinetic theory, that includes a wide range of clinically relevant values of perfusion parameters (CBV, CBF, MTT) as ground truth. Correlation, p90 absolute difference and mean relative difference between the output of ico**brain** ctp device and the ground truth values were calculated, and compared to preestablished performance goals based on academic literature.
	• on a clinical dataset:
	  • the accuracy of the TMax and CBF abnormality volumes
	  • the reproducibility of the TMax and CBF abnormalities volumes
	  • the accuracy of the soft tissue segmentation
		Viz.ai Inc. performed software verification and validation testing of the device and additional performance testing on a commercially available simulated dataset (digital phantom) generated by simulating tracer kinetic theory, and includes a wide range of clinically relevant values of perfusion parameters as ground truth. Correlations between the output of the Viz CTP device and the ground truth values were calculated, and compared to published correlations between the ground truth and the outputs of 7 other commercially available and academic CTP post-processing software.
		
		The results of performance testing showed that the Viz CTP device achieved the pre-established performance goals for AIF detection, soft matter extraction, and each perfusion parameter: cerebral blood flow (CBF), cerebral blood volume (CBV), mean transit time (MTT), and time to maximum residue (TMax).
			iSchemaView conducted extensive performance validation testing and software verification and validation testing of the RAPID system. This performance validation testing demonstrated that the RAPID system provides accurate representation of key diffusion and perfusion processing parameters under a range of clinically relevant parameters and perturbations associated with the intended use of the software. Software validation and verification testing demonstrated that the RAPID system met all design requirements and specifications.

5.7 Performance testing

To demonstrate the performance of ico**brain** ctp, the measurements are validated for accuracy and reproducibility. Literature review has been performed to set relevant acceptance criteria for each type of experiment.

The device was tested on a dataset of clinical CTP scans. The subjects upon whom the software was tested include stroke patients. In a first accuracy experiment, the CBF and Tmax abnormality volumes were compared to the corresponding volumes from the reference device. The acceptance criteria were set on the percentile 90 of the volume differences for both the CBF abnormality and the Tmax abnormality. In a second accuracy experiment, the unbiased CBF abnormality volume was compared to ground truth volumes from manually delineated DWI images. The acceptance criteria were set on the percentile 90 of the volume differences. In a third accuracy experiment, the region of interest (ROI) volume was compared to ground truth volumes from manually annotated ROI. The acceptance criteria were set on the percentile 90 of the volume differences. Reproducibility was tested on test and retest CT perfusion images. The retest images were produced by simulating patient motion on the test images. The acceptance criteria were set on the percentile 90 of the volume differences for both the CBF abnormality and the Tmax abnormality.

Additionally, the perfusion parameter maps were tested for accuracy on a digital phantom, generated by simulating tracer kinetic theory, that includes a wide range of clinically relevant values of perfusion parameters (CBV, CBF, MTT) as ground truth. The acceptance criteria were set on the correlation, the percentile 90 absolute difference and the mean relative difference between the ground truth and the estimated values. All experiments passed the acceptance criteria. In the digital phantom, the correlation for each perfusion parameter was above 0.90.

Besides the verification experiments, validation tests demonstrate the system as a whole provides all the capabilities necessary to operate according to its intended use.

5.8 Conclusions

The performance testing presented above establishes that the ico**brain** ctp is safe and effective for its intended use. The comparison above demonstrates that the ico**brain** ctp device is substantially equivalent to the predicate device.

Declarations:	• This summary includes only information that is also covered in the body of the 510(k). • This summary does not contain any puffery or unsubstantiated labeling claims. • This summary does not contain any raw data, i.e., contains only summary data. • This summary does not contain any trade secret or confidential commercial information. • This summary does not contain any patient identification information.

This document is reviewed and approved by Dirk Smeets, Vice President Clinical Applications of ico **metrix**, based on the present data and information.

Signature	Date
	28 Feb 2020