May 13, 2024

Brainomix Limited
% Thais Sala
Senior Quality Assurance and Regulatory Affairs Manager
First Floor, Seacourt Tower
West Way
OXFORD, OX2JJ
UNITED KINGDON

Re: K233875
Trade/Device Name: Brainomix 360 e-Lung
Regulation Number: 21 CFR 892.1750
Regulation Name: Computed Tomography X-Ray System
Regulatory Class: Class II
Product Code: JAK
Dated: December 7, 2023
Received: April 15, 2024

Dear Thais Sala:

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,

Lu Jiang

Lu Jiang, Ph.D.
Assistant Director
Diagnostic X-Ray Systems Team
DHT8B: Division of Radiologic Imaging
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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: 07/31/2026
See PRA Statement below.

510(k) Number *(if known)*
K233875

Device Name
Brainomix 360 e-Lung

Indications for Use *(Describe)*
The e-Lung software provides reproducible CT values for pulmonary tissue, which is essential for providing quantitative support in the examination of radiological findings. These radiological findings can then be evaluated by the physician in conjunction with a range of ancillary information to form a potential diagnosis or list of likely diagnoses. The e-Lung software package is intended to be a workflow enhancement and visualization tool for the assessment of CT thoracic datasets. e-Lung can be used to support the physician when examining the pulmonary and thoracic tissue (i.e. lung parenchyma) in CT thoracic datasets. 3D segmentation, volumetric measurements, density evaluations, and reporting tools are combined with a dedicated workflow.

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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K233875

510(K) Summary
Brainomix Limited – Brainomix 360 e-Lung

Date Prepared:	07Dec2023
Applicant's Name:	Brainomix Limited
Applicant's Address:	First Floor, Seacourt Tower, West Way Oxford, OX2 0JJ United Kingdom
Official Contact:	Thais Sala +44 (0) 7375 967 695 tsala@brainomix.com
Device Proprietary Name:	Brainomix 360 e-Lung
Regulation Name:	Computed tomography x-ray system
Regulatory Class:	Class II
Product Code:	JAK
Regulation Number:	21 C.F.R. §892.1750

1. Predicate Device

Brainomix 360 e-Lung is Substantially Equivalent to the following Legally Marketed device:

Trade Name: Vida | Vision
Manufacturer: VIDA Diagnostics Inc.
Regulation Number: 21 C.F.R. §892.1750
Regulatory Class: Class II
Regulation Name: Computed tomography x-ray system
Product Code: JAK
Submission Number: K200990

2. Device Description

Brainomix 360 e-Lung is a software package compliant with the DICOM standard and running on an off-the-shelf physical or virtual server. e-Lung is a CT processing module which operates within the integrated Brainomix 360 platform.

Brainomix 360 e-Lung is a stand-alone software device which uses a set of image processing algorithms to perform evaluation (3D segmentation and isolation of sub-compartments, volumetric measurements, and density evaluations), editing, and reporting tools which are combined with a dedicated workflow.

e-Lung can be used to support the physician in the examination of radiological findings that may be indicative of chest diseases e.g. when examining the pulmonary and thoracic tissue (i.e. lung parenchyma) in CT thoracic datasets. These radiological findings can then be evaluated by the

physician in conjunction with a range of ancillary information to form a potential diagnosis or list of likely diagnoses.

e-Lung is designed to analyze pulmonary CT slice data and display analysis results. Each voxel of the scan is measured by Hounsfield units (HU), a measurement of x-ray attenuation that is applied to each volume element in three dimensional space. The HU are utilized to distinguish between air, water, tissue and bone, such distinction is common in the industry.

e-Lung provides computed tomography (CT) viewing, and parenchymal density analysis in one application. e-Lung provides quantitative measurements and tabulates quantitative properties.

e-Lung focuses on what is visible to the eye and applies volumetric methods that might otherwise be too time consuming to use.

The software does not perform any function which cannot be accomplished by a trained user utilizing manual tracing methods; the software does not reconstruct a 3D rendering image of the lung; the intent of the software is to enhance the workflow by saving time and automating potential error prone manual tasks.

e-Lung has functions for loading, analyzing, and saving datasets, and will generate screen displays, computations and aggregate statistics. e-Lung data output may be exported to a CSV, Excel or PDF file.

3. Intended Use / Indications for Use

The e-Lung software provides reproducible CT values for pulmonary tissue, which is essential for providing quantitative support in the examination of radiological findings. These radiological findings can then be evaluated by the physician in conjunction with a range of ancillary information to form a potential diagnosis or list of likely diagnoses. The e-Lung software package is intended to be a workflow enhancement and visualization tool for the assessment of CT thoracic datasets. e-Lung can be used to support the physician when examining the pulmonary and thoracic tissue (i.e. lung parenchyma) in CT thoracic datasets. 3D segmentation, volumetric measurements, density evaluations, and reporting tools are combined with a dedicated workflow.

4. Performance Data

4.1 Clinical Study (lung segmentation)

A retrospective study has been carried out to validate the lung segmentation functionality of e-Lung. The study evaluated the accuracy of the e-Lung lung mask generation compared to a ground truth mask generated from the consensus of three experienced US board certified radiologists, who segmented the lungs following their usual standard of care. The similarity between the device lung masks and the ground truth lung masks was evaluated using Dice Similarity Coefficients (DSC), which index the amount of overlap between the two masks. The acceptability criterion for the study was an average DSC across all cases of over 0.95 (defined by the lower bound of the confidence interval).

The dataset for this validation study comprised 100 computed tomography (CT) chest studies performed in the clinical context of evaluation of lung disease. Cases were selected from two sources: from a research registry held at Boston Medical Center (N=38) and from a commercial database of clinical imaging data (N=62). The number of cases from different scanner manufacturers and models

is shown in Table 1. A range of convolution kernels and acquisition parameters were included in the dataset, including 24 cases acquired with contrast.

The dataset was enriched to ensure a distribution of clinical and demographic variables (e.g. age, gender, race/ethnicity, clinical site, BMI, smoking history and radiological findings) that allows generalizability to the patient population for whom use is intended. The median age was 61 years (inter-quartile range [IQR]: 52.5-70, total range: 23-100). The number of cases in relevant demographic or clinical subgroups is shown in Table 2.

All cases were successfully processed by the device. All cases showed a DSC of above the acceptability criterion (DSC=0.95). The distribution of DSC is shown in Figure 1. The median DSC was 0.978 (IQR: 0.974-0.980). Hence, the study met the acceptability criterion. Performance was consistent for the left and right lungs (left: median DSC=0.976, IQR: 0.972-0.978; right: median DSC=0.979, IQR: 0.976-0.981). Table 3 reports the median (and IQR) DSC for clinically-relevant subgroups, including age, gender, race/ethnicity, BMI, smoking status, radiological findings, hospital location, scanner manufacturer, slice thickness, KvP and contrast. Lung segmentation performance of the device was consistent across all subgroups.

Table 1. Table showing the number of cases in the lung segmentation dataset using different scanner manufacturers and models.

Manufacturer	***Model***	***N***
SIEMENS	**All**	**36**
	SOMATOM Perspective	22
	SOMATOM go.Up	6
	SOMATOM Definition AS+	3
	SOMATOM Definition AS	2
	Sensation 16	2
	SOMATOM go.Top	1
GE	**All**	**28**
	Revolution Apex	9
	Revolution Frontier	8
	Revolution CT	7
	LightSpeed VCT	2
	BrightSpeed S	1
	Discovery STE	1
Philips	**All**	**23**
	IQon – Spectral CT	12
	Brilliance 16	4
	Brilliance 64	4
	Brilliance 6	2
	Gemini	1
Toshiba	**All**	**13**
	Aquilion	9

	Aquilion ONE	4

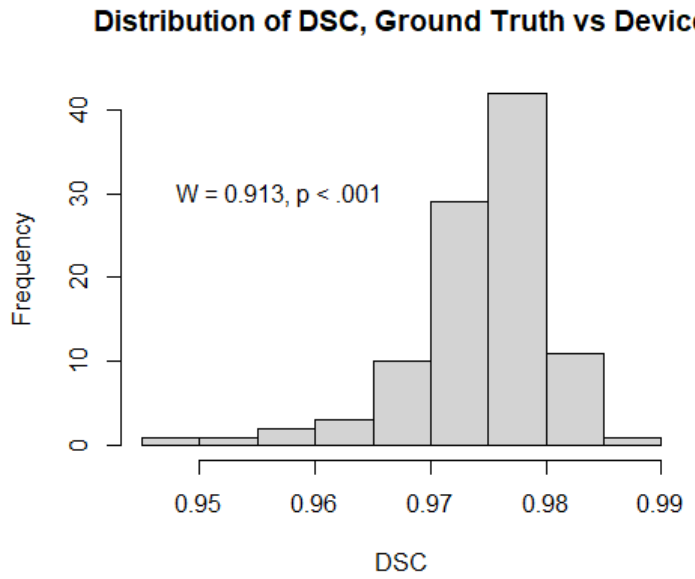

Figure 1.Histogram showing the distribution of Dice Similarity Coefficients (DSC) between ground truth lung masks and e-Lung device lung masks. The results of the Shapiro-Wilks normality test is also shown.

Table 2. Median Dice Similarity Coefficients (DSC) and interquartile ranges (IQR) for cases stratified by relevant demographic, clinical and imaging variables. The number of cases per subgroup (N) is also shown.

Subgroup Variable	***N***	***Median DSC [IQR]***
Age:		
Under 60	45	0.978 [0.974 – 0.980]
60 or over	55	0.978 [0.974 – 0.980]
Gender:		
Female	55	0.978 [0.973 – 0.979]
Male	45	0.978 [0.976 – 0.981]
Race / Ethnicity:		
Black or African American	14	0.974 [0.970 – 0.978]
White	11	0.978 [0.976 – 0.978]
Hispanic or Latino	7	0.974 [0.970 – 0.978]
Asian	3	0.980 [0.979 – 0.981]

Subgroup Variable	***N***	***Median DSC [IQR]***
Other	3	0.974 [0.972 – 0.978]
Unknown / declined	62	0.978 [0.975 – 0.980]
BMI:		
Underweight	3	0.985 [0.980 – 0.985]
Healthy Weight	6	0.977 [0.973 – 0.978]
Overweight	17	0.977 [0.972 – 0.980]
Obese	12	0.974 [0.971 – 0.978]
Unknown	72	0.978 [0.975 – 0.980]
Smoking Status:		
Current smoker	25	0.978 [0.977 – 0.981]
History of smoking	18	0.978 [0.978 – 0.979]
Non-smoker	23	0.975 [0.972 – 0.978]
Unknown	34	0.978 [0.972 – 0.980]
Radiological Findings:		
Ground Glass	20	0.979 [0.972-0.979]
Linear Opacities	35	0.978 [0.977-0.981]
Airways Abnormalities	22	0.979 [0.978-0.981]
Extrapulmonary Findings	18	0.978 [0.974-0.979]
Nodules	48	0.978 [0.976-0.980]
Atelectasis	12	0.974 [0.971-0.978]
Hospital Location:		
Massachusetts	38	0.976 [0.972 – 0.978]
New York	31	0.978 [0.978 – 0.980]
Ohio	17	0.978 [0.976 – 0.980]
New Jersey	4	0.962 [0.958 – 0.966]
Wisconsin	4	0.980 [0.978 – 0.980]

Subgroup Variable	***N***	***Median DSC [IQR]***
Florida	3	0.972 [0.970 – 0.976]
Maryland	2	0.974 [0.971 – 0.976]
South Dakota	1	0.980 [NA]
Scanner Manufacturer:		
SIEMENS	36	0.979 [0.977 – 0.979]
GE Medical Systems	28	0.976 [0.976 – 0.981]
Philips	23	0.975 [0.970 – 0.978]
Toshiba	13	0.980 [0.977 – 0.981]
Slice Thickness:		
Under 3mm	70	0.978 [0.973 – 0.979]
3mm or over	30	0.979 [0.977 – 0.980]
KvP:		
100	3	0.978 [0.976 – 0.978]
110	24	0.979 [0.978 – 0.980]
120	55	0.978 [0.972 – 0.980]
130	5	0.977 [0.972 – 0.978]
140	13	0.975 [0.974 – 0.981]
Contrast:		
Without contrast	76	0.978 [0.976 – 0.980]
With contrast	24	0.974 [0.970 – 0.978]

4.2 Digital Phantom (Density Evaluations)

Specific validation has been carried out to test the density analysis output (structural density filtering and density histogram evaluation). This testing made use of synthetic digital phantom data together with a real-world data bridging study created to provide a ground truth against which the performance of the density evaluations can be assessed and demonstrated.

The density evaluations are validated by ensuring a good Dice score (min 0.80) between the e-Lung structural densities and histogram densities and those pre-defined parameters generated in the digital phantom dataset.

5. Prescriptive Statement

Caution: Federal law restricts this device to sale by or on the order of a physician.

6. Safety and Effectiveness

Brainomix 360 e-Lung has been designed, verified and validated in compliance with 21 CFR, Part 820.30 requirements. The device has been designed to meet the requirements associated with ISO 14971:2019 (risk management).

7. Summary of Technological Characteristics

The proposed device (Brainomix 360 e-Lung) have the same intended use and substantially similar indications for use, core functionalities and outputs compared to the predicate device (VIDA | vision). Both devices have substantially equivalent indications for use, technical approaches and roles within a clinical workflow relative to the analysis of pulmonary tissue on CT Thoracic datasets. The proposed device does not introduce any new risks when compared to the predicate.

Where the proposed device and predicate device differ in technical characteristics is that:

- e-Lung offers a subset of the intended use and functionality offered by the predicate (e.g., proposed device does not provide reconstruction of two-dimensional images into a three-dimensional image format) and therefore, the risks associated with these types of analysis are not applicable to the proposed device.
- e-Lung offers a peripheral sub-compartment of the lungs which is generated based on the lung segmentation and a depth selected by the user from a range of 5 and 25mm at 5mm increments. In the proposed device, the preferred depth is defined by a trained clinical professional with an admin user privilege, the user can also choose not to have a peripheral sub-compartment. Describing the distribution of radiographic features in terms of their proximity to the center of the body or the periphery can be helpful in diagnosing the causative disease. This device is intended to support the user in the examination of radiological findings as an enhancement and visualization tool which provides reproducible CT values for pulmonary tissue. Therefore, the technical differences in sub-compartment method between the proposed and predicate device do not raise different questions of safety and effectiveness.
- e-Lung offers density histogram evaluation and structural density filtering evaluation where the metrics for the density evaluations are defined by a trained clinical professional with an admin user privilege. The density evaluations support the intended use of the device (examination of the pulmonary and thoracic tissue) and are volumetric calculations of imaging features with parameters defined by a trained user. Furthermore, the outputs of the density evaluation have been validated as part of this submission. Therefore, the technical

differences in density evaluations between the proposed and predicate device do not raise different questions of safety and effectiveness.

- The proposed device uses a non-adaptive deterministic algorithm to automatically segment the lung mask, similarly to the predicate device, with comprehensive validation so therefore does not add any new risks or raise different questions of safety and effectiveness given the minor difference in algorithms.

We conclude that Brainomix 360 e-Lung is safe and effective, raises no unanswered questions with regards to safety and efficacy and is substantially equivalent to the chosen predicate, VIDA|vision.

8. Substantial Equivalence

A table comparing the key features of the subject and predicate devices is provided below.

Characteristics/Parameter	Proposed Device Brainomix 360 e-Lung	Predicate Device VIDA|vision
510(k) Number	K233875	K200990
Product Code	JAK	JAK
Regulation Number	21 CFR §892.1750	21 CFR §892.1750
Regulation Name	System, X-Ray, Tomography, Computed	System, X-Ray, Tomography, Computed
Intended Use/Indications for Use	The e-Lung software provides reproducible CT values for pulmonary tissue, which is essential for providing quantitative support in the examination of radiological findings. These radiological findings can then be evaluated by the physician in conjunction with a range of ancillary information to form a potential diagnosis or list of likely diagnoses. The e-Lung software package is intended to be a workflow enhancement and visualization tool for the assessment of CT thoracic datasets. e-Lung can be used to support the physician when examining the pulmonary and thoracic tissue (i.e. lung parenchyma) in CT thoracic datasets. 3D segmentation, volumetric measurements, density evaluations, and reporting tools are combined with a dedicated workflow.	The VIDA|vision software provides reproducible CT values for pulmonary tissue, which is essential for providing quantitative support for diagnosis and follow up examinations. VIDA|vision can be used to support the physician in the diagnosis and documentation of pulmonary tissue images (e.g., abnormalities) from CT thoracic datasets. Three-D segmentation and isolation of sub-compartments, volumetric analysis, density evaluations, low density cluster analysis and reporting tools are combined with a dedicated workflow. The VIDA|vision software package is also intended to be a real-time interactive evaluation in space and time for CT volume data sets that provides the reconstruction of two dimensional images into a three-dimensional image format.

Characteristics/Parameter	Proposed Device Brainomix 360 e-Lung	Predicate Device VIDA|vision
Image Source Modalities	CT	CT
DICOM Conformance	Yes	Yes
Comparative Review	2D	2D, 3D
3D Lung Mapping	No	Yes
3D Measurements	3D volume of masks	Volume Effective Diameter
2D Measurements	None	Line and ROI tools with statistics Diameter 2D Area
Density Measurements	Admin user defined density histogram evaluation and structural density filtering evaluation	Minimum, maximum and average HU
Deployment	Standard off-the-shelf server or virtual server	Standalone computer / distributed
OS	Ubuntu Linux	Windows
User Interface	Yes	Yes
Algorithm	Each voxel of the scan is measured by Hounsfield Units (HU), a measurement of x-ray attenuation that is applied to each volume element in three dimensional space ('voxel'). The HU are utilised to distinguish between air, water, tissue and bone, such distinction is common in the industry. A (non-AI) image processing approach is applied to CT imaging data to automatically segment lung mask.	Each voxel of the scan is measured by Hounsfield Units (HU), a measurement of x-ray attenuation that is applied to each volume element in three dimensional space ('voxel'). The HU are utilised to distinguish between air, water, tissue and bone, such distinction is common in the industry. A non-adaptive deep learning-based algorithm is applied to the CT imaging data to automatically segment lung regions.
Workflow	Automated segmentation Automated measurements (including those based on user configurations)	Automated contouring Automated measurements Manual Correction <u>Distinct user workflows:</u>

Characteristics/Parameter	Proposed Device Brainomix 360 e-Lung	Predicate Device VIDA|vision
		Airway Mapping and Lung Volume Analysis
Graphic User Interface	Yes	Yes
Interactive 3D Visualisation	No	Yes
Input/Output	Users can browse, select, and load CT scan files. Users can save and load analyses, export via reporting tools. CT scan files are organized by patient in the scan viewer. User can generate a report that displays quantitative data items that can be saved. DICOM info displayed. Data import through DICOM query/retrieve available.	Users can browse, select, and load CT scan files. Users can save and load analyses, export via reporting tools. CT scan files can be organized by user-defined projects, and tracked by usage. User can generate a report that displays quantitative data items that can be saved. DICOM info displayed. Data import through DICOM query/retrieve available.
Path Planning	No	Yes – airways and lung tissue
User Editing	Yes	Yes
Reports	Yes – CSV, Excel and PDF format	Yes – CSV and PDF format configurable for specific use cases
Scan Quality Assessment	• Scan protocol is assessed for compatibility with software • Incompatibility issues flagged during import and on report	• Scan protocol is assessed for compatibility with software • Incompatibility issues flagged during import and on report • Scanner calibration assessment • Warning issued for out-of-range air/blood measurements

9. Conclusion

In conclusion, Brainomix 360 e-Lung has the same intended use and is substantially equivalent in technological characteristics, safety, and performance characteristics to the legally marketed predicate device, VIDA|vision (K200990). Brainomix 360 e-Lung is therefore substantially equivalent to the selected legally marketed predicate device and does not raise any questions of safety or effectiveness.