July 22, 2025

NeuroSpectrum Insights Corp.
% James Luker
Sr. Regulatory Consultant
Innolitics LLC
1101 W 34th St. Suite 550
Austin, Texas 78705

Re: K250686
Trade/Device Name: GyriCalc (Version 1.0.0)
Regulation Number: 21 CFR 892.2050
Regulation Name: Medical Image Management And Processing System
Regulatory Class: Class II
Product Code: LLZ
Dated: June 20, 2025
Received: June 20, 2025

Dear James Luker:

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.

All medical devices, including Class I and unclassified devices and combination product device constituent parts are required to be in compliance with the final Unique Device Identification System rule ("UDI Rule"). The UDI Rule requires, among other things, that a device bear a unique device identifier (UDI) on its label and package (21 CFR 801.20(a)) unless an exception or alternative applies (21 CFR 801.20(b)) and that the dates on the device label be formatted in accordance with 21 CFR 801.18. The UDI Rule (21 CFR 830.300(a) and 830.320(b)) also requires that certain information be submitted to the Global Unique Device Identification Database (GUDID) (21 CFR Part 830 Subpart E). For additional information on these requirements, please see the UDI System webpage at https://www.fda.gov/medical-devices/device-advice-comprehensive-regulatory-assistance/unique-device-identification-system-udi-system.

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,

Digitally signed by Michael D. O'hara -S
Date: 2025.07.22 12:22:45 -04'00'

for
Daniel M. Krainak, Ph.D.
Assistant Director
DHT8C: Division of Radiological
Imaging and Radiation Therapy Devices
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.

Submission Number *(if known)*

K250686

Device Name

GyriCalc

Indications for Use *(Describe)*

GyriCalc is intended for automatic labeling, visualization, and quantification including volume, surface area and gyrification analysis (i.e., gyrification index) of segmentable brain structures from a set of MR images.

GyriCalc is intended to be used by qualified personnel and interpreted by a qualified clinician.

GyriCalc is not intended to be used for visualization or quantification of neurologic lesions.

GyriCalc is intended for children between 24 to 36 months of age.

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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510(k) Summary

(21 CFR 807.92(c))

1. Contact Information

Company Name	NeuroSpectrum Insights Corp.
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Phone Number	908-304-4858
Company Representative	Andrew D. Stewart, CEO
Official Correspondent	James Luker, Innolitics
Email	JLuker@Innolitics.com
Date Prepared	March 2, 2025

2. Device Information

Trade Name	GyriCalc
Common Name	Neuroanatomy measuring software
Product Code	LLZ
Regulation Number	892.2050
Class	Class II
Panel	Radiology

3. Predicate Device Information

Predicate Device Name	NeuroQuant
Predicate Device K Number	K170981
Product Code	LLZ
Regulation Number	892.2050

Class	Class II
Panel	Radiology

4. DEVICE DESCRIPTION

GyriCalc is an automated imaging post-processing software medical device (SaMD) that provides automatic labeling, visualization, volumetric quantification, surface area, thickness and gyrification analysis of brain structures for children ages 24-36 months of age from a set of MR images and returns segmented images and morphometric reports. GyriCalc is a proprietary application which incorporates customized, state-of-the-art open-source software to perform image analysis and quantitative functionality.
The resulting output is provided as a PDF report with segmented color overlays and morphometric reports that can be displayed on commonly used Off The Shelf (OTS) PDF viewer. GyriCalc is not intended to be used for image review. The PDF report is the sole output of the device.
GyriCalc provides morphometric measurements based on 3D T1 MRI series. The output of the software includes volumes that have been annotated with color overlays, with each color representing a particular segmented region, and morphometric reports that provide measured volumes and other qualitative and quantitative data.

GyriCalc 's processing architecture includes functionality that performs:

- Preprocessing
  - Artifact correction (correct for various artifacts and distortions, such as motion, intensity inhomogeneity, and scanner-related differences),
  - Skull-stripping to remove non-brain tissue,
  - Bias field correction,
  - Intensity normalization,
- Volumetric measurement,
- Surface area measurement,
- Morphological/morphometric analysis,
- Gyrification measurement and report generation.

Detailed descriptions of the above functionality are provided below.

Artifact correction

GyriCalc includes the following artifact correction functionality:

- Motion correction,
- Phase unwrapping,
- Slice timing correction,
- Intensity inhomogeneity correction,
- Distortion correction,
- Susceptibility artifact correction,

Automated segmentation

GyriCalc includes the following segmentation functionality:

- Right/Left Hemispheres (Pial) surface segmentation
- Cortical region segmentation/parcellation
  - Right/Left Superior Frontal Gyri
  - Right/Left Middle Frontal Gyri
  - Right/Left Cuneus
  - Right/Left Lingual Gyri
  - Right/Left Inferior Temporal Gyri
  - Right/Left Inferior Parietal Cortex
  - Right/Left Fusiform Gyri

Volumetric Measurement

GyriCalc includes the following volumetric measurement functionality:

- Total Cortex volume
- Right/Left Cortex volume
- Cortical region volume:
  - Right/Left Superior Frontal volume
  - Right/Left Middle Frontal volume
  - Right/Left Cuneus volume

- Right/Left Lingual volume
- Right/Left Inferior Temporal volume
- Right/Left Inferior Parietal Cortex volume
- Right/Left Fusiform volume

Morphological/morphometric analysis

GyriCalc includes surface area and gyrification index measurement functionality for the following regions of the brain

- Total Cortex
- Left/Right Cortex
- Cortical regions :
  - Right/Left Superior Frontal
  - Right/Left Middle Frontal
  - Right/Left Cuneus
  - Right/Left Lingual
  - Right/Left Inferior Temporal
  - Right/Left Inferior Parietal Cortex
  - Right/Left Fusiform

5. INDICATIONS FOR USE

GyriCalc is intended for automatic labeling, visualization, and quantification including volume, surface area and gyrification analysis (i.e., gyrification index) of segmentable brain structures from a set of MR images.

GyriCalc is intended to be used by qualified personnel and interpreted by a qualified clinician.

GyriCalc is not intended to be used for visualization or quantification of neurologic lesions.

GyriCalc is intended for children between 24 to 36 months of age.

6. SUBSTANTIAL EQUIVALENCE DISCUSSION

6.1. Device Comparison Table

Feature/Function	**GyriCalc**	**NeuroQuant (K170981) Primary Predicate Device**	**Equivalence Discussion**
Regulation Number	21 CFR 892.2050	21 CFR 892.2050	Same
Regulation Description	Medical image management and processing system	Picture archiving and communications system	Same
Classification Name	System, Image Processing, Radiological	System, Image Processing, Radiological	Same
Class	Class II	Class II	Same
Product Code	LLZ	LLZ	Same
Device Description Device type	Software medical device (SaMD)	Software medical device (SaMD)	Same- Both devices are SaMD
Physical characteristics	• Software package • Operates on off-the-shelf hardware (multiple vendors)	• Software package • Operates on off-the-shelf hardware (multiple vendors)	Same
Operating System	Client: Supports Windows 11 or MAC OS 12 Server: Ubuntu 23.04 LTS	Supports Linux, Mac OS X and Windows	Equivalent- Both the subject and predicate devices are software devices (SaMD) which run on industry standard computing hardware and Operating Systems. The GyriCalc device has been tested to confirm that it meets it's stated requirements and performs as intended on the stated operating system(s). GyriCalc does not support the Linux OS. This difference does not affect the safety or effectiveness as compared to the NeuroQuant predicate device.

Feature/Function	GyriCalc	NeuroQuant (K170981) Primary Predicate Device	Equivalence Discussion
General Device Description	Fully automated MR imaging post-processing medical device software which includes: -automatic labeling, visualization and volumetric quantification of brain structures from a set of MR images and returns segmented images and morphometric reports. (Morphometric measurements based on 3D T1 MRI series)	Fully automated MR imaging post-processing medical device software which includes: -automatic labeling, visualization and volumetric quantification of brain and lesions from a set of MR images and returns segmented images and morphometric reports. (Morphometric measurements based on 3D T1 MRI series)	Equivalent- The primary functionality is the same with the exception that the subject GyriCalc device does not include lesion labeling or volumetric quantification of such lesions. As lesion detection is not intended to be performed by GyriCalc, its absence does not affect Intended Use, safety or effectiveness comparison of the subject and predicate devices. The subject device measurements include volume, area and gyrification whereas the predicate device provides only volume measurement. The addition of area and gyrification measurements are considered technological characteristics which are supported by clinical performance testing. As the area and gyrification are also measurements, they do not add a new 'intended use' and do not affect the safety and/or effectiveness of the subject device as compared to the predicate device or raise new questions relating to safety and/or effectiveness.
Design and Incorporated Technology	- Automated measurement of brain tissue structures for volume, area and gyrification. - Automatic segmentation and quantification of brain structures using deep learning	• Automated measurement of brain tissue volumes and structures and lesions • Automatic segmentation and quantification of brain structures using a dynamic probabilistic neuroanatomical atlas, with age and gender specificity, based on the MR image intensity	Equivalent- The design and technological characteristics of the subject GyriCalc device and the predicate NeuroQuant device are equivalent. Both devices are software medical devices (SaMD) and utilize DICOM MRI images of the brain which are automatically segmented into regions and then perform measurements. The subject device measurements include volume, area and gyrification whereas the predicate device provides only volume measurement. The addition of area and gyrification are considered technologic characteristics which are supported by clinical performance testing. As the area and

Feature/Function	GyriCalc	NeuroQuant (K170981) Primary Predicate Device	Equivalence Discussion
			gyrification are also measurements, they do not add a new 'intended use' and do not affect the safety and/or effectiveness of the subject device as compared to the predicate device or raise new questions relating to safety and/or effectiveness. Differences: -GyriCalc does not include lesion quantification functionality whereas the NeuroQuant predicate does. Lesion quantification functionality is not an aspect of GyriCalc's intended use and does not affect the safety or effectiveness as compared to the predicate device. -GyriCalc's automated segmentation utilizes FreeSurfer's robust SynthSeg algorithm whereas the predicate device uses a dynamic probabalistic neuroanatomical atlas for its automated segmentation functionality. GyriCalc's segmentation results have been validated using an 'expert reader' study. Note: NEUROPHET (K220437) has been added as a Reference device to support the technological characteristic of the use of FreeSurfer for segmentation initialization. A separate comparison table is provided for the reference device. - GyriCalc does not include gender specificity. Gender specificity is not necessary for GyriCalc to perform its its intended use in a safe and effective manner. The differences do not affect the safety or effectiveness as compared to the predicate device and are supported by clinical performance testing.
Processing Architecture	Automated internal pipeline that performs:	Automated internal pipeline that performs:	Equivalent - The subject device and the predicate

Feature/Function	GyriCalc	NeuroQuant (K170981) Primary Predicate Device	Equivalence Discussion
	- artifact correction - segmentation - volume calculation - gyrification analysis - report generation	- artifact correction - segmentation - lesion quantification - volume calculation - report generation	have similar processing architectures, with the exception that the subject device also uses gyrification analysis for measuring Local Gyrification Index (LGI). This additional technological characteristic (i.e., gyrification analysis) does not raise different questions of safety and effectiveness. The functionality has been supported by performance testing. Additionally, as previously stated, GyriCalc does not include lesion quantification as it is not within the scope of its intended use/indications.
Data Source	• MRI scanner: 3D T1 MRI scans acquired with specified protocols from 1.5 and 3 Tesla MR imaging devices. • GyriCalc supports DICOM format as input	• MRI scanner: 3D T1 MRI scans acquired with specified protocols • NeuroQuant Supports DICOM format as input	Equivalent GyriCalc performance has been successfully tested on DICOM images from 1.5 and 3.0 Tesla MR imaging devices. The available information on the NeuroQuant predicate device does not appear to specify the magnet strength. However, the following note in the NeuroQuant Clinical Training material states that "Some NeuroQuant parameters vary depending on scanner manufacturer & field strength". This supports that NeuroQuant supports various magnet strengths.
Output	- Provides volumetric measurements of brain structures, including gyrification information - Includes segmented color overlays and morphometric reports - The information is provided as a .pdf report.	- Provides volumetric measurements of brain structures and lesions - Includes segmented color overlays and morphometric reports - Automatically compares results to reference percentile data and to prior scans when available - Supports DICOM format as output of results that can be displayed on DICOM workstations and	Equivalent Both the GyriCalc subject device and the NeuroQuant predicate device provide volumetric measurements of brain structures and segmented color overlays and morphometric reports. **Differences-** The GyriCalc device provides gyrification information whereas NeuroQuant does not. This additional technological characteristic (i.e., gyrification analysis) does not raise different questions of safety and effectiveness. The

Feature/Function	GyriCalc	NeuroQuant (K170981) Primary Predicate Device	Equivalence Discussion
		Picture Archive and Communications Systems	functionality has been supported by performance testing. GyriCalc does not compare results to reference percentile data and to prior scans. This functionality is not within the scope of GyriCalc's intended use/indications as GyriCalc is intended for quantification rather than comparison at this time. However, GyriCalc does include 'sample values' which are supported by the data used in the performance validation testing. GyriCalc does not output DICOM for display on PACS devices. GyriCalc's sole output is a .pdf report which can be viewed on standard .pdf reading applications or may be printed. The stated differences do not alter the intended use, safety or performance of the GyriCalc device as compared to the NeuroQuant predicate device.
Specific Device Output	Provides morphometric measurements based on 3D T1 MRI series	Provides morphometric measurements based on 3D T1 MRI series	Same
MR Scan Parameters	-Plane: Sagittal, Axial -Mode: –3D -Type: T1 weighted -Matrix: 256 x 256 -Resolution: Ideally isotropic with a voxel size of 1mm x1mm x1mm -NEX/NSA: 1 -Slice Thickness: 1 mm	Plane –sagittal Mode –3D T1 weighted Matrix –192 x 192 NEX / NSA 1 Slice thickness –1.2 mm Spacing –1.2 mm Number of slices –160 -170 FOV 24 – 25.6	Equivalent- GyriCalc's MR Scan parameters are mainly the same (equivalent) to the NeuroQuant predicates parameters. GyriCalc's parameters are consistent with optimizing the images for analysis by the GyriCalc software. However, there are potentially minor variations between the parameters of the two devices which do not alter the safety, effectiveness or performance of the GyriCalc device.
Use Cases	For use in routine patient care as a support tool for	For use in both clinical trial research and routine patient	Equivalent- GyriCalc does not explicitly intend the

Feature/Function	GyriCalc	NeuroQuant (K170981) Primary Predicate Device	Equivalence Discussion
	clinicians in assessment of structural MRIs	care as a support tool for clinicians in assessment of structural MRIs	software to be used in clinical trials or research.
Output (Brain Regions)	-Total brain -Left/Right Hemisphere (Cortex) - Left/Right Hemisphere (Cuneus) - Left/Right Hemisphere (Fusiform) - Left/Right Hemisphere (Inferiorparietal) - Left/Right Hemisphere (Inferiortemporal) - Left/Right Hemisphere (Lingual) - Left/Right Hemisphere (Middlefrontal) - Left/Right Hemisphere (Superiorfrontal)	-Total brain -Left/Right Hemisphere (Cortex) - Left/Right Occipital lobe - Left/Right Hemisphere (Fusiform) - Left/Right Hemisphere (Inferiorparietal) - Left/Right Hemisphere (Inferiortemporal) -Left/Right Hemisphere (Middlefrontal) - Left/Right Hemisphere (Superiorfrontal)	Equivalent- Both the subject GyriCalc device and the predicate NeuroQuant device segment and quantify the same structures. NeuroQuant appears to include additional brain structures in their reports which are not needed by GyriCalc to perform its intended use.
Output (Measurements)	Volume, Area, Gyrification Index	Volume	Equivalent- Both the subject GyriCalc and predicate NeuroQuant devices include volumetric measurements for the segmented brain regions. GyriCalc includes area measurements and gyrification measurements which are required for its stated intended use. The addition of area and gyrification measurements are technological differences which do not raise new questions relating to safety or effectiveness and have been successfully tested to assure accuracy.
Safety	Automated quality control functions - Tissue contrast check - Scan protocol verification - Atlas alignment check - Results must be reviewed by a qualified clinician	Automated quality control functions - Tissue contrast check - Scan protocol verification - Atlas alignment check - Results must be reviewed by a qualified physician	Same- The subject device (GyriCalc) and the predicate device (NeuroQuant) have the same automated quality control functions.

Feature/Function	GyriCalc	NeuroQuant (K170981) Primary Predicate Device	Equivalence Discussion
Report	GyriCalc results are documented in a pdf report which is available to the clinician	A report is generated Results are provided in a standard DICOM format as additional MR series that can be displayed on third-party DICOM workstations and PACS.	Equivalent- GyriCalc's sole output is a .pdf report which can be viewed digitally using standard .pdf reading software as well as can be printed if desired. GyriCalc does not provide DICOM series which can be viewed on third-party DICOM workstations and PACS as this functionality is not required for GyriCalc to perform its intended use. The absence of DICOM series output does not raise new questions relating to the safety or effectiveness of the GyriCalc device.
Cybersecurity	GyriCalc utilizes current 'state of the art' cybersecurity processes and controls which align with FDA's current guidance and recommendations.	No information is publicly available on cybersecurity.	Equivalent (or better) The K170981 submission of NeuroQuant did not contain specific information related to cybersecurity. In recent years, the requirements related to cybersecurity have greatly evolved. GyriCalc utilizes current 'state of the art' cybersecurity processes and controls which align with FDA's current guidance and recommendations.
Performance Testing	GyriCalc performance was evaluated by comparing segmentation accuracy with expert manual segmentations and by measuring segmentation reproducibility between same subject scans. The system yields reproducible results that are well correlated with computer-aided expert manual segmentations. GyriCalc's segmentation accuracy compared to expert manual segmentations of 3D T1	NeuroQuant performance was evaluated by comparing segmentation accuracy with expert manual segmentations and by measuring segmentation reproducibility between same subject scans. The system yields reproducible results that are well correlated with computer-aided expert manual segmentations. NeuroQuant's segmentation accuracy compared to expert manual segmentations of 3D T1	Equivalent The performance of GyriCalc and NeuroQuant was verified using comparison against expert manual segmentation. The results of testing have confirmed equivalent performance. GyriCalc has equivalent segmentation accuracy performance for the major cortical regions is equivalent to the NeuroQuant predicate. Note 1: GyriCalc does not perform subcortical brain structures. Note 2: NEUROPHET (K220437) has been added as a Reference device to support the technological characteristic of the use of FreeSurfer for

Feature/Function	GyriCalc	NeuroQuant (K170981) Primary Predicate Device	Equivalence Discussion
	MRI scans was evaluated using Dice's coefficient metric. The results were in the range of 92-99% with an average of 95% confidence. Volume Measurements: GyriCalc's mean percentage absolute volume difference of the major cortical regions was in the range of 0.45 -12.1 **%** Area Measurements: GyriCalc's mean absolute surface area error was in the range of 0.33 - 12.6 %. Gyrification Measurements: GyriCalc's mean absolute gyrification Index error was in the range of 0.04 - 0.89%. Description of Subjects: The imaging data was collected retrospectively from a population of anonymized patients 2-3 years (24-36 months) with curated clinical records. Safety and Effectiveness: The measurements met the predetermined acceptance criteria. Adverse Events: As the clinical performance testing was performed retrospectively on previously acquired T1 weighted MRI scans, there were no adverse events	MRI scans was evaluated using Dice's coefficient metric. For major subcortical brain structures Dice's coefficients are in the range of 80-90% and for major cortical regions are in the range of 75-85%. For lesion segmentations evaluated separately using 3D T1 and T2 FLAIR MRI scan pairs of subjects with brain lesions, Dice's coefficient exceeds 80%**.** Brain structure segmentation reproducibility of repeated 3D T1 MRI scans for same subjects was evaluated by using the percentage absolute volume differences. The mean percentage absolute volume differences for all major subcortical structures were in the range of 1-5%. Brain lesion segmentation reproducibility was evaluated separately using 3D T1 and T2 FLAIR MRI repeated scan pairs of subjects with brain lesions. The mean absolute lesion volume difference was less than 0.25cc, while the mean percentage lesion absolute volume difference was less than 2.5%.	segmentation initialization. A separate comparison table is provided for the reference device. Volume Measurements: GyriCalc performed in an equivalent manner to the NeuroQuant in terms of volumetric measurements. (Note: NeuroQuant reported on major subcortical structures rather than the major cortical structures) The NeuroQuant predicate device does not include area or gyrification measurements. These 'Technological Characteristics' are supported by the results of the clinical performance testing and do not raise new questions relating to safety and/or effectiveness as compared to the predicate device. GyriCalc does not perform lesion segmentations or quantification of lesions as this functionality is not within it's stated intended use/indications. As lesion functionality is not within GyriCalc's intended use, the lack of such functionality does not raise new questions related to safety or effectiveness of the GyriCalc device.

Feature/Function	GyriCalc	NeuroQuant (K170981) Primary Predicate Device	Equivalence Discussion
	(AEs) noted.		

7. REFERENCE DEVICE COMPARISON

(For segmentation methodology)

Feature/Function	GyriCalc	NEUROPHET (K220437) Reference Device	Equivalence Discussion
Regulation Number	21 CFR 892.2050	21 CFR 892.2050	Same
Regulation Description	Medical image management and processing system	Medical image management and processing system	Same
Classification Name	System, Image Processing, Radiological	System, Image Processing, Radiological	Same
Class	Class II	Class II	Same
Product Code	LLZ	LLZ	Same
Indications for Use	GyriCalc is intended for automatic labeling, visualization, and quantification including volume, surface area and gyrification analysis (i.e., gyrification index) of segmentable brain structures from a set of MR images. GyriCalc is intended to be used by qualified personnel and interpreted by a qualified clinician.	Neurophet AQUA is intended for Automatic labeling, visualization and volumetric quantification of segmentable brain structures from a set of MR images. Volumetric data may be	Equivalent - Both the subject device (GyriCalc) and the reference device (Neurophet AQUA) are intended to be used for automatic labeling, visualization, volumetric quantification of segmentable brain structures from a set of MR images. The subject device measurements include volume, area and gyrification whereas the reference device provides only volume measurement. The addition of area and gyrification measurements are considered technological characteristics which are supported by clinical performance testing. As the area and gyrification are also measurements, they do not add a new 'intended use' and do not affect the safety and/or effectiveness of the subject

	GyriCalc is not intended to be used for visualization or quantification of neurologic lesions. GyriCalc is intended for children between 24 to 36 months of age.	compared to reference percentile data.	device as compared to the reference device or raise new questions relating to safety and/or effectiveness. GyriCalc does not include a normative database with which to compare brain structures to 'normal' patients. This functionality is not needed as GyriCalc is intended for visualization and quantification only at this time. However, GyriCalc does include 'reference values' which are supported by the data used in the performance validation testing. For clarity, GyriCalc has added an explicit statement that the device is intended to be used by qualified personnel and interpreted by a qualified clinician. The reference Neurophet AQUA device Indications statement does not state this explicitly but it is assumed as Neurophet AQUA is an Rx only device.
Target Anatomical Sites	Brain	Brain	Same
Data Source	- MRI scanner: 3D T1 scans acquired with specified protocols - Supports DICOM format as input.	- MRI scanner: 3D T1 scans acquired with specified protocols - Supports DICOM format as input.	Same
Design and Incorporated Technology	- Automated measurement of brain tissue volumes and structures. - Automatic segmentation and quantification of brain structures using deep learning.	- Automated measurement of brain tissue volumes and structures - Automatic segmentation and quantification of brain structures using deep learning	Equivalent- Both the subject GyriCalc and Reference NEUROPHET device perform segmentation based on deep-learning methodologies whereas the Primary Predicate device utilizes a technically similar 'atlas-based' segmentation methodology. GyriCalc's segmentation accuracy compared to expert manual segmentations of 3D T1 MRI scans was evaluated using Dice's coefficient metric. The results were in the range of 92-99% with an average of 95% confidence. The results of the segmentation support that the subject GyriCalc device is as safe and effective as the reference device.

8. Summary of Technological Characteristics Comparison

GyriCalc is functionally equivalent to the primary predicate device (NeuroQuant K170981).

- Both the subject GyriCalc and predicate NeuroQuant devices are intended for automatic labeling, visualization and quantification of segmentable brain structures from a set of MR images.
- Both devices provide morphometric measurements based on 3D T1 MRI images.
- Both devices produce similar reports. The output includes volumes that have been annotated
  with color overlays, with each color representing a particular segmented region, and morphometric reports.
- Both devices utilize the same automated safety measures and have similar processing architecture.
- Both systems are used by qualified medical professionals as a support tool in assessment of structural MRIs.
- Both devices have been validated using clinical performance testing.

9. Performance Testing Summary

9.1. Software Verification and Validation

Software verification and validation testing were conducted, and documentation was provided as recommended by 2023 FDA Guidance “Content of Premarket Submissions for Device Software Functions”.

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

As the intended use, functionality and performance of the subject device and the predicate device are equivalent, the result of the performance testing is evidence that the GyriCalc performs in an equivalent manner to the NeuroQuant.

9.2. Clinical Performance Assessment

The performance of GyriCalc and NeuroQuant was verified using comparison against expert manual segmentation as well as measuring segmentation reproducibility between same subject

scans. GyriCalc's segmentation accuracy compared to expert manual segmentations of 3D T1 MRI scans was evaluated using Dice's coefficient metric. The results were in the range of 0.92-0.99 with an average of 0.95 confidence.

Volume Measurements:
GyriCalc's mean percentage absolute volume difference of the major cortical regions was in the range of 0.45 -12.1 **%**

Area Measurements:
GyriCalc's mean absolute surface area error was in the range of 0.33 - 12.6 %.

Gyrification Measurements:
GyriCalc's mean absolute gyrification Index error was in the range of 0.04 - 0.89%.

9.2.1. Patient Population & Imaging Characteristics

The dataset used in the clinical performance assessment consisted of 82 T1 head MRIs from 82 patients with ages ranging from 24 to 36 months with normal-appearing brains. This dataset represents a new, independent sampling of patients that were not involved in the development of the device.

Patient Characteristic	**Count**
Patient Sex	
Male	57
Female	25
Patient Age (months)	
24-27	18
27-30	24
30-33	16
33-36	24
Location	

Patient Characteristic	Count
U.S.	54
Brazil	28

Imaging Characteristics	
Magnetic Field Strength	**Count**
1.5 T	67
3.0 T	15
Manufacturer	**Count**
Philips	25
GE	56
SIEMENS	1
Voxel Spacing (mm)	**Median [Range]**
Pixel Spacing X	0.45 [0.35, 1.25]
Pixel Spacing Y	0.45 [0.35, 1.30]
Slice Thickness	3.00 [0.99, 5.00]
Slice Count	48 [24, 341]

Because MR imaging of healthy patients in the age range 24-36 months is rare, all patients selected had normal-appearing brains as described in radiological reports. Patients with traumatic brain injury, post-surgical changes, or brain lesions were excluded. The following tables summarize the reasons patients underwent an MRI study and the radiological findings/potential confounders for patients in the test dataset.

Reason for MRI	Count *
Not specified	29

Reason for MRI	Count *
Seizure(s)	20
Developmental Delay	14
Episode of altered mental status	3
Epilepsy	2
Estropia	2
Vomiting	2
Weakness/Lethargy	2
Ataxia, exotropia, headaches, macrocephaly, microcephaly, optic nerve hypoplasia, orbital mass, spastic hemiparesis, nystagmus, spastic diplegia, suspected pituitary disorder	11 (1 for each)

* some patients with multiple reasons for MRI

Radiological Findings/Potential Confounders	Count *
None/Not Specified	23
Seizure(s)/Epilepsy	22
Sinus Inflammation/Infection	19
Developmental Delay	14
Premature Birth	4
Diminutive Pituitary	2
Eye Disorder	5
Movement Disorder	5
Asymmetry of hippocampus, benign ventricular cyst, ear infection, focal cortical displasia, hyperthyroidism, macrocephaly, microcephaly, neonatal infarction, orbital dermoid	9 (1 for each)

* some patients with multiple radiological findings/potential confounders

9.2.2. Reference Standard

Each image was annotated independently by 3 experts. A total of 6 experts in two groups of three were used to establish the reference segmentations of the brain:

- Group 1: 32 cases annotated. Consisted of two U.S-based neuroradiologists and one U.S.-based neuroimaging consultant PhD.
- Group 2: 50 cases annotated. Consisted of three U.S.-based neuroradiologists.

For each brain MRI, the expert used an annotation platform to view the image series and a pre-loaded initialization of 16 subregions of the brain. The expert then reviewed the initial segmentation and edited the segmentations as necessary for accuracy.

The segmentations of the 3 experts where then combined to produce a single segmentation using the STAPLE method. Reference measurements (i.e., volume, surface area, and local gyrification index) were derived from the combined segmentation.

9.3. Results

The average Dice score between the predicted volumes of brain subregions and the reference volumes ranged from 0.92 to 0.99, with an average of 0.95 for all regions. The region with the lowest average Dice score was the left inferior parietal gyrus (0.92 [0.90, 0.94]).

The mean absolute errors for volume, surface area, and gyrification index for each of the specified regions of the brain are reported below.

Structure/Region	Mean Absolute Volume Error	Mean Absolute Surface Area Error	Mean Absolute Gyrification Index Error
Total Cortex Left Cortex Right Cortex	2.14% [1.66%, 2.61%] 2.41% [1.81%, 3.01%] 1.88% [1.49%, 2.28%]	N/A*	N/A*
Superior Frontal Left Right	 0.48% [0.25%, 0.72%] 0.59% [0.31%, 0.87%]	 0.46% [0.17%, 0.76%] 0.63% [0.21%, 1.05%]	 0.04% [0.02%, 0.05%] 0.04% [0.02%, 0.05%]
Middle Frontal Left Right	 0.51% [0.29%, 0.72%] 0.45% [0.29%, 0.60%]	 0.49% [0.08%, 0.91%] 0.33% [0.16%, 0.49%]	 0.05% [0.03%, 0.06%] 0.04% [0.03%, 0.05%]

Structure/Region	Mean Absolute Volume Error	Mean Absolute Surface Area Error	Mean Absolute Gyrification Index Error
Fusiform			
Left	1.44% [0.74%, 2.14%]	1.40% [0.48%, 2.32%]	0.07% [0.05%, 0.10%]
Right	1.37% [0.66%, 2.08%]	1.30% [0.47%, 2.13%]	0.08% [0.04%, 0.12%]
Inferior Temporal			
Left	1.11% [0.71%, 1.51%]	1.14% [0.62%, 1.67%]	0.12% [0.06%, 0.17%]
Right	1.05% [0.59%, 1.52%]	1.09% [0.56%, 1.61%]	0.12% [0.06%, 0.17%]
Inferior Parietal			
Left	12.10% [8.44%, 15.77%]	12.58% [8.72%, 16.43%]	0.89% [0.56%, 1.22%]
Right	7.88% [5.68%, 10.07%]	8.42% [5.98%, 10.86%]	0.49% [0.32%, 0.67%]
Lingual			
Left	4.92% [3.85%, 6.00%]	5.70% [4.11%, 7.29%]	0.32% [0.23%, 0.41%]
Right	4.46% [3.59%, 5.33%]	5.45% [4.09%, 6.80%]	0.49% [0.35%, 0.63%]
Cuneus			
Left	10.75% [8.50%, 13.00%]	11.64% [8.75%, 14.54%]	0.48% [0.32%, 0.65%]
Right	10.18% [7.79%, 12.57%]	11.28% [8.51%, 14.05%]	0.50% [0.36%, 0.64%]

* identical surfaces, so the error is zero

The pre-specified acceptance criteria for volume, surface area, and gyrification index errors was below 10%. The total cortex, superior frontal, middle frontal, fusiform, inferior temporal, and lingual regions met the expected performance thresholds.

Two regions exceeded the stated thresholds. For the inferior parietal gyrus (left), the average volume error was 12.10% [8.44%, 15.77%] and the average surface area error was 12.58% [8.72%, 16.43%]. For the cuneus (left & right): the average volume error was 10.75% [8.50%, 13.00%] and 10.18% [7.79%, 12.57%] for the left and right, respectively, and the average surface area error was 11.64% [8.75%, 14.54%] and 11.28% [8.51%, 14.05%] for the left and right, respectively. All regions met the expected performance thresholds for gyrification index error.

10. CONCLUSION

- GyriCalc has the equivalent indications for use and intended use as NeuroQuant.
- Both devices have similar technological characteristics as they are both automatically label, visualize, and quantify segmentable brain structures from a set of MR images.

- Any differences in technological characteristics between both devices, such as the addition of area measurements and gyrification analysis, do not raise different questions of safety and effectiveness. The GyriCalc subject device has also undergone successful verification and validation testing, which supports the safe and effective performance of the device.

These similarities support the substantial equivalence of GyriCalc to the predicate NeuroQuant device.